AN ANALOGUE STUDY OF LOVING-KINDNESS MEDITATION AS A BUFFER AGAINST SOCIAL STRESS

by

Rita W. Law

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As members of the Dissertation Committee, we certify that we have read the dissertation prepared by Rita W. Law entitled An Analogue Study of Loving-Kindness Meditation as a Buffer against Social Stress and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy

____Date:
David A. Sbarra

____Date:
Varda Shoham

____Date:
Richard R. Bootzin

____Date:
Jeff Greenberg

Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copies of the dissertation to the Graduate College.

I hereby certify that I have read this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

____ Date:
Dissertation Director: David A. Sbarra

STATEMENT BY AUTHOR

SIGNED: Rita W. Law

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DEDICATION

I dedicate this dissertation to…

… my late father, Sun-Wah Law, who had a kind heart and a generous spirit,

… my mother, Yuk-Ha Chan, who taught me unconditional love, forgiveness, and patience,

… my twin sister, Jasper Law, who has been a great companion since the day I was born,

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ABSTRACT

Loving-kindness meditation (LKM) has the potential to improve intrapersonal and interpersonal functioning. This unique quality of LKM makes it a desirable candidate for buffering the stress of being social evaluated or socially excluded. Using the Trier Social Stress Test and the Cyberball social exclusion paradigm, the present study investigated the effectiveness of a brief LKM session in buffering against social evaluative and social exclusion stress. Three specific questions were addressed: In what domains can LKM exert positive effects? For whom does it work? And, how does it work? One hundred and thirteen participants (N = 113, 49 men) were randomly assigned to either a 10-minute LKM session or a 10-minute visualization control session. Findings showed that even just 10 minutes of LKM had an immediate relaxing effect as evidenced by increased respiratory sinus arrhythmia (RSA), an index of parasympathetic cardiac control, and decreased respiration rate. In addition, the brief LKM intervention led to greater implicit positivity towards the self relative to the control intervention (p = .052). The brief LKM intervention also protected against some of the negative physiological and psychological effects of social stress. The majority of these effects are moderated by trait social anxiety and pre-meditation mood states (or pre-meditation mood state alone). Contrary to expectation, trait social anxiety alone did not moderate any of the LKM effects. Importantly, receiving a brief session of LKM while *not* being in a positive mood or being in a negative mood led to iatrogenic physiological and psychological effects. Providing an explanation for one of LKM's effects, findings showed that change in RSA during LKM fully mediated the LKM Intervention *x* Positive Affect interaction effect on

change in post-social-stress RSA. In conclusion, findings of the present study have extended our understanding of LKM and have specific implications for future research and practice.

1. BACKGROUND AND RATIONALE

Loving-Kindness Meditation

Loving-kindness meditation (LKM) is a Theravada Buddhist tradition that aims to cultivate loving-kindness (or *metta* in Sanskrit), which refers to the wish of well-being and happiness for oneself and others. It is among the meditative practices developed to counteract self-centered tendencies and to prime behaviors compatible with a benevolent attitude (Gethin, 1998). Unlike other forms of focused attention meditation, LKM is unique in that it requires a focus on specific intentions of good will rather than on one's breathing or a mantra. According to Buddhist teachings, loving-kindness can overcome feelings of separateness between the self and others and bring about a realization of connectedness (Salzberg, 1995). A series of recent empirical studies on LKM lends support to these ideas. For example, a laboratory-based study showed that even just seven minutes of LKM increased feelings of social connection and positivity towards strangers on both implicit and explicit levels (Hutcherson, Seppala, & Gross, 2008). Ninety-three non-meditators were randomly assigned to one of two guided visualization tasks: LKM or imagery induction. In the LKM condition, participants were asked to imagine two loved ones standing to either side of them and sending them love for four minutes. In the imagery induction condition, participants first imagined two acquaintances for whom they did not have strong feelings standing to either side of them for four minutes. All participants were then asked to open their eyes and to look at a photograph of one of the strangers. Participants in the LKM group reported feeling significantly more connected, similar, and positive toward a target stranger as well as non-target strangers. Furthermore, the findings extended beyond self-report: The LKM group's implicit evaluative responses towards the target stranger also became significantly more positive.

Using a more extensive, seven-week training program, Fredrickson, Cohn, Coffey, Pek, and Finkel (2008) showed that LKM produced positive changes in both self and other perceptions. Participants were randomly assigned to either the LKM training group or a waitlist control group (n = 139). The LKM training was provided by a stress-management specialist with extensive experience practicing and teaching LKM and included the following: six 60-minute group sessions with 20 to 30 participants per group and home practice of guided meditation following a CD (five days per week for seven weeks). Over the course of training, participants gradually moved from directing love and compassion to self, to loved ones, to acquaintances, to strangers, and finally to all living beings. Results showed that LKM produced significant increases in a wide range of personal resources including self-acceptance, perceived positive relations with others, and perceived social support received from others. Consistent with these findings, two studies of the eight-week mindfulness-based stress reduction (MBSR) program that included an additional LKM component showed significant increases in self-compassion (Shapiro, Astin, Bishop, & Cordova, 2005; Shapiro, Brown, & Biegel, 2007) and empathy (Shapiro, Schwartz, & Bonner, 1998). Supporting the idea that LKM increases empathy, Lutz et al. (2008) found that a loving-kindness-compassion meditation state was associated with greater activation in anterior insula and anterior cingulate cortex—brain regions that have been linked to emotion sharing or empathy for others' suffering (Singer et al., 2004).

Despite recent efforts to understand the effects of LKM and relatively consistent findings regarding its positive effects on intrapersonal and interpersonal functioning, a number of important questions remain open for study. In most respect, these questions take the form of questions that we ask about any psychological intervention. Specifically, in what situations can LKM exert positive effects? What are these effects? For whom does it work? And how does it work? In other words, in what types of situations is LKM an effective intervention? What kinds of benefits does LKM offer? Do these effects apply to everyone or do pre-existing individual difference variables condition, or limit, LKM's effectiveness? What are the mediating processes that explain these effects? To fill in the literature gap regarding these important questions about LKM, the present study investigates whether experimentally inducing a loving-kindness state of mind (LKSM) can alleviate stress in two different types of social situations, namely, social evaluation and social exclusion. Based on the idea that LKM induces changes in people's attitudes towards the self and others within a short time frame (see Hutcherson et al., 2008), I will use a brief LKM session that is designed to induce short-term changes in attitudes and behaviors that would, to a certain extent, be consistent with the expected long-term effects of sustained LKM practice. Specifically, I examine whether a brief LKM session can ameliorate the effects of social stress on autonomic reactivity, affective reactivity, stress level, feelings of negative evaluations, mood, fulfillment of psychological needs, self-regulation, and prosocial behavior. In addition, the role of social anxiety as a potential moderating variable is examined. Finally, to explain the effects of LKM, the potential mediating roles of cognition and physiology are tested.

What is Social Stress?

Before discussing why LKM may alleviate social stress, it is important to provide a concrete definition of social stress. Integrating interruption theory from stress research (Mandler, 1982) and identity theory from social psychological research (Carver & Scheier, 1981), Burke (1991) put forward a comprehensive model that explains the mechanisms of social stress. According to Burke (1991), social stress results when there is an interruption to the identity control system, which operates to maintain a homeostasis between the input from one's social environment and one's internal identity standards. These standards are "a set of meanings applied to the self in a social role or situation defining what it means to be who one is" (Burke, 1991, p. 837). Once an identity is activated, a feedback loop that continuously compares one's input (i.e., perceived self-meanings or reflected appraisals in the social setting) with one's identity standard is established. As the degree of incongruence between the two increases, autonomic activity (experienced as distress) also increases, prompting an output of behaviors that are aimed to reduce the incongruence by altering the input. However, if a person is prevented from outputting behaviors that can reduce the incongruence, an "interruption" to the continuously adjusting identity processes is said to have occurred, leading to social stress. As evidence for this idea, Burke (1991) cites research by Harvey, Kelley, and Shapiro (1947) who found that college students who received unfavorable personal evaluations from their peers experienced "tension" to the extent the received ratings differed from their self-ratings. Subsequent research also supports the distressing effects of incongruence (e.g., Deutsch & Soloman, 1959; Swann, Hixon, Stein-Seroussi, & Gilbert, 1990). In sum, social stress is the result of an interrupted identity process that arises when the discrepancy between one's perceived self and one's internal standards cannot be reduced.

What are the Potential Consequences of Social Stress?

Certain social situations, such as social evaluation and social exclusion, are particularly stressful and may have implications for both psychological and physical health. Research on social stress has used a standardized procedure called the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993)—a laboratory analogue task that is presumed to activate feelings of social evaluation in a manner that approximates how social evaluative processes operate outside of the laboratory (Dickerson & Kemeny, 2004). Using the TSST, researchers have shown that acute social evaluative stress is linked to increased shame or embarrassment, decreased social self-esteem (Gruenewald, Kemeny, Aziz, & Fahey, 2004), decreased self-esteem (Bosch et al., 2009), increased negative mood or negative affect (Bosch et al., 2009; Izawa et al., 2008; Schoofs, Preuß, & Wolf, 2008; Wolf, Minnebusch, & Daum, 2009), impaired executive functioning (Scholz et al., 2009), impaired working memory (Schoofs et al., 2008), impaired declarative memory performance (Kirschbaum, Wolf, May, Wippich & Hellhammer, 1996), impaired recognition performance for positive stimuli (Domes, Heinrichs, Rimmele, Reichwald, & Hautzinger, 2004), impaired memory retrieval for emotionally arousing material (Kuhlmann, Piel, & Wolf, 2005), impaired ability to acquire a simple conditioned motor response (Wolf et al., 2009), increased heart rate (Bosch et al., 2009; Gallo, Smith, & Kircher, 2000), decreased preejection period (indicative of increased sympathetic activity), increased heart rate variability (indicative of decreased parasympathetic activity) (Bosch et al., 2009), increased diastolic and systolic blood pressure (Gallo et al., 2000), increased salivary alpha-amylase (sAA; a marker of autonomic nervous system activity) (Nater et al., 2005; Schoofs et al., 2008), increased adrenocorticotropic hormone (ACTH; a key component of the hypothalamic-pituitary-adrenal axis) (McRae, Saladin, Brady, Upadhyaya, Back, & Timmerman, 2006), increased cortisol (Bosch et al., 2009; Gruenewald et al., 2004; McRae et al., 2006; Schoofs et al., 2008; Wolf et al., 2009), increased proinflammatory cytokine activity (Dickerson, Gable, Irwin, Aziz, & Kemeny, 2009), and a modest increase in alcohol consumption in healthy, non-problem social drinkers (de Wit, Söderpalm, Nikolayev, & Young, 2003). Overall, acute social evaluative stress impacts the autonomic, endocrine, and immune systems in a manner that has distinct negative implications for both psychological and physical health (see Foley & Kirschbaum, 2010 and Kemeny, 2009 for reviews).

Another social situation that can take a toll on health is social exclusion, or ostracism, which occurs when a person is being excluded from surrounding social interactions and made to feel invisible or non-existent. Substantial evidence demonstrates the adverse effects of social exclusion on both intrapersonal and interpersonal levels (see Williams, 2007 for a review). These effects include increased cortisol (Blackhart, Eckel, & Tice, 2007; Stroud, Salovey, & Epel, 2002), reduced positive affect (see Blackhart, Nelson, Knowles, & Baumeister, 2009 for a meta-analytic review), reduced fulfillment of primary needs including belonging, control, self-esteem, and meaningful existence

(Williams, Cheung, & Choi, 2000; Zadro, Williams, & Richardson, 2004), increased conformity behavior (Williams et al., 2000), impaired self-regulation (Baumeister, DeWall, Ciarocco, & Twenge, 2005), numbness to physical pain and emotions (DeWall & Baumeister, 2006), less empathy for others (DeWall & Baumeister, 2006; Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007), less prosocial behavior (Twenge et al., 2007), and increased aggression (Twenge, Baumeister, Tice, & Stucke, 2001). In addition, being ostracized elicits brain activations that are consistent with the emotional reactions to physical pain. Using a standardized ostracism paradigm named Cyberball (wherein a participant ostensibly gets excluded by other players in an online ball-tossing game; Williams et al., 2000; Williams & Jarvis, 2006) and functional magnetic resonance imaging (fMRI), Eisenberger, Lieberman, and Williams (2003) found that feelings of being socially excluded are associated with activations in the same brain regions that get activated during the experience of physical pain. Finally, studies of long-term ostracism reveal its contribution to violence against self and others, including both suicidal (Williams & Zadro, 2001) and homicidal behaviors (Leary, Kowalski, Smith, & Phillips, 2003).

Why are Social Evaluative and Social Exclusion Situations Particularly Stressful?

According to Burke's (1991) integrative model of social stress, social evaluative situations are particularly stressful because normal identity processes are more likely to be interrupted in these situations. Several characteristics of social evaluative situations contribute to the higher probability of interruptions: (1) Lack of immediate feedback—many social evaluative situations (such as exams, interviews, competitions, and performances) do not provide immediate feedback that allows for the continuous process of input-standard comparison; (2) Lack of control over input— in certain social situations, an individual's behavior has little or no effect on the evaluative input. For instance, in stress interviews or the TSST, the interviewers or judges behave in the same reserved manner regardless of what the interviewee or participant does, making it impossible to reduce any perceived incongruence; and, (3) An over-controlled identity system—in the face of an impending evaluation, one may tighten the control system for the identity being evaluated in order to make sure performance is up to internal standards. A tightened control system means more frequent monitoring and adjustments, which requires more conscious attentional resources. However, because conscious attentional resources are limited, a tightly controlled identity can lead to frequent interruptions of the normal identity processes. According to Burke's (1991) model, any type of interruptions to the normal continuous identity processes is responsible for the feelings of distress in social evaluative situations.

Although Burke (1991) did not discuss social exclusion per se in his discussion of social stress, the above mechanisms can certainly be extrapolated to the experience of being socially excluded. Take the Cyberball social exclusion paradigm as an example: When the participant is ignored by the other players who do not pass the ball to him or her, the participant gets no feedback as to why he or she is being excluded, which creates a discrepancy between input (e.g., "I am excluded because there's something they don't like about me") and one's internal standards (e.g., "I am a worthwhile person if other people accept me"). In an attempt to reduce the discrepancy (and thus distress), the participant makes attributions based on the type of information that is known to the other players. As evidence for this, research shows that the type of information known to other players during Cyberball affects how long participants would experience distress (Wirth & Williams, 2009). Specifically, when participants' permanent group membership (i.e. gender) vs. temporary group membership (i.e., an assigned color that was different than the other players') was known to other players during Cyberball, participants took longer to recover from the ostracizing experience. In addition to getting no feedback from other players, Cyberball participants also have no control over other players' behaviors; regardless of what the participant does, the other players pass the ball between themselves and exclude him or her, which makes it impossible for the participant to affect the input in the identity control system. Furthermore, as a result of the ostracizing experience, the participant may start to tighten the identity control system, which leads to more frequent interruptions of the normal identity processes. In sum, just like social evaluative situations, Cyberball, or any other ostracizing situations, can create social stress due to a lack of immediate feedback, a lack of control over input, and an over-controlled identity system.

The "What" Question: Can LKM Buffer against Social Stress?

As Blumer (1962) and Burke (1991) pointed out, identities are "processual," meaning they are not fixed states or traits. Rather, they are continuous feedback processes that are open to changes in input (perceived self-meanings), output (behavioral modifications), how tightly controlled the identity system is, and at times, how the identity standards are set. Moreover, these processes depend on which identity is activated in the situation and whether that identity is important to the individual. In other words, a variety of intrapersonal and interpersonal factors go into the homeostatic balance of the identity control system. What makes LKM a desirable candidate for buffering against social stress is its potential in reducing interruptions in the identity processes by modifying both intrapersonal and interpersonal factors that can affect the feedback loop.

Because input involves the individual's perception of how he or she is doing as well as the individual's perception of how others perceive his or her self, LKM may enhance input in two different ways. First, the increased levels of self-acceptance (Fredrickson et al., 2008) and self-compassion (Shapiro et al., 2005; Shapiro et al., 2007) that are achievable through LKM can improve perceptions of one's self, thereby enhancing perceived self-meanings. Second, the increased levels of positivity towards others (Hutcherson et al., 2008), perceived positive relations with others, and perceived social support from others (Fredrickson et al., 2008) that are achievable through LKM can improve the perception of others and the perception of others' evaluations, which also enhances perceived self-meanings. Additionally, because LKM involves sending good thoughts to friends, family, and all beings in this world, it may prime the activation of the "friend," "family member," or "human being" identity over identities that have more tangible and more competitive standards. In sum, LKM may reduce interruptions in the identity processes, and thus reduce social stress, by enhancing the input and changing the type of identity being activated. Consistent with the notion that LKM can reduce social stress, Pace et al. (2009) found a significant correlation between amount of compassion meditation[1] practiced and decreased TSST-induced distress and proinflammatory cytokine (interleukin 6) among college students. In the present study, I seek to examine whether a brief session of LKM can ameliorate the effects of social evaluative and social exclusion stress on autonomic reactivity, affective reactivity, stress level, feelings of negative evaluation, mood, fulfillment of psychological needs, self-regulation, and prosocial behavior.

The "For Whom" Question: Social Anxiety as a Potential Moderating Variable

In addition to addressing the "What" (situations and outcomes) question, the present study also addresses a "For Whom" question by asking whether the buffering effects of LKM in socially stressful situations would be less pronounced among individuals high in trait social anxiety. Socially anxious individuals are characterized by unrealistically high standards for social performance (Clark & Wells, 1995) and the tendencies to underrate their performance (Clark & Arkowitz, 1975; Lundh & Sperling, 2002; Rapee & Lim, 1992; Stopa & Clark, 1993), expect negative evaluations (Leary, Kowalski, & Campbell, 1988; Winton, Clark, & Edelmann, 1995), view feedback as more negative, and recall an excess of negative feedback (O'Banion & Arkowitz, 1977). When entering social situations, socially anxious individuals tend to shift attention toward the self and increase withdrawal behavior, which prevents them from attending to

[1]The six-week meditation training program used in this study was derived from a Tibetan Buddhist tradition (called Tibetan lojong; The Dalai Lama, 2001) and included sending feelings of love to an ever expanding circle of people beginning with the self, a practice that is similar to that of LKM. One major difference between LKM and Tibetan lojong, however, is that Tibetan lojong also utilizes a cognitive, analytic approach to challenge unexamined thoughts and feelings towards other people. Prior to the cognitive training and the compassion practice, participants in the training program used in this study were also given training in concentrative and mindfulness practices.

the external environment and seeking information that may disconfirm negative beliefs and alleviate associated anxiety (Wells, 1998). Consistent with their general expectation of negative evaluations by others, socially anxious individuals also assume that other people will judge their perceived symptoms of anxiety negatively (Clark & Wells, 1995).

Supporting the idea that socially anxious individuals experience more distress in stressful social situations, Condren, O'Neill, Ryan, Barrett, and Thakore (2002) found that a social stressor consisting of a mental arithmetic task and a short-term memory test in front of three observers elicited a greater cortisol response in patients with social phobia than in controls. Although the same heightened cortisol response to social stress was not found among socially anxious individuals in non-clinical samples (Shirotsuki et al., 2009; Takahashi et al., 2005), socially anxious college students show more autonomic reactivity (Takahashi et al., 2005) and tension anxiety (Shirotsuki et al., 2009) in response to the TSST.

In addition to struggling when faced with social evaluative stress, socially anxious individuals are also more vulnerable to the stress of social exclusion. Using the Cyberball social exclusion paradigm, Oaten, Williams, Jones, and Zadro (2008) found that while all ostracized participants reported higher felt ostracism and showed diminished self-regulatory behavior compared to non-ostracized participants, only socially anxious participants in the ostracized group continued to report felt ostracism and show diminished self-regulation 45 minutes after the ostracizing experience. Consistent with these findings, Zadro, Boland, and Richardson (2006) showed that while both high socially anxious and low socially anxious participants showed diminished primary needs (belonging, control, self-esteem, and meaningful existence; Williams, 2001) after the Cyberball game, only high socially anxious participants showed delayed recovery in these needs 45 minutes after the ostracizing experience.

Apart from being more vulnerable to social stress, socially anxious individuals may also have more difficulties engaging in LKM, which is social in nature and requires sending love and kindness to oneself and others. In particular, due to the predominance of negative self-statements (Cacioppo, Glass, & Merluzzi, 1979; Dodge, Hope, Heimberg, & Becker, 1988; Glass, Merluzzi, Biever, & Larsen, 1982) and the tendency to socially withdraw (Wells, 1998), sending positive thoughts and feelings to oneself and others may be unfamiliar to socially anxious individuals. Overall, as a result of a greater reactivity to social stress and a reduced ability to engage in LKM, the effects of LKM in buffering against social stress, at least in the short term, may be less pronounced among socially anxious individuals.

The "How" Question: Cognition and Physiology as Potential Mediating Processes

The final question addressed in the present investigation concerns the potential mediating mechanisms that may link LKM with positive outcomes. I examine two major categories of mediators: (1) Cognition—As explained earlier, one of the reasons why LKM is a desirable candidate for alleviating social stress lies in its potential in improving perceptions of the self and others. Therefore, it is plausible that these improved interpersonal cognitions represent one of the mediating pathways that explain the buffering effects of LKM ; and, (2) Physiology—Supporting Burke's (1991) idea that social distress is heightened autonomic activity experienced as distress, research finds evidence of increased autonomic reactivity in response to social stressors (e.g., Blackhart et al., 2007; Bosch et al., 2009; Gallo et al., 2000; Gruenewald et al., 2004; McRae et al., 2006; Nater et al., 2005; Schoofs et al., 2008; Stroud et al., 2002; Wolf et al., 2009). The close connection between social stress and autonomic activity raises the possibility that an overall reduction of autonomic activity through LKM may reduce both physiological and psychological reactivity to social stressors. In the present study, autonomic activity is assessed through skin conductance, heart rate, and respiratory sinus arrhythmia, and their potential mediating roles in the buffering effects of a brief LKM session are examined.

Respiratory sinus arrhythmia (RSA) as a potential mediating variable. Among the three candidate physiological mediators, there is reason to believe that RSA would be especially associated with LKM and, in turn, the positive outcomes associated with inducing this state of mind. RSA refers to the rhythmic fluctuations in heart rate that are associated with breathing. Determined largely by vagal influences on the heart, RSA is considered a noninvasive index of parasympathetic activity (Berntson, Cacioppo, & Quigley, 1993; Grossman & Kollai, 1993; Grossman & Taylor, 2007). In the past two decades, an increasing volume of theory and research has linked RSA to emotional reactivity and emotion regulatory efforts (Beauchaine, 2001; Demaree, Robinson, Everhart, & Schmeichel, 2004; Diamond & Hicks, 2005; Fabes & Eisenberg, 1997; Frazier, Strauss, & Steinhauer, 2004; Kettunen, Ravaja, Naatanen, & Keltikangas-Jarvinen, 2000; Porges,1995a, 1995b; Porges, Doussard-Roosevelt, & Maiti, 1994; Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996; Thayer & Lane, 2000). Despite mixed findings regarding the exact role of RSA in emotional responding, two major hypotheses organize much of the work in this area (see Butler, Wilhelm, & Gross, 2006). The first hypothesis predicts that individuals with a higher level of resting RSA, which is purported to index the capacity for the autonomic nervous system to respond flexibly, will have greater emotional reactivity (e.g., Porges, 1995b; Porges et al., 1994, 1996; Thayer & Lane, 2000). The second hypothesis predicts that acute within-person changes in RSA are associated with emotion regulatory efforts and mood state (e.g., Beauchaine, 2001; Frazier et al., 2004; Porges, 1995b, 2003; Porges et al., 1996; Thayer & Lane, 2000); more specifically, whereas increases in RSA are associated with self-regulatory efforts that facilitate engagement or relaxation and are accompanied by positive mood states, decreases in RSA are associated with self-regulatory efforts that facilitate fight-or-flight activation and are accompanied by negative mood states (Beauchaine, 2001; Porges, 1995b; Thayer & Lane, 2000).

The present study investigates changes in RSA as a potential mediating variable in the buffering effects of LKM. Two different baselines will be obtained. First, as researchers of RSA agree that RSA is a valid indicator of phasic vagal modulation of heart rate only when respiratory parameters are equated across participants (e.g., Grossman & Kollai, 1993; Grossman & Taylor, 2007; Hayano et al., 1991), the present study obtains the first RSA baseline using a two-minute paced breathing task that limits respiratory variability across participants (e.g., Butler et al., 2006). In addition to putting the participants on the same respiratory cycle, the paced breathing task also slows breathing to .15 Hz, which facilitates the measurement of the maximal level of vagal capacity. Second, to measure baseline RSA without limiting respiration, a four-minute video of nature scenes with a relaxing music background is used to ensure an adequate level of attentional deployment. Finally, as RSA is strongly influenced by respiration rate (Berntson et al., 1993; Grossman & Kollai, 1993; Grossman et al., 1990; Houtveen et al., 2002), respiration rate is measured throughout the entire physiological data collection period.

The Present Study

Main hypotheses. The present study investigates the effectiveness of a brief LKM session for alleviating the physiological, psychological, and behavioral sequelae of two different types of social stress. The first type of social stress, i.e., social evaluation, will be induced through the public speaking portion of the TSST (Kirschbaum et al., 1993). The second type of social stress, i.e., social exclusion, will be induced through the Cyberball social exclusion paradigm (Williams et al., 2000; Williams & Jarvis, 2006). The intervention—a 10-minute audio with instructions for LKM or a 10-minute audio with control instructions—will be administered immediately before each of the social stress tasks. I predict that, compared to control participants, participants in the LKM condition will show (1) greater decreases in SC and HR from baseline to audio, less decrease in RSA from paced breathing baseline to audio (indicating less decrease in vagal capacity for autonomic responses), and greater increase in RSA from nature video baseline to audio (indicating an increase in parasympathetic cardiac control); (2) more positivity towards self or others and less negativity towards self or others following the intervention; (3) less increase in affective intensity, less decrease in positive affect, less subjective stress, less feelings of being negatively evaluated, less anger, more enjoyment, and less need depletion (including belonging, control, self-esteem, and meaningful existence) during the social stress task; (4) less increases in SC and HR from baseline to the post-social-stress task recovery period, less reduction in RSA from the paced breathing baseline to the post-social-stress-task recovery period (indicating less decrease in vagal capacity for autonomic responses), and less reduction in RSA from the nature video baseline to the post-social-stress task recovery period (indicating less reduction in parasympathetic cardiac control); and, (5) a greater degree of self-regulation (as indexed by Stroop performance) and more prosocial behavior (as indexed by number of laboratory experiments volunteered to participate in) after the recovery period. Type of social stress task (SST) and sex are not expected to moderate the effects of the LKM vs. Control Intervention (LKM Intervention hereafter) on any of the outcome variables.

With regard to the "For Whom" question, it is expected that the buffering effects of a brief LKM session will be less pronounced among those high in trait social anxiety. Accordingly, I predict a LKM Intervention *x* Social Anxiety interaction, such that buffering effects of a brief LKM session on the outcomes above will be weaker among those who are more socially anxious. Finally, I address the "How" question by examining two groups of potential mediational pathways that may explain the LKM Intervention main effects and/or the LKM Intervention *x* Social Anxiety interaction effects. These putative mediational pathways include: (1) physiological indices of reduced autonomic reactivity and/or increased autonomic flexibility during the LKM intervention (as indexed by reduced SC, reduced HR, less reduction in RSA from paced breathing baseline to audio, and/or increased RSA from nature video baseline to audio); and (2) improved interpersonal cognitions following LKM (as indexed by more positivity toward the self or others and less negativity towards the self or others). Accordingly, for each significant LKM Intervention main effect and for each putative mediator, I predict a mediation effect (Baron & Kenny, 1986) on the outcome variable in which the main effect of the LKM Intervention is at least partially explained by the putative mediator. Furthermore, for each significant LKM Intervention *x* Social Anxiety interaction effect and for each putative mediator, I predict a mediated moderation effect (Preacher, Rucker, & Hayes, 2007) on the outcome variable in which the interaction effect of LKM Intervention *x* Social Anxiety is at least partially explained by the putative mediator.

Exploratory research questions. To provide more information about the "For Whom" question and, possibly, the "How" question, I will also examine the potential moderating roles of mood states, in conjunction with trait social anxiety, in the buffering effects of LKM. As previous research shows that positive affect and negative affect are independent constructs that represent two different activation systems of affect (e.g., Watson, Wiese, Vaidya, & Tellegen, 1999), their potential roles in the buffering effects of LKM will be considered separately. First, being in a positive mood state can broaden one's attention and thinking (Fredrickson, 1998) and create an openness to attitude change (Petty, Schumann, Richman, & Strathman, 1993). Thus, it is plausible that individuals who are in a more positive mood state would be more open to participating in LKM, which, in turn, may lead to a stronger LKSM and greater buffering effects. This may be especially true for low socially anxious individuals who are already more apt to engage in a LKM session. Accordingly, I will explore the possibility that individuals with a combination of low social anxiety (trait) and high positive affect (state) will benefit the most from the LKM intervention. Specifically, I predict a LKM Intervention *x* Social Anxiety *x* Positive Affect interaction effect on each of the outcome variables, such that the LKM intervention is most effective in improving outcomes among those who are low in social anxiety and high in (pre-intervention) positive affect and least effective in improving outcomes among those who are high in social anxiety and low in (pre-intervention) positive affect. Additionally, for each significant LKM Intervention *x* Social Anxiety *x* Positive Affect interaction effect and for each putative mediator (mentioned above), I predict a mediated moderation effect (Preacher et al., 2007) on the outcome variable in which the interaction effect of LKM Intervention *x* Social Anxiety *x* Positive Affect is at least partially explained by the putative mediator.

Whereas positive affect may enhance the benefits of LKM, negative affect may work in the opposite way. Associated with a high level of self-focus (Carver & Seheier, 1981; Duval & Wicklund, 1972; Mor & Winquist, 2002; Pyszczynski & Greenberg, 1987), a condition that may be incompatible with the other-focused elements of LKM, negative affect may prevent an individual from fully engaging in LKM, thus reducing the buffering effects of LKM. This may be especially true for high socially anxious individuals who are already inapt in engaging in a LKM session. Accordingly, I will explore the possibility that individuals with a combination of high social anxiety (trait) and high negative affect (state) will benefit the least from LKM. Specifically, I predict a LKM Intervention *x* Social Anxiety *x* Negative Affect interaction effect on each of the outcome variables, such that the LKM intervention is least effective in improving outcomes among those who are high in social anxiety and high in (pre-intervention) negative affect and most effective in improving outcomes among those who are low in social anxiety and low in (pre-intervention) negative affect. Additionally, for each significant LKM Intervention *x* Social Anxiety *x* Negative Affect interaction effect and for each putative mediator (mentioned above), I predict a mediated moderation effect (Preacher et al., 2007) on the outcome variable in which the interaction effect of LKM Intervention *x* Social Anxiety *x* Negative Affect is at least partially explained by the putative mediator.

2. METHODS

Participants and Study Design

The participants were 113 undergraduate students from The University of Arizona who received course credit for their participation (49 men and 64 women; *M* age = 18.97, *SD* = 1.60). Approximately 2100 students who were enrolled in introductory psychology courses in Spring 2010 and Fall 2010 completed screening questionnaires that included the Brief Fear of Negative Evaluation scale, version 2 (BFNE-II; Carleton, McCreary, Norton, & Asmundson, 2006)—an index of social anxiety. To enhance statistical power and probability of detecting the proposed interactions (McClelland & Judd, 1993), efforts were made to oversample participants who were either high or low in BFNE. In the present sample, 44.25% of the participants scored below the 30^{th} percentile of the participant pool's distribution in BFNE, 33.63% of the participants scored above the 70^{th} percentile of the distribution, and the remaining 22.12% scored between the 30^{th} and 70^{th} percentiles. The distribution of self-reported ethnicity was 69% White (non-Hispanic) American, 17.7% Hispanic American, 4.4% African American, 4.4% Asian American, 0.9% Native American, and 3.5% Other.

Participants were randomly assigned to either the LKM condition (*n* = 59) or the control condition (*n* = 54). Within each condition, participants were randomly assigned to either the TSST group (*n* = 57; 29 LKM participants and 28 control participants) or the Cyberball group (*n* = 56; 30 LKM participants and 26 control participants). Participants were told that the purpose of the experiment was to better understand how personality may affect interpersonal behavior. All participants spoke fluent English and provided written consent prior to the experimental session. All procedures in the present study were approved by the Human Subjects Research and Institutional Review Board (IRB) for The University of Arizona.

Procedures

Participants arrived at the laboratory individually. After completing a questionnaire battery that included demographic information and psychological measures (described below), participants were fitted with autonomic measurement equipment in a physiological measurement chamber that included a computer, a video camera, and a speaker for presentation of experimental stimuli and communication between the participant and the experimenter (who sat in a control room next door). After equipment set-up, physiological measurement began with a two-minute paced breathing task (PBT) that followed Butler et al.'s (2006) description. Participants listened to a soft tone that rose and fell in pitch and were instructed to breathe in as the tone was rising and breathe out as the tone was falling. The tonal pattern was designed to induce a respiratory frequency of nine cycles per minute. Following the PBT, participants watched a four-minute video with nature scenes and relaxing background music. After this baseline period, participants in the LKM condition listened to a 10-minute audio that instructed them to close their eyes and imagine sending positive energies of kindness, generosity, forgiveness, and love to oneself, to one's family and friends, and then to all beings (see Appendix A for the full script); participants in the control condition listened to a 10-minute audio that instructed them to close their eyes and visualize the various facial features of oneself, of a family member, and then of a friend (see Appendix B for the full script). The same relaxing music background was used in both audios. Participants were told that the purpose of the audio instructions was to help them relax and familiarize with the laboratory environment. The LKM and control conditions were coded as 1 and 0, respectively, in the data analysis.

Immediately following the audio intervention, participants completed an implicit attitude assessment that measured their implicit attitude towards the self and others. Participants then completed either the TSST or the Cyberball game according to prior random assignment. After each social stress task (SST), participants were asked to fill out a brief questionnaire (described below) that assessed their experience during the SST. Upon completion of the brief questionnaire, participants were asked to sit quietly for four minutes, which served as a recovery period following the SST. Finally, after the recovery period, participants completed the color-naming Stroop task (which measured their self-regulatory resources) and were asked whether they would be interested in volunteering for other experiments (which measured their prosocial behavior). Physiological data were collected throughout the entire experimental paradigm from the PBT to the Stroop task. Upon completion of each experimental session, the experimenter debriefed the participant by providing a clear explanation of the procedures and objectives of the investigation, thanked them for their participation, and then excused them.

Baseline Self-report Psychological Measures

Brief Fear of Negative Evaluation, version 2 (BFNE-II). The 12-item version of BFNE-II (Carleton et al., 2006) was used to assess social anxiety in the present study. The BFNE-II is a revised version of the Brief Fear of Negative Evaluation scale (BFNE;

Leary, 1983), which measures fear of negative evaluation, a core feature of social anxiety disorders (Rapee & Heimberg, 1997). The BFNE-II consists of items that describe fearful or worrying cognition, such as “I am afraid that others will not approve of me” and “I often worry that I will say or do wrong things” (see Appendix C for the full scale). The respondent indicates the extent to which each item describes himself or herself on a 5-point Likert scale ranging from 0 (not at all characteristic of me) to 4 (extremely characteristic of me). The BFNE-II is scored by summing the ratings given to each of the 12 items. Therefore, the minimum possible BFNE-II score is 0 and the maximum possible BFNE-II score is 48, with a higher score indicating more social anxiety. The BFNE-II has demonstrated excellent internal consistency, convergent validity, and discriminant validity (Carleton, Collimore, & Asmundson, 2007). In addition, factor analyses have supported a unitary factor structure (Carleton et al., 2006). In the present sample, internal consistency for the BFNE-II was strong (α = 0.97). The mean BFNE-II score was 19.08 (*SD* = 13.58; range = 0 to 48). The mean for those who scored below the group mean was 8.49 (*SD* = 5.21; *n* = 63) and the mean for those who scored above the group mean was 32.41 (*SD* = 7.85; *n* = 50). No studies to date have examined the specificity and sensitivity of the BFNE-II for diagnosing social anxiety disorder. Using also an undergraduate sample (*N* = 184), Carleton et al. (2006) reported a mean of 32.8 (*SD* = 10.04) for BFNE-II, which is similar to that found among those who scored above the mean in the present sample.

Beck Depression Inventory (BDI). As depressive symptoms may affect participants’ receptiveness of LKM and stress reactivity, baseline depressive symptoms were measured to ensure equivalence across LKM and control groups as well as TSST and Cyberball groups. The BDI is a widely used inventory that assesses severity of depressive symptoms (BDI; Beck, Rush, Shaw, & Emery, 1979). It consists of 21 items that assess depressive symptoms including depressed mood, sense of failure, suicidal thoughts, sleep disturbance, fatigue, lack of concentration, loss of sex interest etc.; each item is rated from 0 to 3, with 3 indicating greater intensity. The BDI is scored by summing the ratings given to each of the 21 items. Therefore, the minimum possible BDI score is 0 and the maximum possible BDI score is 63, with a higher score indicating greater severity of depressive symptoms. The BDI has demonstrated high internal consistency, convergent validity, and discriminant validity (Beck, Steer, & Garbin, 1988). In the present sample, internal consistency for the BDI was high ($\alpha = 0.89$). The mean BDI score was 8.91 (*SD* = 7.31; range = 0 to 36); 61.06% of the participants scored < 10 (indicating no to minimal depression), 29.02% of the participants scored between 10 and 18 (indicating mild to moderate depression), 7.08% of the participants scored between 19 and 29 (indicating moderate to severe depression), and 2.65% of the participants scored > 29 (indicating severe depression).

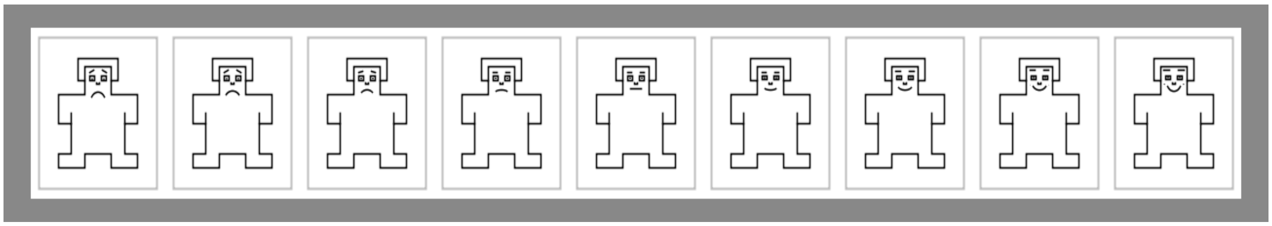
Positive and Negative Affect Schedule—Now (PANAS—Now). As affect may impact participants' receptiveness of LKM and stress reactivity, baseline positive and negative affect were measured to ensure equivalence across LKM and control groups as well as TSST and Cyberball groups. Consisting of two 10-item scales, the PANAS (Watson, Clark, & Tellegen, 1988) was developed to provide brief measures of positive affect (PA) and negative affect (NA). The items (such as enthusiastic, interested, and inspired for PA, and afraid, upset, and irritable for NA) were derived from a principal components analysis of Zevon and Tellegen's (1982) mood checklist and were supposed to broadly tap the affective lexicon. For the state version used in the present study, respondents are asked to rate the extent to which they are experiencing each particular emotion "at the present moment" on a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). PA and NA are scored by summing the ratings given to each of the 10 corresponding items. Therefore, the minimum possible PA score (or NA score) is 10 and the maximum possible PA score (or NA score) is 50, with a higher score indicating greater positive affect (or negative affect). The PANAS has demonstrated high internal consistency, convergent validity, and discriminant validity (Watson et al., 1988). In the present sample, internal consistencies for PA and NA were high ($\alpha = 0.90$ for PA; $\alpha = 0.84$ for NA). The mean PA score was 31.47 ($SD = 9.02$; range = 13 to 49) and the mean NA score was 16.00 ($SD = 5.91$; range = 10 to 38).

Self-Assessment Manikin (SAM). The SAM is a non-verbal assessment that quantifies subjective feeling states using a series of gender-neutral figures (Lang, 1980). It is a quick and easy method for assessing self-reports of affective experience. In the present study, baseline affective valence (ranging from extremely unpleasant to extremely pleasant) and affective arousal (ranging from extremely calm to extremely aroused) were measured using the SAM in a paper-and-pencil format. Figure 1 illustrates the version of the SAM used in the present study; it has nine icons that define a 9-point scale for each dimension. For each dimension, the icons from the furthest left to the furthest right are scored as 1 through 9, with a greater score indicating greater positive

Figure 1. Self-Assessment Manikin (SAM) measures of affective valence and affective arousal

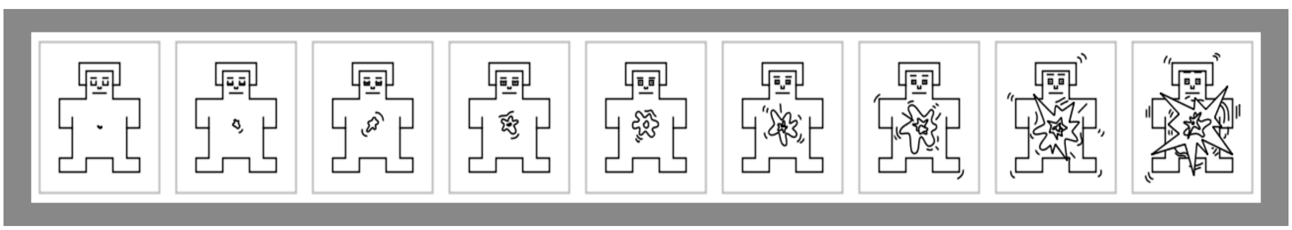
Affective Valence

Using the images below, please place a mark over the image that best represents ***how you felt during the public speaking task (or the Cyberball game).***



Affective Arousal

Using the images below, please place a mark over the image that best represents ***how intensely you experienced your emotions during the public speaking task (or the Cyberball game).***



affective valence (PAV) or greater affective arousal (AA). Reports of affective valence and affective arousal using SAM are widely used in the psychophysiological literature and have demonstrated high test-rest reliability (Lang, Greenwald, Bradley, & Hamm, 1993) and convergent validity (Bradley & Lang, 1994). In addition, these two affective dimensions measured by the SAM covary reliably with physiological reactivity (e.g., skin conductance and heart rate) to emotional stimuli, suggesting that the SAM is a valid measure of emotional responding (Lang et al., 1993). One participant did not complete the baseline SAM measures; thus, only 112 of the 113 participants had complete SAM data. In the present sample, the mean PAV score was 6.60 (*SD* = 1.38; range = 3 to 9) and the mean AA score was 4.33 (*SD* = 1.88; range = 1 to 9). Similar to findings of prior studies (Bradley & Lang, 1994; Lang et al., 1993), PAV and AA were linearly independent in the present study (*r* = -.04).

Physiological Hookup and Adaptation

Upon completion of the questionnaire battery, participants were prepared for psychophysiological recording. First, to record skin conductance (SC) level, two Ag/AgCl Biopac TSD203 transducers filled with Isotonic Recording Gel (0.05M-NaCl) were attached to the distal phalanges of the index and ring fingers of the participant's non-dominant hand (i.e., the hand they do not write with). Then, to prepare the sites for electrocardiogram (EKG) data collection, the participant's skin at the three sensor locations (i.e., underneath left wrist, inside of right forearm, and lower left leg) were rubbed lightly with a clean abrasive pad to remove dead skin cells. Three EL503 Ag/AgCl disposable electrodes (Biopac Technologies, San Barbara, CA) were attached to each participant in a standard Lead-II configuration (right arm to left leg) wherein one electrode was affixed to the left wrist (ground), a second to the right forearm, and a third to the left leg. To enhance conductivity, a small drop of clear electrode gel was put on each electrode before being placed at each of the three sensor locations. Finally, to record respiration rate, a respiration band was placed directly over the participant's diaphragm. SC levels, EKG signals, and respiration rate were measured continuously over the entire study period from the PBT to the Stroop task.

Physiological Recording and Signal Reduction

Skin conductance (SC) data were amplified using Biopac's GSR100C amplifier using a gain of 10 μΩ with a low-pass filter of 10 Hz. Mean SC levels in microsiemens were computed using the Mindware EDA 2.6 post-processing program. Electrocardiogram (EKG) data were obtained using a Biopac MP100 System and EKG amplifier. EKG signals were digitized at 1000 samples per second and amplified using a Biopac 100C system with a gain of 1000. Signals were stored on a computer running Biopac's Acqknowledge physiological data acquisition software. Post-processing artifact detection and data cleaning of EKG interbeat interval (IBI) signals were conducted using the MindWare Technologies HRV 2.6 application (www.Mindwaretech.com, Westerville, OH). Heart rate (HR) was assessed as beats per minute. RSA was quantified as the natural logarithm of the variance in the residual time series occurring within the frequency bandpass associated with respiration (0.12 – 0.40 Hz), which has proven to be a good estimate of parasympathetic vagal influences on cardiac chronotropy (Berntson, Cacioppo, Binkley, Uchino, & et al., 1994; Berntson, Cacioppo, Quigley, & Fabro, 1994). Minute-by-minute summary scores of SC, HR, and RSA were computed for the two-minute paced breathing task, the four-minute nature video viewing task, the 10-minute audio intervention, and the four-minute post-SST recovery period during which there was minimal physical movement. Due to equipment failure, SC levels were not assessed in seven participants; thus, only 106 of the 113 participants had data on SC levels. Also, due to technical difficulties, HR and RSA data were not available for two participants; thus only 111 out of the 113 participants had data on HR and RSA levels.

Mean baseline SC level during nature video and during audio was 6.94 (*SD* = 3.96; range = .18 to 20.04) and 6.66 (*SD* = 4.07; range = .35 to 18.29), respectively. Repeated measures analysis showed that SC level decreased significantly from nature video baseline to audio, Wilk's $\Lambda = .95$, $F(1, 105) = 5.18$, $p < .05$, multivariate $\eta^2 = .047$. Mean baseline HR level during nature video and during audio was 75.29 beats per minute (*SD* = 11.59; range = 46.80 to 109.08) and 72.92 (*SD* = 11.63; range = 45.70 to 102.77), respectively. Repeated measures analysis showed that HR level decreased significantly from nature video baseline to audio, Wilks's $\Lambda = .58$, $F(1, 110) = 78.26$, $p < .001$, multivariate $\eta^2 = .416$. Mean baseline RSA level during paced breathing task was 8.03 (*SD* = 1.14; range = 4.47 to 9.90) and mean baseline RSA level during nature video was 6.55 (*SD* = 1.12; range = 2.88 to 9.16). Due to the controlled slow breathing in the paced breathing task, RSA level during paced breathing was expectedly higher than that during nature video, Wilks's $\Lambda = .25$, $F(1, 110) = 336.33$, $p < .001$, multivariate $\eta^2 = .754$. Mean RSA level during audio was 6.84 (*SD* = 1.05; range = 3.99 to 9.15). Consistent with the expectation that the maximal level of vagal capacity for autonomic responses was measured during the paced breathing task, repeated measures analyses showed that RSA level decreased significantly from paced breathing to audio, Wilks's $\Lambda = .31$, $F(1, 110) = 241.01$, $p < .001$, multivariate $\eta^2 = .687$. In contrast, RSA level increased significantly from nature video to audio, Wilks's $\Lambda = .81$, $F(1, 110) = 26.61$, $p < .001$, multivariate $\eta^2 = .195$.

Post-intervention Measurement of Implicit Attitudes

Implicit attitude assessment. Following the intervention, implicit attitudes towards the self and others were assessed using semantic priming in a lexical decision task (Fazio & Olson, 2003). The participant was presented with positive evaluative words (i.e., delightful, appealing, helpful, kind, loyal) and negative evaluative words (i.e., awful, repulsive, irresponsible, cruel, immoral) one at a time on the computer screen, and was asked to indicate, as quickly as possible, whether the presented word was a positive word or a negative word. Immediately prior to the presentation of each word (target word), a supraliminal prime in the form of either a self-referring word (i.e., I, me, or myself) or other-referring word (i.e., they, them or themselves) was presented for one second. It is assumed that faster responses to positive target words that appeared after a specific prime category (e.g., self-referring words) imply a more positive evaluation of that prime category, whereas faster responses to negative target words that appeared after a specific prime category (e.g., other-referring words) imply a more negative evaluation of that prime category (e.g., Fazio & Olson, 2003). After eight practice trials, the participant completed 60 trials of which 25% presented positive words with self-referring primes, 25% presented positive words with other-referring primes, 25% presented negative words with self-referring primes, and 25% presented negative words with other-referring primes. These trials were presented to the participant in a random order. Performance on the task was recorded via percent accurate and reaction time (RT) in milliseconds (ms). A faster mean average RT (smaller value) for positive words following self-referring primes indicates more positivity towards the self. A faster mean average RT (smaller value) for positive words following other-referring primes indicates more positivity towards others.

A faster mean average RT (smaller value) for negative words following self-referring primes indicates more negativity towards the self. A faster mean average RT (smaller value) for negative words following other-referring primes indicates more negativity towards others. The implicit attitude assessment task was programmed using Eprime 2.0 (Psychology Software Tools, Inc.; www.pstnet.com/eprime.cfm). The total length of the task was about three minutes.

Two participants whose accuracy levels in the implicit attitude task were 3 standard deviations below the group mean were excluded from analysis. In addition, to reduce measurement errors introduced by extraneous variables such as attention, each participant's average reaction time was adjusted by eliminating trials with reaction times that exceeded 3 *SD*'s above the pooled mean reaction time. After these adjustments, the mean percent accurate was 98.32% (*SD* = 2.23%; range = 88% to 100%); 48.65% of the participants scored at 100% and 50.45% of the participants scored over 90%. The mean average RT for positive words following self-referring primes was 782.07 ms (*SD* = 182.33 ms; range = 486.67 ms – 1380.08 ms), the mean average RT for positive words following other-referring primes was 799.39 ms (*SD* = 189.65 ms; range = 492.27 ms to 1459.54 ms), the mean average RT for negative words following self-referring primes was 818.34 ms (*SD* = 200.45 ms; range = 499.47 ms to 1599.15 ms), and the mean average RT for negative words following other-referring primes was 815.13 ms (*SD* = 186.86 ms; range = 490.60 ms to 1525.78 ms).

Because it is possible that LKM affects *not* the absolute levels of positivity or negativity towards self and others but the relative levels of positivity or negativity towards one's self relative to others, implicit positive bias towards the self relative to others (Implicit Positive Bias - Self Relative To Others) was assessed by subtracting the adjusted average RT in response to positive words after self-referring primes from the adjusted average RT in response to positive words after other-referring primes. A greater positive value indicates more positive bias towards the self relative to others; a greater negative value (absolute value) indicates a more positive bias towards others relative to the self. Implicit negative bias towards others relative to the self (Implicit Negative Bias – Self Relative To Others) was assessed by subtracting the adjusted average RT in response to negative words after self-referring primes from the adjusted average RT in response to negative words after other-referring primes. A greater positive value indicates more negative bias towards the self relative to others; a greater negative value (absolute value) indicates a more negative bias towards others relative to the self. In the present sample, the mean Implicit Positive Bias – Self Relative to Others score was 49.28 ms (*SD* = 38.57 ms; range = 3.20 ms to 180.24 ms) for those who had a positive bias towards the self relative to others (i.e., 63.96% of the participants), and was -39.42 ms (*SD* = 31.26 ms; range = -113.67 ms to -.17 ms) for those who had a positive bias towards others relative to the self (i.e., 36.04% of the participants). The mean Implicit Negative Bias – Self Relative to Others score was 41.16 ms (*SD* = 38.01 ms; range = 1.47 ms to 164 ms) for those who had a negative bias towards the self relative to others (i.e., 50.45% of the participants), and was -48.38 ms (*SD* = 40.94 ms; range = -150.53 ms to -1.07 ms) for those who had a negative bias towards others relative to the self (i.e., 49.55% of the participants).

Because it is also possible that some individuals respond to LKM with increased positivity and/or reduced negativity towards the self relative to others and others respond to LKM with increased positivity and/or reduced negativity towards others relative to the self, implicit positive bias towards the self relative to others or towards others relative to the self (Implicit Positive Bias – Self or Others) was assessed through the absolute difference between the adjusted average RT in response to positive words after other-referring primes and the adjusted average RT in response to positive words after self-referring primes. A greater value indicates a higher level of implicit positive bias towards the self (relative to others) or others (relative to the self). Implicit negative bias towards the self relative to others or towards others relative to the self (Implicit Negative Bias – Self or Others) was assessed through the absolute difference between the adjusted average RT in response to negative words after self-referring primes and the adjusted average RT in response to negative words after other-referring primes. A greater value indicates a higher level of implicit negative bias towards the self (relative to others) or others (relative to the self). In the present sample, the mean Implicit Positive Bias – Self or Others score was 45.73 ms (*SD* = 36.27 ms; range = .17 ms to 180.24 ms) and the mean Implicit Negative Bias – Self or Others score was 44.74 ms (*SD* = 39.48 ms; range = 1.07 ms to 164 ms).

Finally, following Hutcherson et al.'s (2008) conceptualization of implicit positivity, which was defined as a bias to respond faster to positive words and slower to negative words after the prime, implicit positivity towards the self (Implicit Positivity towards the Self – Positive Relative to Negative Words) was assessed by subtracting the adjusted average RT in response to positive words after self-referring primes from the adjusted average RT in response to negative words after self-referring primes. A greater value indicates more positivity towards the self. Implicit positivity towards others (Implicit Positivity towards Others – Positive Relative to Negative Words) was assessed by subtracting the adjusted average RT in response to positive words after other-referring primes from the adjusted average RT in response to negative words after other-referring primes. A greater value indicates more positivity towards others. In the present sample, the mean Implicit Positivity towards the Self – Positive Relative to Negative Words score was 36.27 ms (*SD* = 67.68 ms; range = -88.29 ms to 237.33 ms) and the mean Implicit Positivity towards Others – Positive Relative to Negative Words score was 15.74 ms (*SD* = 60.97 ms; range = -209.60 ms to 135.07 ms).

Social Stress Task

Trier Social Stress Test. Following the implicit attitude assessment, half of the participants completed the TSST according to prior random assignment. The present study used the public speaking portion of the TSST (Kirschbaum et al., 1993), which involved a preparation period and a speech delivery period in front of two judges. Prior to the TSST, the participant was given the following instructions:

> For the next task, we'll ask you to give a brief speech. In a moment, you'll be given four minutes to prepare a speech as to why you're the best candidate for a job position. It can be any job position. The main point is that we *really* want you to try to sell yourself while you're delivering your speech. The only stipulation is that you must sell yourself using only truthful personal information—no fabrications or exaggerations. There will be two judges who will be sitting in front of you. Both of them are specially trained in evaluating verbal and non-verbal performance. Throughout your speech, a voice frequency analyzer will record the tone and inflections in your voice, and video cameras will record your

> movements, gestures, and facial expressions. All of these measures will be used to evaluate you both during and after your speech.

The participant spent four minutes preparing for the speech and four minutes delivering the speech in front of a male judge and a female judge. These judges were undergraduate research assistants who wore white laboratory coats and carried an evaluation form on a clip board; they wrote on the evaluation form during the speech and were instructed to be reserved and to refrain from any emotional expressions during the entire speech. To further increase the level of stress, the participant was given a piece of paper on which they could jot down some notes for the upcoming speech during the preparation period. However, immediately before the speech, the experimenter asked for the participant's notes and told them the judges would evaluate the notes during the speech. The total length of the TSST was 8 minutes in the present study. The TSST is a widely used procedure in psychobiological research and has been shown to reliably elicit a hypothalamic-pituitary-adrenal (HPA) axis response including a substantial cortisol response (e.g., Dickerson & Kemeny, 2004; Kirschbaum et al., 1993).

Cyberball social exclusion task. Following the implicit attitude assessment, half of the participants completed the Cyberball social exclusion task (Williams et al., 2000; Williams & Jarvis, 2006) according to prior random assignment. The participant played a virtual ball-tossing game with what they believed to be two other players who were also student research participants. However, in reality, there were no other players; the participant was playing with a preset computer program instead. Throughout the game, a picture of the participant (taken at the beginning of the study) was displayed on the computer screen next to the iconic representation of the participant along with pictures of the other two “players.” Prior to the game, the participant was given the following instructions:

> During the ball-tossing game, please mentally visualize the entire experience and imagine you are playing with the two players in person. Visualize the two other students that you’re playing with. What kind of people are they? What do they look like? Visualize the way they throw the ball, the motion of the ball, as well as they way you interact with them.

These instructions were intended to enhance experimental realism. As another measure that was intended to enhance realism, the Cyberball game proceeded in three phases. The participant first watched the other two players play Cyberball for approximately 2 minutes (the observation phase). This phase was designed to help the participant familiarize with the screen, practice visualizing the other two players, and build up an expectation for participating in the game. To explain to the participant why they were just watching, they were told that connection to the other two players was not yet established due to technical difficulties. Then, the participant proceeded to play with the other two players without being excluded for approximately 3 minutes (the inclusion phase). This phase was designed to make sure there was a certain level of interaction between the participant and the other two players prior to exclusion. Finally, the participant was excluded by the other two players for approximately 3 minutes during which the other two players threw the ball only between themselves and stopped throwing the ball to the participant (the exclusion phase).

The total length of the Cyberball game was about 8 minutes with a total of 194 throws among the three players in the present study. During the inclusion phase, participants received 34% of the throws; during the inclusion phase and the exclusion phase, participants received 18% of the throws; across the entire game from the observation phase to the exclusion phase, participants received 14% of the throws. Immediately following the Cyberball game, participants answered three questions: (1) “What percent of the throws were thrown to you?”; (2) “On a scale of 1 (not at all) to 9 (very much), to what extent were you included by the other participants during the game?”; and (3) On a bipolar scale of 1 (accepted) to 9 (rejected), how accepted/rejected were you during the game?” The mean estimated percent of received throws was 32.02 (*SD* = 15.47; range = 5 to 90), the mean level of perceived inclusion was 3.91 (*SD* = 1.70; range = 1 to 9), and the mean level of perceived rejection was 5.91 (*SD* = 2.01; range = 1 to 9). These values are comparable to those found in other studies (e.g., Williams et al., 2000; Zadro et al., 2004). The Cyberball ostracism paradigm has been shown to reliably induce feelings of being rejected and decrease levels of belonging, control, self-esteem, and meaningful existence (e.g., Williams et al., 2000; Zadro et al., 2004).

The TSST and Cyberball conditions were coded as 1 and 0, respectively, in the data analysis.

Self-report Measures about Experience during Social Stress Task

Self-Assessment Manikin (Time 2 or T2). To assess affective reactivity, affective valence and arousal during SST were measured for the second time immediately after the SST using the SAM. Mean PAV (T2) score was 4.76 (*SD* = 1.60; range = 1 to 9); 4.26 (*SD* = 1.75; range = 1 to 8) for TSST participants and 5.27 (*SD* = 1.26; range = 3 to 9) for Cyberball participants. As expected, repeated measures analysis showed that PAV increased significantly from baseline to SST, Wilk's Λ = .44, $F(1, 111) = 142.11$, $p < .001$, multivariate $\eta^2 = .561$. Analysis of covariance (ANCOVA) with baseline PAV as a covariate showed that, compared to Cyberball participants, TSST participants had significantly greater decrease in PAV during SST, $F(1, 109) = 13.46$, $p < .001$, partial η2 = .110. Mean AA (T2) score was 4.52 (*SD* = 2.35; range = 1 to 9); 5.77 (*SD* = 2.03; range = 1 to 9) for TSST participants and 3.25 (*SD* = 1.95; range = 1 to 8) for Cyberball participants. Although AA did not change significantly from baseline to SST when the two social stress groups were collapsed into one group, Wilk's Λ = .99, $F(1, 111) = .65$, $p > .05$, multivariate $\eta^2 = .006$, ANCOVA with baseline AA as a covariate showed that, compared to Cyberball participants, TSST participants had significantly greater increase in AA during SST, $F(1, 109) = 56.32$, $p < .001$, partial η2 = .341.

Stress. Overall stress level during SST was assessed with a single item: "Overall, how stressful did you find the public speaking task?" for TSST participants and "Overall, how stressful did you find the Cyberball game?" for Cyberball participants. Mean stress levels were 5.11 (*SD* = 1.84; range = 1 to 7) for TSST participants and 1.77 (*SD* = 1.18; range = 1 to 6) for Cyberball participants. ANOVA showed that TSST participants reported significantly more stress than did Cyberball participants, $F(1, 111) = 131.62$, $p < .001$, partial η2 = .542.

Feelings of negative evaluation. To assess feelings of being negatively evaluated by others, the following six items were used (items for Cyberball participants in brackets): (1) "I felt that the judges were satisfied with my performance" (or "I felt that the other participants were satisfied with my performance") (reverse-coded); (2) "I felt that the judges liked me" (or "I felt that the other participants liked me") (reverse-coded); (3) "I felt like I was being harshly judged during the task" (or "I felt like I was being harshly judged during the game"); (4) "I felt that the judges didn't like me" (or "I felt that the other participants didn't like me"); (5) "I felt that the judges were thinking how poor my performance was" (or "I felt that the other participants were thinking how poor my performance was"); (6) "I felt that the judges were being critical of me" (or "I felt that the other participants were being critical of me"). Participants rated these items on a 9-point Likert scale ranging from 1 (not at all) to 9 (very much so). Feelings of negative evaluation is scored by summing the ratings given to each of the six items. Therefore, the minimum possible score is 6 and the maximum possible score is 54, with a higher score indicating more feelings of negative evaluation. Internal consistency for this scale was high ($\alpha = 0.88$). Mean feelings of negative evaluation scores were 5.71 (*SD* = 1.86; range = 2 to 9) for TSST participants and 3.68 (*SD* = 1.41; range = 1 to 7) for Cyberball participants. ANOVA showed that TSST participants reported significantly more feelings of negative evaluation than did Cyberball participants, $F(1, 111) = 42.70$, $p < .001$, partial $\eta 2 = .278$.

Mood. In addition to the SAM measures, the post-SST questionnaire also assessed anger and enjoyment during SST. Following Zadro et al.'s (2004) post-Cyberball-game measures, these items were "I felt angry during the public speaking task" (or "I felt angry during the Cyberball game") and "I enjoyed the public speaking task" (or "I enjoyed playing the Cyberball game"). Participants rated these items on a 9-point Likert scale ranging from 1 (not at all) to 9 (very much so), with higher scores indicating more anger or more enjoyment. Mean anger scores were 3.05 (*SD* = 2.17; range = 1 to 9) for TSST participants and 1.84 (*SD* = 1.51; range = 1 to 8) for Cyberball participants. Mean enjoyment scores were 3.09 (*SD* = 2.56; range = 1 to 9) for TSST participants and 3.68 (*SD* = 2.12; range = 1 to 9) for Cyberball participants. Analysis of variance (ANOVA) showed that TSST participants reported significantly more anger than did Cyberball participants, $F(1, 111) = 11.82$, $p < .01$, partial $\eta 2 = .096$; but TSST participants were not different from Cyberball participants in enjoyment during SST, $F(1, 111) = 1.79$, $p > .05$, partial $\eta 2 = .016$.

Primary Needs. Zadro et al.'s (2004) measurement of primary needs (i.e., belonging, control, self-esteem, and meaningful existence) was adopted. Items for TSST participants were based on the items used in Zadro et al. (2004) but were reworded accordingly; items for Cyberball participants were identical to those used in Zadro et al. (2004). A sample item for the need for belonging was: "I felt poorly accepted by the judges" for TSST participants and "I felt poorly accepted by the other participants" for Cyberball participants (reverse-coded); a sample item for the need for control was: "I felt that I was able to do what I wanted during the tasks" for TSST participants and "I felt that I was able to throw the ball as often as I wanted during the game" for Cyberball participants; a sample item for the need for self-esteem was: "During the public speaking task, I felt good about myself" for TSST participants and "During the Cyberball game, I felt good about myself" for Cyberball participants; and finally, a sample item for the need for meaningful existence was: "I felt that my performance [e.g., the clarity and content of my speech] had some effect on the judges" for TSST participants and "I felt that my performance had some effect on the direction of the game" for Cyberball participants (see Appendix D for the full scale). Participants rated these items on a 9-point Likert scale ranging from 1 (not at all) to 9 (very much so), with higher scores indicating a greater fulfillment of needs. Each of the subscales is scored by summing the ratings given to each of the corresponding items. Therefore, the minimum possible score is 5 for belonging (5 items) and 3 for control, self-esteem and meaning, respectively (3 items each), and the maximum possible score is 45 for belonging and 27 for control, self-esteem, and meaningful existence, respectively, with a higher score indicating greater fulfillment of primary needs. In the present sample, internal consistency for belonging was high (α = 0.83), internal consistencies for self-esteem and meaningful existence were acceptable (α's = 0.77 and 0.62, respectively), and the internal consistency for control was low (α = 0.48).

The mean belonging scores were 3.85 (*SD* = 1.83; range = 1 to 8) for TSST participants and 4.47 (*SD* = 1.64; range = 1 to 8) for Cyberball participants, the mean control scores were 3.91 (*SD* = 1.80; range = 1 to 8) for TSST participants and 4.24 (*SD* = 1.49; range = 1 to 8) for Cyberball participants, the mean self-esteem scores were 4.56 (*SD* = 2.03; range = 1 to 9) for TSST participants and 5.85 (*SD* = 1.82; range = 2 to 9) for Cyberball participants, and the mean meaningful existence scores were 5.92 (*SD* = 1.98; range = 1 to 9) for TSST participants and 4.91 (*SD* = 1.82; range = 1 to 8) for Cyberball participants. ANOVA showed that TSST participants reported significantly lower self-esteem but significantly higher meaningful existence than did control participants, $F(1, 111) = 12.58$, $p < .01$, partial $\eta 2 = .102$ for self-esteem, $F(1, 111) = 7.94$, $p < .01$, partial η2 = .067 for meaningful existence; however, TSST participants were not different from Cyberball participants in belonging or control , $F(1, 111) = 3.67$, $p > .05$, partial η2 = .032 for belonging, $F(1, 111) = 1.17$, $p > .05$, partial η2 = .010 for control.

Physiological Measurements during Post-social-stress-task Recovery Period

Mean SC level during the recovery period was 10.45 (*SD* = 4.95; range = 1.68 to 27.37); 10.59 (*SD* = 5.00; range = 2.58 to 27.37) for TSST participants and 10.32 (*SD* = 4.95; range = 1.68 to 25.05) for Cyberball participants. Mean HR during the recovery period was 74.55 beats per minute (*SD* = 11.97; range = 45.45 to 107.27); 75.53 beats per minute (*SD* = 12.20; range = 45.45 to 107.27) for TSST participants and 73.55 beats per minute (*SD* = 11.74; range = 47.79 to 104.19) for Cyberball participants. Mean RSA during the recovery period was 6.70 (*SD* = 1.09; range = 3.87 to 9.32); 6.68 (*SD* = 1.23; range = 3.87 to 9.2) for TSST participants and 6.72 (*SD* = 1.06; range = 4.58 to 9.32) for Cyberball participants. Repeated measures analysis showed that SC level increased significantly from nature video baseline to recovery period, Wilk's $\Lambda = .36$, $F(1, 105) = 189.50$, $p < .001$, multivariate $\eta^2 = .643$, suggesting a possible increase in autonomic reactivity. However, HR did not change significantly from nature video baseline to recovery period, Wilk's $\Lambda = .97$, $F(1, 110) = 3.30$, $p > .05$, multivariate $\eta^2 = .029$. In addition, RSA increased significantly from nature video baseline to recovery period, Wilk's $\Lambda = .96$, $F(1, 110) = 4.94$, $p < .05$, multivariate $\eta^2 = .043$, suggesting a recovery of parasympathetic cardiac control after the social stress task. Consistent with the expectation that the maximal level of vagal capacity for autonomic responses was measured during the paced breathing task, RSA decreased significantly from paced breathing baseline to recovery period, Wilk's $\Lambda = .27$, $F(1, 110) = 291.75$, $p < .001$, multivariate $\eta^2 = .726$, suggesting a recovery of vagal capacity for autonomic responses. ANCOVA with baseline values as covariates showed that TSST and Cyberball participants did not differ in changes in SC, HR, RSA from paced breathing baseline to recovery, and RSA from nature video baseline to recovery, $F(1, 103) = 2.55$, $p > .05$, partial $\eta 2 = .024$ for change in SC, $F(1, 108) = .56$, $p > .05$, partial $\eta 2 = .005$ for change in HR, $F(1, 108) = .71$, $p > .05$, partial $\eta 2 = .001$ for change in RSA from nature video baseline to recovery, and $F(1, 108) = .14$, $p > .05$, partial $\eta 2 = .001$ for change in RSA from paced breathing baseline to recovery.

Post-recovery-period Measurements

Stroop task. Following the recovery period, participants were given the color-naming Stroop (1935) task. Color words either in the same color (e.g., the word "red" in the color red) or a different color (e.g., the word "red" in the color blue) were presented on the computer screen. The participant was instructed to respond to the color of the word, regardless of what the word says, by pressing four different keys located in the center of the keyboard ("h" for the color blue, "g" for the color yellow, "u" for the color green, and "t" for the color red). After 16 practice trials, the participant completed 72 trials of which 50% were congruent trials (color words in the same color) and 50% were incongruent trials (color words in a different color). Performance on the task was recorded via percent accurate and reaction time (RT) in milliseconds (ms). The Stroop task was programmed using Eprime 2.0 (Psychology Software Tools, Inc.; www.pstnet.com/eprime.cfm). The total length of the task was about two minutes.

One participant whose accuracy level in the Stroop task was 3 standard deviations below the group mean was excluded from analysis. In addition, to reduce measurement errors introduced by extraneous variables such as attention, each participant's average reaction time was adjusted by eliminating trials with reaction times that exceeded 3 *SD*'s above the pooled mean reaction time. After these adjustments, mean Stroop accuracy levels were 97.97% (*SD* = 2.08%; range = 90.28% to 100%) for TSST participants and 97.70% (*SD* = 2.33%; range = 86.11% to 100%) for Cyberball participants. ANOVA showed that TSST and Cyberball participants did not differ in Stroop accuracy level, $F(1, 109) = .40$, $p > .05$, partial $\eta 2 = .004$. Overall, 27.03% of the participants scored at 100% and 72.07% of the participants scored above 90%. Mean average RT's were 837.28 ms (*SD* = 160.18 ms; range = 538.89 ms to 1242.92 ms) for TSST participants and 838.87 ms (*SD* = 150.58 ms; range = 570.11 ms to 1179.71 ms) for Cyberball participants. ANOVA showed that TSST and Cyberball participants did not differ in mean average RT, $F(1, 109) = .003$, $p > .05$, partial $\eta 2 = .000$.

To assess self-regulation, Stroop interference was computed by subtracting the adjusted average RT for the congruent trials from the adjusted average RT for the incongruent trials. A higher Stroop interference score indicates a lower level of self-regulation. In the present sample, mean Stroop interference levels were 89.99 ms (*SD* = 64.32 ms; range = -93.49 ms to 263.95 ms) for TSST participants and 97.42 ms (*SD* = 66.15 ms; range = -55.68 ms to 243.14 ms) for Cyberball participants. ANOVA showed that TSST and Cyberball participants did not differ in Stroop interference level, $F(1, 109) = .36$, $p > .05$, partial $\eta 2 = .003$. Because the Stroop task requires the inhibition of dominant responses (i.e., the semantic dimension of the words), executive attentional capacity is needed (e.g., Alvarez & Emory, 2006; Engle, 2002; Macleod, 1991). Prior research has shown that social stressors (such as interracial interactions for those with prejudiced attitudes) may impair Stroop performance (e.g., Richeson & Shelton, 2003).

Intention to volunteer. To assess prosocial behavior, participants' intention to volunteer was measured. After unhooking the participant from the physiological equipment, the experimenter explained to the participant that more volunteers were needed for several pilot studies in the lab, and that each of them would take no more than 15 minutes. Participants were told that they could volunteer for up to 4 of these pilot studies, and that we would contact them once we were ready to recruit participants. A greater number of experiments the participant agreed to participate in reflects a higher level of intention to volunteer. Due to administrative errors, intention to volunteer was not assessed in six participants; thus, only 107 of the 113 participants had data on this outcome variable. Mean number of experiments participants volunteered for were 1.48 (SD = 1.42; range = 0 to 4) for the TSST group and 2.00 (SD = 1.37; range = 0 to 4) for the Cyberball group. ANOVA showed that TSST and Cyberball participants did not differ in their intention to volunteer, $F(1, 105) = 3.68$, $p > .05$, partial $\eta 2 = .034$. Overall, 19.63% of the participants volunteered to participate in four experiments, 4.67% volunteered for three experiments, 31.78% volunteered for two experiments, 17.76% volunteered for one experiment, and 26.17% did not volunteer.

In summary, results suggest that participating in either of the social stress tasks leads to worsened affective outcomes and possibly increased autonomic reactivity.

Specifically, participating in either of the social stress tasks leads to decreased positive affect and increased skin conductance level. In addition, participating in the TSST leads to increased affective intensity. Results of the TSST vs. Cyberball group differences in the self-report measures suggest that participating in the TSST leads to worse affective outcomes, more subjective stress, more anger, and lower self-esteem than participating in the Cyberball game. However, participating in the Cyberball game leads to a lower level of meaningful existence than participating in the TSST.

Statistical Analysis

To ensure group equivalence, baseline characteristics were compared between LKM and control groups and between TSST and Cyberball groups using *t*-tests. To examine differences between LKM and control groups in changes of affect and physiology, one-way analysis of covariance (ANCOVA) that adjusted for the baseline value of each variable was used. In addition, multiple linear regressions were used to examine effects of the LKM intervention on change in RSA from nature video baseline to audio (accounting for change in respiration rate), change in RSA from paced breathing baseline to audio (accounting for respiration rate during audio), change in RSA from nature video baseline to recovery (accounting for change in respiration rate), and change in RSA from paced breathing baseline to recovery (accounting for respiration rate during recovery). Furthermore, *t*-tests and ANCOVA were used to examine differences between LKM and control groups in the following outcome variables: implicit attitude variables (obtained immediately after the audio intervention), self-report variables about experience during SST (obtained immediately after the SST), as well as Stroop and prosocial behavior variables (obtained after the post-SST recovery period). Finally, to confirm that any effects the LKM Intervention might have on the outcome variables were not dependent on the type of SST or sex, two-way ANOVA, two-way ANCOVA, and multiple linear regressions were used to test the LKM Intervention *x* SST effects and the LKM Intervention *x* Sex effects.

Moderation analyses. Three different models addressed the "For Whom" (statistical moderation) question. Model (A)—To test if effects of the LKM Intervention were stronger among those lower in social anxiety and weaker among those higher in social anxiety (assessed using the BFNE-II scale prior to intervention) , hierarchical linear regressions were used to examine the LKM Intervention *x* BFNE interaction effects on the outcome variables. Model (B)—To test if effects of the LKM Intervention were stronger among those lower in social anxiety and higher in positive affect and weaker among those higher in social anxiety and lower in positive affect (PA; assessed using the PANAS—Now scale prior to intervention), hierarchical linear regressions were used to examine the LKM Intervention *x* BFNE *x* PA interaction effects on the outcome variables. Model (C)—To test if effects of the LKM Intervention were stronger among those lower in social anxiety and lower in negative affect and weaker among those higher in social anxiety and higher in negative affect (NA; assessed using the PANAS—Now scale prior to intervention), hierarchical linear regressions were used to examine the LKM Intervention *x* BFNE *x* NA interaction effects on the outcome variables.

Mediation analyses. Finally, to address the "How" (statistical mediation) question, any significant LKM Intervention effects or moderated LKM Intervention effects were examined using Baron and Kenny's (1986) conceptualization of mediation and mediated moderation. Specifically, the possibility that the main effects or moderated effects of the LKM Intervention were mediated through physiological (changes in SC, HR, RSA from paced breathing baseline to audio, and/or RSA from nature video baseline to audio) and/or cognitive (implicit attitude variables following the audio intervention) processes was examined.

For all outcome variables that differed significantly between TSST and Cyberball participants, SST was statistically accounted for in the analysis. In addition, all predictor variables were grand-mean centered (Aiken & West, 1991) in all regression analyses.

3. RESULTS

Group Equivalence

Tables 1 and 2 present *t*-test results of baseline equivalence between LKM and control groups and between TSST and Cyberball groups. As expected from the random assignment procedures, no significant differences were found between LKM and control groups or between TSST and Cyberball groups on baseline levels of depressive symptoms, social anxiety, positive affect (PA), negative affect (NA), positive affective valence (PAV), affective arousal (AA), mean skin conductance (SC), mean heart rate (HR), and mean RSA (measured during paced breathing or nature video) (ps > .05).

Effects of LKM, LKM x SST, and LKM x Sex

Differences between LKM and control groups in physiological changes, affective changes, and several self-report measures about experience during the social stress task (SST) were tested using ANCOVA (see Table 3). Baseline value of each of the physiological and affective variables was included as a covariate in each analysis. For stress level, feelings of negative evaluation, anger, self-esteem, and meaningful existence during SST, which differed between TSST and Cyberball participants, SST was included as a covariate in the analysis. Results showed that none of these variables was significantly different between LKM and control groups (ps > .05).

Table 4 presents results of two regression models that examined the effects of LKM Intervention on RSA during audio (Audio RSA; M = 7.11, SD = 0.86 for the LKM group; M = 6.55, SD = 1.16 for the control group). Results showed that LKM Intervention was a significant predictor of Audio RSA after accounting for baseline RSA

Table 1. *Independent-samples t-test results of baseline equivalence between LKM and control groups*

	LKM		Control		
	M	*SD*	*M*	*SD*	*t*
Age (in years)	18.80	1.06	19.17	2.03	-1.20
Beck Depression Inventory II	8.42	5.97	9.44	8.56	-.73
Brief Fear of Negative Evaluation II	19.36	13.28	18.77	14.01	.23
Positive and Negative Affect Schedule—Now					
Positive Affect	32.19	9.23	30.69	8.81	.88
Negative Affect	15.51	5.87	16.54	5.96	-.92
Self-Assessment Manikins (Time 1)					
Positive affective valence	6.76	1.14	6.43	1.59	1.27
Affective arousal	4.22	1.89	4.44	1.87	-.62
Mean skin conductance (SC)					
Nature video baseline (NVB)	6.94	3.68	6.93	4.29	.01
Mean heart rate (HR)					
Nature video baseline (NVB)	74.78	11.14	75.85	12.16	-.48
Mean respiratory sinus arrhythmia (RSA)					
Paced breathing baseline (PBB)	8.10	1.07	7.95	1.21	.72
Nature video baseline (NVB)	6.65	1.08	6.44	1.16	.99

Note. No significant differences were found between LKM and control groups (*p*s > .05).

during nature video and change in respiration rate from nature video baseline to audio, $\Delta R^2 = 1.6\%$, $\Delta F(1,107) = 7.55$, $p < .01$. Specifically, the LKM intervention increased RSA from the nature video baseline to the audio intervention relative to the control intervention, indicating an increase in parasympathetic cardiac control during the LKM intervention but not during the control intervention. Consistent with this effect, LKM participants had a significantly lower level of respiration rate than did control participants ($M = 11.43$, $SD = 3.23$ for LKM participants; $M = 14.50$, $SD = 3.84$ for control participants), $t(109) = -4.45$, $p < .001$. Change scores (i.e., respiration rate during audio –

Table 2. *Independent-samples t-test results of baseline equivalence between TSST and Cyberball groups*

	LKM		Control		
	M	*SD*	*M*	*SD*	*t*
Age (in years)	18.80	1.06	19.17	2.03	-1.20
Beck Depression Inventory II	8.42	5.97	9.44	8.56	-.73
Brief Fear of Negative Evaluation II	19.36	13.28	18.77	14.01	.23
Positive and Negative Affect Schedule—Now					
Positive Affect	32.19	9.23	30.69	8.81	.88
Negative Affect	15.51	5.87	16.54	5.96	-.92
Self-Assessment Manikins (Time 1)					
Positive affective valence	6.76	1.14	6.43	1.59	1.27
Affective arousal	4.22	1.89	4.44	1.87	-.62
Mean skin conductance (SC)					
Nature video baseline (NVB)	6.94	3.68	6.93	4.29	.01
Mean heart rate (HR)					
Nature video baseline (NVB)	74.78	11.14	75.85	12.16	-.48
Mean respiratory sinus arrhythmia (RSA)					
Paced breathing baseline (PBB)	8.10	1.07	7.95	1.21	.72
Nature video baseline (NVB)	6.65	1.08	6.44	1.16	.99

Note. No significant differences were found between TSST and Cyberball groups on any of the baseline variables (*p*s > .05).

respiration rate during video) revealed that whereas control participants had an increase in respiration rate during the audio (*M* = 2.23, *SD* = 4.21), LKM participants had a decrease in respiration rate during the audio (*M* = -.82, *SD* = 3.24). Independent-samples *t*-test results showed that these change scores were significantly different between the LKM and control groups, $t(109) = -4.30$, $p < .001$. These findings suggest that the LKM intervention successfully induced a relaxation effect on the participants relative to the control intervention. In contrast, LKM Intervention was not a significant predictor of Audio RSA after accounting for RSA during paced breathing and respiration rate during

Table 3. *ANCOVA results for differences between LKM and control groups*

	LKM		Control					
	Mean	*SD*	*Mean*	*SD*	*F*	*df*	*p*	partial η^2
Audio intervention								
Mean SC[a]	6.62	3.71	6.70	4.49	.133	1, 103	.716	.001
Mean HR[a]	72.63	10.76	73.23	12.61	.689	1, 108	.408	.006
Self-report about experience during social stress task								
Positive affective Valence (Time 2)[a]†	4.88	1.50	4.63	1.71	.021	1, 108	.884	.000
Affective arousal (T2)[a]†	4.47	2.39	4.57	2.33	.057	1, 108	.811	.001
Stress†	3.34	2.27	3.57	2.30	.246	1, 110	.621	.002
Feelings of negative evaluation†	4.66	1.94	4.76	1.94	.022	1, 110	.881	.000
Anger†	2.32	1.75	2.59	2.19	.451	1, 110	.503	.004
Self-esteem†	5.25	1.98	5.15	2.09	.035	1, 110	.851	.000
Meaningful existence†	5.67	1.79	5.14	2.11	2.462	1, 110	.119	.022
Recovery period								
Mean SC[a]	10.20	4.27	10.74	5.68	1.165	1, 103	.283	.011
Mean HR[a]	74.58	11.68	74.51	12.38	1.819	1, 108	.180	.017

Notes. [a]Baseline value was included as a covariate in this analysis.
†Type of social stress task (i.e., TSST vs. Cyberball) was included as a covariate in this analysis.

audio, $\Delta R^2 = 1.2\%$, $\Delta F(1,107) = 3.39$, $p > .05$. In other words, LKM Intervention did not predict change in RSA from paced breathing baseline to audio, indicating that the LKM intervention (before considering the effects of potential moderating variables) did not change vagal capacity for autonomic responses relative to the control intervention. Table 5 presents results of two regression models that examined effects of LKM Intervention on RSA during the recovery period (Recovery RSA; $M = 6.80$, $SD =$

1.00 for the LKM group; $M = 6.59$, $SD = 1.18$ for the control group). Contrary to expectation, LKM Intervention was not a significant predictor of change in RSA from

Table 4. *Results of hierarchical regression models that examined the effect of LKM intervention on change in RSA from baseline to audio*

	Change in RSA from paced breathing to audio[a]			Change in RSA from nature video baseline to audio[b]		
Predictors	*b*	*t*	*p*	*b*	*t*	*p*
Baseline RSA (during NV)				.77	18.00***	.000
ΔRR (from baseline to audio)				-.04	-2.75**	.007
Baseline RSA (during PB)	.63	11.61***	.000			
RR (during audio)	-.07	-4.00***	.000			
LKM Intervention	.24	1.84	.068	.28	2.75**	.007

Notes. NV = Nature video; PB = Paced breathing; RR = Respiration rate
[a]R^2 = 63.4%, adjusted R^2 = 62.4%, $F(3, 107) = 61.88$, $p < .001$
[b]R^2 = 77.9%, adjusted R^2 = 77.3%, $F(3, 107) = 125.76$, $p < .001$
** $p < .01$ *** $p < .001$

Table 5. *Results of hierarchical regression models that examined the effect of LKM intervention on Change in RSA from baseline to recovery and change in RSA from paced breathing task to recovery*

	Change in RSA from paced breathing to recovery[a]			Change in RSA from nature video baseline to recovery[b]		
Predictors	*b*	*t*	*p*	*b*	*t*	*p*
Baseline RSA (during NV)				.79	14.74***	.000
ΔRR (from baseline to recovery)				-.05	-3.32**	.001
Baseline RSA (during PB)	.69	11.00***	.000			
RR (during recovery)	-.04	-2.15*	.034			
LKM Intervention	.10	.72	.476	.04	.36	.722

Notes. NV = Nature video; PB = Paced breathing; RR = Respiration rate
[a]R^2 = 55.3%, adjusted R^2 = 54%, $F(3, 107) = 44.05$, $p < .001$
[b]R^2 = 68.1%, adjusted R^2 = 67.2%, $F(3, 107) = 76.01$, $p < .001$
* $p < .05$ ** $p < .01$ *** $p < .001$

paced breathing baseline to recovery, ΔR^2 = 0.2%, ΔF(1,107) = 0.476, p > .05, or change in RSA from nature video baseline to recovery, ΔR^2 = 0%, ΔF(1,107) = 0.13, p > .05. Table 6 presents *t*-test results of differences between LKM and control groups in implicit attitude, self-report about experience during SST, Stroop variables, and prosocial behavior. Contrary to expectation, none of these variables was significantly different between LKM and control groups (*p*s > .05). However, the difference in Implicit Positivity towards the Self – Positive Relative to Negative Words approached significance (p = .052), indicating that the LKM intervention led to a higher level of implicit positivity towards the self (as construed as a faster response to positive words and a slower response to negative words after self-referring primes) than did the control intervention.[2]

Finally, ANOVA, ANCOVA, and regression analyses revealed no evidence for the LKM Intervention *x* SST effects or the LKM Intervention *x* Sex effects on the main study outcomes (*p*s > .05; tables not shown). Thus, without considering the potential moderating roles of social anxiety and/or mood state, the LKM intervention did not

[2]Because of the skewed distributions of (1) the RT for negative words following self-referring primes (kurtosis = 1.42, *SE* = .455) and (2) the RT for negative words following other-referring primes (kurtosis = 1.34, *SE* = .455), in addition to the original raw scores, all analyses including *t*-test and Models A through C also used log-transformed scores (not shown in tables). Specifically, the mean of natural logarithm transformations of individual-trial latencies were computed for (1) and (2), respectively. “The rationale for the log transformation is provided by the typically extended upper tails of latency distributions. The log transformation improves the symmetry of latency distributions by shrinking the upper tail and is thereby expected to improve central tendency estimates” (Greenwald, Nosek, & Banaji, 2003, p. 200). Additional analyses were also performed for the log-transformed scores of (3) RT for positive words following self-referring primes (kurtosis = .53, *SE* = .455) and (4) RT for positive words following other-referring primes (kurtosis = .63, *SE* = .455). Contrary to expectation, the log-transformed scores (1 – 4) were not significantly predicted by any of the proposed predictors in any of the additional analyses (*p*s > .05).

Table 6. *Independent-samples t-test results for differences between LKM and control groups*

	LKM		Control				
	Mean	*SD*	*Mean*	*SD*	*t*	*df*	*p* (2-tail)
Implicit attitude							
Accuracy	98.33	2.25	98.30	2.23	.08	109	.940
RT (positive words, self primes)	775.92	181.61	789.05	184.67	-.38	109	.707
RT (positive words, other primes)	798.73	198.11	800.14	181.51	-.04	109	.969
RT (negative words, self primes)	823.88	212.81	812.05	187.31	.31	109	.758
RT (negative words, other primes)	819.00	191.71	810.75	182.98	.23	109	.818
Implicit positive bias – self relative to others	22.80	60.22	11.09	50.38	1.10	109	.272
Implicit negative bias – self relative to others	-4.89	64.53	-1.30	54.34	-.32	109	.754
Implicit positive bias – self or others	50.29	39.78	40.55	31.41	1.42	109	.159
Implicit negative bias – self or others	49.94	40.64	38.84	37.64	1.49	109	.140
Implicit positivity towards the self	47.96	70.11	23.00	62.85	1.96	109	.052
Implicit positivity towards others	20.27	67.37	10.61	52.97	.83	109	.407
Self-report about experience during social stress task							
Enjoyment	3.75	2.49	2.98	2.16	1.74	111	.085
Belonging	4.24	1.64	4.06	1.89	.55	111	.586
Control	4.18	1.72	3.96	1.59	.68	111	.499
Stroop							
Accuracy	97.77	2.45	97.90	1.92	-.31	109	.757
Overall RT	855.87	148.48	818.59	160.56	1.27	109	.207
Interference	95.97	66.46	91.15	64.00	.39	109	.698
Prosocial Behavior							
Number of experiments volunteered	1.80	1.35	1.67	1.49	.50	105	.620

Notes. RT = Reaction time; RT (positive words, self primes) = Reaction time for positive words following self-referring primes (a smaller value indicates more positivity towards the self); RT (positive words, other primes) = Reaction time for positive words following other-referring primes (a smaller value indicates more positivity towards others); RT (negative words, self primes) = Reaction time for negative words following self-referring primes (a smaller value indicates more negativity towards the self); RT (negative words, other primes) = Reaction time for negative words following other-referring primes (a smaller value indicates more negativity towards others) demonstrate stress buffering effects that were unique to either of the social stress tasks or either of the sex groups.

Intercorrelations (Collapsing Across Intervention Conditions)

Collapsing across the two intervention conditions, Table 7 presents zero-order correlations among potential predictor and outcome variables. BFNE (an index of social anxiety) was moderately correlated with PA (r = -0.27, $p < .01$) and NA (r = 0.35, $p < .001$) in the expected directions. The moderate correlations support the idea that BFNE, PA, and NA are relatively independent constructs. In addition, consistent with prior research, PA and NA were not correlated (r = 0.08, $p > .05$). The lack of a significant correlation supports the idea that PA and NA represent two different activation systems of affect (e.g., Watson et al., 1999). Also in line with expectations, BFNE (a trait measure of social anxiety obtained before the intervention) was associated with a variety of self-report measures of experience during SST (obtained immediately after the SST), including less PAV, enjoyment, belonging, control, self-esteem, and meaningful existence as well as more stress, feelings of negative evaluation, and anger. PA and NA (state measures of affect prior to the intervention) were associated with several self-report measures of experience during SST (obtained immediately after the SST). PA (prior to intervention) was positively correlated with PAV, enjoyment, control, self-esteem, and meaningful existence during the SST and was negatively correlated with feelings of negative evaluation during SST. NA (prior to intervention) was positively correlated with anger during SST and was negatively correlated with PAV and self-esteem during the

Table 7. *Intercorrelations among potential predictors and outcome variables*

	BFNE	PA	NA	Audio SC	Audio HR	Audio RSA
PA	-.27**					
NA	.35***	.08				
Audio SC	-.08	.02	-.10			
Audio HR	.11	.00	-.06	.23*		
Audio RSA	-.08	.02	-.11	-.02	-.49***	
RT Pos/S	-.09	-.05	-.04	.06	.01	-.02
RT Pos/O	-.05	-.05	.00	.05	-.02	-.00
RT Neg/S	-.06	-.02	-.01	.04	.04	.00
RT Neg/O	-.08	-.04	-.01	.05	.03	-.03
Pos Bias S-O	.12	-.02	.14	-.02	-.08	.04
Neg Bias S/O	.15	-.13	-.10	-.14	.10	-.06
PAV (Time 2)	-.33***	.26**	-.21*	.07	-.09	.30**
AA (Time 2)	.27**	-.17	.13	.04	.09	-.11
Stress	.22*	-.05	.10	.04	.10	-.17
Neg Eval	.40***	-.29**	.17	-.23*	.05	-.11
Anger	.29**	-.13	.25**	-.08	.00	-.12
Enjoyment	-.25**	.25**	-.07	.01	-.10	.21*
Belonging	-.31***	.18	-.13	.21*	-.07	.21*
Control	-.39***	.30**	-.09	-.06	.03	.12
Self-Esteem	-.46***	.27**	-.22*	.17	-.04	.12
Meaning	-.28**	.24*	-.13	.23*	.05	.13
Recovery SC	-.08	.05	-.02	.84***	.13	.01
Recovery HR	.12	-.01	-.07	.18	.93***	-.44***
Recovery RSA	-.09	.03	-.08	-.07	-.58***	.82***
Stroop Acc	.10	-.05	-.01	-.12	-.04	.05
Stroop RT	.05	.01	.08	.06	-.01	-.06
Stroop Int	.06	.01	.14	-.06	.12	-.03
Volunteer	-.10	.04	-.12	.03	.13	-.05

Notes. RT = Reaction time; RT (Pos/S) = Reaction time for positive words following self-referring primes; RT (Pos/O) = Reaction time for positive words following other-referring primes; RT (Neg/S) = Reaction time for negative words following self-referring primes; RT (Neg/O) = Reaction time for negative words following other-referring primes; Pos Bias (S-O) = Implicit positive bias – self relative to others; Neg Bias (S/O) = Implicit negative bias – self or others; PAV = Positive affective valence; AA = Affective arousal; Stroop Acc = Stroop accuracy; Stroop Int = Stroop interference; Volunteer = Number of experiments volunteered for; * $p < .05$ ** $p < .01$ *** $p < .001$

Table 7 (continued). *Intercorrelations among potential predictors and outcome variables*

	RT Pos/S	RT Pos/O	RT Neg/S	RT Neg/O	Pos Bias S-O	Neg Bias S/O
RT Pos/O	.96***					
RT Neg/S	.94***	.94***				
RT Neg/O	.96***	.95***	.96***			
Pos Bias S-O	-.02	.28***	.13	.10		
Neg Bias S/O	.10	.13	.20*	.18	.12	
PAV (Time 2)	-.10	-.11	-.12	-.12	-.04	-.23*
AA (Time 2)	.08	.06	.07	.09	-.05	.07
Stress	.21*	.23*	.22*	.24*	.07	.03
Neg Eval	.10	.09	.12	.12	-.03	.19*
Anger	.08	.13	.09	.10	.18	.18
Enjoyment	-.07	-.10	-.10	-.12	-.11	-.12
Belonging	.02	.011	-.01	.00	-.03	-.16
Control	-.13	-.14	-.18	-.17	-.06	-.16
Self-Esteem	-.02	-.04	-.03	-.03	-.06	-.22*
Meaning	-.07	-.05	-.03	-.08	.08	-.17
Recovery SC	-.00	.00	-.01	-.00	.01	-.13
Recovery HR	.04	.02	.06	.06	-.07	.11
Recovery RSA	-.12	-.12	-.11	-.14	-.01	-.09
Stroop Acc	.20*	.23*	.24*	.23*	.12	.03
Stroop RT	.32**	.37***	.36***	.40***	.20*	.18
Stroop Int	.13	.19	.21*	.21*	.20*	.16
Volunteer	-.01	.00	.01	.02	.05	-.02

Notes. Implicit Negative Bias – Self Relative to Others and Implicit Positivity towards Others – Positive Relative to Negative Words were not significantly correlated with any of the outcome variables (*p*s > .05; not shown in table). Implicit Positivity towards the Self – Positive Relative to Negative Words was not significantly correlated with any of the outcome variables (*p*s > .05; not shown in table) except for Stroop RT and Stroop interference ($r = .21$, $p < .05$ and $r = .27$, $p < .01$, respectively; not shown in table); RT = Reaction time; RT (Pos/S) = Reaction time for positive words following self-referring primes (a smaller value indicates more positivity towards the self); RT (Pos/O) = Reaction time for positive words following other-referring primes (a smaller value indicates more positivity towards others); RT (Neg/S) = Reaction time for negative words following self-referring primes (a smaller value indicates more negativity towards the self); RT (Neg/O) = Reaction time for negative words following other-referring primes (a smaller value indicates more negativity towards others); Pos Bias (S-O) = Implicit positive bias – self relative to others; Neg Bias (S/O) = Implicit negative bias – self or others; PAV = Positive affective valence; AA = Affective arousal; Stroop Acc = Stroop accuracy; Stroop Int = Strop interference; Volunteer = Number of experiments volunteered for; * $p < .05$ ** $p < .01$ *** $p < .001$

SST. Take together, these correlational results support the idea that individuals high in social anxiety, low in PA, or high in NA have more difficulties coping with social stress.

Physiological variables measured during audio intervention were correlated with some of the outcome variables. SC during audio (Audio SC) was positively correlated with belonging, meaningful existence, and, as expected, SC during the recovery period (Recovery SC); in addition, Audio SC was negatively correlated with feelings of negative evaluation. HR during audio (Audio HR), as expected, was positively correlated with HR during recovery (Recovery HR), and was negatively correlated with RSA during recovery (Recovery RSA). Audio RSA was associated with higher PAV, greater enjoyment, and more belonging; as expected, Audio RSA was positively correlated with Recovery RSA and was negatively correlated with Recovery HR.

Reaction time (RT) across all four categories of stimuli (positive words following self-referring primes, positive words following other-referring primes, negative words following self-referring primes, and negative words following other-referring primes) in the implicit attitude assessment were positively correlated with stress and Stroop RT. These results showed that participants who had less positivity towards the self and others tended to experience more stress during the SST and respond more slowly in the Stroop task. However, contrary to expectation, these results also showed that participants who had less negativity towards the self and others tended to experience more stress during the SST and responded more slowly in the Stroop task.

The inconsistency in these results suggests it is more likely that those who reacted more slowly in the lexical decision task, perhaps as a result of a lower level of attentional or regulatory resources, tended to be more stressed during the social stress task and to react more slowly in the Stroop task. Similarly, it is likely that RT for negative words following self-referring and RT for negative words following other-referring primes were positively correlated with Stroop interference, Implicit Positive Bias – Self Relative to Others was positively correlated with both Stroop RT and Stroop interference, and Implicit Positivity towards the Self – Positive Relative to Negative Words was also positively correlated with both Stroop RT (r = .21, $p < .05$; not shown in table) and Stroop interference (r = .27, $p < .01$; not shown in table) because they all shared overlapping variance related to reaction time to attention-demanding tasks.

Implicit Negative Bias – Self or Others (measured immediately after the intervention through implicit attitude assessment) was correlated with three outcome variables in the expected directions. Specifically, Implicit Negative Bias – Self or Others was positively correlated with feelings of negative evaluations during SST and was negatively correlated with PAV and self-esteem during SST. These correlational findings suggest that Audio SC, Audio HR, Audio RSA, and Implicit Negative Bias – Self or Others can potentially serve as a mediator for any moderated LKM effects that I present below.

Moderation Analyses

Model A: Effects of LKM Intervention x BFNE. Table 8 presents results of hierarchical regression analyses that examined whether BFNE (a trait measure of social anxiety obtained before the intervention) moderated effects of the LKM Intervention. For each outcome variable, the appropriate baseline variable and covariate (if any), LKM

Table 8. *Hierarchical linear regression results for Model A*

	Overall Model			LKM Intervention *x* BFNE		
	Adjusted R^2	*F*	*df*	ΔR^2	ΔF	*df*
Mean audio SC – *accounting for NVB*	.90	238.36***	4, 101	.00	.10	1, 101
Mean audio HR – *accounting for NVB*	.94	437.92***	4, 106	.00	.48	1, 106
Mean audio RSA[a] – *accounting for PBB*	.62	36.69***	5, 105	.00	.43	1, 105
Mean audio RSA[b] – *accounting for NVB*	.77	74.05***	5, 105	.00	.00	1, 105
Implicit attitude accuracy	-.02	.47	3, 107	.01	.85	1, 107
RT (positive words, self primes)	-.01	.76	3, 107	.01	1.35	1, 107
RT (positive words, other primes)	-.01	.66	3, 107	.02	1.73	1, 107
RT (negative words, self primes)	-.01	.60	3, 107	.01	1.37	1, 107
RT (negative words, other primes)	-.02	.47	3, 107	.01	.66	1, 107
Implicit positive bias – self relative to others	.00	1.05	3, 107	.00	.47	1, 107
Implicit negative bias – self relative to others	-.01	.80	3, 107	.02	1.91	1, 107
Implicit positive bias – self or others	.00	1.09	3, 107	.00	.01	1, 107
Implicit negative bias – self or others	.02	1.85	3, 107	.01	.75	1, 107
Implicit positivity towards the self	.01	1.45	3, 107	.00	.12	1, 107
Implicit positivity towards others	.01	1.44	3, 107	.02	2.60	1, 107
PAV† – *accounting for baseline*	.25	8.57***	5, 106	.00	.17	1, 106
AA† – *accounting for baseline*	.45	18.91***	5, 106	.00	.78	1, 106
Stress†	.57	38.00***	4, 108	.00	.24	1, 108
Feelings of negative evaluation†	.40	19.94***	4, 108	.00	.37	1, 108
Anger†	.15	5.84***	4, 108	.00	.14	1, 108
Enjoyment	.07	3.70*	3, 109	.00	.18	1, 109
Belonging	.08	4.09**	3, 109	.00	.22	1, 109
Control	.15	7.36***	3, 109	.01	1.63	1, 109
Self-esteem†	.28	12.06***	4, 108	.00	.00	1, 108
Meaningful existence†	.15	5.89***	4, 108	.01	1.21	1, 108

Notes. None of the LKM Intervention *x* BFNE effects was significant (*p*s > .05).
NVB = Nature video baseline; PBB = Paced breathing baseline; RT = Reaction time
† Type of social stress task (i.e., TSST vs. Cyberball) was included as a covariate.
[a]Respiration rate during audio was included as a covariate in this analysis.
[b]Change in respiration rate from nature video baseline to audio was included as a covariate.
* $p < .05$ ** $p < .01$ *** $p < .001$

Table 8 (continued). *Hierarchical linear regression results for Model A*

	Overall Model			LKM Intervention *x* BFNE		
	Adjusted R^2	*F*	*df*	ΔR^2	ΔF	*df*
Mean recovery SC – *accounting for NVB*	.71	67.315***	4, 101	.00	1.06	1, 101
Mean recovery HR – *accounting for NVB*	.87	183.467***	4, 106	.00	.13	1, 106
Mean recovery RSA[c] – *accounting for PBB*	.54	26.97***	5, 105	.01	2.31	1, 105
Mean recovery RSA[d] – *accounting for NVB*	.67	45.50***	5, 105	.00	1.14	1, 105
Stroop accuracy	-.02	.41	3, 107	.00	.02	1, 107
Stroop reaction time	.03	1.92	3, 107	.03	3.87	1, 107
Stroop interference	-.01	.49	3, 107	.01	.88	1, 107
Number of experiments volunteered	-.02	.47	3, 103	.00	.21	1, 103

Notes. None of the LKM Intervention *x* BFNE effects was significant (*p*s > .05).
NVB = Nature video baseline; PBB = Paced breathing baseline
[c]Respiration rate during recovery was included as a covariate in this analysis.
[d]Change in respiration rate from nature video baseline to recovery was included as a covariate.
*** $p < .001$

Intervention, and BFNE were entered in the first step of the hierarchical regression model, and the LKM Intervention *x* BFNE interaction was entered in the second step. Contrary to expectation, no significant LKM Intervention *x* BFNE effect was found for any of the outcome variables.

Model B: Effects of LKM Intervention x BFNE x PA. Table 9 presents results of hierarchical regression analyses that examined whether BFNE (a trait measure obtained before the intervention) and PA (a state measure obtained before the intervention) moderated effects of the LKM Intervention. For each outcome variable, the appropriate baseline variable and covariate (if any), LKM Intervention, BFNE, PA, LKM Intervention *x* BFNE, LKM Intervention *x* PA, and BFNE *x* PA were entered in the first

Table 9. *Hierarchical linear regression results for Model B*

	Overall Model			LKM Intervention *x* BFNE *x* PA		
	Adjusted R^2	*F*	*df*	ΔR^2	ΔF	*df*
Mean audio SC – *accounting for NVB*	0.90	115.58***	8, 97	.000	.03	1, 97
Mean audio HR – *accounting for NVB*	0.94	219.67***	8, 102	.002	2.90	1, 102
Mean audio RSA[a] – *accounting for PBB*	0.64	22.52***	9, 101	.000	.00	1, 101
Mean audio RSA[b] – *accounting for NVB*	0.77	41.21***	9, 101	.004	2.09	1, 101
Implicit attitude accuracy	0.02	1.29	7, 103	.008	.90	1, 103
RT (positive words, self primes)	-.01	.79	7, 103	.013	1.39	1, 103
RT (positive words, other primes)	-.02	.64	7, 103	.010	1.08	1, 103
RT (negative words, self primes)	-.03	.59	7, 103	.006	.60	1, 103
RT (negative words, other primes)	-.03	.51	7, 103	.005	.51	1, 103
Implicit positive bias – self relative to others	.00	1.02	7, 103	.001	.09	1, 103
Implicit negative bias – self relative to others	-.03	.49	7, 103	.001	.12	1, 103
Implicit positive bias – self or others	0.07	2.10	7, 103	.000	.04	1, 103
Implicit negative bias – self or others	0.03	1.46	7, 103	.008	.87	1, 103
Implicit positivity towards the self	-.01	.91	7, 103	.007	.76	1, 103
Implicit positivity towards others	.05	1.75	7, 103	.010	1.13	1, 103
PAV† – *accounting for baseline*	0.25	5.12***	9, 102	.005	.67	1, 102
AA† – *accounting for baseline*	0.48	12.31***	9, 102	.002	.40	1, 102
Stress†	0.56	18.44***	8, 104	.000	.00	1, 104
Feelings of negative evaluation†	0.42	11.26***	8, 104	.000	.03	1, 104
Anger†	0.13	3.13**	8, 104	.000	.01	1, 104
Enjoyment	0.08	2.37*	7, 105	.000	.03	1, 105
Belonging	0.07	2.29*	7, 105	.013	1.53	1, 105
Control	0.18	4.40***	7, 105	.007	.94	1, 105
Self-esteem†	0.28	6.49***	8, 104	.001	.13	1, 104
Meaningful existence†	0.15	3.37**	8, 104	.000	.00	1, 104

Notes. NVB = Nature video baseline; PBB = Paced breathing baseline; RT = Reaction time

† Type of social stress task (i.e., TSST vs. Cyberball) was included as a covariate.

[a]Respiration rate during audio was included as a covariate in this analysis.

[b]Change in respiration rate from nature video baseline to audio was included as a covariate.

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 9 (continued). *Hierarchical linear regression results for Model B*

	Overall Model			LKM Intervention *x* BFNE *x* PA		
	Adjusted R^2	*F*	*df*	ΔR^2	ΔF	*df*
Mean audio SC – *accounting for NVB*	0.72	34.69***	8, 97	.004	1.62	1, 97
Mean audio HR – *accounting for NVB*	0.88	98.89***	8, 102	.006	5.79*	1, 102
Mean audio RSA[c] – *accounting for PBB*	0.55	16.02***	9, 101	.001	.14	1, 101
Mean audio RSA[d] – *accounting for NVB*	0.66	25.18***	9, 101	.002	.58	1, 101
Stroop accuracy	-0.04	0.39	7, 103	.011	1.17	1, 103
Stroop reaction time	0.00	0.97	7, 103	.008	.93	1, 103
Stroop interference	-0.05	0.27	7, 103	.003	.33	1, 103
Number of experiments volunteered	-0.06	0.21	7, 99	.001	.11	1, 99

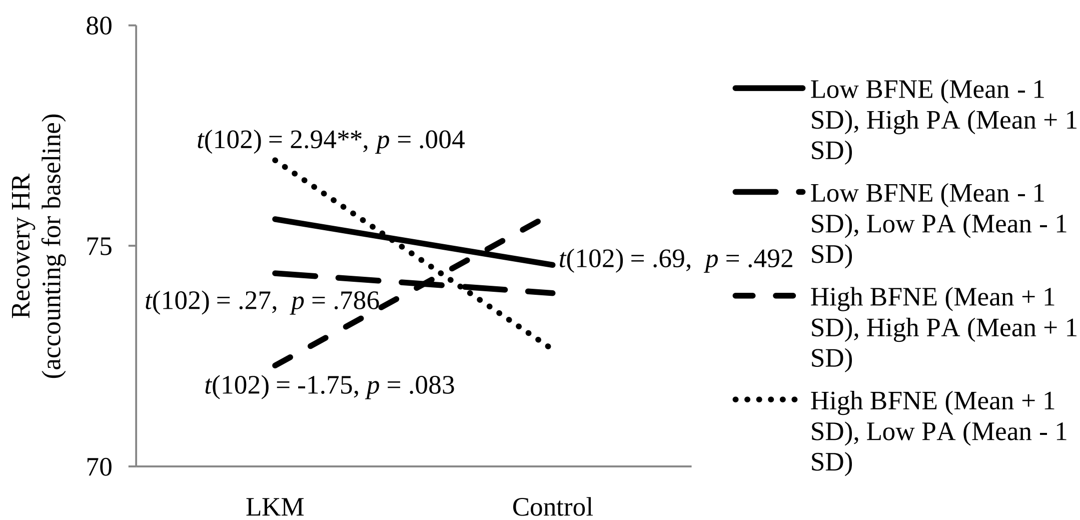
Notes. NVB = Nature video baseline; PBB = Paced breathing baseline
[c]Respiration rate during recovery was included as a covariate in this analysis.
[d]Change in respiration rate from nature video baseline to recovery was included as a covariate.
* $p < .05$ *** $p < .001$

step of the hierarchical regression model, and LKM Intervention *x* BFNE *x* PA was entered in the second step. Results of Model B showed a significant LKM Intervention *x* BFNE *x* PA effect in predicting change in HR from baseline to recovery (ΔR^2 = 0.6%, $p < .05$). None of the other LKM Intervention *x* BFNE *x* PA effects was significant (*p*s > .05). However, significant LKM Intervention *x* PA effects were found for change in RSA from paced breathing baseline to audio, Implicit Positive Bias – Self or Others, and change in RSA from paced breathing baseline to recovery (*p*s < .05).

Probing significant LKM Intervention x BFNE x PA effect. To examine the significant LKM Intervention *x* BFNE *x* PA interaction effect on Recovery HR (accounting for baseline), simple slopes were computed at two particular values of

BFNE, i.e., mean + 1 *SD* (High BFNE) and mean – 1 *SD* (Low BFNE) (both of which stay within the observed range of BFNE) and at two particular values of PA, i.e., mean + 1 *SD* (High PA) and mean – 1 *SD* (Low PA) (both of which stay within the observed range of PA). Specifically, based on the two continuous variables, simple slopes were computed for four hypothetical groups of individuals: (1) Low BFNE and High PA; (2) Low BFNE and Low PA; (3) High BFNE and High PA; and (4) High BFNE and Low PA (see Figure 2). A significance test for each simple slope was performed by regressing Recovery HR on baseline HR, LKM Intervention, BFNE (high or low), PA (high or low), LKM Intervention *x* BFNE (high or low), LKM Intervention *x* PA (high or low), BFNE (high or low) *x* PA (high or low), and the three-way interaction term LKM Intervention *x* BFNE (high or low) *x* PA (high or low). As shown in the figure, the simple slope for the

Figure 2. Simple slopes for change in heart rate (HR) from baseline to recovery for four hypothetical groups of individuals who differ in Brief Fear of Negative Evaluation (BFNE; mean + 1 *SD* or mean – 1 *SD*) and Positive Affect (PA; mean + 1 *SD* or mean – 1 *SD*)



High BFNE and Low PA group was significantly different from zero ($p < .01$), but the simple slopes for the rest of the groups were not (ps > .05). These results suggest that LKM Intervention's effect on Recovery HR (accounting for baseline) was only significant among those who had the "double deficit" of being high in social anxiety and low in (pre-intervention) positive affect. Specifically, compared to control participants who were high in social anxiety and low in (pre-intervention) positive affect, LKM participants who were also high in social anxiety and low in (pre-intervention) positive affect showed less reduction in HR from the nature video baseline to the post-SST recovery period. However, among the rest of the participants, LKM Intervention had no effect on change in HR from baseline to recovery. These findings suggest the possibility that LKM may have a detrimental physiological effect on those who have the "double deficit" of being high in social anxiety and low in (pre-intervention) positive affect.

Probing significant LKM x PA effects. Table 10 presents results of hierarchical models that tested the LKM Intervention *x* PA effects on change in RSA from paced breathing baseline to audio, Implicit Positive Bias – Self or Others, and change in RSA from paced breathing baseline to recovery (without controlling for BFNE, LKM Intervention *x* BFNE, or LKM Intervention *x* BFNE *x* PA). Results confirmed the significant LKM Intervention *x* PA effects in predicting Audio RSA (accounting for paced breathing RSA and respiration rate during audio), Implicit Positive Bias – Self or Others, and Recovery RSA (accounting for paced breathing RSA and respiration rate during recovery) (ps < .05).

To examine the significant LKM Intervention *x* PA effects, simple slopes were

Table 10. *Hierarchical linear regression results for the LKM Intervention x PA effects*

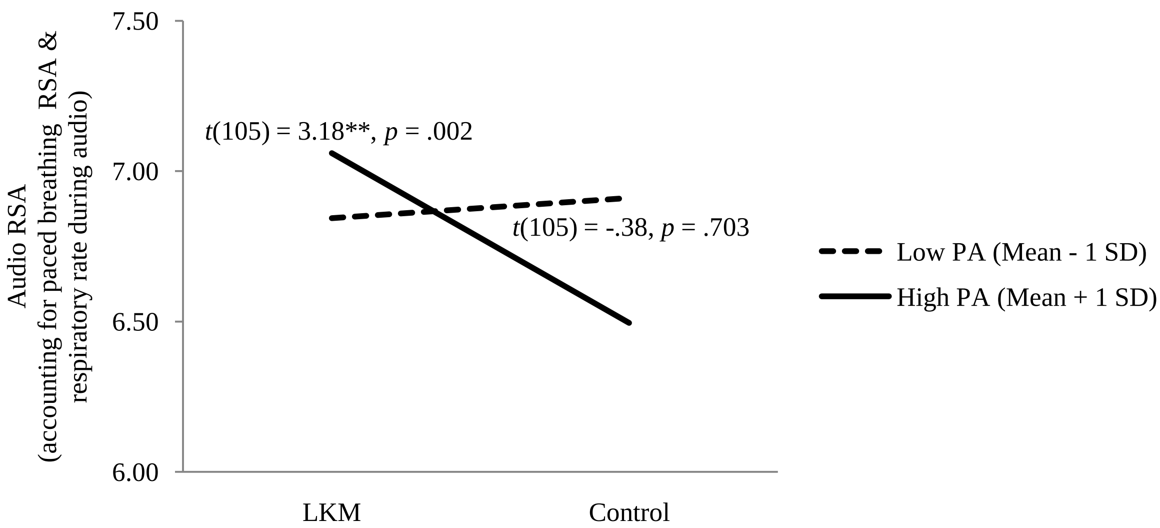
	Overall Model			LKM Intervention *x* PA		
	Adjusted R^2	*F*	*df*	ΔR^2	*F*	*df*
Mean audio RSA[a] – *accounting for PBB*	.64	40.40***	5, 105	.022	6.87*	1, 105
Implicit positive bias – self or others	.06	3.33*	3, 109	.076	9.00**	1, 109
Mean recovery RSA[b] – *accounting for PBB*	.57	29.60***	5, 105	.032	8.21**	1, 105

Notes. PBB = Paced breathing baseline
[a]Respiration rate during audio was included as a covariate.
[b]Respiration rate during recovery was included as a covariate.
* $p < .05$ ** $p < .01$ *** $p < .001$

computed for each outcome variable at two particular values of PA, i.e., mean + 1 *SD* (High PA) and mean – 1 *SD* (Low PA) (both of which stay within the observed range of PA). In addition, a significance test for each simple slope was performed by regressing the outcome variable on the appropriate baseline variable and covariate (if any), LKM Intervention, PA (high or low), and the product term.

Figure 3 presents the simple slopes for Audio RSA (accounting for paced breathing RSA and respiration rate during audio) for two hypothetical groups of individuals, i.e., those who are 1 *SD* above the mean of PA (High PA) and those who are 1 *SD* below the mean of PA (Low PA). Significance test results showed that the simple slope for the High PA group was significantly different from zero ($p < .01$), but the simple slope for the Low PA group was not ($p > .05$). These results revealed that LKM Intervention's effect on change in RSA from paced breathing baseline to audio was only significant among those who had the "advantage" of being high in (pre-intervention) positive affect. Specifically, compared to control participants who were high in (pre-

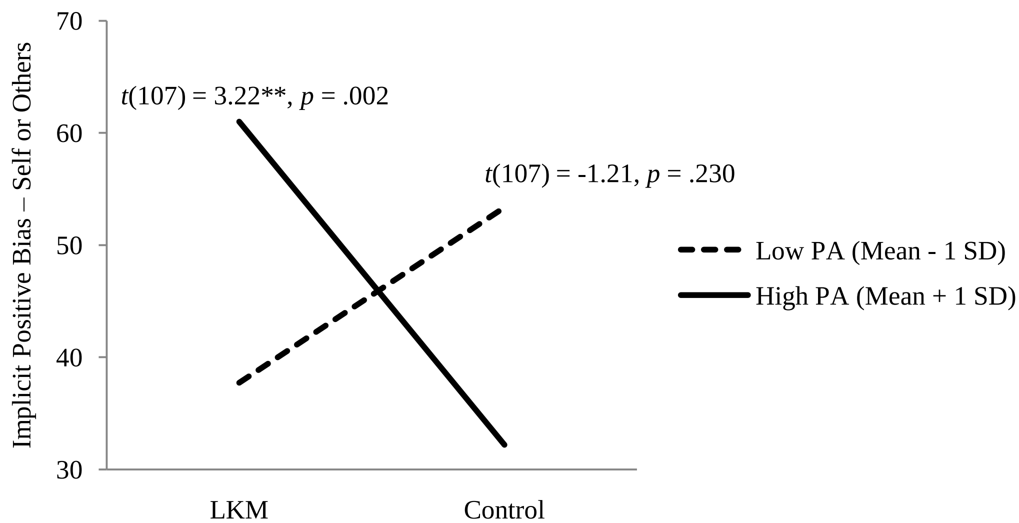
Figure 3. Simple slopes for change in RSA from paced breathing task to audio at 1 *SD* above the mean of Positive Affect and 1 *SD* below the mean of Positive Affect (PA)



intervention) positive affect, LKM participants who were also high in (pre-intervention) positive affect had less decrease in RSA from the paced breathing baseline to the audio, indicating less decrease in vagal capacity for autonomic responses (cf. Beauchaine, 2001). However, among participants who were low in (pre- intervention) positive affect, LKM Intervention had no effect on change in RSA from paced breathing baseline to audio. These findings suggest that LKM may have a beneficial physiological effect for those have the “advantage” of being high in (pre- intervention) positive affect but not for those who are low in (pre-intervention) positive affect.

Figure 4 presents the simple slopes for Implicit Positive Bias – Self or Others for two hypothetical groups of individuals, i.e., those who are 1 *SD* above the mean of PA (High PA) and those who are 1 *SD* below the mean of PA (Low PA). Significance test results showed that the simple slope for the High PA group was significantly different

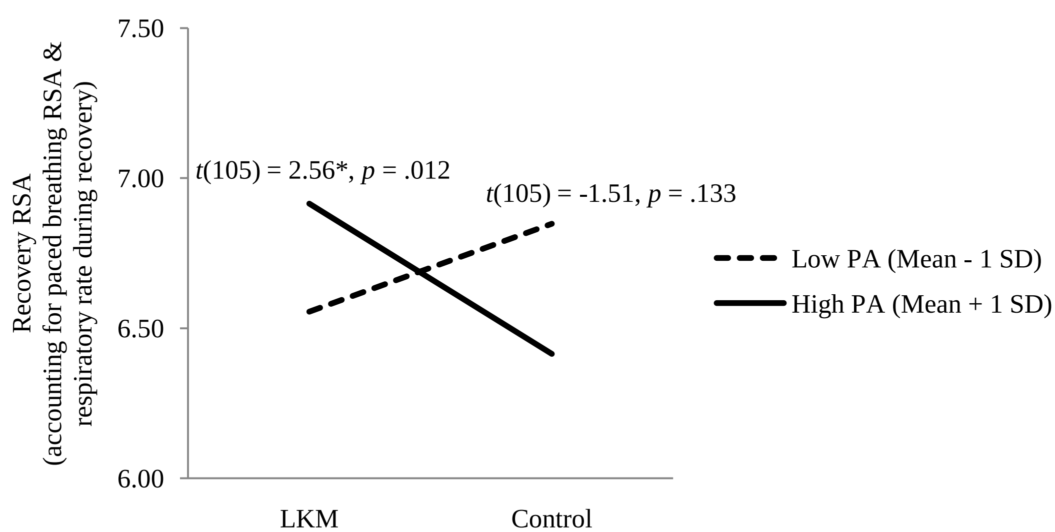
Figure 4. Simple slopes for Implicit Positive Bias – Self or Others at 1 *SD* above the mean of Positive Affect and 1 *SD* below the mean of Positive Affect (PA)



from zero ($p < .01$), but the simple slope for the Low PA group was not ($p > .05$). These results revealed that LKM Intervention's effect on Implicit Positive Bias – Self or Others was, again, only significant among those who had the "advantage" of being high in (pre-intervention) positive affect. Specifically, compared to control participants who were high in (pre-intervention) positive affect, LKM participants who were also high in (pre-intervention) positive affect had a higher level of positive bias towards the self (relative to others) or others (relative to the self) after the audio intervention. In contrast, among participants who were low in (pre-intervention) positive affect, LKM intervention had no effect on Implicit Positive Bias – Self or Others. However, it is arguable whether a higher level of implicit positive bias towards the self (relative to others) or others (relative to the self) is a positive cognitive effect. In the present sample, the majority of the participants (63.70%; 34.51% LKM participants and 29.20% control participants) had a higher level of implicit positive bias towards the self (relative to others) and the remaining participants (36.3%; 17.70% LKM participants and 18.58% control participants) had a higher level of implicit positive bias towards others (relative to the self).

Figure 5 presents the simple slopes for Recovery RSA (accounting for paced breathing RSA and respiration rate during recovery) for two hypothetical groups of individuals, i.e., those who are 1 *SD* above the mean of PA (High PA) and those who are 1 *SD* below the mean of PA (Low PA). Significance test results showed that the simple slope for the High PA group was significantly different from zero ($p < .05$), but the simple slope for the Low PA group was not ($p > .05$). In congruence with the findings for change in RSA from paced breathing baseline to audio, these findings suggest that LKM may have a beneficial physiological effect for those have the “advantage” of being high in (pre-intervention) positive affect but not for those who are low in (pre-intervention) positive affect. Specifically, participants who received a pre-SST session of LKM had

Figure 5. Simple slopes for change in RSA from paced breathing baseline to recovery at 1 *SD* above the mean of Positive Affect and 1 *SD* below the mean of Positive Affect (PA)



less decrease in RSA from paced breathing baseline to recovery *if* they reported a high level of positive affect prior to the intervention, indicating greater persistence or maintenance of autonomic capacity among high positive affect participants after the social stress tasks. Take together, findings of the LKM Intervention *x* PA effects suggest that LKM may benefit those who are high in (pre-intervention) positive affect by producing positive changes in physiology.

Model C: Effects of LKM Intervention x BFNE x NA. Table 11 presents results of hierarchical regression analyses that examined whether BFNE (a trait measure obtained before the intervention) and NA (a state measure obtained before the intervention) moderated effects of the LKM Intervention. For each outcome variable, the appropriate baseline variable and covariate (if any), LKM Intervention, BFNE, NA, LKM Intervention *x* BFNE, LKM Intervention *x* NA, and BFNE *x* NA were entered in the first step of the hierarchical regression model, and LKM Intervention *x* BFNE *x* NA was entered in the second step. Results of Model C showed significant LKM Intervention *x* BFNE *x* NA effects in predicting Implicit Negative Bias – Self or Others (ΔR^2 = 5.1%, $p < .05$) and Positive Affective Valence (ΔR^2 = 3.4%, $p < .05$).

Because the LKM Intervention *x* BFNE *x* NA effect in predicting self-esteem during SST approached significance ($p = .062$), I examined this 3-way interaction effect in the TSST group and the Cyberball group separately. Results showed that the LKM Intervention *x* BFNE *x* NA effect was significant in predicting self-esteem in the Cyberball group, ΔR^2= 8.1%, $\Delta F(1, 48) = 5.61$, $p < .05$, but not in the TSST group, ΔR^2=

Table 11. *Hierarchical linear regression results for Model C*

	Overall Model			LKM Intervention *x* BFNE *x* NA		
	Adjusted R^2	*F*	*df*	ΔR^2	*F*	*df*
Mean audio SC – *accounting for NVB*	.90	118.60***	8, 97	.000	.47	1, 97
Mean audio HR – *accounting for NVB*	.94	213.89***	8, 102	.000	.52	1, 102
Mean audio RSA[a] – *accounting for PBB*	.63	21.42***	9, 101	.013	3.75	1, 101
Mean audio RSA[b] – *accounting for NVB*	.76	40.26***	9, 101	.000	.01	1, 101
Implicit attitude accuracy	-.02	.73	7, 103	.020	2.14	1, 103
RT (positive words, self primes)	-.04	.44	7, 103	.000	.03	1, 103
RT (positive words, other primes)	-.03	.51	7, 103	.000	.02	1, 103
RT (negative words, self primes)	-.03	.50	7, 103	.003	.31	1, 103
RT (negative words, other primes)	-.04	.38	7, 103	.002	.18	1, 103
Implicit positive bias – self relative to others	-.01	.89	7, 103	.000	.01	1, 103
Implicit negative bias – self relative to others	-.04	.47	7, 103	.003	.30	1, 103
Implicit positive bias – self or others	.03	1.41	7, 103	.014	1.56	1, 103
Implicit negative bias – self or others	.08	2.39*	7, 103	.051	6.05*	1, 103
Implicit positivity towards the self	.01	1.07	7, 103	.014	1.51	1, 103
Implicit positivity towards the others	-.01	.81	7, 103	.007	.80	1, 103
Positive affective valence†	.27	5.47***	9, 102	.034	5.10*	1, 102
Affective arousal†	.45	11.21***	9, 102	.005	1.03	1, 102
Stress†	.56	18.72***	8, 104	.001	.14	1, 104
Feelings of negative evaluation†	.39	10.03***	8, 104	.008	1.45	1, 104
Anger†	.16	3.73**	8, 104	.006	.81	1, 104
Enjoyment	.05	1.91	7, 105	.008	.99	1, 105
Belonging	.06	2.01	7, 105	.017	1.98	1, 105
Control	.14	3.59**	7, 105	.005	.68	1, 105
Self-esteem†	.29	6.84***	8, 104	.023	3.57	1, 104
Meaningful existence†	.12	2.94**	8, 104	.000	.01	1, 104

Notes. † Type of social stress task (i.e., TSST vs. Cyberball) was included as a covariate.
NVB = Nature video baseline; PBB = Paced breathing baseline; RT = Reaction time
[a]Respiration rate during audio was included as a covariate in this analysis.
[b]Change in respiration rate from nature video baseline to audio was included as a covariate.
* $p < .05$ ** $p < .01$ *** $p < .001$

Table 11 (continued). *Hierarchical linear regression results for Model C*

	Overall Model			LKM Intervention *x* BFNE *x* NA		
	Adjusted R^2	*F*	*df*	ΔR^2	*F*	*df*
Mean audio SC – *accounting for NVB*	.71	33.69***	8, 97	.000	.02	1, 97
Mean audio HR – *accounting for NVB*	.87	90.84***	8, 102	.000	.00	1, 102
Mean audio RSA[c] – *accounting for PBB*	.54	15.05***	9, 101	.004	.92	1, 101
Mean audio RSA[d] – *accounting for NVB*	.67	25.23***	9, 101	.003	.94	1, 101
Stroop accuracy	-.03	.52	7, 103	.010	1.02	1, 103
Stroop reaction time	.00	1.05	7, 103	.001	.15	1, 103
Stroop interference	.00	.96	7, 103	.022	2.43	1, 103
Number of experiments	-.01	.87	7, 99	.004	.39	1, 99

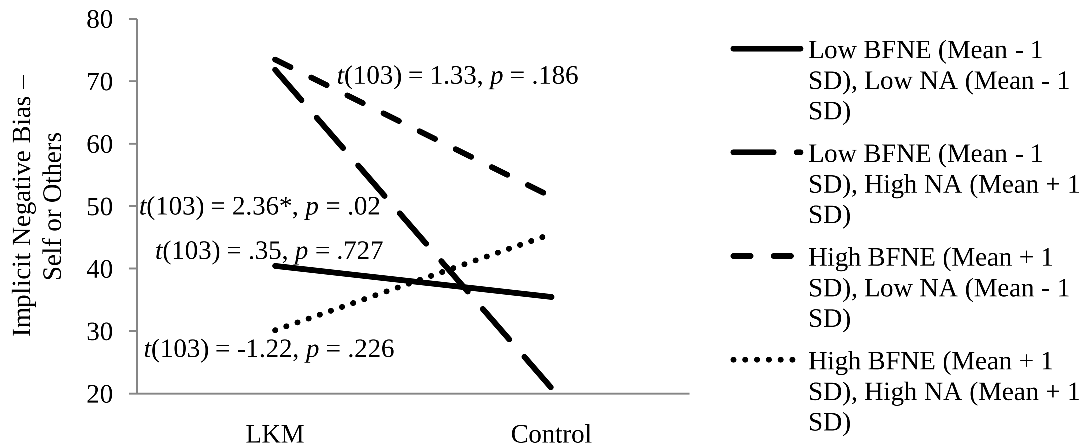
Notes. NVB = Nature video baseline; PBB = Paced breathing baseline
[c]Respiration rate during recovery was included as a covariate in this analysis.
[d]Change in respiration rate from nature video baseline to recovery was included as a covariate.
*** $p < .001$

0.7%, $\Delta F(1, 49) = .52$, $p > .05$. The lack of significance of these LKM Intervention *x* BFNE *x* NA effects in the overall sample was likely due to insufficient statistical power. The LKM Intervention *x* BFNE *x* NA effect on Stroop interference was also examined separately in the two SST groups. Results showed that the LKM Intervention *x* BFNE *x* NA interaction term contributed to a 5.9% increase in adjusted R^2 in the TSST group, $\Delta R^2 = 11.3\%$, $\Delta F(1, 48) = 6.62$, $p < .05$. Although the overall model was not significant, $R^2 = 17.9\%$, $F(7, 48) = 1.49$, $p > .05$, probably due to the large number of parameters in relation to the number of participants ($n = 56$), these findings suggest the possibility that LKM is effective in buffering against depletion in self-regulatory resources (as indexed by Stroop interference level) following a social evaluative stressor. In contrast to these findings in the TSST group, the LKM Intervention *x* BFNE *x* NA interaction effect was not significant in predicting Stroop interference in the Cyberball group, ΔR^2= 0.1%, $\Delta F(1, 47) = .03$, $p > .05$.

Probing significant LKM Intervention x BFNE x NA effects. To examine the significant LKM Intervention *x* BFNE *x* NA effects on Implicit Negative Bias – Self or Others, PAV during SST, self-esteem during SST (in the Cyberball group) and Stroop interference (in the TSST group), simple slopes were computed for each outcome variable at two particular values of BFNE, i.e., mean + 1 *SD* (High BFNE) and mean – 1 *SD* (Low BFNE) (both of which stay within the observed range of BFNE) and at two particular values of NA, i.e., mean + 1 *SD* (High NA) and mean – 1 *SD* (Low NA) (both of which stay within the observed range of NA). Specifically, simple slopes were computed for four hypothetical groups of individuals: (1) Low BFNE and Low NA; (2) Low BFNE and High NA; (3) High BFNE and Low NA; and (4) High BFNE and High NA. A significance test for each simple slope was performed by regressing the outcome variable on LKM Intervention, BFNE (high or low), NA (high or low), LKM Intervention *x* BFNE (high or low), LKM Intervention *x* NA (high or low), BFNE (high or low) *x* NA (high or low), and the three-way interaction term LKM Intervention *x* BFNE (high or low) *x* NA (high or low).

Figure 6 presents the simple slopes for Implicit Negative Bias – Self or Others for four hypothetical groups of individuals who differ in BFNE (mean + 1 *SD* or mean – 1 *SD*) and NA (mean + 1 *SD* or mean – 1 *SD*). Significance test results showed that the simple slope for the Low BFNE and High NA group was significantly different from zero

Figure 6. Simple slopes for Implicit Negative Bias – Self or Others for four hypothetical groups of individuals who differ in Brief Fear of Negative Evaluation (BFNE; mean + 1 *SD* or mean – 1 *SD*) and Negative Affect (NA; mean + 1 *SD* or mean – 1 *SD*)

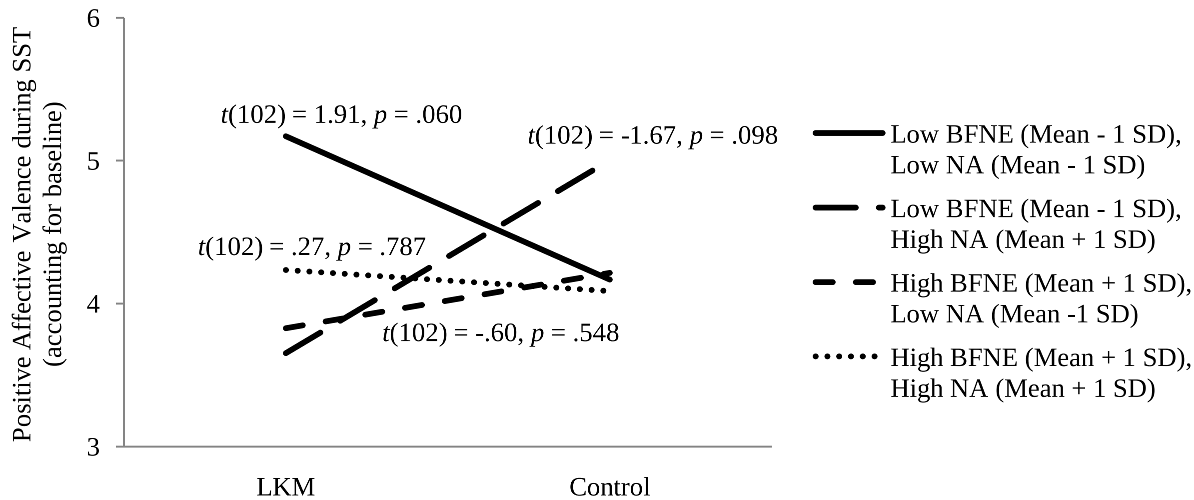


($p < .05$), but the simple slopes for the rest of the groups were not (*p*s > .05). Compared to control participants who were low in social anxiety but high in (pre-intervention) negative affect, LKM participants who were also low in social anxiety but high in (pre-intervention) negative affect had a higher level of negative bias towards the self or others. However, among participants who were low in both social anxiety and (pre-intervention) negative affect and among participants who were high in social anxiety, LKM Intervention had no effect on Implicit Negative Bias – Self or Others. These findings suggest the possibility that LKM may have a detrimental effect on implicit interpersonal cognition for those who are low in social anxiety but high in (pre-intervention) negative affect.

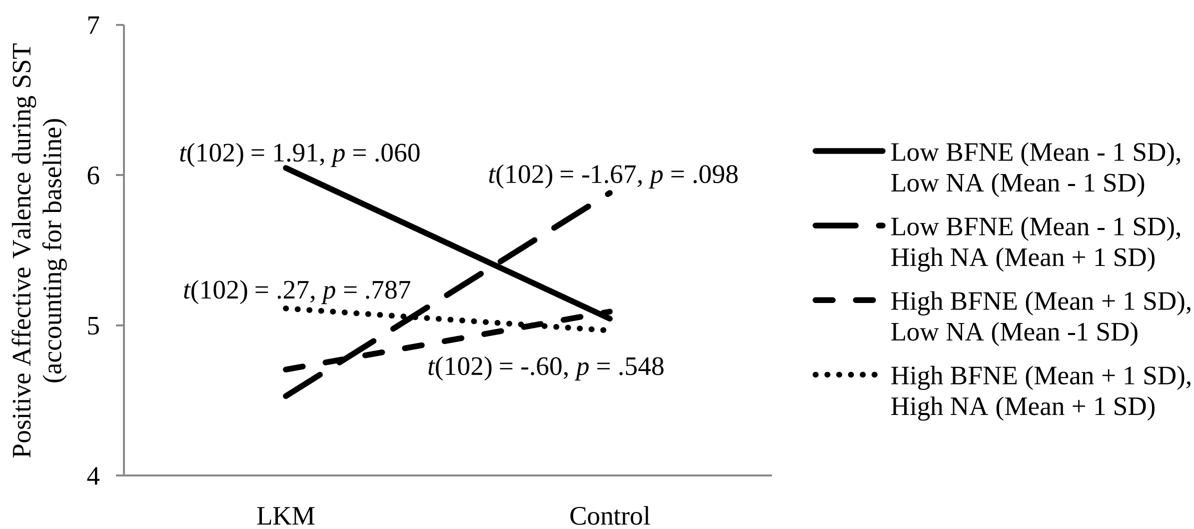
Figure 7 presents the simple slopes for PAV during SST (accounting for baseline). For each SST group (i.e., the TSST group who scored significantly lower in

Figure 7. Simple slopes for Positive Affective Valence during SST (accounting for baseline) for four hypothetical groups of individuals who differ in Brief Fear of Negative Evaluation (BFNE; mean + 1 *SD* or mean – 1 *SD*) and Negative Affect (NA; mean + 1 *SD* or mean – 1 *SD*)

TSST participants only



Cyberball participants only

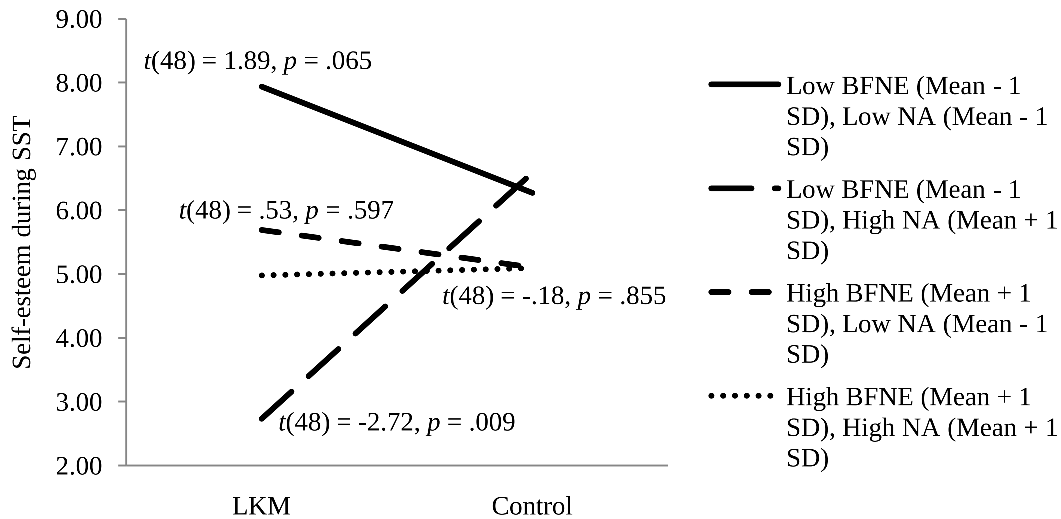


PAV during SST vs. the Cyberball group who scored significantly higher in PAV during SST; $p < .01$), simple slopes for four hypothetical groups of individuals who differ in BFNE (mean + 1 *SD* or mean – 1 *SD*) and NA (mean + 1 *SD* or mean – 1 *SD*) were computed. Significance test results showed that none of the simple slopes were significant (*p*s > .05); however, the simple slopes for the Low BFNE and Low NA groups approached significance ($p = .060$). Compared to control participants who were low in both social anxiety and (pre-intervention) negative affect, there may be a tendency for LKM participants who were also low in both social anxiety and (pre-intervention) negative affect to have less reduction in positive affect during SST. However, among participants who were low in social anxiety and but high in (pre-intervention) negative affect and among participants who were high in social anxiety, LKM intervention had no effect on positive affect during SST. These findings suggest the possibility that LKM may have a beneficial effect on positive affect during social stressors for those who are low in social anxiety and (pre-intervention) negative affect. The lack of significance in the simple slopes may be due to insufficient statistical power.

Figure 8 presents the simple slopes for self-esteem during SST for the Cyberball group. Simple slopes for four hypothetical groups of individuals who differ in BFNE (mean + 1 *SD* or mean – 1 *SD*) and NA (mean + 1 *SD* or mean – 1 *SD*) were computed. Significance test results showed that the simple slope for the Low BFNE and High NA group was significantly different from zero ($p < .05$), but the simple slopes for the rest of the groups were not (*p*s > .05). These results suggest that LKM Intervention's effect on self-esteem during SST was only significant among Cyberball participants who were low

Figure 8. Simple slopes for self-esteem for four hypothetical groups of individuals who differ in Brief Fear of Negative Evaluation (BFNE; mean + 1 *SD* or mean – 1 *SD*) and Negative Affect (NA; mean + 1 *SD* or mean – 1 *SD*) in the Cyberball group

Cyberball participants only



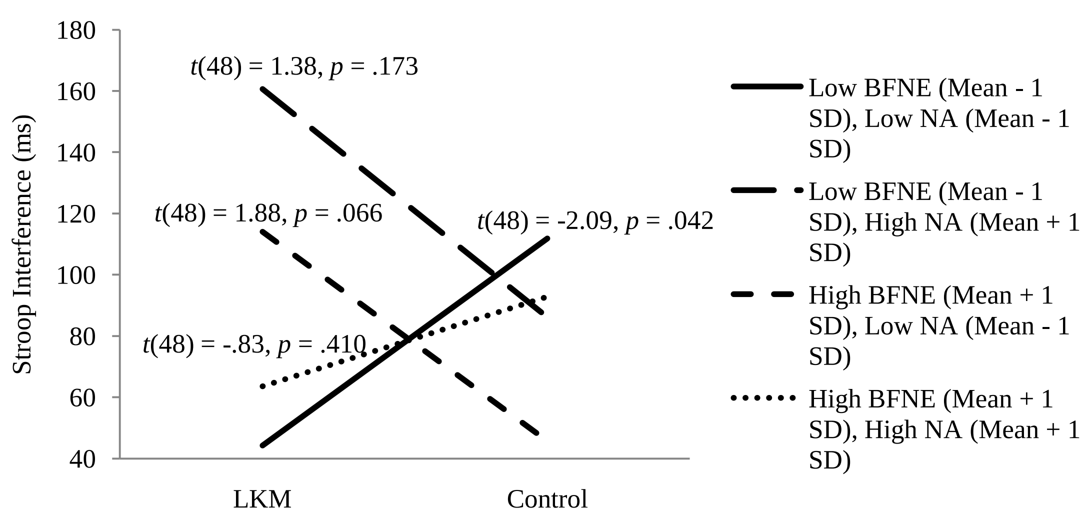
in social anxiety but high in (pre-intervention) negative affect. Specifically, compared to control Cyberball participants who were low in social anxiety but high in (pre-intervention) negative affect, LKM Cyberball participants who were also low in social anxiety but high in (pre-intervention) negative affect had a lower level of self-esteem during SST. However, among the rest of the participants, LKM Intervention had no effect on self-esteem during SST. These findings suggest the possibility that LKM may have a detrimental psychological effect on socially excluded individuals who are low in social anxiety but high in (pre-intervention) negative affect.

As mentioned earlier, although the overall model for post-SST Stroop interference was not significant across SST groups or within either of the SST groups (*p*s > .05), the

LKM Intervention *x* BFNE *x* NA interaction term contributed to significant increase in R^2 in the TSST group. Therefore, the simple slopes for Stroop interference in the TSST group were examined. Simple slopes for four hypothetical groups of individuals who differ in BFNE (mean + 1 *SD* or mean – 1 *SD*) and NA (mean + 1 *SD* or mean – 1 *SD*) were computed (see Figure 9). Significance test results showed that the simple slope for the Low BFNE and Low NA group was significantly different from zero ($p < .05$), but the simple slopes for the rest of the groups were not (*p*s > .05). Compared to control TSST participants who were low in both social anxiety and (pre-intervention) negative affect, LKM TSST participants who were also low in both social anxiety and (pre-

Figure 9. Simple slopes for Stroop interference for four hypothetical groups of individuals who differ in Brief Fear of Negative Evaluation (BFNE; mean + 1 *SD* or mean – 1 *SD*) and Negative Affect (NA; mean + 1 *SD* or mean – 1 *SD*) in the TSST group

TSST participants only



intervention) negative affect had a lower level of Stroop interference. However, among the rest of the participants, LKM Intervention had no effect on Stroop interference. These findings suggest the possibility that LKM may have a salubrious effect on self-regulatory resources for socially evaluated individuals who are low in social anxiety and (pre-intervention) negative affect.

Simple Mediation Analysis

Because the LKM intervention had no significant main effect in predicting any of the responses to the social stress tasks (i.e., changes in SC, HR, and RSA, changes in affective measures, self-report measures about experience during SST, Stroop performance, and intention to volunteer), simple mediation was not a possibility and was therefore not examined.[3]

Mediated Moderation Analyses

Testing mediated moderation effects for the three-way interactions. To test the idea that the LKM Intervention *x* BFNE *x* PA effects and the LKM Intervention *x* BFNE *x* NA effects may be physiologically (through changes in SC, HR, or RSA) or cognitively (through implicit attitude variables following intervention) mediated, potential mediating mechanisms were examined using Baron and Kenny's (1986) conceptualization of mediated moderation and the procedures specified by Muller, Judd, and Yzerbyt (2005).

[3]As reported earlier, the main effect of the LKM Intervention on Implicit Positivity towards the Self – Positive Relative to Negative Words approached significance (p = .052). The potential mediating role of this variable was examined for all significant LKM Intervention effects and moderated LKM Intervention effects using regression analyses. Results showed that Implicit Positivity towards the Self – Positive Relative to Negative Words was not a mediator for any of the LKM Intervention effects or moderated LKM Intervention effects.

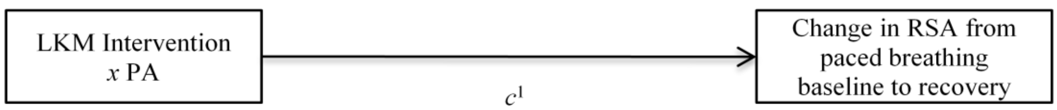
Applying Muller et al.'s (2005) specifications, a significant mediated moderation effect requires the following conditions: (1) A significant LKM Intervention *x* BFNE *x* PA (or NA) effect on the outcome variable; (2a) A significant LKM Intervention *x* BFNE *x* PA (or NA) effect on the mediator and a significant effect of the mediator on the outcome variable after accounting for LKM Intervention, BFNE, PA (or NA), LKM Intervention *x* BFNE, LKM Intervention *x* PA (or NA), BFNE *x* PA (or NA), LKM Intervention *x* BFNE *x* PA (or NA), Mediator *x* BFNE, Mediator *x* PA (or NA), and Mediator *x* BFNE *x* PA (or NA); and/or (2b) A significant LKM intervention effect on the mediator and a significant Mediator *x* BFNE *x* PA (or NA) effect on the outcome variable after accounting for LKM Intervention, BFNE, PA (or NA), LKM Intervention *x* BFNE, LKM Intervention *x* PA (or NA), BFNE *x* PA (or NA), LKM Intervention *x* BFNE *x* PA (or NA), Mediator, Mediator *x* BFNE, and Mediator *x* PA (or NA); and (3) The magnitude of the LKM Intervention *x* BFNE *x* PA (or NA) effect on the outcome variable is reduced after accounting for LKM Intervention, BFNE, PA (or NA), LKM Intervention *x* BFNE, LKM Intervention *x* PA (or NA), BFNE *x* PA (or NA), Mediator *x* BFNE, Mediator *x* PA (or NA), and Mediator *x* BFNE *x* PA (or NA). An examination of the significant three-way interaction findings (shown earlier) and the performance of additional regression analyses revealed that none of the potential mediated moderation effects (for the LKM Intervention *x* BFNE *x* PA effects or the LKM Intervention *x* BFNE *x* PA effects) satisfied Conditions 1 and 2.

Testing mediated moderation effects for the LKM Intervention x PA interaction. Using the same conceptualization of mediated moderation (Baron & Kenny, 1986) and the same procedures specified by Muller et al. (2005), the idea that the LKM Intervention *x* PA effects may be physiologically (through changes in SC, HR, or RSA) or cognitively (through implicit attitude variables following the audio intervention) mediated was tested. Applying Muller et al.'s (2005) specifications, a significant mediated moderation effect requires the following conditions in this case: (1) A significant LKM Intervention *x* PA effect on the outcome variable; (2a) A significant LKM Intervention *x* PA effect on the mediator and a significant effect of the mediator on the outcome variable after accounting for LKM Intervention, PA, LKM Intervention *x* PA and Mediator *x* PA; and/or (2b) A significant LKM intervention effect on the mediator and a significant Mediator *x* PA effect on the outcome variable after accounting for LKM Intervention, PA, LKM Intervention *x* PA and Mediator; and (3) The magnitude of the LKM Intervention *x* PA effect on the outcome variable is reduced after accounting for LKM Intervention, PA, Mediator, and Mediator *x* PA.

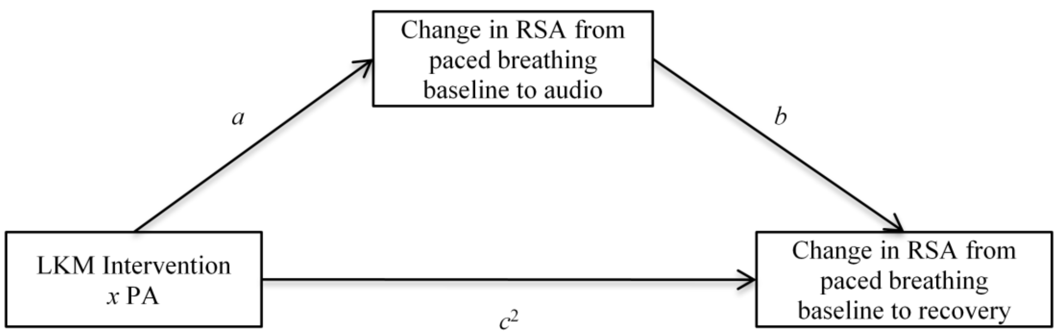
An examination of the significant LKM Intervention *x* PA interaction effects (shown earlier) and the performance of additional regression analyses revealed that only one mediated moderation effect satisfied Conditions 1 and 2. This potential mediated moderation effect is illustrated in Figure 10. As shown in the figure, if the overall LKM Intervention *x* PA effect (c^1) is significant (Condition 1), paths *a* and *b* are significant (Condition 2), and $c^2 < c^1$ (Condition 3), change in RSA from paced breathing baseline to audio would at least be partially mediating the LKM Intervention *x* PA effect on change in RSA from paced breathing baseline to recovery. This potential mediated moderation

Figure 10. Illustration of the mediated moderation effect of LKM Intervention *x* PA on change in RSA from paced breathing baseline to recovery. A mediated moderation effect requires that $c^2 < c^1$.

Significant overall LKM Intervention *x* PA effect



Mediated moderation effect



effect was tested through the three multiple linear regression models specified by Muller et al. (2005) (see results in Table 12).

Results in Table 12 indicate a mediated moderation effect by showing that Conditions 1 through 3 were satisfied: (1) Model 1 (part of which was reported earlier in Table 10) shows a significant LKM Intervention *x* PA effect on Recovery RSA after accounting for paced breathing RSA, respiration rate during recovery, LKM Intervention, and PA (path c^1 in Figure 10).

As indicated by the interaction-probing results reported earlier (see Figure 5), LKM decreased reduction in RSA from paced breathing baseline to recovery for those

Table 12. *Multiple linear regression results for mediated moderation of change in RSA from baseline to recovery*

	Recovery RSA (Model 1)		Audio RSA (Model 2)		Recovery RSA (Model 3)	
Predictors	*b*	*t*	*b*	*t*	*b*	*t*
PB RSA	.68	11.28***	.63	11.90***	.21	2.86**
Recovery RR	-.04	-2.41*			-.06	-3.74***
Audio RR			-.07	-4.12***	.07	3.37**
LKM	.10	.76	.25	1.92	-.05	-.38
PA	-.02	-2.12*	-.02	-2.36*	-.01	-.72
LKM Intervention *x* PA	.04	2.87**	.04	2.62*	.02	1.37
Audio RSA					.75	8.50***
Audio RSA x PA					.00	.54

PB RSA = Mean RSA measured during the paced breathing task; RR = Respiration rate; PA = Positive Affect; Audio RSA = Mean RSA measured during the audio intervention; Recovery RSA = Mean RSA measured during the post-social-stress-task recovery period.
* $p < .05$ ** $p < .01$ $p < .001$

high in (pre-intervention) PA but had no effect on change in RSA from paced breathing baseline to recovery for those low in (pre-intervention) PA; (2) Model 2 (part of which was also reported earlier in Table 10) shows a significant LKM Intervention *x* PA effect on Audio RSA after accounting for paced breathing RSA, respiration rate during audio, LKM Intervention, and PA (path *a* in Figure 10). As indicated by the interaction-probing results reported earlier (see Figure 3), and parallel to the results for Recovery RSA, LKM lessened the reduction in RSA from paced breathing baseline to audio for those high in (pre-intervention) PA but had no effect on change in RSA from paced breathing baseline to audio for those low in (pre-intervention) PA. Additionally, Model 3 shows that Audio RSA was significant in predicting Recovery RSA after accounting for paced breathing RSA, respiration rate during recovery, respiration rate during audio, LKM Intervention, PA, LKM Intervention *x* PA, and Audio RSA *x* PA (path *b* in Figure 10), indicating that a higher level of Audio RSA contributed to a higher level of Recovery RSA; and (3) Finally, a comparison between Models 1 and 3 shows that when accounting for the effect of change in RSA from paced breathing baseline to audio on change in RSA from paced breathing baseline to recovery (path *b* in Figure 10), the direct impact that the LKM Intervention *x* PA effect had on change in RSA from paced breathing baseline to recovery decreased (i.e., $c^2 = .02 < c^1 = .04$).

Based on these analyses, and because c^2 decreased to non-significance ($p > .05$), I find evidence for full mediated moderation, i.e., change in RSA from paced breathing baseline to audio fully mediated the LKM Intervention *x* PA effect on change in RSA from paced breathing baseline to recovery. In other words, LKM lessened the reduction of RSA during audio for those high in (pre-intervention) positive affect, which, in turn, led to less reduction in RSA during recovery for those high in (pre-intervention) positive affect.

4. DISCUSSION

The present study aimed to expand the literature on loving-kindness meditation (LKM) by answering three major questions: In what situations and what domains can LKM exert positive effects? For whom does it work? And, how does it work? Specifically, I examined whether a 10-minute LKM session would buffer against the effects of social evaluation and social exclusion on autonomic reactivity, affective reactivity, stress level, feelings of negative evaluations, mood, fulfillment of psychological needs, self-regulation, and prosocial behavior. In addition, I examined whether pre-meditation individual differences in social anxiety and mood states would moderate these effects and whether changes in physiology and cognition would mediate effects of the LKM intervention.

Was the Brief LKM Session Successful in Inducing a LKSM?

Before answering the "What," "For whom," and "How" questions, it is important to ask whether the brief LKM intervention used in the present study was successful in inducing a loving-kindness state of mind (LKSM). To answer this question, I evaluated the immediate effects of the LKM intervention, i.e., changes in physiological responding from the baseline to the audio intervention and responses to the implicit attitude assessment measured after the audio intervention. The findings revealed two significant main effects of the LKM Intervention (i.e., changes in RSA and respiration rate) and one main effect of the LKM Intervention that approached significance (i.e., Implicit Positivity towards the Self – Positive Relative to Negative Words); all other initial responses to the LKM intervention depended on participants' trait social anxiety and mood state (or mood state alone) at study entry. Contrary to expectation, the main effects of the LKM Intervention on changes in SC and HR from baseline to audio and the implicit attitude variables were not significant. Furthermore, none of the proposed LKM Intervention *x* Social Anxiety interaction effects was significant in predicting any of the physiological changes from baseline to the audio intervention or the implicit attitude variables following the intervention.

Increase in RSA. Consistent with the study's hypothesis, the LKM intervention led to an increase in RSA from the nature video baseline to the audio intervention. Both Porges' Polyvagal Theory (Porges, 1995b; Porges et al., 1994, 1996) and Thayer's Model of Neurovisceral Integration (Thayer & Lane, 2000) provide a theoretical context for understanding this finding. According to their theories, as flexible, environmentally contingent behavior was necessary for survival in the evolutionary history of mammals, the connection between the vagus nerve and the heart evolved in a way such that a "vagal brake" functions to increase parasympathetic influences on the heart in relaxing situations, which in turn reduces heart rate and facilitates attending to and engaging in the situation. This "vagal braking" process is reflected in the increased level of RSA from baseline to the LKM audio intervention in the present study, indicating an increase in parasympathetic cardiac control during the LKM intervention but not during the control intervention. These findings provide the first evidence that LKM is associated with increases in RSA. Consistent with these findings, Ditto, Eclache, and Goldman (2006) found that another form of meditative technique (i.e., a mindfulness-based body scan meditation) is also associated with increases in RSA.

Decrease in respiration rate. Consistent with the relaxing effect of the LKM intervention (as evidenced by the increase in RSA mentioned above), the LKM intervention also led to a significantly lower level of respiration rate relative to the control intervention. Importantly, neither of the interventions mentioned anything about breathing. Yet, participants in the LKM condition slowed down their breathing significantly, whereas participants in the control condition demonstrated an increase in respiration rate. These findings provide further support to the effectiveness of the present study's LKM intervention.

More Implicit Positivity towards the Self. The main effect of LKM Intervention on Implicit Positivity towards the Self – Positive Relative to Negative Words approached significance (p = .052). This finding suggests that, regardless of social anxiety or mood state, receiving a brief LKM intervention may lead to more implicit positive attitudes towards the self—as construed as a faster response to positive words and a slower response to negative words after self-referring primes— relative to a visualization control intervention.

More Implicit Negative Bias – Self or Others. Although trait social anxiety alone did not moderate the immediate effects of the LKM Intervention, it became a significant moderating variable when mood state was taken into account. Specifically, the moderating effects of trait social anxiety on Implicit Negative Bias – Self or Others became evident when the moderating role of negative mood state was considered. Low socially anxious participants showed more implicit negativity towards the self (relative to others) or others (relative to the self) following the LKM intervention than following the control intervention *if* they also reported a high level of negative affect prior to the intervention. These findings suggest that being exposed to a brief LKM session while being in a negative mood can accentuate implicit negative attitudes towards the self or others among those who are low in trait social anxiety such that they suffer from receiving a brief LKM session in a way that is consistent with an unexpected negative effect (or iatrogenic effect; see Bootzin & Bailey, 2005). However, this type of iatrogenic effect did not extend to other immediate effects of the LKM intervention. Contrary to expectations, none of the other proposed LKM Intervention *x* Social Anxiety *x* Negative Affect interaction effects or LKM Intervention *x* Social Anxiety *x* Positive Affect interaction effects was significant in predicting any of the physiological changes from baseline to audio or the implicit attitude variables following the intervention.

Less reduction in RSA. Positive affect moderated the immediate effects of the LKM Intervention on RSA regardless of trait social anxiety level. Participants who received a brief LKM session had less reduction in RSA from the paced breathing baseline to the audio (indicating less reduction in vagal capacity for autonomic responses) *if* they reported a high level of positive affect prior to the intervention. In other words, a brief session of LKM had a positive physiological effect for participants who were in a positive mood state prior to the intervention. It is possible that being in a positive mood facilitates engagement in LKM, which in turn leads to a stronger LKSM and thus stronger immediate effects on RSA. Although the LKM intervention had an immediate beneficial effect on RSA for those who were in a positive mood state prior to the intervention, the positive effects of a positive pre-meditation mood state did not extend to other immediate physiological effects of the LKM intervention.

More Implicit Positive Bias – Self or Others. Positive affect also moderated the immediate effects of the LKM Intervention on Implicit Positive Bias – Self or Others regardless of trait social anxiety level. Participants who received a brief LKM session had a higher level of Implicit Positive Bias – Self or Others, again, *if* they reported a high level of positive affect prior to the intervention. However, LKM Intervention *x* PA had no effect on any other implicit attitude variables including reaction time towards positive words following self-referring primes, reaction time towards positive words following other-referring primes, Implicit Positivity towards the Self – Positive Relative to Negative Words, and Implicit Positivity towards Others – Positive Relative to Negative Words. Implicit Positive Bias – Self or Others indicates a more implicit positive bias towards self (relative to others) *or* a more positive bias towards others (relative to the self). In other words, a higher level of Implicit Positive Bias – Self or Others indicates more discrepancy in implicit positivity towards the self vs. implicit positivity towards others. It is debatable whether this discrepancy is a beneficial cognitive effect. On the one hand, greater positivity towards the self (relative to others) may manifest as positive perceptions towards one's self, which can be stress-buffering, but it may also indicate less ability to recognize the positive aspects of one's social surroundings including other people's favorable evaluations. On the other hand, a greater positivity towards others (relative to the self) may facilitate a more favorable view towards other people's evaluations, but it may also indicate less ability to recognize the positive aspects in one's self. One way to determine whether Implicit Positive Bias – Self or Others has beneficial effects is to examine whether it has buffering effects against potential negative responses to social stress. However, in the present study, Implicit Positive Bias – Self or Others was not significantly associated with any of the outcome variables.

To summarize, the brief LKM session used in the present study produced an immediate iatrogenic effect through more implicit negativity towards the self or others for low socially anxious individuals who reported a high level of negative affect prior to the intervention. However, the LKM intervention also produced immediate positive effects. Specifically, the LKM session produced an increase in RSA during the intervention (indicating increased parasympathetic cardiac control from baseline to the audio intervention for LKM participants relative to control participants), a decrease in respiration rate, and greater implicit positivity towards the self as construed as a faster response to positive words and slower response to negative words after self-referring primes (p = .052); and, for those who were in a positive mood state prior to the intervention, the LKM session led to less of a reduction in RSA from the paced breathing baseline to the audio intervention (indicating greater persistence or maintenance of autonomic capacity among high positive affect participants in the LKM condition). These positive effects of a brief pre-stressor LKM session may form a foundation for its buffering effects against social stressors.

Was the brief LKM session successful in inducing a LKSM? The fact that the only significant main effects of the LKM Intervention was on RSA reactivity and respiration rate raises concerns about whether the LKM intervention produces only a relaxation effect rather than a LKSM. Two findings argue against this possibility. First, the effect of the LKM Intervention on Implicit Positivity towards the Self approached significance (*p* = .052), suggesting that the LKM intervention increased implicit positivity towards the self as construed as a faster response to positive words and a slower response to negative words after self-referring primes. Second, the LKM intervention did enhance implicit positive bias towards self or others among those high in positive affect prior to the intervention. Although the specific meaning of an increased implicit positivity towards the self (relative to others) or others (relative to the self) is unclear, this finding does suggest that the LKM intervention changed an essential theoretical dimension associated with LKM (i.e., implicit positivity towards the self or others) among those high in positive affect. Third, the LKM intervention increased implicit negativity towards self or others among low socially anxious participants who were in a negative mood state prior to the intervention. Although the intention of a LKM session is to reduce rather than increase negativity towards self or others, this finding does suggest that the LKM intervention changed an essential theoretical dimension of LKM (i.e., implicit negativity towards the self or others) among those low in social anxiety but high negative mood state.

In What Situations and Domains can LKM Exert Positive Stress Buffering Effects and For Whom?

In what situations can LKM exert positive stress buffering effects? Findings showed that the positive buffering effects of the LKM intervention were the same across the TSST and the Cyberball conditions except for one instance. Specifically, I found evidence that the beneficial effect on Stroop interference (for low socially anxious and low negative affect individuals) may be unique to the TSST. These findings suggest that the buffering effects of LKM on certain outcomes may depend on both individual factors (i.e., social anxiety and mood state) and situational factors (i.e., type of social stressor).

Can a brief LKM session buffer against the negative effects of social evaluative and social exclusion stress? Although none of the main effects of the LKM Intervention or the LKM Intervention *x* Social Anxiety interaction effects was significant in predicting any of the SST outcomes, the LKM intervention was found to exert positive buffering effects on changes in positive affective valence, Recovery RSA, and Stroop interference depending on the individual's social anxiety and/or pre-intervention mood state. Although trait social anxiety alone did not moderate the effects of the LKM Intervention in predicting SST outcomes, it became a significant moderating variable when pre-intervention mood state was taken into account.

The roles of social anxiety and negative affect. The moderating effect of trait social anxiety on change in positive affective valence became evident when the moderating role of negative mood state was taken into account. As expected, low socially anxious participants who received a brief LKM session prior to the SST reported less reduction in positive affective valence during the SST *if* they reported a low level of negative affect prior to the intervention. In other words, these findings suggest that low socially anxious individuals benefit from a pre-stressor session of LKM by feeling less reduction in positive affect during a social stressor if they were not in a negative mood prior to the intervention. Similarly, the moderating effect of trait social anxiety on Stroop interference became apparent when the moderating role of negative mood state was considered. As mentioned earlier, possibly due to insufficient statistical power, the LKM *x* BFNE *x* NA interaction effect on Stroop interference was only significant in the TSST group. In addition, the overall model was not statistically significant. Despite these limitations, there is some evidence suggesting that low socially anxious participants who received the LKM session prior to the SST had a lower level of post-TSST Stroop interference *if* they reported a low level of negative affect prior to the intervention. In other words, findings suggest the possibility that that low socially anxious individuals may benefit from receiving a brief pre-stressor LKM session by way of a higher level of self-regulatory resources after a social evaluative stressor *if* they were not in a negative mood prior to the intervention.

The role of positive affect. Positive affect moderated the effects of the LKM Intervention on change in RSA from paced breathing baseline to recovery regardless of trait social anxiety level. Specifically, participants who received the LKM session prior to SST had less decrease in RSA from paced breathing baseline to recovery *if* they reported a high level of positive affect prior to the intervention, indicating greater persistence or maintenance of autonomic capacity among high positive affect participants after the social stress tasks. In other words, exposure to the brief pre-stressor LKM session led to less depletion of autonomic resources or self-regulatory strength (Segerstrom & Nes, 2007) *if* the participant was in a positive mood state prior to the intervention.

To summarize, the findings suggest that although the brief pre-stressor session of LKM produced no direct main effects on any of the putative outcomes during or after

SST, it produced positive buffering effects in affective, physiological, and behavioral dimensions depending on the individual's social anxiety level and/or mood state and, at times, the situation. Receiving the brief pre-stressor session of LKM while *not* being in a negative mood state led to less reduction in positive affect during either a social evaluative or social exclusion stressor and, possibly, a higher level of regulatory resources after a social evaluative stressor for low socially anxious individuals. In addition, receiving the brief pre-stressor session of LKM while being in a positive mood state led to less depletion in autonomic resources after either a social evaluative or social exclusion stressor regardless of social anxiety level. It is possible that while *not* being in a negative mood helps low socially anxious participants engage in LKM, being in a positive mood helps all participants engage in LKM, which in turn leads to a stronger LKSM and thus stronger buffering effects. Contrary to expectation, however, except for changes in positive affect and Stroop interference, the LKM intervention had no effect on those who had the "double advantage" of being low in social anxiety and negative mood state. Moreover, except for changes in RSA, the LKM intervention had no effect on high positive mood state individuals in any other ways.

Overall, the moderated buffering effects of the LKM intervention found in the present study are parallel to the results reported by Pace et al. (2009) who also did not find any significant main effect of group assignment on neuroendorcine and affective responses to TSST. What they found, instead, was a significant association between increased meditation practice and decreased TSST-induced inflammatory cytokine interleukin 6 and subjective distress within the compassion meditation group. Thus, it is not the case that everyone who is exposed to LKM would benefit from it. Rather, it is plausible that individuals with certain pre-meditation characteristics (such as high positive affect and low negative affect) are more inclined to engage in loving-kindness type meditation and that these individuals tend to benefit more from the meditation.

Can LKM Exert Iatrogenic Effects and For Whom?

The LKM intervention was found to have iatrogenic effects on heart rate reactivity and self-esteem. Both of these effects were dependent on the individual's social anxiety and mood state.

The roles of social anxiety and positive affect. High socially anxious participants who received a brief LKM session prior to the SST had a higher level of heart rate during rest after the SST *if* they also reported a low level of positive affect prior to the intervention. In other words, the findings suggest that high socially anxious individuals suffered from receiving a brief pre-stressor LKM session by way of less reduction in heart rate (indicating a more sustained autonomic activation) after a social stressor if they were *not* in a positive mood prior to the intervention. This physiological iatrogenic effect has potential health implications. Research shows that heart rate reactivity in response to an acute psychological stressor is associated with increased cortisol concentrations and natural killer cytotoxicity (Sgoutas-Emch et al., 1994). In addition, prolonged high heart rate is an important risk factor for hypertension and both cardiovascular and non-cardiovascular mortality (Palatini & Julius, 1997).

The roles of social anxiety and negative affect. Results showed that, in the Cyberball group, low socially anxious participants who received a brief LKM session prior to the SST had a lower level of self-esteem during a social exclusion task *if* they reported a high level of negative affect prior to the intervention. In other words, the findings suggest that low socially anxious individuals suffered from social exclusion as a result of receiving a brief pre-stressor LKM session by way of a lower level of self-esteem if they were in a negative mood prior to the intervention.

To summarize, the LKM intervention produced iatrogenic effects when considered in combination with social anxiety, mood state, and, at times, the situation. Receiving the brief pre-stressor session of LKM while *not* being in a positive mood state led to less reduction in heart rate after a social stressor among high socially anxious individuals. At the same time, receiving the brief pre-stressor session of LKM while being in a negative mood state led to a lower level of self-esteem during a social exclusion stressor among low socially anxious individuals. These findings suggest the possibility that being exposed to LKM while *not* being in a positive mood is detrimental to those who are high in trait social anxiety (regardless of type of social situation), and being exposed to LKM while being in a negative mood is detrimental to those who are low in trait social anxiety (in socially exclusive situations only). Contrary to expectations, however, the brief LKM intervention had no effect on high socially anxious *and* low positive mood state individuals or low socially anxious *and* high negative mood state individuals in any other ways.

What are Some Possible Explanations for the Iatrogenic Effects?

Findings suggest that not only does a brief LKM session not work for everyone, it can actually have negative effects as a function of pre-meditation individual differences.

(1) Cognitive effects—Low socially anxious *and* high negative affect individuals who received the brief LKM intervention evidenced greater implicit negativity towards self or others following the intervention; (2) Psychological effects—Low socially anxious *and* high negative affect individuals who received the brief LKM intervention reported lower self-esteem during a social exclusion stressor; and, (3) Physiological effects—High socially anxious *and* low positive affect individuals who received the brief LKM intervention showed less reduction in heart rate after the social stressor. An important commonality across all of the iatrogenic effects is that participants who experienced negative effects were either high in negative affect or low in positive affect prior to the intervention. One possible reason for these iatrogenic effects may be due to the inward attention inherent in LKM. Engaging in LKM may bring attention to whatever feelings the participant is having in the moment. If the participant enters into a LKM session in a negative mood (or not in a positive mood), these negative (or non-positive) feelings would become more salient during the meditation. While these negative (or non-positive) feelings may dissipate in a longer meditation session, they may actually become accentuated in the short run in a brief meditation session. These unintended negative affective effects of a brief LKM session may be the "culprit" for the iatrogenic effects in the present study.

From a statistical perspective, the structure of the present sample also contributed to the detection of iatrogenic effects among high negative affect or low positive affect individuals. In the present study, high and low socially anxious individuals were oversampled in order to increase the probability for detecting the proposed interaction effects (see McClelland & Judd, 1983). As social anxiety was significantly correlated with both positive affect (r = -0.27, p < .01) and negative affect (r = 0.35, p < .001), it is likely that high positive affect and low positive affect individuals as well as high negative affect and low negative affect individuals were also oversampled, which increased the probability for detecting interaction effects that involved positive affect or negative affect.

How Does LKM work?

To address the "How" question, the potential mediating roles of cognition and physiology in the effects of the LKM intervention were tested. Results showed that only one of the LKM Intervention effects was successfully explained by a proposed mediating mechanism. Specifically, the LKM Intervention *x* Positive Affect effects on change in RSA from paced breathing baseline to recovery was fully mediated by change in RSA from paced breathing baseline to audio. In other words, individuals who were in a positive mood prior to the pre-stressor session of LKM benefited physiologically by having less reduction in RSA (reflecting greater persistence or maintenance of autonomic capacity) after the social stressor because they experienced less reduction in RSA (from the paced breathing task) during the meditation period.

Contrary to expectation, I found no evidence for the mediating role of the implicit attitude variables for any of the LKM Intervention effects (or moderated LKM Intervention effects). These findings are inconsistent with those reported in Reb, Junjie, and Narayanan (2010), which showed that positive feelings towards the other party fully mediated the effects of an 8-minute LKM (vs. visualization control) prior to a dictator game on the amount of resources allocated to the other party during the game. One explanation for this discrepancy is that whereas Reb et al. (2010) measured explicit attitude towards others, implicit attitude was measured in the present study. In addition, whereas Reb et al. (2010) measured the participant's attitude towards one specific individual that was ostensibly the responder that the participant was to interact with in the dictator game, the present study measured general attitude towards others using other-referring primes (i.e., "they", "them", "themselves"). These measurement discrepancies may explain why attitude towards others did not mediate any of the LKM Intervention effects (or moderated LKM Intervention effects).

Limitations

Several limitations in the present study prevent us from drawing definitive conclusions about the effects of LKM. First, the short-term changes in attitudes and behaviors conferred by a brief session of LKM are presumed to be consistent with the expected long-term effects of sustained LKM practice in the present study. However, because the present study used a 10-minute intervention of LKM, it is unknown whether the present findings can be generalized to more extensive LKM interventions or training programs. For instance, would the effects of a more extensive LKM intervention also be conditioned by trait social anxiety and mood state? Would the mediating mechanisms proposed in the present study be supported if a more extensive LKM intervention was examined? More research is needed to answer these questions. In addition, because the present study used a sample of college students who had little to no experience in meditation, it is unknown whether the present findings can be generalized to regular meditation practitioners. For instance, would the effects of LKM also be conditioned by trait social anxiety and mood state among regular practitioners? Would the mediating mechanisms proposed in the present study be supported when regular practitioners of LKM are compared to non-practitioners? Would the physiological, cognitive, psychological, and behavioral benefits of LKM be more pronounced in regular practitioners of LKM? These are important questions for future research. Several studies by Lutz and colleagues have demonstrated that the neurological effects of compassion meditation, including activation in the insula in response to negative sounds and electroencephalographic high-amplitude gamma-band oscillations and phase-synchrony, are modulated by expertise such that long-term meditators have stronger responses during meditation than novice meditators (Lutz et al., 2008; Lutz, Greischar, Perlman, & Davidson, 2009; Lutz, Greischar, Rawlings, Ricard, & Davidson, 2004). These findings suggest that the effects of LKM may differ between long-term meditators and novice meditators.

Another characteristic of the present sample also contributed to a methodological limitation. Specifically, although efforts were made to recruit both high and low socially anxious individuals from the undergraduate subject pool, “high socially anxious” individuals in the present study were only so in relative terms and most likely did not have a level of social anxiety that reached clinical significance. In probing the significant interaction effects that involved BFNE-II, the hypothetical group of “high socially anxious” participants scored at one standard deviation (i.e., 13.58) above the mean (i.e., 19.08) of BFNE-II, which was a score of 32.7. This score was roughly equal to the mean of BFNE-II (i.e., 32.8) in the undergraduate sample used in Carleton et al. (2006), suggesting that the “high socially anxious” participants in the present study were not clinically socially anxious. It is possible that if clinically socially anxious participants were included in the sample, the findings regarding the moderating role of social anxiety would be different. Future research about the moderating role of social anxiety in the effects of LKM should include clinically socially anxious participants.

An additional limitation stems from the way social stress was operationalized. To test whether LKM can buffer against the negative effects of social stress, the present study used brief social evaluative and social exclusion stressors that involved strangers rather than people in one’s immediate social network. It is unknown whether the buffering effects found in the present study can be generalized to socially stressful situations in the real world, which tend to stretch longer periods of time and involve individuals that are closer to one’s social circle and are more salient in one’s identity. Furthermore, the present study used a control condition that was designed to be as neutral as possible while matching the visualization requirement of LKM and the presence of social stimuli. Participants were asked to visualize the various features of their face, one of their friends’ face, and one of their family members’ face, which was more tangible and specific than visualizing abstract concepts of love and kindness and various non-specific social groups. Since a no-task control condition was not included in the present study, it is unknown whether this particular procedure may have required more attentional resources and/or elicited any aversive physiological, cognitive, and affective changes, thus making LKM seem like a beneficial intervention in comparison.

Additionally, positive emotions are considered by some researchers as a major mediating mechanism for the positive effects of LKM (e.g., Frederickson et al., 2008). However, although affective state was measured at baseline and immediately following the social stressor in the present study, it was not assessed immediately after the intervention. As a result, while physiological changes and interpersonal cognitions were examined as potential mediating mechanisms for the effects of a brief LKM session, affective changes were not.

Finally, it is unclear whether the nonsignificant findings in prosocial behavior indicates that a brief LKM session has no effect on post-social-stress prosocial behavior, or that the time lapse between the meditation session and the behavioral measurement was too long. Specifically, since there was approximately a 25-minute time lapse between the end of the meditation session and the measurement of prosocial behavior, it is possible that the effects of the 10-minute LKM session had worn out by the time the measurements were made. Without shortening the time gap between meditation and assessment of behavioral measures (and/or using a LKM training program that spans a more extensive period of time), it is impossible to conclude whether LKM can buffer against the potential negative effects of a social stressor on prosocial behavior. Contrary to our null findings in prosocial behavior, Reb et al. (2010) showed that an 8-minute session of LKM was sufficient in increasing prosocial behavior. Participants who received LKM prior to the dictator game gave more of the resource they received (10 Singapore Dollars) to the other party than participants who received a neutral visualization exercise. The time lapse between the end of the meditation session and behavioral measurement was, however, far less than 25 minutes in Reb et al.'s (2010) experiment.

Theoretical Implications

With the abovementioned limitations in mind, it is important to think about the theoretical, research, and clinical implications of this study. Applying Burke's (1991) model of social stress, I argued earlier that LKM is a desirable candidate for buffering against social stress because it has the potential to reduce interruptions in the identity processes. One of the ways this can be done is by modifying the input (or perceived self-meanings) in the feedback loop. As individuals have more positive views towards themselves and others, their evaluations of their self and their evaluations of other peoples' perceptions will likely improve. Improved perceived self-meanings have a greater probability of matching up with one's internal standards, thus reducing the chance for discrepancies and interruptions in the identity processes and decreasing the chance for social stress. Within the context of the present study, the idea that LKM can modify perceived self-meanings can be tested through examining the implicit attitude variables following the LKM intervention. As reported earlier, the main effect of the LKM Intervention on implicit positivity towards the self (construed as a faster response to positive words and a slower response to negative words) approached significance, suggesting that a brief LKM session may improve implicit positivity towards the self. However, the meaning of the moderated LKM Intervention effect on implicit positive bias towards self or others was unclear; the LKM Intervention had no beneficial effects on implicit negative bias towards self or others; and, the LKM Intervention had no significant effects on any other implicit attitude variables. Furthermore, none of the implicit attitude variables served as a mediator for any of the LKM Intervention effects or moderated LKM Intervention effects. Future studies should use a more precise measure of implicit attitudes towards the self and others (such as the implicit association test; Greenwald, McGhee, & Schwartz, 1998) in order to test LKM's effect on positivity towards the self and others and its potential role in mediating the effects of LKM. Finally, as argued earlier, LKM may also reduce interruptions in the identity processes by priming a higher-level identity that has less tangible and less competitive standards. Future studies may investigate this idea by measuring the cognitive accessibility of, for instance, the "human being" identity vs. the "college student" identity, following LKM.

Research Implications

The present study is the first to investigative the "What," "For Whom," and "How" questions about LKM in a systematic fashion following social stress. To test the generalizability of the findings, future studies should examine LKM's effectiveness in buffering against real-life experiences of social evaluation and social exclusion. In addition, to further understand the "What" (situations) question about LKM, researchers may investigate whether LKM can buffer against the stress posed by other types of stressors that can also threaten an individual's identity (e.g., academic stress, occupational stress, job loss, illnesses, injuries, and relationship dissolutions). Finally, the present study suggests that, if LKM can buffer against the effects of social stressors on prosocial behavior, a shorter time lapse between the intervention and the measurement of prosocial behavior and/or a more extensive LKM intervention is needed to detect these potential effects.

In answering the "For Whom" question about LKM, I find that the effects of a brief LKM session depend on the individual's pre-meditation trait social anxiety and mood state. In particular, being in a positive mood or *not* being in a negative mood prior to the meditation session can enhance the effectiveness of LKM and avoid iatrogenic effects. Other studies have found that pre-intervention individual differences moderate the effectiveness of the intervention. For example, Shoham, Bootzin, Rohrbaugh, and Urry (1995) showed that paradoxical treatment was more effective for patients who were high in psychological reactance. The fact that mood state may affect the effectiveness of LKM should prompt researchers to assess affect immediately before any LKM intervention. In addition, to confirm the idea that there is a causal association between mood state and LKM effectiveness, future studies may utilize mood induction paradigms to examine the association between mood state and LKM effects experimentally.

Furthermore, future studies may investigate individual characteristics that may affect the effectiveness of longer-term LKM practice. For example, since one consistent effect of LKM is an improved perception of the self, it would be interesting to examine whether long-term LKM practice is particularly beneficial to individuals who start out with a high level of self-criticism. Investigating a similar "For Whom" (statistical moderation) question, Lane, Seskevich, and Pieper (2007) showed in a three-month prospective study that a mantra-based meditation training program (four 1-hour classes over two weeks) led to greater improvements in negative mood and perceived stress among participants who were higher in baseline neuroticism. Understanding the roles of pre-meditation attributes has the potential to inform meditation teachers and clinicians about ways to create conditions in which LKM is more effective, reduce the potential for iatrogenic effects, and apply LKM to those for whom LKM is most effective. In addition, the efforts to maximize the benefits and minimize the harms of any individual LKM session will likely reduce attrition in both clinical treatments and research programs that aim to understand the long-term effects of LKM.

To explain the effects of a brief LKM session, both physiological and cognitive mediating mechanisms were examined in the present study. While increased RSA was found to fully mediate LKM Intervention *x* Positive Affect interaction effects on post-social-stress RSA, the mediating effects of implicit attitude variables were not supported. Since changes in thoughts and feelings towards one's self and others is a core theoretical mechanism of change for LKM, the lack of support for the mediating role of cognitive changes is problematic because it suggests that LKM may function just like any other relaxation exercise or meditation practice and does not offer unique advantages for alleviating social stress. However, as mentioned earlier, the present findings are inconclusive due to the limitations of the intervention and the sample. Further research with a more elaborate LKM intervention and a sample with a broader range of LKM experience are needed in order to find out whether attitude changes towards self and others mediate the effects of LKM. In addition, to examine whether LKM has a unique advantage in buffering against social stress over other forms of intervention, future studies should pit LKM against other forms of intervention including other forms of meditation and relaxation techniques.

Clinical Implications

Self-criticism is linked to many forms of maladjustments and psychiatric problems (e.g., Blatt, Quinlan, Chevron, McDonald, & Zuroff, 1982; Franche & Dobson, 1992; Hewitt & Flett, 1991; Klein, Harding, Taylor, & Dickstein, 1988; Lakey & Ross, 1994; Zuroff & deLorimer, 1989; Zuroff & Mongrain, 1987). In fact, self-criticism is one of the defining features of clinical depression according to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR, American Psychiatric Association, 2000). At the same time, hostility towards others is linked to physical, social, and psychological problems (e.g., Barefoot, Dahlstro, & Williams, 1983; Kneip, Delamater, Ismond, Milford, & Schwartz, 1993; Julkunen, Salonen, Kaplan, & Salonen, 1994; Barefoot, Larsen, von der Leith, & Schroll, 1995; Vahtera, Kivima, Koskenvuo, & Pentti, 1997; Rachor, Sanderman, Bouma, Buunk, & Heuvel, 1997; Miller, Smith, Turner, Guijarro, & Hallet, 1996; Kivimaki, Elovainio, Vahtera, Nurmi, Feldt, Keltikangas-Jarvinen, & Pentti, 2002). In direct opposition to the maladaptive self-criticizing and hostile tendencies is LKM's emphasis on giving love, kindness, and forgiveness to oneself and others and its potential in improving intrapersonal and interpersonal functioning. Accordingly, researchers have started to examine the utility of LKM in clinical settings. For instance, Carson et al. (2005) studied an eight-week LKM program among chronic low back pain patients in a pilot trial. Forty three patients were randomly assigned to a LKM program or standard care. Results showed that patients who participated in the

LKM program demonstrated significant improvements in pain as well as psychological distress, but patients who received standard care showed no changes in pain or psychological distress. Additionally, analyses of daily data showed that more LKM practice on a given day was associated with less pain that day and less anger the following day. Consistent with these promising results, findings of the present study suggest that even just 10 minutes of LKM have physiological effects on the meditator consistent with a relaxation state (including increased RSA reactivity and decreased respiration rate) regardless of pre-meditation individual differences. These findings provide a potential physiological explanation for the benefits of regular LKM practice and provide further support for the potential utility of LKM in clinical settings.

As mentioned earlier, findings in the present study suggest that being in a positive mood state prior to meditation increases the effectiveness of a brief LKM session and *not* being in a negative mood state prior to meditation is particularly important for those who are low in social anxiety. In contrast, *not* being in a positive mood state or being in a negative mood state prior to meditation may result in negative effects. The findings that both beneficial and iatrogenic effects of a brief LKM session may depend on trait social anxiety and/or mood state should alert clinicians to pay attention to the individual characteristics as well as the pre-meditation mood state of the patient. For example, neither Pace et al. (2009) or Shapiro, Bootzin, Figueredo, Lopez, and Schwartz (2003)—who studied, respectively, the effects of a six-week LKM training among university students and a six-week MBSR program with a LKM component among women with a history of Stage II breast cancer—found support for the main effect of intervention.

Instead, both groups of researchers found a significant correlation between amount of meditation and better outcomes. These findings suggest that, given the same instructions and expectations to practice meditation, certain individuals tend to spend more time on practicing meditation than others and that those who do tend to reap more benefits from the meditation intervention. Based on findings of the present study, it is plausible that one reason why someone would follow the trajectory of more meditation practice has to do with their mood state prior to the early meditation sessions. Individuals who are *not* in a positive mood or in a negative mood tend to receive no benefits or even negative effects from a brief LKM session, which may discourage future practice through operant conditioning processes. On the contrary, individuals who are in a positive mood or *not* in a negative mood tend to receive benefits from a brief LKM session, which may reinforce future meditation practice. Findings about the moderating role of mood state suggest the potential importance of reminding meditation instructors and meditators about the role of mood state prior to meditation and perhaps the potential usefulness in enhancing meditators' mood state prior to meditation.

Conclusions

The present study was the first to examine the ability of LKM to buffer against the autonomic, affective, psychological, and behavioral effects of social evaluative and social exclusion stress. In addition, the present study also was the first to examine whether the effects of LKM are moderated by pre-meditation individual differences. The results show that a brief session of LKM may have positive and negative (iatrogenic) effects before and after a subsequent social stressor. The present findings provide the first evidence that a brief LKM intervention increases RSA and decreases respiration rate. There is also evidence that a brief LKM intervention increases implicit positivity towards the self (p = .052). The rest of the observed effects operated as a function of trait social anxiety and pre-intervention mood state (or mood state alone). Contrary to expectations, trait social anxiety alone does not determine whether one would benefit or suffer from a brief LKM session. Instead, mood state prior to meditation (whether alone or in conjunction with trait social anxiety) was a more important factor in determining the effects of a brief LKM session. Providing an explanation for one of LKM's effects, findings show that less reduction in RSA during LKM fully mediates the LKM Intervention *x* Positive Affect interaction effect on post-social-stress RSA. In conclusion, findings of the present study have extended our understanding of LKM and have specific implications for future research and practice.

APPENDIX A

Loving-kindness Meditation Script

Sit in a comfortable position.
Gently close your eyes.
Bring your attention to your breath, and allow your body to relax.

As you inhale, imagine positive energies of the universe, such as kindness, generosity, forgiveness, and love flowing into your body.
As you exhale, release any tension in your body.
Take another deep breath in.
As you exhale, imagine releasing negative emotions such as anxiety, anger, self-criticism, or feelings of failure.

Gently bring your attention inward and focus on the center of your upper chest-- the center of compassionate emotion and loving kindness.
Breathe in to this point and as you do so experience positive energies of kindness, generosity, and love flowing into this area.
Allow these feelings of loving kindness to flow outwardly from the center of your being.
Continue to breathe, drawing these positive energies into the center of the chest, and directing these energies of loving kindness outward.

Continue to send out this loving kindness in a number of stages.
First, wish well to yourself for a few minutes.
Feel the energy coming from the center of your chest and flowing over you.
As you continue to breathe in and out, silently recite to yourself:
May I be free from danger
May I be free from emotional suffering
May I be free from physical suffering
May I be happy
Now, begin to extend this flow of positive energy, these feelings of loving kindness to a wider circle of family and friends.
Inhale and feel positive energies entering the center of the chest.
Exhale and feel the energies in the form of loving kindness flowing out to your family and friends.
As you continue to breathe in and out, silently recite to yourself:
May my family and friends be free from danger
May my family and friends be free from emotional suffering
May my family and friends be free from physical suffering
May my family and friends be happy
Continue to do so for a few moments.

Now, extend this flow of energy to all beings in this world.
Feel the positive energies entering the center of the chest.
Exhale and feel the energies in the form of loving kindness flowing out to all beings in this world.
As you continue to breathe in and out, silently recite to yourself:
May all beings be free from danger
May all beings be free from emotional suffering
May all beings be free from physical suffering
May all beings be happy
Continue to do so for a few moments.
Now, gently draw your focus back to yourself.
Observe the way you feel at this moment.
When you’re ready, gently open your eyes, and take in your surroundings.
(449 words)

APPENDIX B

Visualization Control Script

Sit in a comfortable position.

Close your eyes.

Now, visualize different parts of your face.

First, focus on the shape of your face. Imagine scanning the contours of the face, from your chin, to the top of your forehead.

Change your focus to your eyebrows. Imagine scanning the outline of your eyebrows, from the inside to the outside.

Now, focus on your eyes. Visualize the various shades of color in your eyes, from the outside of your eyes to the inside of your eyes.

Next, focus on your ears. Imagine scanning the contours of your left ear. Then, imagine scanning the contours of your right ear. Visualize what they look like in your mind.

Next, focus on your lips. Imagine scanning the outline of your lips. Visualize their color and texture.

Now, think about a family member, the one that first came to mind. When you're ready, visualize the various parts of his or her face.

First, focus on the shape of this family member's face. Imagine scanning the contours of the face, from the chin, to the top of the forehead.

Change your focus to his or her eyebrows. Imagine scanning the outline of the eyebrows, from the inside to the outside.

Now, focus on the eyes. Visualize the various shades of color in his or her eyes, from the outside of the eyes to the inside of the eyes.

Next, focus on the ears. Imagine scanning the contours of the left ear. Then, imagine scanning the contours of the right ear. Visualize what they look like in your mind.

Next, focus on his or her lips. Imagine scanning the outline of the lips. Visualize their color and texture.

Now, think about a friend, the one that first came to mind. When you're ready, visualize the various parts of his or her face.

First, focus on the shape of his or her face. Imagine scanning the contours of the face, from the chin, to the top of the forehead.

Change your focus to his or her eyebrows. Imagine scanning the outline of the eyebrows, from the inside to the outside.

Now, focus on the eyes. Visualize the various shades of color in his or her eyes, from the outside of the eyes to the inside of the eyes.

Next, focus on the ears. Imagine scanning the contours of the left ear. Then, imagine scanning the contours of the right ear. Visualize what they look like in your mind.

Next, focus on his or her lips. Imagine scanning the outline of the lips. Visualize their color and texture.

Now, gently draw your focus back to yourself.
When you're ready, open your eyes, and take in your surroundings.

[447 words]

APPENDIX C

Brief Fear of Negative Evaluation, Version 2
(Carleton, McCreary, Norton, & Asmundson, 2006)

Read each of the following statements carefully and indicate how characteristic it is of you according to the following scale:

0 = Not at all characteristic of me
1 = Slightly characteristic of me
2 = Moderately characteristic of me
3 = Very characteristic of me
4 = Extremely characteristic of me

	Not at all	Slightly	Moderately	Very	Extremely
I worry about what other people will think of me even when I know it doesn't make any difference.	0	1	2	3	4
It bothers me when people form an unfavorable impression of me.	0	1	2	3	4
I am frequently afraid of other people noticing my shortcomings.	0	1	2	3	4
I worry about what kind of impression I make on people.	0	1	2	3	4
I am afraid that others will not approve of me.	0	1	2	3	4

	Not at all	Slightly	Moderately	Very	Extremely
I am concerned about other people's opinions of me.	0	1	2	3	4
I am usually worried about what kind of impression I make.	0	1	2	3	4
If I know someone is judging me, it tends to bother me.	0	1	2	3	4
Sometimes I think I am too concerned with what other people think of me.	0	1	2	3	4
I often worry that I will say or do wrong things.	0	1	2	3	4
I worry about what other people will think of me even when I know it doesn't make any difference.	0	1	2	3	4

APPENDIX D

Measurement of Belonging, Control, Self-Esteem, and Meaningful Existence (Zadro, Williams, & Richardson, 2004)

For TSST Participants

According to how you felt during the public speaking task, please indicate to what extent you agree with each of the following statements on a 9-point scale from not at all (1) to very much so (9) by circling the most appropriate number.

	Not at all *Very much so*
I felt poorly accepted by the judges.	1----2----3----4----5----6----7----8----9
I felt as though I had made a ‘‘connection’’ or bonded with one or more of the judges.	1----2----3----4----5----6----7----8----9
I felt like an outsider during the public speaking task.	1----2----3----4----5----6----7----8----9
I felt rejected during the public speaking task.	1----2----3----4----5----6----7----8----9
I felt distant from the judges during the public speaking task.	1----2----3----4----5----6----7----8----9
I felt that I was able to do what I wanted during the tasks.	1----2----3----4----5----6----7----8----9
I felt somewhat frustrated during the public speaking task.	1----2----3----4----5----6----7----8----9

	Not at all *Very much so*
I felt in control during the public speaking task.	1----2----3----4----5----6----7----8----9
During the public speaking task, I felt good about myself.	1----2----3----4----5----6----7----8----9
I felt that the judges failed to perceive me as a worthy and likeable person.	1----2----3----4----5----6----7----8----9
I felt somewhat inadequate during the public speaking task.	1----2----3----4----5----6----7----8----9
I felt that my performance [e.g., the clarity and content of my speech] had some effect on the judges' judgments.	1----2----3----4----5----6----7----8----9
I felt non-existent during the public speaking task.	1----2----3----4----5----6----7----8----9
I felt as though my existence was meaningless during the public speaking task.	1----2----3----4----5----6----7----8----9

Measurement of Belonging, Control, Self-Esteem, and Meaningful Existence (Zadro, Williams, & Richardson, 2004)

For Cyberball Participants

According to how you felt during the game, please indicate to what extent you agree with each of the following statements on a 9-point scale from not at all (1) to very much so (9) by circling the most appropriate number.

	Not at all *Very much so*
I felt poorly accepted by the other participants.	1----2----3----4----5----6----7----8----9
I felt as though I had made a ‘‘connection’’ or bonded with one or more of the participants during the Cyberball game.	1----2----3----4----5----6----7----8----9
I felt like an outsider during the Cyberball game.	1----2----3----4----5----6----7----8----9
I felt rejected during the Cyberball game.	1----2----3----4----5----6----7----8----9
I felt distant from the other participants during the Cyberball game.	1----2----3----4----5----6----7----8----9
I felt that I was able to throw the ball as often as I wanted during the game.	1----2----3----4----5----6----7----8----9
I felt somewhat frustrated during the Cyberball game.	1----2----3----4----5----6----7----8----9
I felt in control during the Cyberball game.	1----2----3----4----5----6----7----8----9

	Not at all *Very much so*
During the Cyberball game, I felt good about myself.	1----2----3----4----5----6----7----8----9
I felt that the other participants failed to perceive me as a worthy and likeable person.	1----2----3----4----5----6----7----8----9
I felt somewhat inadequate during the Cyberball game.	1----2----3----4----5----6----7----8----9
I felt that my performance [e.g., catching the ball, deciding whom to throw the ball to] had some effect on the direction of the game.	1----2----3----4----5----6----7----8----9
I felt non-existent during the Cyberball game.	1----2----3----4----5----6----7----8----9
I felt as though my existence was meaningless during the Cyberball game.	1----2----3----4----5----6----7----8----9

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