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Effect of compassion meditation on neuroendocrine, innate immune and behavioral responses to psychosocial stress

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Summary Meditation practices may impact physiological pathways that are modulated by stress and relevant to disease. While much attention has been paid to meditation practices that emphasize calming the mind, improving focused attention, or developing mindfulness, less is known about meditation practices that foster compassion. Accordingly, the current study examined the effect of compassion meditation on innate immune, neuroendocrine and behavioral responses to psychosocial stress and evaluated the degree to which engagement in meditation practice influenced stress reactivity. Sixty-one healthy adults were randomized to 6 weeks of training in compassion meditation ($n = 33$) or participation in a health discussion control group ($n = 28$) followed by exposure to a standardized laboratory stressor (Trier social stress test [TSST]). Physiologic and behavioral responses to the TSST were determined by repeated assessments of plasma concentrations of interleukin (IL)-6 and cortisol as well as total distress scores on the Profile of Mood States (POMS). No main effect of group assignment on TSST responses was found for IL-6, cortisol or POMS scores. However, within the meditation group, increased meditation practice was correlated with decreased TSST-induced IL-6 ($r_p = -0.46$, $p = 0.008$) and POMS distress scores ($r_p = -0.43$, $p = 0.014$). Moreover, individuals with meditation practice times above the median exhibited lower TSST-induced IL-6 and POMS distress scores compared to

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individuals below the median, who did not differ from controls. These data suggest that engagement in compassion meditation may reduce stress-induced immune and behavioral responses, although future studies are required to determine whether individuals who engage in compassion meditation techniques are more likely to exhibit reduced stress reactivity.

1. Introduction

Increasing evidence suggests that meditation practices may impact physiological pathways, including the immune and neuroendocrine systems, which are modulated by stress and are relevant to disease development and progression (Taylor, 1995; Carlson et al., 2003, 2007; Davidson et al., 2003; Hidderley and Holt, 2004; Ospina et al., 2007; Tang et al., 2007). For example, Davidson et al. reported that training in mindfulness meditation enhanced antibody production following influenza vaccination (Davidson et al., 2003), and Carlson et al. found that participants with early stage cancer who were trained in mindfulness-based stress reduction (MBSR) showed decreases in monocyte numbers as well as decreased stimulated production of interferon-gamma and interleukin (IL)-10, which persisted for 1 year (Carlson et al., 2003, 2007). In addition, Tang et al. found that training in an ''integrative meditation'' was associated with reduced cortisol responses to a 3-min mental arithmetic stressor (Tang et al., 2007).

To date, the majority of studies examining the effects of meditation on immune and neuroendocrine parameters have focused on practices that emphasize calming the mind (e.g. transcendental meditation [TM®]), improving focused attention, or developing mindfulness (e.g. MBSR) (Ospina et al., 2007; Lutz et al., 2008a). We wondered whether forms of meditation that build upon these practices by adding techniques designed to actively generate compassion for other people might also be effective in modulating physiological stress responses. Examples of these types of compassion practices include loving-kindness (*metta*) from the Theravada Buddhist tradition and mind-training (*lojong*) from Tibetan Buddhism (The Dalai Lama, 2001; Salzberg, 2002; Lutz et al., 2008a). Although little is known regarding the effect of compassion meditation (or other compassion training techniques) on stress-related behavioral and neurobiological responses (Carson et al., 2005; Gilbert and Procter, 2006; Lutz et al., 2008a), interest in compassion meditation within the research community has heightened significantly over the last 5 years as a result of several inter-related findings. First, while practicing compassion meditation, advanced Tibetan Buddhist practitioners appear capable of strongly inducing EEG patterns previously associated with positive emotionality and enhanced adaptive immune functioning (Goleman, 2003). Second, a recent study suggests that even brief exposure to compassion meditation training may affect activity in stress-relevant brain areas such as anterior cingulate and amygdala (Lutz et al., 2008b). Third, *metta* practices have been shown to increase self-compassion (Shapiro et al., 2005, 2007). Self-compassion, in turn, has been associated with a variety of desirable endpoints, including reductions in perceived stress, burnout, depression, and anxiety as well as increases in life satisfaction (Neff et al., 2005; Shapiro et al., 2005; Gilbert and Procter, 2006; Neff et al., 2007; Shapiro et al., 2007). Finally, of direct relevance to the current study, data also suggest that individuals with strong self-compassion demonstrate attenuated negative emotional reactions to laboratory psychosocial stressors. For example, self-compassion (but not self esteem) was associated with less anxiety in response to a mock job interview and less distress after receiving neutral feedback in response to a videotaped speech performance (Leary et al., 2007; Neff et al., 2007). Because laboratory psychosocial stressors have been shown to reliably activate innate immune and neuroendocrine pathways (Bierhaus et al., 2003; Dickerson and Kemeny, 2004; Pace et al., 2006; Steptoe et al., 2007), it is possible that compassion meditation training may reduce emotional responses to stress and thereby attenuate stress-induced activation of innate immune and neuroendocrine responses. Nevertheless, to our knowledge, no studies have examined this possibility.

Accordingly, the current study was designed as an initial investigation into the effect of *lojong*-based compassion meditation training on innate immune and neuroendocrine responses to psychosocial stress. More specifically, we sought to test the hypothesis that training in and practice of compassion meditation would reduce interleukin (IL)-6 and cortisol responses to a standardized laboratory psychosocial stressor (Trier social stress test [TSST]) in medically healthy young adults when compared to a health discussion control group. Testing the effect of meditation on these physiological responses is of significant potential health relevance given increasing data that chronic life stress increases plasma concentrations of IL-6 and that even mildly increased levels of plasma IL-6 (and/or its downstream product c-reactive protein) predict the development of a number of disease states, including vascular disease, diabetes and dementia (Ridker, 2000; Pradhan et al., 2001; Kiecolt-Glaser et al., 2003; Perry et al., 2007; Steptoe et al., 2007). Major depression has also been repeatedly associated with increased plasma concentrations of IL-6 (Raison et al., 2006). Likewise, increases in cortisol have been frequently observed in major depression and have been posited to contribute to stress-related metabolic abnormalities and neurotoxicity (Raison and Miller, 2003). Moreover, recent data indicate that cortisol responses to stress may modulate IL-6 responses and thus may contribute to long-term effects of stress on disease development via modulatory effects on the innate immune response (Bower et al., 2007).

Finally, because of the paucity of studies that have examined the relative engagement of research subjects in compassion meditation techniques (Carson et al., 2005; Lutz et al., 2008a,b), we also sought to assess the extent of participation in the compassion meditation program (as reflected by class attendance and meditation practice) and its potential relationship with relevant immune, neuroendocrine and behavioral outcome variables.