Cultivating Compassion:
The Effects of Compassion- and Mindfulness-based Meditation on Pro-social Mental States and Behavior

by Paul C. Condon

B.A. in Psychology, Gonzaga University
M.A. in Psychology, Northeastern University

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David DeSteno
Professor of Psychology
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Abstract of Dissertation

Meditation practices have grown in popularity throughout Western culture over the past thirty years, in part due to an increasing number of scientific studies documenting many personal benefits resulting from meditation. Studies have shown, for example, that meditation improves cognitive capacities, mental health outcomes, and increases gray matter in the brain. Yet little empirical research has investigated the social impact of meditation. A primary goal of meditation-related practices in their spiritual contexts centers on the elimination of suffering and the development of pro-social capacities such as compassion. Although increases in compassionate mental states and behavior should be a primary outcome of meditation, scientists have only recently begun to examine this claim.

Even as scientists have begun to examine the effects of meditation on prosocial outcomes, the conclusions that can be drawn with respect to compassion have been limited by designs that lack real-time person-to-person interactions centered on suffering or designs that employ self-report measures that are biased due to recall errors (e.g., over the past week, the past month, or an entire lifetime). Previous work has utilized meditators’ self-reported intentions and motivations to behave in supportive manners toward others and computer-based games requiring economic generosity to assess altruistic action. Such methods suggest that meditation may increase generalized prosocial responding but have not objectively and clearly gauged responses meant to mitigate the suffering of other individuals.

To address this gap, two studies examined whether meditation practices increase compassionate behaviors and mental states in ecological valid settings outside of the laboratory. In Study 1, I utilized a design in which participants were confronted with a person in pain using actresses to construct a real-world orchestrated scenario. Participants with little to no prior
meditation experience were randomly assigned to an eight-week course on compassion- or mindfulness-based meditation or a non-meditation wait-list control. At the end of the study, participants arrived at a lab individually to complete purported measures of cognitive ability. Upon entering a communal waiting area for many research labs, participants seated themselves in the last remaining chair in a row of three; confederates occupied the other two chairs. As the participant sat and waited, a third confederate using crutches and a large walking boot entered the waiting area while displaying discomfort. I assessed compassionate responding by whether participants gave up their seat to allow the confederate with crutches to sit, thereby relieving her pain. As predicted, participants who completed a meditation course gave up their seat more frequently than did those from the wait-list control.

Study 2 aimed to build on the previous finding by testing whether participation in an eight-week meditation course increased compassionate responding toward a difficult target following an interpersonal conflict in the laboratory. Study 2 also examined the effect of meditation on subjective experience (e.g., anger, compassion) in daily life and physiological responding to the interpersonal conflict. Contrary to prediction, those who completed a meditation course were not more likely than controls to behave compassionately toward the rude individual. Those practicing compassion meditation experienced the longest cardiovascular recovery. It may be that compassion meditation prolongs arousal in response to an angering event. Finally, as predicted, those completing compassion meditation experienced more compassion in their daily lives compared with those completing the mindfulness course or a non-meditation control course. In sum, this work provides the first evidence that brief-meditation training can increase compassionate responses to the suffering of others in real time, but there may be boundaries to that limit the scope of compassionate responding.
Table of Contents

Acknowledgments ii
Abstract v
Table of Contents vii
List of Tables viii
Chapter 1: Introduction 1
Chapter 2: Does meditation increase compassionate behavior? 17
Chapter 3: Does meditation increase compassion and reduce anger? 34
Chapter 4: General Discussion 69
References 72
Tables 88
List of Tables

Table 1a: Study 1, mindfulness-based training protocol 88
Table 1b: Study 1, compassion-based training protocol 89
Table 2: Study 1, frequency of helping behavior across conditions 90
Table 3a: Study 2, mindfulness-based training protocol 91
Table 3b: Study 2, compassion-based training protocol 92
Table 3c: Study 2, psychology of happiness and wellbeing protocol 93
Table 4: Study 2, momentary experience before and after eight-week course 94
Table 5: Study 2, baseline physiology before and after eight-week course 95
Table 6a: Study 2, values of physiological reactivity at pre- and post-task 96
Table 6b: Study 2, significance tests of physiological reactivity at pre- and post-testing 97
Table 7: Study 2, frequency of helping behavior across conditions 98
Chapter 1: Introduction

Meditation practices and contemplative traditions grew in popularity in Western culture throughout the late twentieth and early twenty-first centuries. In 2007, the National Health Interview Survey estimated that approximately 20 million American adults used meditation for a variety of health problems, including anxiety, pain, depression, stress, insomnia, physical or emotional symptoms associated with chronic illnesses and their treatment (such as heart disease, HIV/AIDS, and cancer) and overall well-being (Barnes, Bloom, & Nahin, 2008). More recently, contemplative practices have gained traction in the corporate world, where companies such as Google, eBay, Twitter, and Facebook began offering courses in meditation to their employees. Furthermore, CEOs of top-level companies frequently cite meditation as an important contributor to their career success (Burton & Effinger, 2014). The development of meditation-related smartphone applications, such as Headspace, Calm, and Buddhify, has become a burgeoning market as well (O’Connor, 2014). At once an esoteric and counter-cultural movement, meditation has become mainstream.

Despite the growing popularity of meditation in the Western hemisphere, the translation of meditation practices into secular settings leaves behind a rich philosophical tradition that provides an elaborate theory of human flourishing. Buddhist philosophical traditions evolved through intense phenomenological investigation to arrive at detailed theories of the mind, chronic dissatisfaction, and consequent remedies. At the heart of the Buddhist theory about flourishing and human potential is the cultivation of virtuous mental states that concern the interdependence of all beings, such as compassion, loving-kindness, sympathetic joy, and equanimity. While the scientific discourse surrounding meditation has acknowledged the importance of these pro-social, self-transcendent qualities, limited scientific work has undertaken
an empirical analysis of the role of meditation in cultivating such qualities. This dissertation aims to address this gap and provide an original contribution to the scientific study of meditation. Specifically, I used experimental methods to test the causal efficacy of secularized mindfulness- and compassion-based meditation training to cultivate virtuous states and behavior related to compassion (which is one of the highest forms of virtue in Buddhist taxonomies).

In Chapter 1, I introduce material from Buddhist philosophy that aids in developing the hypothesis that modern forms of secularized meditation help cultivate virtue. I then review extant scientific literature on meditation and virtuous outcomes and highlight the need for further research. In Chapter 2 and 3, I present two experiments that directly test the hypothesis that mindfulness- and compassion-based meditation practices help cultivate compassion. In Chapter 4, I end with a discussion of the results, including their contribution to Western psychology and contemplative traditions as well as their broader societal implications.

**Buddhist Meditation and Virtue**

The Buddhist goal to cultivate virtue finds its roots in the Four Noble Truths, which were the earliest teachings of Siddhārtha Gautama (i.e., the Historical Buddha) and provide the basis for all subsequent Buddhist teachings (Bodhi, 1984; Gethin, 1998; Harvey, 2013; Ray, 2001). Here, I provide a brief overview of the Four Noble Truths to highlight why virtue is a proposed goal and outcome of contemplative practice.

The Buddhist scholar Peter Harvey (2013) noted that the Four Noble Truths resembled (or perhaps influenced) the treatment of physical ailments by the earliest Indian doctors, who sought to: (i) diagnose an illness, (ii) identify its cause, (iii) determine whether it is curable, and

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1 Western psychology does not typically categorize mental states and behavior as “virtuous” or “non-virtuous” but rather as “positive” or “negative” with respect to valence or hedonic experience of a given states. In Buddhism, virtuous qualities are those mental states and behaviors that constitute an absence of suffering and promote wellbeing in the longrun, whereas non-virtuous qualities are those mental states and behaviors that constitute suffering and promote suffering in the long-run (Dreyfus, 2002).
(iv) outline a course of treatment to cure it. The Buddha applied this disease model to “suffering” (Skt: duḥkha). Duḥkha refers not only to physical suffering—that is, physical pain, hunger, and death—but also the chronic mental dissatisfaction and emotional stress that is thought to be a universal aspect of human experience (Harvey, 2013). Thus, duḥkha is often translated as “suffering” but may be better understood as constant dissatisfaction, discomfort, or “dis-ease” running through our lives (Bodhi, 1984; Gethin, 1998).

The First Noble Truth states that suffering is a universal experience. In this view, even those who appear wealthy and successful suffer. Gethin (1998) stated simply: “sooner or later, in some form or another, no matter what they do, beings are confronted by and have to deal with duḥkha.” (p.60). The relevance of the First Noble Truth is apparent in modern culture. In the United States, more than one third of annual medication prescriptions are used to manage some form of psychological stress (http://www.tedmed.com/greatchallenges). These medications include tranquilizers, antidepressants, sleeping pills and antianxiety medication. The level of stress among citizens of the modern world far exceeds what most people recognize, and these enduring levels of stress can contribute to a large number of psychological and physical health problems, including obesity, drug abuse, and cancer (American Cancer Association, 2012). Although seemingly pessimistic, subsequent Buddhist teachings offer a prescription leading to the cessation of suffering.

The Second Noble Truth identifies the cause of suffering as mental states rooted in “desire” or “craving” (Skt: ṭṛṣṇā; Gethin, 1998; Harvey, 2013). The Buddha observed that humans have deep-seeded desires (or “wants”) that manifest in three forms of mental poison (Skt: kleśas): greed, hatred, and delusion. These mental poisons present great opportunity for suffering and frustration. Greed, or “attachment,” can cause suffering when the desired object or
situation is not obtained or when it is lost. Desire can also lead to hatred, or aversion, toward things that obstruct such attachments. Finally, according to Buddhist perspectives, the mind has a tendency to create a secure, stable sense of self—an identity as an autonomous, separate individual who exists separately from others, which is in fact a delusion. In the Buddhist view, everything is in constant flux, including a person’s identity and the external world. One cannot find an unchanging, isolated self amidst the phenomenal experience of the components of body and mind. Rather, habitual patterns of thought and emotion are mere constructions of more basic elements of the body and mind (i.e., physical sensation, sensory awareness, perceptions, chains of thought and emotion). Yet from the vantage point of a permanent self, all situations and experiences are interpreted in a way that supports the impression of an unchanging self (Harvey, 2013; Makransky, 2007). Attempts to accumulate things for the self will inevitably cause suffering. Ignorance (or “delusion”) projects a field of attachment and aversion to particular experiences and other people, which can give rise to destructive emotion (e.g., anger, jealousy, pride) and harmful action.

The Third Noble Truth claims that suffering can be overcome through the “cessation of craving” (Skt: nirvāṇa). Nirvāṇa has various dimensions and interpretations, but can be understood as the content of experience at the moment of the cessation of craving. At the moment of nirvāṇa, a person’s thoughts, words, and actions are free from the motivations of greed, hatred, and delusion and instead motivated by generosity, friendliness, and wisdom. The Third Noble Truth claims that this state of being is attainable while the Fourth Noble Truth prescribes a course of action (i.e., “The Eightfold Path”) to overcome suffering attain that state. Part of the path represented here concerns the cultivation of virtue to counteract destructive emotions. The Fourth Noble Truth encompasses all of the practices derived from the Buddha’s
teachings that are thought to eradicate a being from the causes of suffering (i.e., delusion, attachment, and aversion). These practices or “prescriptions” include three key methods of training: moral virtue, mental stability, and wisdom (Bodhi, 1984; Gethin, 1998; Harvey, 2013). These modes of training include explicit practices that aim to cultivate specific mental states that oppose delusion, attachment, and aversion. There are explicit meditation practices that facilitate these modes of training, some of which explicitly focus on loving-kindness and compassion.

The Buddhist model represented by the Eightfold Path views virtue, mental stability, and wisdom as three threads that all mutually support and give rise to each other. Various meditative practices support the cultivation of virtuous mental states and behavior. Meanwhile, action motivated by virtue and wisdom is thought to enhance the effectiveness and progression of one’s meditation practice. The three stages of the path are not linear, but rather develop in a mutually dependence and reciprocal relationship (Gethin, 1998).

A vast number of practice forms, rituals, and philosophical positions evolved throughout the early development of Buddhism. Early Buddhist scholars recognized a need to specify the preferred meditative techniques and the mental landscape with which these practices were concerned. This led to the development of a scholastic tradition called the Abhidharma, which constitutes a systematic classification of the various mental states. Here, the early Buddhist scholars developed lists of the various possible mental states, including categories of non-virtuous states (i.e., those that constitute suffering) and virtuous states (i.e., those that constitute an absence of suffering).

Two principal axioms emerge from the Abhidharma texts (Gethin, 1998; Lutz, Dunne, & Davidson, 2007). First, Buddhist activities are united in their purpose of eliminating suffering. The elimination of suffering is in fact the starting point for all Buddhist practice. Gethin (1998)
notes, in turn, that the wish to relieve suffering can only be rooted in a feeling of compassion for the suffering of self or of others. Thus, it is assumed, in one way or another, Buddhist meditation practices aim to change one’s cognitive and emotional states so as to develop virtuous mental qualities such as compassion (Lutz, Dunne, & Davidson, 2007). Despite this assumption, little scientific work has addressed the role of contemplative practice in cultivating virtuous states and behavior. Before reviewing the scientific work on explicit meditation practices that cultivate virtuous qualities, I first clarify what is meant by the term “meditation” and describe two prevalent meditation forms that will be explored in the empirical research for this dissertation.

Defining mindfulness and compassion meditation

“Meditation” broadly refers to practices involving emotion and attention regulation training that aim to achieve various ends (Lutz, Slagter, Dunne, & Davidson, 2008). Within Buddhism alone, “the visualization of a deity, the recitation of a mantra, the visualization of ‘energy’ flowing in the body, the focusing of attention on the breath, the analytical review of arguments or narratives, and various forms of objectiveless meditations would all be counted as ‘meditation.’” (p. 502, Lutz, Dunne, & Davidson, 2007). It is therefore important for scientists to provide precise descriptions of the meditation practices examined in empirical research and, to the extent possible, identify the traditions from which those meditations emanate. The current research aimed to examine two common forms of contemplative practice that were developed in various strands of Buddhism, namely mindfulness meditation and compassion meditation.

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2In this dissertation, I use the terms meditation and contemplative practice to refer to specific techniques that have been developed in Buddhism. Although various forms of meditation exist across many religious and spiritual traditions, I focus specifically on techniques from Buddhism because they represent the meditation techniques that were examined in this dissertation. Furthermore, these practices have received the greatest amount of attention from the scientific community. This is in part because Buddhist practices have been translated to Western contexts that are adaptable for a secular audience.
Mindfulness meditation. In scientific contexts, the term “mindfulness” is most frequently associated with the Mindfulness-Based Stress Reduction (MBSR) program developed by Jon Kabat-Zinn (Kabat-Zinn, 1994). Kabat-Zinn (1994) defines mindfulness as “paying attention in a particular way: on purpose, in the present moment, and non-judgmentally” (p. 4). Despite the popularity of MBSR, many scientists and contemplative scholars have critiqued Kabat-Zinn’s definition, noting that this definition does not map directly onto the meaning of mindfulness in its original Buddhist context (e.g., Bodhi, 2011). Kabat-Zinn’s use of “non-judgmental awareness,” for example, is particularly confusing, as this term appears to map onto the Buddhist construct of equanimity (e.g., Desbordes et al., in press). Whereas mindfulness is a mental factor that corresponds with attention or a higher-level awareness of one’s experience, equanimity is a mental factor that corresponds with an even-minded disposition toward all experiences (i.e., “non-judgmental awareness”; Desbordes et al., in press). In general, there is considerable debate within science and Buddhism about understandings of mindfulness resulting in the lack of a unified or authoritative account of “mindfulness” (Brown et al., 2007; Dreyfus, 2011; Dunne, 2011; Gethin, 2011; Grossman & Van Dam, 2011; Rosch, 2007; Vago & Silbersweig, 2012).

Further points of divergence from Buddhist conceptions of mindfulness manifest in an ethically neutral interpretation of mindfulness. According to various Buddhist scholars, mindfulness originally had some ethical connotation, but this has not been emphasized in modern contexts (Gethin, 2011; Olendzki, 2011). Mindfulness has been described as “bare attention” or simply attending one’s present-moment experience (e.g., Brown et al., 2007), but attention is an elementary aspect of the practice of mindfulness and is distinguished from a fuller understanding of mindfulness (i.e., “right mindfulness”; Bodhi, 2011). Later writers, particularly American
teachers, assimilated “bare attention” with “right mindfulness” (Gethin, 2011). According to Gethin (2011), a traditional Theravada perspective argues that mindfulness refers to “insight” (vipassana) and “calm abiding” (shamatha) forms of meditation; however, the more contemporary mindfulness meditation tradition equates mindfulness exclusively with insight meditation. Historically, mindfulness is also referred to as a particular state or mental factor amongst other mental factors that co-arise during both insight and calm abiding practice and which need to be equally balanced. For example, mindfulness meditation includes a variety of important contextual variables, such as setting intentions (e.g., a particular aim at which the meditation is directed), energy, and discipline.

In descriptions of mindfulness in Buddhist contexts, two terms constantly recur: mindfulness (sati) and clear comprehension (sampajāna) (Bodhi, 2011). Sati originally meant “memory”. The Buddha ascribed the meaning “lucid awareness” to sampajāna. According to Bodhi (2011), sati provides access to contents of experience whereas sampajāna determines and defines contents for what they are, turns into wisdom with the contemplation of the arising and vanishing of each type of object (i.e., wisdom equates to recognizing the impermanence of phenomena). This act also explicitly relates experience to the broad Abhidharma scheme (i.e., categories of virtuous and non-virtuous states) (Bodhi, 2011). In short, mindfulness (sati) brings experience to the forefront of consciousness and clear comprehension (sampajāna) recognizes the presence or absence of a particular hindrance. In this sense, mindfulness includes discrimination about mental qualities, intended deeds, and the conviction to engage in purposeful action—that is, it may not always be “non-judgmental” (Bodhi, 2011). The combination of mindfulness with “right view” allows the meditator to distinguish virtuous from non-virtuous qualities and actions whereas the combination of mindfulness with “right effort” allows the
meditator to remove non-virtuous qualities and acquire virtuous qualities (Bodhi, 2011). Many modern scientists refer to the latter process as “meta-awareness” or awareness of thinking itself.

Throughout this dissertation, I follow Gethin (2011) by referring to “mindfulness” not as a unified construct, but rather as a set of practices. Participants in the current studies assigned to mindfulness meditation completed an eight-week program similar to Mindfulness-based Stress Reduction (MBSR)\(^3\). The participants learned various stages of mindfulness practice reflected in the four foundations of mindfulness (i.e., the four satipatthāna; Anālayo, 2003). Bodhi (2011) describes the progression of the practice as beginning with awareness that involves a close repetitive observation of a chosen object (such as the body, feelings, mind, or phenomena). Participants began by focusing attention on the body and learning to let go of thoughts of the past or future when they arose. In subsequent weeks, participants extended this practice to the breath, a visual object, and eventually thoughts themselves. With the strengthening of mindfulness, clear comprehension (sampajāna) supervenes. In insight meditation, the meditator clearly comprehends the nature and qualities of arisen phenomena. During the last three weeks of the eight-week course, participants began to develop a meta-awareness of thoughts and of the mind, recognizing thoughts as transient phenomena.

Based on Buddhist perspectives of mindfulness, I predict that these practices will aid in the development of virtuous mental states and behavior. The progressive development of clear comprehension (sampajāna) should provide participants with greater awareness and access to their cognitive and emotional habits in relation to their own potential to cause harm to oneself and others. Although secularized mindfulness practices do not feature explicit discussions and prescriptions for ethical actions, some meditation teachers assert that such mindfulness practices

\(^3\) The mindfulness protocols in the current research followed the eight-week format introduced by MBSR, but did not include yoga practices or an additional one-day retreat, which are featured in MBSR (Kabat-Zinn, 1990).
may still bring about virtuous and ethical outcomes through clear comprehension and an implicit form of moral virtue or ethics that arises through close observations of one’s own mental habits. Kabat-Zinn (2011) asserts that mindfulness as cultivated in MBSR includes “an awareness of one’s conduct and the quality of one’s relationships, inwardly and outwardly…” (p. 294). Thus, mindfulness meditation is thought to enhance prosocial, virtuous outcomes by providing the practitioner with insight into the afflictive outcomes of non-virtuous actions and the therapeutic, nourishing effects of virtuous actions. Thus, the practitioner would naturally experience the desire to behave virtuously toward oneself and others. In a similar manner, scientists have proposed that mindfulness may yield a diminished bias for self-related affective information thereby shifting one’s perspective of the self as an isolated entity toward a self in relation to others (e.g., Hölzel, Lazar, et al., 2011; Vago & Silbersweig, 2012). Clear comprehension may be a mental factor that accounts for such a shift. This process may also free up cognitive and affective resources to engage in perspective-taking and experience sharing, ultimately supporting prosocial, virtuous outcomes (e.g., Vago & Silbersweig, 2012).

**Compassion meditation.** In Buddhist traditions, love and compassion are closely related concepts (Makransky, 2007; 2012). In turn, many scientific studies conflate “compassion” with “loving-kindness” meditation, yet these two concepts can be distinguished according to one’s motivation: obtaining happiness or relieving suffering (Makransky, 2007). In this view, love is the wish for beings to have happiness both in the present and in the future whereas compassion is the wish for beings to be immediately free of suffering. Although closely related, these two aspirations manifest in rather different forms of meditation across divergent Buddhist traditions.

Loving-kindness (“mettā”) refers to a particular form of meditation that comes from Theravāda Buddhism. In mettā practice, the practitioner begins by directing wishes for happiness
and peace toward the self, typically by repeating silent phrases such as “May you be happy, may you be safe” (Buddhaghosa, 1975; Salzberg, 2004). The same wishes are then progressively directed at close others, neutral others/strangers, difficult others, and ultimately all sentient beings. Mettā manifests as compassion when the practitioner turns attention to the suffering of self and others, silently repeating phrases such as “May you be free from suffering” (Buddhaghosa, 1975). Many recent scientific reports that have examined the effects of compassion training on responses to others suffering have used this variation of mettā practice (e.g., Weng et al., 2013; Leiberg et al., 2011). Nevertheless, mettā practices should be distinguished from other forms of compassion practice that appear in later forms of Buddhism. Although compassion is an element in Buddhist practice since its earliest forms (e.g., Theravada Buddhism), compassion plays a more central role in later developments, particularly within Tibetan practices in Mahāyāna Buddhism. Early Buddhism did not generally consider the cultivation of compassion to be essential to the realization of the highest spiritual goals of Buddhism (i.e., nirvana). In Mahāyāna Buddhism, particularly Tibetan Buddhism, the explicit cultivation of compassion becomes a defining feature of Buddhist practice and necessary for the achievement of “Buddhahood,” which is characterized by the altruistic motivation to help others attain nirvana.

The most widespread forms of compassion meditation in Tibetan Buddhism come from the “mind training” (lojong) tradition transmitted by the Indian master Atisha. Similar to the variety of practices subsumed under the term “mindfulness,” lojong refers to a set of meditation practices. Lojong practices take the form of cognitive arguments that the meditation practitioner memorizes and rehearses during sitting meditation and in everyday life (Rinpoche, 1993; Kongtrul, 1987). Here I describe the specific steps that have been adapted for a secular Western audience.

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4 In a Tibetan Buddhist context, these practices take the form of seven specific steps called the Seven Points of Mental Training (D.K. Rinpoche, 1993; Kongtrul, 1987). Here I describe the specific steps that have been adapted for a secular Western audience.
Kongtrul, 1987). In a Tibetan Buddhist context, the meditator begins by contemplating the care he or she received from one’s mother as a helpless infant. If practiced properly, a feeling of compassion will naturally arise for one’s mother. Tibetans subscribe to a Buddhist cosmology in which all people have lived an infinite number of previous lives, and as such, all sentient beings were at one point one’s mother (i.e., in previous lives). Using this argumentation, the Tibetan Buddhist practitioner extends the compassion that one naturally feels for one’s mother to an expanding range of people: friends, poor or destitute others, wealthy people, enemies or disliked people, and finally all sentient beings. Subsequently, the meditator intentionally develops the resolve and aspiration to take on others’ suffering and give away one’s own happiness (tonglen). Tonglen is an active compassion practice in which the practitioner visualizes the suffering of others entering a stream of black tar. The meditator then takes on that suffering into his or her heart, with a sense of joy, and sends his or her own happiness to others. Tonglen is often referred to as “Exchange of Self and Other,” but a sense of equanimity in which all beings are perceived in a similar manner is a common feature in all of the mind training practices (Rinpoche, 1993; Shantideva, 1997).

Another form of compassion training has recently emerged in Western context based on practices that are traditionally referred to as “preliminary practices” (Tbt: ngondro). Ngondro refers to preliminary practices in Tibetan Buddhism—that is, preliminary to engaging in more advanced practices, such as non-dual practices in Mahamudra and Dzogchen traditions. Ngondro practices were originally transmitted by Padmasambhava in the eighth century. These practices are thought necessary to purify the mind before the practitioners takes on higher-level practices. Recently, a Western lama, John Makransky, has adapted a particular stage of ngondro called “guru yoga” as a form of compassion training for a modern Western audience (Markransky, 5 This practice is also sometimes referred to as “exchanging happiness and suffering” or giving and taking (tonglen).
2007). In the context of guru yoga, meditators visualize a “benefactor” sending love and compassion to the meditation practitioner. (In its original Buddhist context, this benefactor was a deity, the mythical figure Chenrezig/Avalokiteshvara, or one’s primary teacher; for a secular audience, Makransky employs the term “benefactor” to refer to any individual or entity that the practitioner experienced as a source of love and compassion in a given moment.) The meditator takes the benefactor as a visible expression to help activate the love and compassion that at present exists only as a potential in the practitioner (Makransky, 2007). The use of a benefactor provides a foundation in which the practitioner feels a sense of love and compassion directed at the self, which then becomes a basis for extending love and compassion to others.

Participants in the present research completed an eight-week program of compassion meditation that featured lojong practices adapted by Lama Willa Miller for a secular audience (in Study 1) or an eight-week program of compassion meditation that featured a combination of ngondro practices adapted by Lama John Makransky and Lama Miller’s lojong practices. In Study 1, participants first learned techniques to calm and focus the mind, including mindfulness of the body (week 1). Participants began the lojong practice by contemplating the kindness they have received from any person (in place of one’s mother), particularly in a time of need or stress and using that as a basis for extending feelings of compassion to others. Participants developed a sense of equanimity for all others by reflecting on the universal desires to experience happiness and relieve suffering (weeks 2-3). Participants then practiced tonglen, progressively moving from one’s own and others’ suffering in general (weeks 4-5) to close others (week 6), neutral others and difficult others (week 7), and all sentient beings (week 8). At the close of each session, participants practiced releasing the focus on one’s own and others suffering into a field of open awareness. In Study 2, the lojong practices (weeks 5-8) were preceded by the benefactor
practice during which the participants practiced receiving compassion (week 2), extending compassion to close others (week 3) and to neutral and difficult others (week 4). The decision to add the benefactor practice was motivated in consultation with Lama Willa Miller and Bob Morrison (who taught the mindfulness course in Study 1 and Study 2).

Compassion meditation practices by definition aim to cultivate prosocial and altruistic mental qualities and aspirations, particularly for relieving the suffering of others. As suggested above, the later stages of lojong practice involve the explicit cultivation of an active desire to alleviate the suffering of others, particularly through tonglen. In a Buddhist context, the effectiveness of these practices is marked not by the achievement of a particular mental state during meditation, but rather through behaviors in everyday life that reflect kindness and compassion (Kongtrul, 1987). If practiced effectively, compassion meditation should lead to the development of altruistic aspirations and compassionate behaviors in everyday life. Furthermore, as with mindfulness practices, compassion practices include the development of equanimity. Through repeated attention to the activity of the mind around different categories of people, the meditator comes to realize that these categories are projections of the mind; members of one category can easily shift into another category (e.g., friends to enemies, enemies to friends). In sum, these practices aim to enhance compassion toward all people as the equality of self and others is a more accurate reflection of reality. I now turn to the scientific studies concerning meditation.

**Scientific Investigations of Meditation and Virtue**

Scientists have been conducting empirical investigations of meditation for many decades, beginning as early as the 1930s (Houshmand, Harrington, Saron, & Davidson, 2002). The majority of early scientific investigations of meditation focused on the health and cognitive
benefits generated from repeated-practice over a sustained period of time (e.g., brain activity in
novice and expert practitioners, Cahn & Polich, 2006; altered brain structure, Fox et al., 2014;
performance on cognitive tasks, Lutz et al., 2009; Slagter et al., 2007; enhance immune function,
Davidson et al., 2003). Various forms of meditation practice were found to generate enhanced
brain activity in attention relevant brain regions and networks (Cahn & Polich, 2006; Fox et al.,
2014; Holzel, Lazar et al., 2011, Vago & Silbersweig, 2012), as well as enhanced cognitive
performance (Lutz et al., 2009; Slagter et al., 2007) and mental and physical health (Grossman,
Niemann, Schmidt, & Walach, 2004; Sawyer, Witt, & Oh, 2010). Perhaps surprisingly, however,
little work has examined the societal or interpersonal impact of meditation.

The focus on basic cognitive skills can be attributed in part to the assumption among
scientists that meditation practices primarily targeted basic cognitive processes (see Davidson,
2010, for a review). In fact, the most ubiquitous form of Buddhist meditation (i.e., śamatha) is
aimed at improving concentration (Lutz, Dunne, & Davidson, 2007), but these practices are also
thought to support virtuous mental states and behavior by counteracting the causes of suffering
(i.e., greed, hatred, and delusion). Of further import, the primary figures who initiated Buddhist-
scientific dialogues were biologists and neuroscientists who had great interest in mind-brain
correspondence and subjective experience (e.g., Hayward & Varela, 1992; Varela, Thompson, &
Rosch, 1992), thus accounting for an expansion in empirical research of meditative effects on
cognitive activity. Nevertheless, as suggested above, attention to Buddhist philosophical
traditions reveals that meditation and related practices are aimed at altering cognitive and
emotional states to support the development of ethical and virtuous qualities for the ultimate goal
of eliminating suffering (Gethin, 1998). Despite an original emphasis on eliminating suffering
and developing concern for the well-being of others, extant scientific investigations of meditation have yet to thoroughly test these claims.

The relationship between meditation and compassion has received notable attention in the past 20 years through ongoing dialogues between scientists and the Fourteenth Dalai Lama, Tenzin Gyatso (e.g., Dalai Lama & Ekman, 2008; Davidson & Harrington, 2002). These conversations have provided impetus for scientific experimentation on the role of meditation in cultivating virtuous, pro-social mental states and capacities. Several scientific papers have since highlighted the potential role of meditation in cultivating positive interpersonal outcomes (Brown, Ryan, & Creswell, 2007; Ekman, Davidson, Ricard, & Wallace, 2004; Lutz et al., 2007; Vago & Silbersweig, 2012). Brown and colleagues (Brown et al., 2007), for example, asserted that the quality of attention and awareness developed via mindfulness meditation should enhance attentiveness not only to one’s own internal state, but also to a partner’s thoughts, emotions, and wellbeing, and therefore enhance capacity for communication and reduce destructive behaviors. Yet the extant empirical research is limited in quantity and in its ability to make strong assertions about the causal efficacy of meditation for promoting virtuous mental states and behavior qualities. Many studies rely on self-report or measurements of neural activity that are removed from the contexts of everyday life. As such, the current literature is limited in its ability to make causal claims about the role of meditation in promoting virtues outcomes. This dissertation seeks to fill this gap by testing the role of two forms of meditation, mindfulness meditation and compassion meditation in promoting compassionate mental states and behavior. In the following chapters, I review the extant scientific literature, discuss their contributions and limitations regarding these questions, and present two original experiments that the role of meditation in promoting virtue.
Chapter 2: Study 1, Meditation increases compassionate responses to suffering

Contemplative science has documented a plethora of *intra-personal* benefits stemming from meditation, including increases in gray matter density (Hölzel, Carmody, et al., 2011), positive affect (Moyer et al., 2011) and improvement in various mental health outcomes (Hölzel, Lazar, et al., 2011). Strikingly, however, much less is known about the *inter-personal* impact of meditation. Although Buddhist teachings suggest that increases in compassionate responding should be a primary outcome of meditation (Davidson & Harrington, 2002), little scientific evidence exists to support this conjecture. In the following sections, I review the empirical studies that have examined the relationships between meditation and self-reported measures and neural activity related to prosocial outcomes. I then discuss the need for social psychological methods to examine the link between meditation and prosocial behavior.

**Self-reported Impact of Meditation**

Many of the previous empirical examinations of mediation have examined the impact of mindfulness, loving-kindness, and compassion training on self-reported positive emotions, social connectedness, and compassion. In one notable line of research, Fredrickson and colleagues (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008; Kok et al., 2013) have examined the influence of 6-weeks of loving-kindness meditation (LKM) on daily experiences of positive emotions and consequential effects on cognitive, psychological, physical, and social resources measured at post-testing. They have demonstrated that participants completing LKM, compared with those assigned to a wait-list control (WLC), report increased positive emotion (e.g., amusement, awe, contentment, gratitude, hope, interest, joy, love, and pride) throughout the training (Fredrickson et al., 2008; Kok et al., 2013). Furthermore, statistical models revealed that increases in positive

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emotion account for increases in a variety of personal resources, including self-reported “positive
relations with others” and “perceived social connection” (Fredrickson et al., 2008; Kok et al.,
2013). Furthermore, participants’ self-reported time spent meditating predicted increases in
positive emotions (Fredrickson et al., 2008). A variety of studies examining the effects of
compassion and/or loving-kindness training have also produced increases in self-reported
compassion and related prosocial qualities (Jazaieri et al., 2013; Neff & Germer, 2012; Sahdra et
al., 2011; Wallmark, Safarzadeh, Daukantaite, & Maddux, 2013). These studies generally
conclude that loving-kindness and/or compassion meditation indeed increased qualities such as
empathy, compassion, and positive interpersonal functioning. There are a number of limitations
that cause uncertainty regarding claims of meditation and prosocial, virtuous outcomes based on
self-report alone, however.

The reliance on self-report is problematic for several reasons. It is well-documented in
social psychology and affective science that people have limited access to the processes
underlying conscious experience (Nisbett & Wilson, 1977). Furthermore, beliefs and heuristics
about emotional states or about the self can influence retrospective and general ratings of past
emotional states (e.g., Barrett, 1997, Robinson & Clore, 2002a,b). For example, men and women
rate themselves differently when using aggregate measures that are influenced by gender role
knowledge, but not when they are reporting on momentary states (Barrett, Robin, Pietromonaco,
& Eyssell, 1998; Robinson, Johnson, & Shields, 1998). The methods used in the literature on
meditation and prosocial outcomes fall into this very category: participants make global ratings
of compassion and related qualities before and after a 6- to 8-week course. These scales require
the participant to summarize a variety of experiences (e.g., over the past 24 hours, week, month,
or one’s lifetime) and aggregate them to make a global judgment about their general affective
state or social behavior. Yet the literature suggests that these global judgments are driven by stereotypical information about emotions (i.e., beliefs about emotions) rather than precise information about emotional instances or episodes themselves (Robinson & Clore, 2002a,b). The upshot, then, is that these studies suggest that compassion and loving-kindness training lead people to believe that they are more compassionate and socially connected.

One might argue, however, that self-reported perceptions of social connectedness and compassionate tendencies might have important downstream psychological and interpersonal benefits. Nevertheless, these studies do not provide conclusive evidence about the role of meditation in promoting virtuous outcomes. People who complete 6 to 8 weeks of meditation are likely motivated to report that meditation was effective or they may have specific expectations about the effects of meditation. Self-report measures concerning meditation-related qualities, such as mindfulness, are likely to conflate achievement with aspiration (Grossman & Van Dam, 2011). The use of wait-list control groups, which do not rule out placebo effects or demand characteristics, limits the confidence with which the field can view these findings.

The work of Fredrickson and colleagues (Fredrickson et al., 2008; Kok et al., 2013) warrants further consideration in that it has unique merits that provide more confidence than other studies, but also unique concerns. The use of daily measurements provides different information regarding positive emotions than the information gleaned from global measurements before and after a longitudinal study (cf., Jazaieri et al., 2013; Neff & Germer, 2012; Sahdra et al., 2011; Wallmark, Safarzadeh, Daukantaite, & Maddux, 2013). While daily measurements are less likely to be impacted by beliefs and heuristics about emotion (Robinson & Clore, 2002a,b), the use of a WLC still leaves concerns about participant expectation and demand characteristics. The daily reports of positive and negative emotion were initiated by participants at their
convenience, which could produce a number of response biases that would impact survey ratings. Participants may have been more likely to complete the survey when they were in a good mood or experiencing little distraction and stress at work (given that data was collected within a company during working hours). Thus while the results are encouraging and suggestive of the impact of a particular form of mediation on virtuous qualities, various alternative explanations remain plausible. Measures that move beyond retrospective self-report will be critical for testing whether meditation promotes virtuous outcomes. To this end, a number of researchers have investigated the neural underpinnings of compassion mediation.

**Neural Impact of Compassion Training**

A number of fMRI studies have examined the neural effects of long-term and short-term compassion-based meditation training. One groundbreaking study investigated the neural correlates of a meditative state during the presentation of emotionally evocative stimuli, including another’s vocal distress (Lutz, Brefcynski-Lewis, Johnstone, & Davidson, 2008). These researchers compared the brain activity of expert Buddhist practitioners with a lifetime dedication to meditation (i.e., largely a sample of Tibetan Buddhist monks) with the brain activity of novice practitioners during resting and compassion-based meditative states while listening to audio stimuli with positive, negative, or neutral valence. Expert meditators exhibited greater neural activity in the insula and the anterior cingulate cortex (i.e., the “experience sharing” network, Zaki & Ochsner, 2012) and the temporo-parietal junction (TPJ) and the right posterior superior temporal sulcus (pSTS; i.e., the “mentalizing” network, Zaki & Ochsner, 2012) during the presentation of negative stimuli. The authors interpreted this evidence as suggesting that expert meditators demonstrated greater empathic responses during the presentation of negative stimuli. Yet the generalizability of these findings is limited by the use of
expert meditators who represent a very unique population from a vastly different cultural context (i.e., Tibet).

Subsequent findings indicated that training novices in compassion leads to activation of similar neural regions as those of expert meditators (Klimecki, Leigerg, Lamm, & Singer, 2013; Klimecki, Leigberg, Ricard, & Singer, in press). These studies examined the effects of a one-day training program in loving-kindness meditation compared with memory training among participants with no prior meditation experience. Results demonstrated that six hours of LKM training, compared with memory training, resulted in greater self-reported positive affect during exposure to videos of others distress as well as increased activation in brain regions associated with affiliation and reward (i.e., the medial orbitofrontal cortex, pallidum, putamen, and ventral tegmental area/substantia nigra; Klimecki et al., 2013). Furthermore, the effects of LKM training differed from the effects of “empathy” training (Klimecki et al., in press). Empathy training, which involved focusing on one’s own and others’ suffering without developing the active wish of compassion, resulted in enhanced subjective ratings of empathy and negative affect during exposure to videos of others’ distress. Empathy training also increased activation in regions associated with the experience-sharing network (i.e., aMCC and AI; Klimecki et al., in press). Yet these findings remain limited in their generalizability, as the meditation-trained participants were encouraged to use the skills they had previously learned while viewing the images. Thus it is unclear whether enhanced empathic/caring responses would spontaneously occur independent of experimenter instructions to engage in a meditative state.

Separate work suggests that meditation produces altered empathic responses even in non-meditative states. Recent work has shown that mindfulness and compassion-based training altered amygdala responses to negative images in non-meditative states (Desbordes et al., 2012).
Among participants with no prior meditation experience, those completing mindfulness training exhibited decreased amygdala response to negative images whereas those completing compassion meditation exhibited increased right-amygdala responses to negative images. This work provides strong evidence that compassion meditation alters neural responses to others’ suffering, even in a non-meditative ordinary state independent of experimenter instructions. Elsewhere, researchers have demonstrated that eight-weeks of compassion training improved performance on a behavioral measure of empathic accuracy (Mascaro, Rilling, Negi, & Raison, 2013). In this work, participants were randomly assigned to an eight-week course in compassion meditation or a health-discussion group and completed a task in which they were asked to label subtle social cues, namely photos depicting the eye region of adult faces (i.e., the “Reading the Mind in the Eyes Test”; RMET). Those completing the compassion-meditation training course demonstrated significant improvement on the RMET at post-testing relative to those in the control group. Finally, similar work yielded meditation-related improvements on an emotion recognition task in which participants were asked to identify subtle cues of “basic emotions” (Kemeny et al., 2012). Meditators outperformed those in a wait-list control group at post-testing. Collectively, these studies provide strong evidence that even relatively brief training in meditation appears to increase the salience of another’s suffering, but it remains unclear whether these neural effects translate to actual, virtuous behavior. I now turn to studies that have begun to explore that very question.

**Does compassion training affect compassionate behavior?**

Studies to date have measured behaviors indirectly related to compassion and the reduction of another’s suffering. Current measures used to assess prosocial behavior, for example, include implicit categorization of social stimuli as a measure of social affiliation
(Hutcherson, Seppala, & Gross, 2008; Kang, Dovidio, & Gray, 2013), non-verbal behaviors indicating affiliation, interest, or a lack of hostility (Kemeny et al., 2011), or economic generosity in computer-based video games and transactions (Leiberg, Klimecki, & Singer, 2011; Weng et al., 2013). In general, these studies are encouraging and suggestive of the role that meditation might play in promoting positive social behaviors and relationships, but none of these measures center on alleviating the suffering of others. A brief 7-minute LKM practice in the laboratory, for example, has been shown to effect explicit and implicit positive social evaluations of neutral others even after short-term training (i.e., one session of practice in the laboratory; Hutcherson, Seppala, & Gross, 2008), thus providing evidence for potential links between meditation and interpersonal harmony. Of greatest interest, recent work indicated that the neural effects of compassion training predict increased altruistic behavior in an economic transaction (Weng et al., 2013). This work, in particular, deserves additional consideration.

In a study that recruited participants for two weeks of compassion training or cognitive reappraisal training, those completing compassion training gave on average $1.14 compared with $0.62 in the context of a “redistribution game”. Participants gave up their personal economic gain from participating in the study to redistribute money from a “dictator” to a “victim”. There was no actual interaction between a “dictator” and a “victim,” however—participants only witnessed the exchange of money on a computer screen. This work is valuable in that it linked altruistic behavior with changes from pre-to-post testing in neural responses to the suffering of others measured in a separate task. Participants viewed images of emotional distress, physical pain, or acts of violence (e.g., a burn victim, a crying child). Regions implicated in experience sharing (i.e., mirror neuron network—right inferior parietal cortex (IPC)) and executive control/emotion regulation (i.e., DLPFC) correlated with increased altruistic donations among
those in the compassion group. Specifically, IPC activity was functionally connected with the DLPFC, which further interacted with the nucleus accumbens (NAcc)—a region implicated in the reward network—to predict altruistic donations among the CT group. Greater DLPFC-NAcc connectivity was correlated with decreases in arousal and predicted greater altruistic donations. Weng et al. (2013) suggested these data indicate CT-enhanced altruism by enhancing neural mechanisms that support the ability to understand another’s mental state, engage in executive control, and up-regulate the experience of reward and positive emotion, and down-regulate arousal. This work provided the strongest evidence to date that meditation could positively impact prosocial, compassion-related behavior. Yet participants were explicitly instructed to use their trained strategy in the scanner while watching negative images, thus the participant’s recent training was made salient during the task and could have influenced the participant’s subsequent behavior in the economic game. Furthermore, it is unclear to what extent this economic-related effect would extend to real world situations in which an individual would be confronted with the suffering of another individual in real-time.

In sum, even as scientists have begun to examine the effects of meditation on prosocial behavior, the conclusions that can be drawn with respect to compassion have been limited by designs that lack real-time person-to-person interactions centered on suffering. These previous studies utilized meditators’ behavior in computer-based economic games requiring economic generosity or cooperation (e.g., Leiberg, Klimecki, & Singer, 2011; Weng et al., 2013) to assess altruistic action. Such methods, while suggesting that meditation may increase generalized prosocial responding, do not clearly and objectively gauge responses meant to mitigate the suffering of others. Prior work is limited, in general, by designs and measures that lack ecological validity or do not convincingly rule out placebo effects and demand characteristics. In
anticipation of this state of the field and a reflection on the early contributions of contemplative science, Lutz, Slagter, et al. (2008) called for research that examines how meditation affects behavior outside of the laboratory and basic mental functions in everyday life. Elsewhere, social psychologists have called for the use of field research and actual behavior throughout psychology (Baumeister, Vohs, & Funder, 2007; Cialdini, 2009).

Social psychological methods that model real-world scenarios offer the exact approach to overcome the limitations of self-report, demand characteristics, and poor ecological validity. Through such an approach, researchers could employ measures of compassionate responding and other virtuous outcomes when the participants themselves are not aware that they are being observed. Furthermore, the use of experimental design that randomly assigns participants with no previous training in meditation to meditation-training groups or non-meditation controls will provide the ability to test the causal link between meditation and virtuous outcomes. The research reported herein followed this strategy.

**Experimental Overview**

Using a social psychological approach, two studies examined whether secularized mindfulness- and compassion-based meditation increase virtuous mental states and behavior related to compassion. I employed confederates (actors posing as participants) and scripted interactions to create social interactions that mimicked real-world social situations. Both studies employed an experimental approach that recruited individuals with little to no prior experience with meditation. Participants were randomly assigned to either a condition that featured eight-weeks of training in mindfulness- or compassion-based meditation or a condition that did not feature meditation. Study 1 examined the effects of mindfulness- and compassion-based meditation on prosocial behavior in a context that exposed participants to the suffering of another
person in real time. Study 2 examined the effects of mindfulness- and compassion-based meditation on 1) momentary experiences of virtuous and non-virtuous states in daily life and 2) peripheral physiological and behavioral responses to an interpersonal conflict in real time. This approach allowed me to overcome the limitations associated with self-report, demand characteristics, and ecological validity. In both studies, I predicted that mindfulness- and compassion-based meditation would act to increase compassion and decrease non-virtuous outcomes directly opposed to compassion, such as anger, hostility, and disdain.

In Study 1, I utilized a design where individuals were confronted with a person in pain in an ecologically valid way. If meditation enhances compassionate responding, participants who completed a brief meditation course should more frequently act to relieve this person’s suffering.

Method

Participants

Thirty-nine individuals (29 female; $M_{age}=25.23, SD_{age}=4.66$) recruited from the Greater Boston community for an eight-week study on meditation comprised the final set of participants. During recruitment, all participants self-reported little to no experience with any type of meditation experience and none reported completing any previous meditation course or meditation retreat. All participants passed a telephone-administered version of the Mini-Mental State Examination as indicated by a score greater than or equal to 21 (Newkirk et al., 2004).

Sixty-seven individuals were initially recruited for the study. Twenty-six dropped out prior to completion of the training portion. Two others were removed prior to analyses: One who did not take a chair in the waiting area upon arrival and one who expressed suspicion about the study. The final sample consisted of 39 individuals (20 meditators, and 19 waitlist controls).
Individuals were randomly assigned either to complete meditation classes or to be on a wait-list control. Those assigned to the meditation condition were further randomly subdivided into one of two protocols: mindfulness or compassion meditation. I utilized two separate meditation protocols both to enhance generalizability and to ensure that any resulting effects of meditation on behavior could not be attributed to demand characteristics. Although techniques to focus and calm the mind were taught in both protocols, direct discussion of compassion and the suffering of others only occurred in compassion meditation training.

**Meditation courses**

Meditation classes were held in a nondenominational venue dedicated to spiritual activities (e.g., prayer, meditation, yoga). Willa Miller, who is an ordained Tibetan Buddhist lama with 30-plus years of meditation experience and approximately 20 years of teaching experience, conducted both courses. The classes were taught in a secular format featuring 60 minutes devoted to instruction, 30 minutes of practice, and 30 minutes for discussion (see Table 1 for class protocols). Participants also received 20-minute audio-guided meditations to complete independently when not in class. Use of the audio recordings was logged weekly. Participants received $60 for their participation.

**Measuring Responses to Suffering**

Following either eight-weeks of meditation practice or approximately eight-weeks after initial recruitment to the waitlist, participants were scheduled to come to the lab under the guise of completing tests of cognitive ability. To obtain a naturalistic measure of responses to suffering, we utilized confederates to construct a test situation outside the laboratory. All confederates were blind both to the hypothesis of the experiment and to each participant’s experimental condition. Prior to the participant’s arrival, two female confederates sat in a
designated waiting area possessing three chairs. Upon arriving at the waiting area, participants sat in the last remaining chair. After the participant had been sitting for one minute, a third female confederate, who played the role of the “sufferer,” appeared around the corner with crutches and a large walking boot. The sufferer, who visibly winced while walking, stopped just as she arrived at the chairs. She then looked at her cell phone, audibly sighed in discomfort, and leaned back against a wall.

To assess compassionate responding, we measured whether the true participant offered his or her seat to the sufferer to relieve her pain. One of the sitting confederates surreptitiously notified the experimenter, who was waiting out of sight, via text message whether the participant offered the seat to the sufferer. If two minutes passed and the participant had not given up his or her seat, the trial was ended and coded as a non-helping response. The experimenter then entered the waiting area, greeted the participant, and escorted him or her to the lab to complete a series of measures unrelated to the goals of the present analysis.

**Measuring Changes in Social Network**

The nature of our design required that one group (i.e., meditators) came together for repeated classes, thereby creating a context that afforded interaction with other individuals participating in the study. The waitlist group had no such possibility of interacting with others due to participation in a structured class. The experience of repeated interaction with fellow participants in a meditation course may have produced social consequences that could account for increased levels of helping behavior relative to a wait-list control (e.g., increased social resources). To rule out this possibility, we obtained a measure of the number of people that participants interacted with on a regular basis before and after training. At pre- and post-testing (i.e., eight weeks apart), participants received an email with a link to an online version of the
Social Network Index (Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997). This survey asked participants to list the initials of every individual that they “interacted with in person or over the phone at least once every two weeks.” The survey prompted participants to list people in the following categories: romantic partner, parents, partner’s parents, children, relatives, friends, classmates, co-workers, acquaintances, members of a spiritual group, members of a volunteer group, and members of unspecified groups. Participants could list up to seven individuals for each category, with the exception of friends and members of unspecified group (up to ten individuals). Our primary interest concerned the total number of people with whom participants reported interacting. If the meditation classes increased social capital, we would expect to find that those in the meditation group reported an increase in their number of relationships at post-testing, relative to the wait-list group.

Results

Confirming the view that meditation directly enhances compassionate responding, meditators more frequently offered their seats to the sufferer than did non-meditators from the waitlist control, $\chi^2(1)=5.13, p=.02, \phi=0.36$ (see Table 2a). Of import, this enhanced prosocial responding did not differ as a function of meditation protocol; those practicing mindfulness meditation were as equally likely to aid the sufferer as were those practicing compassion meditation, $\chi^2(1)=0.20, p>.65, \phi=0.10$ (see Table 2b).

Amount of Training

On average, meditating participants attended 6.60 ($SD=0.50$) instruction sessions and reported completing independent 20-minute intervals of meditation 3.74 ($SD=1.04$) times per week. A logistic regression analysis was conducted to predict helping behavior as a function of the amount of time participants reported meditating outside of class. Visual inspection of the data
revealed one outlier (i.e., one person who only meditated 5 days outside of class). After removing this data point, the logistic regression revealed a non-significant trend indicating that days practiced outside of class predicted helping behavior ($b=0.11$, $p=.22$).

**Gender**

Gender differences in helping behavior have been reported in numerous studies, although the direction of these differences varies depending on context. Males help more frequently in some contexts (e.g., short-term encounters), but females help more in others (e.g., long-term close relationships; for a review, see Eagly & Crowley, 1986). In the current study, we found that participant gender did not affect frequency of helping behavior, $f_{\text{females}}=10$ out of 29, $f_{\text{males}}=3$ out of 10, $\chi^2(1)=0.07$, $p>.79$. Furthermore, the composition of male and female participants in the meditation and control groups did not differ, $\chi^2(1)=0.41$, ns.

**Social Network**

A 2 (time: pre, post) X 2 (group: meditators, wait-list) repeated measures ANOVA, with time as the repeated factor, revealed no main effect of group on social capital ($M_{\text{meditators}}=11.58$; $SD_{\text{meditators}}=4.53$; $M_{\text{wait-list}}=12.35$ $SD_{\text{wait-list}}=5.07$), $F(1,31)=0.21$, $p>.65$, and no effect of time ($M_{\text{pre-test}}=12.18$; $SD_{\text{pre-test}}=5.60$; $M_{\text{post-test}}=11.58$ $SD_{\text{post-test}}=5.10$), $F(1,31)=0.83$, $p>.37$. There was no interaction, $F(1,31)=1.40$, $p>.24$ (note that 6 participants from the WL control group did not provide responses to the post-test SNI). In sum, participants in the meditation group did not experience a growth in their social network as a function of participating in an organized class. Thus, the experience of participating in a group activity is unlikely to account for the central finding that meditation increases compassionate responding.

**Discussion**
Eight weeks of meditation increased the odds of acting to relieve another’s pain by more than five times (odds ratio=5.33). This is even more striking given that it occurred in a social context whose features should attenuate such behavior. The simple presence of the two confederates and their disregard for the pain of the sufferer constitutes a classic bystander manipulation where both diffusion of responsibility and norms suggesting an acceptance of nonintervention are heightened (cf. Darley & Latané, 1968).

**Limitations**

This study is limited by the use of a WLC. The use of a WLC does not control for participant expectations, experimenter demand, or the delivery format (i.e., interaction with other members of the class and a caring teacher). The activity of meditation itself co-varied with exposure to an instructor as well as other participants who had similar interests in meditation and desire to participate in a scientific study to learn meditation. Thus, it could be argued that exposure to a caring or charismatic instructor might have exerted an influence, principally through modeling. Although the WLC is a serious concern, there are several strengths to this particular design that suggest these factors are not responsible for the observed effect of meditation on pro-social, compassionate responding.

First, I believe that modeling of the instructor’s caring behavior is unlikely to account for the findings in the present case. If it were the influence of exposure to a caring instructor, I would expect to find a greater effect of meditation on prosocial behavior among participants following the compassion meditation protocol, where actual discussion of the virtue of relieving the suffering of others was discussed by the instructor. In the mindfulness meditation condition,
no such discussions occurred; all instruction centered on techniques involved in centering attention (e.g., breathing), and consequently provided no opportunity for prosocial behavior to be modeled on or directly influenced by the instructor’s explicit goals.

Second, it is unlikely that the observed effect could be accounted for due to increases in social capital stemming from participating in a group activity. The social network analyses revealed that participants in all groups did not report an increase in the number of people that they regularly interacted with after the study. Thus, those in the meditation group did not regularly interact with each other outside of the course itself.

Finally, our primary measure was obtained in context such that participants were not aware that they were being measured. From the participants’ perspective, there were no research personnel present and they were not inside the laboratory. Their expectations about the effects of meditation are unlikely to influence behavior in this setting. Furthermore, our laboratory has recently replicated this effect using a smartphone application to train mindfulness compared against an active control group (Lim, Condon, & DeSteno, 2014). Those participants who completed approximately 14 days of mindfulness training, compared with 14 days of cognitive training (e.g., attention, memory), more frequently gave up their seat for a woman on crutches using the identical paradigm.

**Future Directions**

The present work does not provide insight on the mechanisms linking meditation practice to enhanced compassion behavior. Future investigation should aim toward disambiguating the exact mechanisms associated with mindfulness and compassion-based training that may underlie the enhancement of prosocial behavior, as well as individual susceptibility to such enhancement. Several meditation-induced mediators (e.g., executive control, heightened awareness, increased...
perspective taking) stand as possible candidates (cf. Hölzel, Lazar et al., 2011; Sahdra et al., 2008; Vago & Silbersweig, 2012). Nonetheless, the current finding is the first to show the power of meditation to increase compassionate responding to suffering, even in the face of social pressures to avoid so doing. As such, it provides scientific credence to ancient Buddhist teachings that meditation increases virtuous prosocial outcomes, namely spontaneous compassionate behavior. In sum, this study indicated that meditation can increase virtuous prosocial behavior. The social context in which helping occurred involved a neutral target, however. There may be boundaries in the extent that eight-weeks of meditation increases prosocial behavior. The experience of interpersonal conflict represents a great threat to relational and societal well-being, and presents an opportunity to expand on the present findings. In Study 2, I further examined whether compassion- and mindfulness-based training decreases the experience of anger and increases compassionate responses to a difficult target.
Chapter 3: Does meditation increase compassion and reduce anger?

Contemplative teachings suggest that compassion training might function as a buffer against the experience of anger. The Buddha stated “Hate is not conquered by hate: hate is conquered by love.” (Mascaro, 1973). In this view, anger in response to another’s torment will condition further hatred in oneself and others. Instead, the cultivation of love and compassion for all beings is a strategy for reducing individual and societal suffering. Early Buddhist models (i.e., Theravada), for example, suggest that compassion and loving-kindness based meditations are particularly effective for people disposed toward anger and hatred (Gethin, 1998; Buddhaghosa, 1975).

Mindfulness-based practices and compassion-based practices are similar in that both aim to develop a sense of equanimity. Desbordes et al. (in press) defined equanimity as “an even-minded mental state or dispositional tendency toward all experiences or objects, regardless of their origin or their affective valence (pleasant, unpleasant, or neutral).” (p. 6-7). One can readily see how the cultivation of such a state might mitigate the deleterious effects of anger. By developing equanimity, through mindfulness training or compassion training, a person may develop the capacity or willingness to hold an experience of anger in awareness without clinging to or reifying anger, producing an ability to reduce emotional reactivity to anger or an angering situation (Wright, Day, & Howells, 2009). Compassion based practices extend the notion of equanimity to particular categories of people, aiming to develop an even-minded mental state toward all people, including those that people typically categorize as close others/friends, neutral others/strangers, and disliked others/enemies. Thus, meditative techniques are thought to be particularly effective for acting as a buffer against the experience of anger. The ability of
compassion meditation to counteract anger, for example, is considered a sign of successful meditation (Lutz et al., 2007). Yet these ideas remain unexamined in Western science.

Although the hypothesis that mindfulness and compassion meditation helps reduce anger and increase compassion toward difficult targets remains untested, some empirical findings lend credence to this argument. Several studies have examined the role of mindfulness, for example, in reducing anger specifically, but they are limited in their ability to provide strong causal support. Self-report studies, for example, reveal negative correlations between greater dispositional mindfulness and hostility or aggression (Borders, Earleywine, & Jajodia, 2010; Brown & Ryan, 2003; Heppner et al., 2008; Kelley & Lambert, 2012). Extant experimental studies provide limited insight on the ability of meditation to causally prevent or reduce anger. In one notable study using social psychological methods, researchers demonstrate that completing a brief, 10-min mindfulness exercise in the laboratory reduced aggression upon receiving social rejection from peers (Heppner et al., 2008). Aggression was measured by the intensity and duration of white noise delivered to a confederate who insulted the participant. Elsewhere, researchers have demonstrated that a brief mindfulness manipulation does not reduce self-reported anger compared with control manipulations, although individual differences in response to the mindfulness manipulation did predict reduced anger (Ortner & Zelazo, 2012). Although these studies are suggestive of the ability of mindfulness to reduce anger and aggression, the conclusions that can be drawn are limited by the use of brief meditation manipulations, which do not rule out the effects of enhanced positive emotion, relaxation, or demand characteristics.

In one notable study, researchers examined the effects of loving-kindness training on daily experiences of anger (Carson et al., 2005). Results demonstrated that engagement in loving-kindness meditation on a given day predicted decreased anger the next day. Yet the
moment of measurement on the subsequent day was either just before or just after the meditation practice that the participant completed following day. Thus it is unclear if reduced anger carried over from the meditation session itself or resulted as a spontaneous effect due to the enduring effects of repeated practice. Finally, in previous work, I demonstrated that a brief laboratory-induced state of compassion—among people with no contemplative training—resulted in decreased self-reported anger as well as decreased aggression directed at a transgressor (Condon & DeSteno, 2011). Participants’ self-reported levels of compassion predicted reduced aggression, suggesting that compassion can prevent a participant from engaging in escalating tit-for-tat punishment. Yet these studies all reveal temporary effects—they do not speak to assertions about the ability of meditation to produce enduring inoculations that would spontaneously buffer against the deleterious effects of anger and possible compassionate outcomes.

Mindfulness and compassion appear to reduce social stress in general. Much of this work has examined how dispositional mindfulness, compassion, or meditation training effects stress reactivity in a public speech paradigm called the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993). Prior work has demonstrated that self-reported individual differences in compassion moderate the effect of social support on reactions to the TSST (Cosley, McCoy, Saslow, & Epel, 2010). Specifically, high dispositional compassion predicted reduced blood pressure, reduced cortisol, and higher high-frequency heart rate variability, suggesting reduced sympathetic and increased parasympathetic activity, during the TSST. Others have demonstrated that dispositional mindfulness also predicted reduced cortisol reactivity during the TSST (Brown, Weinstein, & Creswell, 2012). Extending beyond these prior correlational findings, experimental studies demonstrated that brief laboratory-based
manipulations of mindfulness and compassion also reduced stress reactivity during the TSST (Creswell, Pacilio, Lindsay, & Brown, 2014; Abelson et al., 2014). Finally, studies employing mindfulness or compassion training over several weeks revealed that the amount of time participants engaged in meditation practice outside of the formal study training predicted reduced blood pressure and cortisol reactivity during the TSST (Kemeny et al., 2012; Nyklikcek, Mommersteeg, Van Beugen, Ramakers, & Van Boxtel, 2013; Pace et al., 2009). Although suggestive, these studies do not address the potential role of meditation to reduce anger in response to interpersonal conflict and actual social behavior directed at difficult others.

In sum, it remains unknown to what extent contemplative practice can produce compassionate tendencies that function as an enduring inoculation against the negative effects of anger and rather yield compassionate behavior toward difficult others. To address this gap, Study 2 examined changes in subjective experience (e.g., anger, compassion) in daily life and physiological and behavioral responses to an anger-provoking interpersonal conflict in a laboratory setting. These physiological and behavioral measures not only provide potential for the corroboration of subjective measures but also serve as novel indicators of the extent to which contemplative practices facilitate inner well-being and interpersonal functioning. They also provide the opportunity to place the current work in the context of prior studies examining the effects of meditation on stress (cf. Creswell et al., 2014; Kemeny et al., 2012; Nyklikcek et al., 2013; Pace et al., 2009) and experience of positive emotion in general (cf., Fredrickson et al., 2008; Kok et al., 2013).

**Experimental Overview**

Study 2 followed a similar experimental design as Study 1 by training participants in an eight-week mindfulness- or compassion-based meditation and comparing them with a non-
meditation active control. Unlike Study 1, participants in the control group for Study 2 met weekly to learn about and discuss topics related to scientific discoveries on happiness and well-being. The overarching goal was to test the hypothesis that meditation reduces anger and increases compassion toward a difficult target. Study 2 also sought to expand on Study 1 by implementing two additional methodological approaches: experience sampling and peripheral physiology. I describe each in turn.

Study 2 sought to examine the effects of contemplative practice on daily subjective experience. Experience sampling, or ecological momentary assessment, can be used to collect self-report data while a participant is immersed in his or her daily life. In this approach, participants are sent alerts at random times during the day on a mobile device which prompt them to answer a series of questions about their experience at that moment or in the very recent past (see Connor & Barrett, 2012 for a review). Studies over the past decade that used this method demonstrated that momentary assessment of psychological stress and emotions outperformed traditional self-report measures in assessing psychological adjustment. An individual’s profile of moment-to-moment emotional experience predicts important mental health outcomes, including depression (Demiralp et al., 2012), borderline personality disorder (Suvak, Litz, Sloan, Zanarini, Barrett, & Hofmann, 2011), alcohol use (Kashdan, Ferssizidis, Collins, & Muraven, 2010), and aggressive behavior (Pond et al., 2012). Experience sampling is the gold standard for studying first-person psychological experience, but prior studies have not been deployed to examine the effects of meditation on daily momentary experience. The current study examined each participant’s momentary experience of specific virtuous states, including compassion, and specific non-virtuous states, including anger and hostility. I predicted that those completing the compassion-meditation course would experience the greatest increase in daily
experiences of compassion and generosity, and the greatest decrease in daily experiences of 
anger and hostility, compared with those in the mindfulness-training or active control group.

Second, to further probe the effects of meditation on social behavior, Study 2 exposed 
participants to an anger-inducing experience in a laboratory context at post-intervention. Under 
the guise of a study on emotional experience, cognitive performance, and the activity of the 
body, participants visited the laboratory to complete a mental arithmetic task similar to those 
completed in prior TSST studies (cf., Pace et al., 2009). At post-testing, during the completion of 
the mental arithmetic task, the experimenter behaved incompetent and rude, resulting in the 
participant’s failure to complete the task in a timely manner (Mauss et al., 2010). Following the 
anger induction, I measured the participant’s self-reported evaluations of the experimenter and 
obtained a measure of the participant’s compassionate behavior by implementing a modified 
version of the hallway scenario used in Study 1. Unlike Study 1, I predicted that those 
completing the compassion-meditation course would engage in the greatest levels of helping 
behavior directed at the rude experimenter, given the unique proposed effectiveness of 
compassion meditation for reducing anger (Buddhaghosa, 1975; Gethin, 1998). Nevertheless, I 
predicted that participants from all groups would give negative ratings to the experimenter, 
compared with a neutral research assistant. That is, I did not expect those in the compassion 
meditation group to give favorable ratings to the experimenter.

Although meditation should act to increase the experience of momentary virtuous states 
in daily life, self-reports of these states cannot be entirely disentangled from participant 
expectation or social desirability. To move beyond self-report, Study 2 employed peripheral 
psychophysiology to provide additional insight on each participant’s reactivity to an 
interpersonal conflict in the laboratory. Specifically, I assessed the impact of compassion- and
mindfulness-based meditation on participants’ autonomic functioning during three key psychological events: during resting states, during an anger-inducing social stress task, and during recovery following the anger-inducing task.

Physiological measures included those that assessed sympathetic activity (i.e., skin conductance) and parasympathetic activity (i.e., respiratory sinus arrhythmia). These physiological indices at rest and in reaction to acute stressors are predictors of important downstream consequences for long-term psychological well-being and physical health (Uchino, Smith, Holt-Lunstad, Camp, & Reblin, 2007). Heart-rate variability (HRV) is a measure of beat-to-beat variability in heart rate that is mediated by the autonomic nervous system. Respiratory sinus arrhythmia (RSA) is a measure of respiratory influence on the heart which is a mediator of high-frequency HRV and is primarily dominated by parasympathetic influence (Berntson et al., 1997). Thus, many researchers use RSA as a measure of HRV. In general, heart rate variability serves as a marker of an individual’s ability to meet and adapt to environmental demands and is associated with several adaptive outcomes (Kemp & Quintana, 2013). For example, reduced baseline heart-rate variability has been associated with depression, anxiety, whereas increased baseline heart-rate variability has been linked to attention, self-regulation, social connectedness, and agreeableness (see Kemp & Quintana, 2013 for a review). Meanwhile, individual differences in blood pressure reactivity are associated with varying levels of stress and dispositional hostility (Fredrickson et al., 2000). Furthermore, non-hostile individuals compared with hostile individuals experience shorter durations of cardiovascular reactivity in response to an anger-inducing stressor (Jamieson & Lavoie, 1987). Large longitudinal studies indicated a link between anger disposition and increased risk of CV diseases. For example, a study with a large sample of African Americans demonstrated an association of anger experience with increased risk of
coronary heart disease (Williams et al., 2000). Finally, prior research has also documented that individual differences in resilience are tied to cardiovascular recovery (Tugade & Fredrickson, 2004). In sum, physiological indices of cardiovascular functioning at rest and in reaction to acute stressors are predictors of important downstream consequences for long-term psychological well-being, particularly reduced anger and hostility.

I predicted that participants from either meditation class to evidence greater parasympathetic activity (i.e., respiratory sinus arrhythmia) at rest, compared with those from an active control. Although I expect the anger-provocation and mental arithmetic task to increase sympathetic arousal in both meditators and non-meditators, I expect those in the compassion-meditation group to experience a quicker cardiovascular recovery to baseline levels of physiological functioning.

Methods

Participants

118 members of the Greater Boston Community (73 women; ages 18-34; 5% Caucasian, 19.7% Asian, 5.1% African-American, 5.8% identified as more than one race) participated in exchange for cash remuneration and entrance to an eight-week well-being course, which was advertised as including the possibility of a course in meditation or a course that covered scientific discussions of well-being. All participants spoke English fluently. Potential participants were excluded if they reported any of the following: 1) current or previous diagnoses with a psychiatric illness, 2) taking medication that could affect cardiovascular functioning (including medication for insomnia, high blood pressure, arthritis, epilepsy/seizers, asthma, or attention-deficit hyperactivity disorder), 3) a personal history of cardiovascular illness or stroke, 4) recurring chest pain or other chronic medical conditions (e.g., pain, hypertension), 5) skin
allergies to adhesives, or 6) use of recreational drugs (e.g., marijuana). Participants were also excluded if they reported having received guided instruction on meditation for more than two weeks within the past year.

118 individuals were initially recruited for the study. 26 (22%) dropped out prior to completion of the training portion. Of the 26 who dropped out, 8 returned to the lab to complete a post-study follow-up for the purposes of conducting intent-to-treat analyses. The final completer sample consisted of 92 individuals (30 compassion; 35 mindfulness; 27 control). Participants who completed the entire study completed a pre-test laboratory visit, an eight-week course in well-being, and a post-test laboratory visit.

**Procedure**

**Pre-test laboratory visit.** After initial screening and recruitment, participants completed a one-hour pre-test laboratory visit. Two trained research assistants conducted each laboratory session. One research assistant played the role of “the research assistant,” (RA) who greeted the participant upon arrival, obtained informed consent and worked with the participant to attach electrodes and acquire physiological recordings. The other research assistant played the role of “the experimenter,” (E) who administered the experimental task. Each staff member introduced herself as with the respective title when interacting with the participant. This status differential was designed as part of the “anger” induction that occurred during the post-testing laboratory visit, following procedures implemented by Mauss et al. (2010).

Participants were informed that the study concerned the relationship between emotional experience, cognitive performance, the activity of the body, and the impact of an eight-week well-being course on these phenomena. Participants were initially informed only that they would be performing a cognitive test that assessed working memory and attentional capacities. No
references were made to the mental arithmetic task. Following consent, the RA measured the participant’s height and weight and attached electrodes and a blood pressure cuff. All participants washed their hands and drank an 8oz cup of water approximately 10 minutes prior to electrode placement. Signal acquisition commenced immediately following electrode placement.

During testing, participants sat alone in a static chair at a small table facing a computer and a video camera in a large testing room. The RA remained in the room during a 10-minute electrode stabilization period during which a single blood pressure measurement was taken to confirm that resting blood pressure did not exceed 140/90 mmHg (all participants met this requirement). The participant also completed a health form questionnaire and registered his or her cellphone to receive text messages as part of the experience sampling component of the study (see more details in measurement section below). The participant completed a sample survey that asked him or her to report on his or her feeling the moment that he or she received the text message (no data were analyzed from this survey). After ten minutes, the participant answered a series of questions on the computer that assessed his or her current (i.e., baseline) emotional state. Among these questions were items that assessed anger (i.e., angry, frustrated, irritated). These items also served as a manipulation check for the anger induction that occurred at post-testing (see additional details in Measurement section). The RA left the room and a 5-min resting baseline measurement of the physiological measurements was recorded. A blood pressure recording was taken at 1:00, 2:30, and 4:00 during the baseline.

After baseline recordings, E entered the room and introduced him or herself as “the experimenter.” She informed the participant that she would begin the experimental task, which would be administered through an intercom system. E left the testing area and delivered the experimental instructions from an intercom. Participants were informed that they would be
completing a mental arithmetic task in which they would be given a large number to subtract from and the number to subtract by (i.e., the subtrahend) for 60 seconds (Quigley, Barrett, & Weinstein, 2002). Participants were instructed to work as quickly and accurately as possible as their answers would be recorded. Following a 30 second practice trial, participants were asked to complete a series of questions on the computer concerning their feelings toward the upcoming tasks. These items assessed demand appraisals and resource appraisals, which have been associated with specific patterns of physiological responding during motivated performance tasks (see Measurement section below; Mendes et al., 2007).

The participant then completed five 1-min trials of mental arithmetic. The experimenter recorded the participant’s responses on all trials, but did not provide any feedback during the first two trials. The experimenter then provided feedback during the last three trials by interrupting the participant if he or she made an incorrect response. In the case of an incorrect response, the experimenter said “Incorrect, begin again with…” and indicated the last previous correct response. Physiological measures were recorded for the entire duration of the mental arithmetic task and blood pressure measures were recorded at the beginning of the first, third, and fifth trials.

Following the five trials of mental arithmetic, participants completed post-task appraisal ratings and a second set emotion ratings identical to those completed prior to the 5-min baseline. E returned to the testing room and informed the participant that the mental arithmetic task was complete and instructed the participant to relax for a few minutes. E left the room and the participant sat while a post-task 5-min resting recovery period was recorded. Physiological measures were recorded for the entire duration of the recovery period and blood pressure measures were recorded at 1:00, 2:30, and 4:00 during the recovery period. After the recovery
period, the RA entered the room and disconnected the participant from the recording equipment, thanked the participant, and offered him or her an opportunity to ask any questions about the mental arithmetic task or any other aspects of the study.

The RA asked the participant to complete several forms, including a demographic form, a form on which to nominate two friends to complete informant-ratings, and an experiment evaluation form. The experiment evaluation form ostensibly served as a standardized evaluation of the research staff for all laboratory studies, but was in actuality a dependent measure assessing the participant’s perception of the RA and the experimenter. The form asked participants to rate the conditions of the testing room as well as the performance of the research assistant and the experimenter (see details in measurement section). Participants completed the survey alone in the testing room, placed them in a sealed envelope, and dropped them in a tray in the testing room. As the participant exited the testing room, the RA provided the participant with an envelope that included a sheet of paper indicating the course to which the participant had been randomly assigned. Participants were randomly assigned to one of three eight-week training courses: compassion-meditation, mindfulness-meditation, or psychology of well-being.

**Pre-test surveys.** Participants were asked to complete a number of internet and cell-phone based surveys prior to the first meeting of the eight-week course. Participants completed seven days of experience-sampling surveys beginning three to four days before the first meeting of the eight-week course. Participants completed sampling via text messages containing links to an online survey that were delivered to their personal cellphone by an experience sampling service (SurveySignal, Chicago, IL) using a protocol adapted from Barrett (2004, Study 3). Sampling occurred at random times between the hours of 9am and 9pm, with seven measurement moments.

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7 All course assignments were randomly assigned by the lead researcher (P.C.), thus the research assistant and experimenter remained blind to all participants’ condition assignment during all phases of the research.
per day. At each sampling instance, participants were provided with 19 emotion adjectives in a randomized order followed by 6 items that assessed mindfulness in a randomized order (see details in measurement section below). Participants were also asked to complete a battery of self-report surveys over the computer on their own time prior to the first class.

**Meditation courses.** Meditation classes were held in a presentation room in the Admissions/Visitor’s Center on the Northeastern University campus. Bob Morrison, who had 30-plus years of meditation experience and 15-plus years of teaching experience, conducted the compassion- and mindfulness-based courses. The classes were taught in a secular format featuring 30 minutes devoted to instruction and discussion and 30 minutes of practice. Participants also received 20-minute audio-guided meditations to complete independently when not in class. Use of the audio recordings was logged weekly. See Tables 3a and 3b for descriptions of the class protocols.

**Psychology of well-being course.** The psychology of well-being course was held in a classroom on the Northeastern University campus. Each weekly meeting was led by an advanced PhD candidate or professor who had expertise in a topic related to happiness and well-being. Each class featured approximately 40 minutes of lecturing and 20 minutes of discussion. Participants received instructions for journal reflections on the given topic for the week as well as readings from mass-market publications. Completion of the journal reflections was logged weekly. See Table 3c for a description of the class protocol.

**Post-test surveys.** Participants were asked to complete a number of internet and cell-phone based following the final meeting of the eight-week course. Using the same protocol as pre-testing, participants completed seven days of experience-sampling surveys beginning three to
four days before the final meeting of the eight-week course. Participants were again asked to complete the same battery of self-report surveys over the computer on their own time.

**Post-test laboratory visit.** After completion of the eight-week course, participants completed a 90 minute post-test laboratory visit. Procedures followed those of the pre-test laboratory visit with a number of key changes.

As before, the RA worked with the participant to acquire physiological recordings. After hook-up a 10-minute stabilization period was acquired. During this time, participants completed a health information form and a demographic form. As before, a single blood pressure measurement was taken to confirm that resting blood pressure did not exceed 140/90 mmHg (all participants met this requirement). This procedure took approximately 7-minutes, thus participants were asked to solve a Sudoku puzzle to occupy the remaining time of the 10-min stabilization period. After ten minutes, the participant completed the baseline emotion-manipulation check. The RA left the room and a 5-min resting baseline measurement of the physiological measurements was recorded. A blood pressure recording was taken at 1:00, 2:30, and 4:00 during the baseline.

After baseline recordings, E entered the room and introduced him or herself as “the experimenter.” Unlike pre-testing, E played the simultaneous roles of the anger inducer and the sufferer. The experimenter delivered a standardized anger manipulation (described below) while using a pair of crutches and large walking boot for transportation when introducing herself to the participant and during an orchestrated scenario immediately after the post-testing visit. The post-test mental arithmetic task was designed to induce anger, following procedures adapted from previous research (Mauss et al., 2010). The participant first completed two “warm-up” trials of

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8 E at post-testing was always played by an individual who had never interacted with the participant before, thus E at post-testing was never the RA or E at pre-testing.
mental arithmetic in the same manner as the pre-test visit, but then completed three additional mental arithmetic trials meant to induce anger. As part of the “anger” trials, participants were asked to count backwards in steps of 7 (for the first two trials) or 13 (for the last trial) from large numbers (e.g., 13,275) during three 1-min periods. The experimenter used pre-recorded, scripted audio files to deliver instructions and harass the participant from over the intercom during the course of these three trials. These audio files were played according to a script from a computer.

Following a script implemented by Mauss et al. (2010), using pre-recorded audio files, E interrupted the participant multiple times with remarks on his or her performance and cooperation, delivered in an increasingly impatient tone. During the third mental math trial, E intentionally told the participant that he or she had made an incorrect response (regardless of the participant’s response), then interrupted the participant, asking him or her to “speak up” and start the trial again from the beginning. After the third trial ended, E proclaimed that the participant had produced “movement artifacts” by moving his or her hand and asked the participant to sit still and speak faster. After the fourth trial ended, E explained that she would need to “recalibrate the signals” and asked the participant to sit still for 1-min. After 1-min, the participant completed a fifth and final trial of mental arithmetic. After the fifth trial, E said in an irritated tone, as if the whole session had not been run properly, “I still can’t get the proper signal. Let’s just stop here. Just answer the next set of questions on the computer and let me know when you’re done.” The use of pre-recorded scripts allowed for a maximally standardized anger provocation and minimal experimenter bias. The anger provocation took an average of eight minutes.

After the anger provocation, participants answered a second set of questions that assessed their emotional state. E returned to the testing room with the crutches and a walking boot and instructed the participant to relax for a few minutes, during which a 5-min recovery period was
recorded. BP measurements were taken at 1:00, 2:30, and 4:00 minutes. The RA then entered the room and disconnected the participant from the recording equipment. After unhooking the participant, the research assistant explained that the participant would complete a post-study interview and debriefing session in a separate room, but the room was not yet ready. The RA then directed the participant to a waiting area in the hallway outside the laboratory.

The situation that unfolded was designed to match the scenario that measured compassionate responding in Study 1. The participant was directed to a set of three chairs where confederates occupied two chairs. The research assistant invited the participant to have a seat in the last remaining seat. The RA left the waiting area and convened with the experimenter who was waiting out of sight. Both the RA and the experimenter (still on crutches) returned to the hallway and carried out an orchestrated interaction while approaching the row of three chairs where the confederates and participant were sitting. As they approached, the experimenter asked the research assistant what happened in the testing room and whether she had secured the connection and placed the electrodes properly. The research assistant explained that everything was fine. The experimenter then sighed and said, “My foot hurts. I’m going to wait here for a few minutes. Just go check the room and let us know when its ready.” E then leaned against the wall next to the row of three chairs such that the two confederates were in between the participant and the experimenter as the RA left the area. The two confederates ignored the unfolding interaction and E as she stood in the waiting area. As in Study 1, the primary measure was whether the true participant offered his or her seat for the experimenter. After 2 minutes, the RA returned and informed the experimenter that the other room was ready. The RA noted whether the participant had given up his or her seat the experimenter.
The current study was run in two waves (across two academic semesters). After the first wave of the study, results indicated that a very small number of participants—regardless of group condition—offered their seat to the rude experimenter (n=3 out of 52), \( \chi^2(2)=2.56, p>.27 \). Given the inability to draw conclusions from this outcome (see more in Discussion section below), I modified the paradigm in the second wave of the study by removing the two bystanders. Thus, in the second wave, participant took a seat in the only chair in the hallway and subsequently had the opportunity to give up that seat for the rude experimenter. The removal of the two bystanders allowed me to examine whether participants would give up their seat for a rude person independent of social norms to avoid helping.

After the compassion measure was taken, E escorted the participant to a testing room to complete a “funnel debriefing” procedure modified from Mauss et al. (2010). The experimenter used a scripted set of questions to assess the extent to which participants were aware of the true nature of the anger manipulation and the hallway scenario. A conservative coding procedure was employed such that even slight suspicious about any aspect of the procedure was coded as some suspicion (Mauss et al., 2010). For example, following Mauss et al., (2010), I comments by the participant after multiple prompts from the experimenter such as “the experiment seemed on edge” as counting as some suspicion. Among the completer sample (n=91), 43 did not report any suspicion at all (47%; n=17 from CM, n=14 from MM, n=12 from WB); 32 reported some suspicion (e.g., whether they thought the experimenter behaved strangely, agreeing without more specific suspicions; 35% n=9 from CM, n=13 from MM, n=10 from WB), and 16 reported strong suspicion (18%; n=4 from CM, n=7 from MM, n=5 from WB). The proportion of strong suspicion is slightly higher than Mauss et al. (2010), which is not surprising given that our participants were visiting the lab for a second time, ostensibly to participate in the same test they
completed at pre-testing. Of import, the groups did not differ in their distribution of suspicion, $\chi^2(4) = 1.72, p = .79, \phi = 0.14$. Furthermore, an independent samples t-test on self-reported anger demonstrated those participants with at least some suspicion ($M = 3.94, SD = 2.70$) did not differ from those without suspicion ($M = 4.05, SD = 2.87$), $t(88) = 0.189, p = .85$.

**Measures**

*Physiological recordings.* Peripheral physiological activity was recorded using an ambulatory device (Model #1001A-1038; MindWare Technologies, Ltd., Gahanna, OH) and software controlled by a personal computer (BioLab, MindWare Technologies, Ltd., Gahanna, OH). Measures included those derived from electrocardiogram (ECG), impedance cardiography (ZCG), non-invasive blood pressure (BP), and electrodermal activity (EDA). For the purposes of this dissertation, only ECG, BP, and EDA data were analyzed; ZCG data were not analyzed for the present report.

ECG was recorded from the right collar bone and the lower leftmost and rightmost ribs using standard Ag/AgCl electrodes, pre-filled with electrolyte gel (ConMed, Utica, NY). ZCG was recorded using four spot electrodes from: (i) 4cm above the base of the neck, roughly on the 4th cervical vertebrae, (ii) the base of the neck, directly above the top of the sternum where the left and right collar bones join, (iii) the bottom of the sternum where the ribs meet, and (iv) approximately 4cm below the end of the sternum on the participant’s lower back. These electrodes passed a 500 Hz alternating current across the thorax. Basal thoracic impedance ($Z_0$), the first derivative of the change in thoracic impedance ($dZ/dt$), and the ECG were measured by the ambulatory device. The ECG and ZCG signals were wirelessly sent to an acquisition computer with ECG and $dZ/dt$ sampled at 500 Hz, and $Z_0$ sampled at 250 Hz. Digitized data were stored for off-line reduction and analysis. Systolic (SBP) and diastolic blood pressure
(DBP) were recorded using a Continuous Noninvasive Arterial Pressure monitor with measurement taken at the brachial artery (Model #500AT; CNSystems, Austria). Three blood pressure measurements were taken during each epoch (i.e., baseline, mental arithmetic, recovery).

EDA was recorded using direct current applied to the skin at a constant voltage. The signal was recorded using electrodes placed adjacently on the hypothenar and thenar eminence of the left palmar surface using disposable, Ag/AgCl foam electrodes pre-gelled with isotonic paste (Biopac Systems, Inc, Goleta, CA.). A small amount of additional paste was added to each electrode prior to placement. Skin conductance responses (SCRs) were defined by a minimum amplitude criterion of 0.01 μS.

**Manipulation checks.** Participants completed two types of manipulation checks before and after the mental arithmetic task during pre- and post-testing laboratory sessions. Following procedures implemented by Mauss et al. (2010), participants rated their emotional state prior to the baseline period as well as immediately following the mental arithmetic task. Participants rated how well 17 different emotion-related adjectives described their internal feeling at that moment on an 11-point scale (0=not at all; 10=extremely). Items included positive (e.g., joyful, calm, happy) and negative affective states (e.g., sad, worried), with specific measures that assessed anger (annoyed, angry, frustrated, irritated) that yielded acceptable alphas (Time 1, pre-math $\alpha =0.88$; Time 1, post-math $\alpha = 0.92$; Time 2, pre-math $\alpha = .86$, Time 2, post-math $\alpha = .93$).

**Experimenter and research assistant evaluation.** At the completion of each laboratory session, participants completed a laboratory evaluation form. This form asked the participant to rate the RA and E on various aspects of her performance. Specifically, participants rated the
RA’s and E’s level of “performance in his/her respective role,” “respectful and mature manner,” “professionalism,” “enthusiasm and positive attitude “motivation and involvement in experiment,” “interpersonal demeanor,” “helpfulness to participants,” and “orderliness.” All statements were rated along a 5-point scale (1=unacceptable, 2=needs improvement, 3=acceptable, 4=good, 5=excellent).

Experience sampling. Participants completed a 1-week experience sampling procedure during the first and the final week of their respective course. At each sampling instance, participants were asked to rate the extent to which emotion-related adjectives characterized their experience at that moment on a 5-point scale (1=not at all; 3=somewhat; 5=very much). Emotion adjectives were chosen to represent all quadrants of affective space (Barrett, 1998), with particular emphasis on adjectives related to compassion (i.e., compassionate, generous, sympathetic) and anger (i.e., angry, annoyed, frustrated, disdainful). Mindfulness questions were adapted from the Five Factor Mindfulness Questionnaire (Baer et al., 2008), with specific questions chosen to represent all five factors (i.e., attention, non-reactivity, non-judgment, observe, describe).

To ensure compliance, participants were required to answer a minimum of 75% of the sampling instances to receive compensation. A 75% compliance threshold is comparable to what has been used in previous experience sampling studies (e.g., Barrett, 2004; Tugade et al., 2004). Among the participants who completed the entire study, that average response rate was 85.6% ($M=41.45, SD=6.23$) at pre-testing and 78.3% at post-testing ($M=38.36, SD=10.86$). Participants also received a $10 gift card to a coffee shop for completing at least 90% of sampling per week.

Data Reduction and Analyses of Experience Sampling Measures

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9 Seven out of 117 participants who enrolled in the study did not own a smartphone and therefore did not complete the experience sampling portion of the study.
Prior to data analysis, I filtered out participants who did not complete at least 20 responses at pre- and post-testing (n=6, less than 10% of the participants). Experience-sampling derived measures were reduced by calculating mean indices for the following constructs: *compassion, anger, virtuous states, non-virtuous states, mindfulness, positive emotions,* and *negative emotions.* I then calculated mean scores for each construct for each participant for each week of experience sampling (i.e., at pre- and post-testing). Subsequent analyses examined cross-sectional changes across time in the average level endorsement of these constructs. Specifically, 2 (time) × 3 (group) mixed ANOVAs, with time as the repeated factor, examined whether experiences of virtuous states increased from time 1 to time 2 among those in the compassion meditation group, relative to those in the mindfulness meditation group and those in the active control group.

**Data Reduction and Analyses of Peripheral Psychophysiology Measures**

Following Quigley et al (2002), ECG-derived physiological measures were reduced using software that permitted visual inspection of electrocardiographic waveforms. ECG data were inspected for movement artifact, and affected beats were not used in the ensemble averages. Movement artifact affected less than 10% of the data. ECG- and EDA-derived data were calculated for each minute of the baseline, mental arithmetic task without feedback, mental arithmetic with feedback, and recovery periods at pre-testing and for each minute of the baseline, mental arithmetic task without feedback, mental arithmetic with anger induction, and recovery periods at post-testing. A measure of baseline physiological levels was computed by averaging the recordings for the 5 min of the baseline period preceding the mental arithmetic task. A 5-min baseline was computed to provide a maximally reliable assessment of baseline function. Psychophysiological reactivity scores were computed as differences from baseline. Following
Mauss et al., (2010), I averaged responses during each of three 1-minute mental arithmetic tasks to obtain an index of responding to the anger induction. In contrast to the analysis of heart rate change by Mauss et al. (2010), I followed Quigley et al., (2002) by computing mean heart period (HP) change, or the change in time between successive heart beats (also called inter-beat interval, IBI). Heart period demonstrates a more linear relationship with the underlying autonomic changes that likely mediate short-term cardiac changes than heart rate (Berntson, Cacioppo, & Quigley, 1995). Blood pressure indices (SPB and DBP) were computed by averaging three measurements for each epoch (i.e., baseline, mental arithmetic, and recovery). The number of skin conductance responses (SCRs) were calculated for each minute and served as a measure of sympathetic activity. Finally, I also examined respiratory sinus arrhythmia (RSA) reactivity. RSA is calculated via high-frequency heart rate variability, which largely reflects variation due to vagal control and has thus been widely used as a measure of parasympathetic influence on the heart (Berntson, Quigley, & Lozano, 2007). I followed the Society for Physiological Recording task force recommendations by calculating RSA using spectral methods to decompose the overall heart period variance into specifiable frequency bands (Berntson et al., 1997). Data processing was carried out by software developed by MindWare Technologies (Gahanna, OH).

In addition to the measures above, I examined cardiovascular recovery. Cardiovascular recovery is uniquely associated with long-term health consequences and may provide a non-invasive measure of equanimity—a state characterized by openness and neutrality (cf., Desbordes et al., in press). To model cardiovascular recovery, I used curve fitting to estimate the duration or recovery following the end of the anger provocation (cf., Christenfeld, Glynn, & Gerin, 2000). Visual inspection of each participant’s heart period at post-testing revealed that
peak onset typically occurred during the fourth and fifth trials of mental math, thus recovery was modeled around these events.

**Results**

**Experience Sampling**

A series of 3 (Group: compassion, mindfulness, control) × 2 (Time: pre-training, post-training) mixed ANOVAs examined mean level experiences of compassion, anger, virtuous states, non-virtuous states, positive emotions, negative emotions, and momentary mindfulness (see Table 4). Across all measures, all three groups showed a general trend toward increased levels of measures indicative of wellbeing (i.e., compassion, virtuous states, mindfulness, and positive emotions) and decreased levels of measures that indicate an absence of wellbeing (i.e., anger, non-virtuous states, and negative emotions; see Table 4). All three groups showed a reliable increase from pre-testing to post-testing on momentary mindfulness, $F(1,75)=6.61, p=.01$, a reliable decrease in non-virtuous states, $F(1,75)=3.25, p<.06$, a reliable decrease in anger, $F(1,75)=11.02, p<.01$, and a marginal increase in virtuous states, $F(1,75)=3.25, p<.10$.

As predicted, however, a contrast revealed a significant group by time interaction on self-reported compassion, $F(2,75)=4.00, p<.05$. Those in the compassion meditation group reported a greater increase in self-reported compassion from pre-testing to post-testing compared with the mindfulness meditation group and the control group (see Table 4). Furthermore, a contrast revealed a marginal interaction on self-reported anger, $F(2,75)=2.31, p<.11$, such that the compassion group reported the largest decrease in self-reported anger. Thus, it appears that compassion meditation produced a unique effect on momentary reports of compassion in daily life.

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$^*$ Contrast weights for the anger and compassion contrasts were modeled as compassion T1 (-2), compassion T2 (2), mindfulness T1 (1), mindfulness T2 (-1), control T1 (1), control T2 (-1). Residuals for the both contrasts were non-significant.
An immediate concern with respect to increased reports of momentary compassion following eight weeks of compassion training is that associated with demand characteristics and participant expectancy (as was highlighted in relation to the compassion meditation literature mentioned above). Although demand characteristics cannot be ruled out with momentary reports, I would also expect such effects to uniquely influence momentary reports on positive emotions among the control group, which learned about the psychology of happiness, and momentary reports of mindfulness among those in the mindfulness group. Yet analyses revealed no interaction of time and condition on reports of positive emotions, $F(2,75)=0.16, \ ns$, or on mindfulness, $F(2,75)=0.04, \ ns$. Rather, all three groups exhibited a reliable increase in mindfulness, $F(1,75)=6.61, \ p=.01$ and a trend toward increased positive emotions, $F(1,75)=1.86, \ p=.18$. It is also worthwhile to note that the participants from the control group did show a unique increase in momentary reports of gratitude, despite spending one week learning about gratitude and completing daily gratitude journals. Thus it is unlikely that demand characteristics are the principle factor leading to increased momentary reports of compassion among those who trained in compassion meditation.

**Laboratory Outcomes**

**Manipulation checks: Responses to the anger induction.** A 2 (time: pre-training, post-training) × 2 (task: baseline, post-math task) repeated-measures ANOVA revealed a significant interaction between time and task on self-reported anger experience, $F(1,82)=4.07, \ p<.05$. At post-testing, participants reported higher amounts of anger after the anger induction ($M=4.01, SD=2.76$) compared with baseline ($M=1.17, SD=1.52$), $t(90)=10.56, \ p<.001$. Furthermore, participants reported more anger after the anger induction at post-testing ($M=4.10, SD=2.76$) than following the mental arithmetic task at pre-testing ($M=3.23, SD=2.59$), $t(83)=2.04, \ p<.05$. 

57
Subsequent analyses examined whether condition assignment affected impacted self-reported experience in response to the anger induction. A $3 \times 2 \times 2$ mixed ANOVA revealed no interaction between condition, task, and time, $F(2,80)=1.82, p=.17$, and no interaction between condition and task, $F(2,80)=2.12, p=.13$. Thus compassion meditation ($M=3.93, SD=2.67$) and mindfulness meditation ($M=4.00, SD=2.92$) did not prevent the subjective experience of anger in response to the laboratory-based anger induction compared with those in the control group ($M=4.12, SD=2.73$), $F(2,90)=0.03, ns.$

**Experimenter evaluations.** A $2 \text{(Role: RA, Experimenter)} \times 2 \text{(Time: pre-training, post-training)} \times 3 \text{(Group: Compassion, Mindfulness, Control)}$ mixed ANOVA revealed no interaction between group, time, and role, $F(2,73) = 0.50, p>.61$. Group assignment did not affect the participants’ ratings of the RA or the Experimenter at pre- or post-training. Yet the same analysis revealed a significant Role $\times$ Time interaction, $F(1,73)=83.25, p<.001$. Post-hoc analyses revealed that ratings of the RA did not differ from pre-training ($M=4.87, SD=0.25$) to post-training ($M=4.89, SD=0.27$), $t(82)=0.63, p=.53$. The experimenter was rated more negatively at post-training ($M=3.49, SD=0.95$) compared with pre-training ($M=4.49, SD=0.60$), $t(76)=8.84, p<.001$. Furthermore, self-reported anger following the anger induction negatively correlated with ratings of the Experimenter at post-training, $r(88)=-.52, p<.001$, but only marginally with ratings of the RA at post-training, $r(89)=-.18, p=.08$. As with the self-reported anger ratings, ratings of the Experimenter at post-training did not differ between those participants with some suspicion ($M=3.38, SD=1.06$) and those participants without suspicion ($M=3.68, SD=0.90$), $t(94)=1.44, p=.15$.

**Resting physiology at baseline.** A series of $3 \text{(Group: compassion, mindfulness, control)} \times 2 \text{(Time: pre-training, post-training)}$ mixed ANOVAs examined resting (baseline) levels of
autonomic activity for each outcome variable separately, including IBI, RSA, RR, SCRs, SCL, SBP, and DBP (see Table 5). Contrary to predictions, there was no group by time interaction on baseline-RSA, $F(2,87)=0.04, p=.96$. Across all groups, participants demonstrated a decrease in RSA from pre-testing ($M=6.92, SD=0.96$) to post-testing ($M=6.67, SD=1.08$), $F(1,87)=9.72, p<.001$. There was also a marginal effect of condition, $F(2,87)=2.96, p<.06$. A post-hoc Tukey HSD revealed that those in the compassion group began the study with lower resting-RSA ($M=6.59, SD=0.95$) than those in the mindfulness group ($M=7.21, SD=0.88$), $p<.05$, but did not differ from those in the control group ($M=6.98, SD=0.98$), $p=.26$. The groups did not differ at post-testing, $F(2,87)=2.18, p=.12$. An inspection of other autonomic variables revealed that all groups exhibited greater arousal at post-testing, as indicated by a main effect of time on IBI ($M_{pre-test}=866.22, SD_{pre-test}=122.69; M_{post-test}=827.85, SD=127.20$), $F(1,87)=13.23, p<.001$, and on the number of SCRs, ($M_{pre-test}=4.03, SD_{pre-test}=2.79; M_{post-test}=5.27, SD=4.11$), $F(1,85)=10.87, p<.001$ (see Table 5).

**Physiological reactivity.** A series of 3 (Group: compassion, mindfulness, control) × 2 (Time: pre-training, post-training) mixed ANOVAs examined physiological reactivity during mental arithmetic trials with no feedback (neutral) from baseline at and during mental arithmetic trials with feedback (feedback or harassment) from baseline levels of autonomic activity for each outcome variable separately, including IBI, RSA, SCRs, SBP, and DBP (see Table 6). As expected, there were no group differences in physiological reactivity to the anger induction at post-testing in IBI, RSA, SCRs, SBP, or DBP ($Fs < 1.56, ps > .22$) (see Table 6). Significant effects of time emerged for IBI ($M_{math\_feedback-baseline}=123.75, SD=88.12; M_{math\_anger-baseline}=155.84, SD=86.60$), $F(1,83)=17.44, p<.001$ and RSA ($M_{math\_feedback-baseline}=-0.39, SD=0.72; M_{math\_anger-baseline}=-0.73, SD=1.17$), $F(2,83)=8.73, p<.01$. These latter effects indicate the math
trials combined with the anger induction at post-testing produced more physiological reactivity than the math trials with neutral feedback at pre-testing. This pattern was not affected by experimental condition.

**Cardiovascular recovery.** Curve fitting (cf. Christenfeld, Glynn, & Gerin, 2000) was used to estimate the duration of time that passed between a) peak response following the final anger provocation and b) resting level. The value obtained was treated as the dependent variable in the following analysis. A one-way ANOVA revealed a significant effect of group on the duration of recovery, $F(2,82)=3.27$, $p<.05$, $d=0.40$. Post-hoc Tukey HSD tests revealed that those in the compassion meditation group had longer duration of recovery ($M=0.95$, $SD=1.12$) than those in the control group ($M=0.34$, $SD=0.39$), $p=.04$. Those in the mindfulness group ($M=0.79$, $SD=0.89$) did not differ from those in the compassion group or those in the control group, $p>.10$. Thus, contrary to prediction, those in the compassion group experienced the longest duration of cardiovascular recovery following an anger provocation.

**Helping behavior.** Contrary to prediction, there were no group differences in helping behavior after the first wave of the study (with two bystanders) or after the second wave of the study (with zero bystanders). After the first wave of the study, a very small number of participants—regardless of group condition—offered their seat to the rude experimenter, $\chi^2(2)=2.56$, $p>.27$, $\phi=0.22$ (see Table 7a). A similar pattern emerged after the second wave of the study with no confederates: a small number of participants—regardless of group condition—offered their seat to the rude experimenter, $\chi^2(2)=0.68$, $p>.71$, $\phi=0.13$ (see Table 7b). Consistent with prior research on helping behavior, the results produced the standard bystander effect, such that the presence of two confederates yielded significantly lower helping rates compared with the absence of confederates, $\chi^2(1)=6.38$, $p<.02$, $\phi=0.27$ (see Table 7c). Participants were more likely
to offer their seat when there were zero confederates compared with two confederates. Of most importance, participants generally did not engage in helping behavior directed at the experimenter. A number of factors may account for low rates of helping behavior observed in the current study compared with results obtained in Study 1. I address these factors in the Discussion section below.

**Discussion**

Study 2 demonstrated somewhat inconsistent support for the hypothesis that meditation increases compassion. Two key conclusions are of greatest relevance, but provide somewhat different accounts. First, experience sampling data indicate that those in the compassion meditation group reported increases in compassion. Second, there were no group differences in physiological reactivity and self-reported experience in response to a controlled anger induction; however, those in the compassion-meditation group experienced the longest duration of cardiovascular recovery. Finally, there were no group differences in compassionate responding to a difficult target (although several design factors present caveats that limit the ability to make a firm conclusion). I discuss these three outcomes in turn.

Participants’ daily reports of momentary experience via experience sampling indicated that those in the compassion group reported increased daily experiences of compassion at post-testing, relative to those in the mindfulness and control group. Similar but non-significant trends also emerged for a reduction in anger, whereby those in the compassion group reported the greatest decrease in anger. Thus, in sum, compassion meditation appears to alter the readiness with which people experience compassion in daily life in a manner that differs from mindfulness meditation and discussions of wellbeing. This outcome is particularly novel as prior reports have indicated that loving-kindness meditation did not increase daily reports of compassion
(Fredrickson et al., 2008). The impact of demand characteristics on self-reported experience of compassion is an obvious concern, but I believe that demand is unlikely to be the principle cause for such increases. Analyses revealed that those in the mindfulness group did not report increased mindfulness relative to the other groups while those in the control group (a psychology of wellbeing class) did not report greater levels of happiness or positive emotions, relative to the other groups. Furthermore, demand characteristics are less likely to impact responding on experience sampling data, in which the respondent’s ratings are more likely driven by semantic and conceptual beliefs about emotional experiences, rather than episodic information (Robinson & Clore, 2002a,b). It is also worthwhile to note that the participants in the control group were also exposed to information about the importance of positive interpersonal relationships, including weekly meetings that discussed the role of gratitude, trust, pro-social spending (money and charity), and meaning in life (including relationships with others), but this group did not report an increase in momentary levels of compassion.

Beyond concerns with demand characteristics, the observed increase in momentary experiences of compassion may have important implications for downstream behavior. The Conceptual Act Theory (Barrett, 2006) proposes that emotions are emergent products of affective changes in the body combined with the integrative conceptualization of body changes, incoming exteroceptive information from the world, and prior experience. Conceptualization of affective experience constitute a prediction of how to act in the world in the presence of an affective stimulus/situation (Barrett, 2012; Condon, Wilson-Mendenhall, & Barrett, 2014; Lindquist & Barrett, 2008; Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011). Thus, people who conceptualize their experience as “compassionate” should be more likely to construe their situation and behave in accordance with compassion-related goals, such as reducing
suffering (Condon & Barrett, 2013). The current results indicate that participants are more frequently conceptualizing their experience as compassionate. Future research should investigate whether these experiential changes act as a mechanism for increasing compassionate behavior such as that observed in Study 1.

The second key conclusion from Study 2 stems from the finding that eight-weeks of meditation does not appear to act as a buffer against the experience of acute anger in response to a controlled laboratory-induction. Regardless of group assignment, participants experienced heightened self-reported anger and heightened sympathetic reactivity (as measured by the number of skin conductance responses) and heightened cardiovascular reactivity (as measured by IBI and BP). This study appears to rule out the hypothesis that eight-weeks of meditation can prevent anger and physiological responses to an interpersonal conflict. Rather, it may be more likely that the ability of meditation to alter emotional states, and anger in particular, may stem from emotion regulation capacities such as reappraisal. It may also be the case that longer-term training might be effective at reducing anger responding and physiological reactivity. That is, the inability of meditation to reduce responses to an anger-provocation might stem from relatively short-term training in meditation (i.e., eight-weeks). Elsewhere, researchers have shown that compassion meditation, relative to a health discussion control group, does not reduce physiological reactivity (Pace et al., 2008). Evidence from a case study on a Buddhist monk with 40+ years of meditation experience, however, indicates that long-term meditation training can reduce physiological reactivity to an evocative stimulus during meditation (Levenson, Ekman, & Ricard, 2012). The current study did not prompt the participants to use the skills they learned over the past eight weeks during the stress/anger-inducing task. Group differences might have
emerged if the participants were prompted to use their practice during the context of the experimental task.

Contrary to predictions, those in the compassion-meditation group experienced the longest duration of cardiovascular recovery following the end of the anger provocation. This result suggests that those in the compassion remained aroused for the most time following the anger provocation. It is unclear why those in the compassion-meditation group experience longer duration of arousal. All groups self-reported feeling angry after the induction, but only the compassion group experienced longer arousal. One possibility could manifest from the link between compassionate motives and moral outrage motivated by social injustice. Prior work, for example, has linked compassionate motives in response to others’ suffering to hostile attitudes toward other people (Keller & Pfattheicher, 2013). Participants in the compassion group may be experiencing a different type of anger than those in the mindfulness or control group, such as anger characterized by a sense of injustice. To the extent that participants in the compassion group feel a greater sense of injustice in response to the anger provocation, they may be slower to recover to baseline. Future research will be necessary to further examine this question.

The final conclusion concerns the limited helping response observed at post-testing. This outcome yields a number of plausible interpretations. One immediate conclusion centers on the inability of compassion or mindfulness training to increase compassionate behavior toward a difficult target. Although plausible, I suspect this conclusion may be less likely than other various interpretations. First, the social context differed than the paradigm previously used in Study 1 in that the person on crutches was no longer a neutral peer, but rather an authority figure who had spent the previous 30 minutes providing the participants with directions and instructions. The nature of the social hierarchy between the participant and the experimenter may
have reduced the likelihood of a helping response. Furthermore, contrary to the methods used in Study 1, the helping scenario unfolded after the laboratory session, rather than before the participant entered the lab. In the current paradigm, participants had just completed a 60-minute, stress inducing lab session. This altered psychological state may also have contributed to a reduced compassionate response. Finally, as with physiological reactivity, it may be the case that eight weeks of meditation is insufficient to produce the level of compassionate behavior that is idealized in Buddhist literature. It may be the case that longer-term meditation could increase compassionate behavior toward a difficult target.

**Limitations and Future Directions**

A few key limitations qualify the results of Study 2. First, the sample may have been a highly conscientious group that had high levels of wellbeing at the outset. Recruitment procedures dictated that the sample had no history of psychiatric diagnoses and no history of cardiovascular illness. Furthermore, the sample largely comprised college students at a highly selective private university (i.e., Northeastern University in Boston, MA) who were willing to participate in an eight-week course that required a significant time commitment during the course of an academic semester. All participants were likely motivated and interested in the course content to begin with. The lack of a wait-list control group further limits the ability to interpret the lack of group differences from pre-to-post testing on physiological variables. The psychology of well-being control group likely conferred a number of benefits to the participants. All groups, for example, exhibited increases in momentary mindfulness in daily life. I did not predict this outcome, but the result is not surprising given the daily homework that participants from the wellbeing group conducted. These participants kept a daily journal about a particular topic related to the upcoming week’s discussion (e.g., gratitude journals, journals about spending
habits, eating and dietary habits, relationships, meaning in life). It is likely the case that writing about their experiences provided participants with similar experiences and benefits as those one might predict to emerge from a meditation practice. That is, writing about one’s experience could function in a manner similar to mindfulness meditation by cultivating insight (vipassana) or clear comprehension (sampajāna). Through writing, these participants may have cultivated mindfulness and awareness of their own emotional experience and cognitive habits.

Psychological science has documented that writing about emotional experiences can function as a therapeutic process, resulting in significant physical and mental health outcomes (Pennebaker, 1997). The current results might be reinterpreted with the addition of a wait-list control comprised of a group of people that did not engage in some type of daily exercise that involved meditative or written reflection on emotional experience. That is, the meditators and those in the wellbeing discussion group might have exhibited decreased physiological reactivity relative to a wait-list control group.

Future analysis of the present dataset might provide further insight on the impact of meditation on physiological reactivity. Previous research has demonstrated that the cardiovascular system is particularly well-tuned to different patterns of appraisal referred to as threat and challenge (Blascovich, Mendes, Salomon, & Hunter, 1999; Blascovich & Tomaka, 1996; Tomaka, Blascovich, Kelsey, & Leitten, 1993). During states of challenge, an individual perceives that he or she has sufficient resources to cope with whatever demands the situation presents. Furthermore, the individual experiences sympathetic stimulation that enhances cardiac performance (e.g., increased heart rate and cardiac output) as well as a decline in systemic vascular resistance (e.g., reduced or no change in total peripheral resistance and blood pressure). This pattern represents efficient mobilization of energy for coping (Blascovich et al., 1999).
During states of threat, however, an individual perceives that he or she does not have sufficient resources to cope with the demands of the situation. The individual experiences sympathetic stimulation, thereby increasing cardiac performance, but also experiences an increase in systemic vascular resistance (e.g., increased total peripheral resistance and blood pressure). The present study might reveal group-level differences in physiological profiles associated with threat and challenge, which could have important implications for reducing the deleterious health impacts of stress and interpersonal conflict.

In sum, the current study extends the literature on meditation and the cultivation of virtue. This is the first study to demonstrate that compassion meditation increases daily experiences of compassion. Furthermore, this conclusion is strengthened by the use of two active control groups, including mindfulness meditation. Nevertheless, there appear to be boundaries in the extent to which compassion training can increase compassionate behavior. The increased daily experiences of compassion, for example, did not translate to increased compassionate behavior toward a difficult target in a controlled, orchestrated real-world scenario at post-testing. It is possible that expanded compassion for a difficult target may require additional training or additional factors that might complement meditation training. In a Buddhist context, for example, meditation training is complemented by factors that explicitly address ethics outside of the meditation practice, including intentions and vows, which might support compassionate behavior in daily life. The study of Buddhist concepts, such as impermanence, interdependence, and suffering, might also function as an important contributor to the types of outcomes discussed in Buddhist literature. It is unclear to what extent such factors might enhance compassionate responding. Furthermore, it would be difficult to test such questions using experimental methods as one would have to recruit participants who are willing to take part in a study on “Buddhist”
meditation—it would be difficult to present such a study in a secularized manner. Nevertheless, the current study provides further encouragement for the application of compassion meditation in particular for cultivating compassion in daily life.
Chapter 4: General Discussion

Taken together, the findings presented here are among the first to show that meditation training can positively impact virtuous mental states and behavior outside of the laboratory in ecologically-valid settings. These studies demonstrated the ability of meditation to increase compassion through an orchestrated real-world scenario in which meditators were more likely to aid a person in physical pain and those practicing compassion-meditation experienced more compassion during their daily lives. Secularized compassion-based training protocols offer an effective avenue to increase compassion among people interested and willing to engage in meditation practice. A number of findings from other studies have indicated positive effects of compassion on well-being, including overall happiness and physical health (Davidson, 2012).

As the empirical investigation of compassion meditation grows, it will be important to note similarities and differences across studies based on divergent training protocols. The secularized mind-training (lojong) practices used in the compassion-groups in Study 1 and 2, for example, were similar to those adopted in the CCARE protocol at Stanford University and the Compassion-Based Cognitive Training at Emory University. Yet to my knowledge, Study 2 is the first to use the benefactor practice adapted from Tibetan deity practices (guru yoga, ngondro). This latter practice may have some similarities with variations of loving-kindness meditation also used elsewhere (e.g., Klimecki et al., 2013; Leiberg et al., 2012). The mindfulness practices also differed from standard MBSR protocols that include elements of yoga and a one-day retreat. A particular intriguing area of future research could focus on understanding the effectiveness of different compassion-based protocols, such as lojong and ngondro, for cultivating compassion and related outcomes. It is also likely that individual differences are likely to impact the manner in which a person responds to such practices.
Identifying the particular challenges and benefits that different individuals experience with different practices may provide important insights on the application of these practices in clinical or educational settings.

The field of contemplative science will make significant progress as investigators begin to isolate the active ingredients and mechanisms responsible for psychological change and positive social outcomes. Laboratory studies that use simple manipulations may be particularly effective toward this end. Recent work, for example, used a simple laboratory-based instruction to investigate the process of “de-centering,” that is, recognizing one’s thoughts as fleeting sensations, which is an important facet of mindfulness training. Results indicated that this simple instruction resulted in the ability to overcome impulsive reactions to desirable food (Papies, Barsalou, & Custers, 2012). De-centering appears to be an important facet in mindfulness training. A similar laboratory based approach for studying compassion (e.g., Abelson et al., 2014) will likely lead to further insight about the elements of meditation training that produce compassion-related outcomes.

The present findings fall within an ongoing dialogue among contemplative scholars, practitioners, and scientists concerning the growing popularity of mediation and the portrayal of the benefits of meditation within the mass media (e.g., North, 2014; Rocha, 2014). Media reports have contributed to the growing belief that meditation is a solution to nearly any problem that afflicts the general population. Yet it is widely acknowledged in contemplative traditions that meditation can also produce a wide range of negative psychological outcomes, including hallucination, anxiety, depression, suicidal ideation, etc. (Rocha, 2014). In fact, negative experiences during meditation are commonly acknowledged in Buddhist texts (Lindahl, Kaplan, Winget, & Britton, 2014). Meditation is not a panacea that will automatically produce happiness,
well-being, and compassion. In its original Buddhist context, meditation is undertaken as a way of life, accompanied by ethical intentions and spiritual goals. The translation of meditation to secular contexts presents a serious challenge and will not always produce the outcomes that meditation practitioners hope for (e.g., compassion). Recognizing the limitations to meditation practice may be an important element of psychological growth that accompanies the practice itself. Nevertheless, the current findings suggest that secularized meditation-based practices could be effective for cultivating pro-social, compassionate behavior in our society.
References


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### Table 1A.

*Mindfulness-based training protocol (Study 1)*

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<tr>
<th>Week</th>
<th>Training components</th>
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| 1    | Open awareness meditation  
    | Introduction of basic techniques (e.g., body-scan) for relaxing the body and monitoring the mind’s natural tendency to wander from the object of attention (i.e., the body). |
| 2    | Mindfulness of a physical object  
    | Introduction and elaboration of practices for learning to calm the conceptually discursive mind for the purpose of attenuating involuntary thoughts. Stability of attention (i.e., on a physical object) is practiced with the goal of sustaining attention in a purposeful, non-judgmental manner for an extended period. |
| 3    | Mindfulness of the breathing with relaxation (I)  
    | Continuing practice of techniques designed to instill a deepening sense of physical and mental relaxation, stillness, and vigilance. When successful, involuntary thoughts subside and vividness of attention gradually increases. This gives rise to an overall sense of greater presence, calm, and equilibrium. |
| 4    | Mindfulness of the breathing with relaxation (II)  
    | Continuing practice from Week 3. Additional instruction focused on common impediments to meditation practice, including sleepiness, agitation, and boredom. |
| 5    | Settling the mind in its natural state (i.e., mindfulness of mental events) (I)  
    | Introduction of practices for further refining the meditator’s metacognitive abilities, with the goal of attenuating the immediate and habitual absorption in one’s thoughts that characterize most mental functioning. When successful, insight into the nature of the mind and its activities is achieved. |
| 6    | Settling the mind in its natural state (II)  
    | Continued practice with the goal of developing increased relaxation, stillness of awareness in the midst of mental activities, and vividness, together with heightened metacognitive abilities to observe mental states and processes without identifying with them. |
| 7    | Awareness of awareness (I)  
    | In this final technique, relaxation, stillness, and vividness of attention continue to be enhanced, leading to a perception of the process of becoming aware, as opposed to only perceiving the contents of awareness. |
| 8    | Mindfulness of awareness and thoughts  
    | Participants use the techniques they’ve learned from all previous weeks and apply them to concentration on the quality of immediate mental experience. Instead of using breath or body as an object, now mind itself becomes the meditation object. Particular attention will be paid to working with the arising and disappearing of thoughts. |
Table 1B.  
*Compassion-based training protocol (Study 1)*  

<table>
<thead>
<tr>
<th>Week</th>
<th>Training components</th>
</tr>
</thead>
</table>
| 1    | **Developing attention and stability of mind**  
Introduction of basic meditation techniques for focusing attention for increasingly longer periods of time. *These techniques are included in the practice of all subsequent compassion meditation components.* |
| 2    | **Baring witness to one’s current life-stressors and difficulties**  
Introduction of practice for noticing and reflecting on current life challenges, such as a difficult situation, event, or person. Participants learn to accept themselves in these moments and relax resistance to discomfort to remain and experience these states without judgment or a need to remedy it. When successful, this practice leads to the dissolution of discomfort. |
| 3    | **Commune with other’s life-stressors and difficulties**  
Introduction of techniques to develop awareness of the commonality of one’s own suffering. Participants learn to recognize that all others feel discomfort just as they do. Participants imagine themselves in a community of others experiencing the same discomfort. |
| 4    | **Extending compassion outward**  
Building on previous practice of bearing witness and communing with suffering, participants visualize breathing own and others suffering into the heart (inhalation) and dissolving all difficulties outward into a spacious sky (exhalation). |
| 5    | **Release of suffering**  
Introduction of practice for letting go of one’s own and others’ suffering into a state of open awareness. |
| 6    | **Exchange with others – close target**  
The culmination of previous instruction are specifically applied to a close other (i.e., a person that one cares about). Participants visualize the disappearance of another’s suffering as they breath it inward and send compassion outward. |
| 7    | **Exchange with others – neutral, unknown target and a difficult, annoying target**  
Extending practice of exchange with others to neutral and difficult targets. |
| 8    | **Exchange with others – all sentient beings**  
Extending practice of exchange with others to all sentient beings. |
Table 2a.
*Study 1: Observed and expected frequencies of helping behavior across conditions.*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Meditation Training</th>
<th>Wait-list Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Expected</td>
</tr>
<tr>
<td>Did not help</td>
<td>10</td>
<td>13.3</td>
</tr>
<tr>
<td>Help</td>
<td>10</td>
<td>6.7</td>
</tr>
</tbody>
</table>

*Note. χ²(1)=5.13, p=.02, φ=0.36.*

Table 2b.
*Study 1: Observed and expected frequencies of helping behavior by meditation group.*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Mindfulness-group</th>
<th>Compassion-group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Expected</td>
</tr>
<tr>
<td>Did not help</td>
<td>5</td>
<td>4.5</td>
</tr>
<tr>
<td>Help</td>
<td>4</td>
<td>4.5</td>
</tr>
</tbody>
</table>

*Note. χ²(1)=0.20, p>.65, φ=0.10.*
<table>
<thead>
<tr>
<th>Week</th>
<th>Training components</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Mindfulness of the body</strong>&lt;br&gt;Introduction of basic techniques (e.g., body-scan) for relaxing the body and monitoring the mind’s natural tendency to wander from the object of attention (i.e., the body).</td>
</tr>
<tr>
<td>2</td>
<td><strong>Mindfulness of the breath</strong>&lt;br&gt;Continuing practice of techniques designed to instill a deepening sense of physical and mental relaxation, stillness, and vigilance. When successful, involuntary thoughts subside and vividness of attention gradually increases. This gives rise to an overall sense of greater presence, calm, and equilibrium.</td>
</tr>
<tr>
<td>3</td>
<td><strong>Mindfulness of a physical object</strong>&lt;br&gt;Introduction and elaboration of practices for learning to calm the conceptually discursive mind for the purpose of attenuating involuntary thoughts. Stability of attention (i.e., on a physical object) is practiced with the goal of sustaining attention in a purposeful, non-judgmental manner for an extended period.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Mindfulness of the breath (abdomen)</strong>&lt;br&gt;Continuing practice from Week 2. Additional instruction focused on common impediments to meditation practice, including sleepiness, agitation, and boredom.</td>
</tr>
<tr>
<td>5</td>
<td><strong>Mindfulness of the breath (nostrils) and tagging thoughts</strong>&lt;br&gt;Introduction of practices for further refining the meditator’s metacognitive abilities, with the goal of attenuating the immediate and habitual absorption in one’s thoughts that characterize most mental functioning. When successful, insight into the nature of the mind and its activities is achieved.</td>
</tr>
<tr>
<td>6</td>
<td><strong>Mindfulness of the breath (nostrils) and setting intention</strong>&lt;br&gt;Continued practice with the goal of developing increased relaxation, stillness of awareness in the midst of mental activities, and vividness, together with heightened metacognitive abilities to observe mental states and processes without identifying with them.</td>
</tr>
<tr>
<td>7</td>
<td><strong>Mindfulness of the breath with peaceful coexistence of thoughts</strong>&lt;br&gt;In this final technique, relaxation, stillness, and vividness of attention continue to be enhanced, leading to a perception of the process of becoming aware, as opposed to only perceiving the contents of awareness.</td>
</tr>
<tr>
<td>8</td>
<td><strong>Mindfulness of awareness and thoughts</strong>&lt;br&gt;Participants use the techniques they’ve learned from all previous weeks and apply them to concentration on the quality of immediate mental experience. Instead of using breath or body as an object, now mind itself becomes the meditation object. Particular attention to working with the arising and disappearing of thoughts.</td>
</tr>
<tr>
<td>Week</td>
<td>Training components</td>
</tr>
<tr>
<td>------</td>
<td>---------------------</td>
</tr>
</tbody>
</table>
| 1    | Developing attention and stability of mind  
Introduction of basic meditation techniques for focusing attention for increasingly longer periods of time. These techniques are included in the practice of all subsequent compassion meditation components. |
| 2    | Receiving compassion from ones benefactor.  
Introduction of benefactor practice for receiving love and compassion from other(s) who acted as a source of compassion or love at a prior moment in one’s life. |
| 3    | Receiving and extending compassion to dear ones.  
Building on previous benefactor practice, participants received love and compassion from others and visualized extending that same sense of love and compassion to a close individual who was currently struggling with some difficulty. |
| 4    | Receiving and extending to neutral and difficult others.  
Building on previous benefactor practice, participants visualized receiving and extending compassion to close others, then neutral others, and finally difficult others, with focus on the negative emotions that others experience (much like one’s own negative emotions). |
| 5    | Leaning in to one’s own suffering.  
Introduction of practice for letting go of one’s own and others’ suffering into a state of open awareness. |
| 6    | Commune with others  
The culmination of previous instruction are specifically applied to a close other (i.e., a person that one cares about). Participants visualize the disappearance of another’s suffering as they breathe it inward and send compassion outward. |
| 7    | Extending compassion outward  
Extending practice of exchange with others to neutral targets. |
| 8    | Extending compassion outward  
Extending practice of exchange with others to difficult targets. |
**Table 3C.**  
*Psychology of Happiness and Well-being protocol (Study 2)*

<table>
<thead>
<tr>
<th>Week</th>
<th>Training components</th>
</tr>
</thead>
</table>
| 1    | **Introduction to Affective Science**  
Introduction of basic information about the role of affect in decision-making and behavior across a range of social and health contexts. |
| 2    | **Affective Forecasting**  
Reviewed material about the errors that humans make when predicting future levels of pleasure and displeasure. |
| 3    | **Gratitude**  
Reviewed material about the intra- and inter-personal benefits of experiencing and cultivating gratitude. Participants completed daily journaling about events for which they felt grateful. |
| 4    | **Behavioral Health**  
Reviewed material about the impact of everyday behaviors on physical health and psychological well-being, including regular sleep, exercise, and healthy eating. Participants completed daily journaling about relevant health behaviors and corresponding feelings of happiness and well-being. |
| 5    | **Trust and Cooperation**  
Reviewed material about the role of trust and cooperation with novel interaction partners and consequences in economic interactions and relationship development and maintenance. Participants completed daily journaling about instances in which trust played a role in detrimental or beneficial outcomes in their life. |
| 6    | **Technology and Happiness**  
Reviewed material about the role of technology in supporting and hurting personal well-being and social relationships. |
| 7    | **Money and Happiness**  
Reviewed material about the role of money in supporting well-being. |
| 8    | **Meaning in Life**  
Reviewed material about hedonic and eudaimonic happiness and the role of purpose, values, and goals in sustaining happiness throughout the lifespan. |
Table 4.  
*Mean (SD) ratings of momentary experience before and after eight-week course.*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group</th>
<th>Pre-testing</th>
<th>Post-testing</th>
<th>Effect</th>
<th>F-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compassion</td>
<td>Compassion</td>
<td>1.89 (0.56)</td>
<td>2.16 (0.84)</td>
<td>Time</td>
<td>F(1,75)=2.71, p&lt;.11</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>1.99 (0.62)</td>
<td>2.02 (0.67)</td>
<td>Condition</td>
<td>F(2,75)=0.35, ns</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.16 (0.84)</td>
<td>2.16 (0.92)</td>
<td>Interaction</td>
<td>F(2,75)=4.0, p&lt;.05†</td>
</tr>
<tr>
<td>Anger index</td>
<td>Compassion</td>
<td>1.68 (0.41)</td>
<td>1.54 (0.36)</td>
<td>Time</td>
<td>F(1,75)=11.02, p&lt;.01</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>1.62 (0.46)</td>
<td>1.53 (0.43)</td>
<td>Condition</td>
<td>F(2,75)=1.25, ns</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.62 (0.41)</td>
<td>1.59 (0.42)</td>
<td>Interaction</td>
<td>F(1,75)=2.31, p&lt;.11†</td>
</tr>
<tr>
<td>Virtuous index</td>
<td>Compassion</td>
<td>1.98 (0.46)</td>
<td>2.13 (0.63)</td>
<td>Time</td>
<td>F(1,75)=3.25, p&lt;.10</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>1.99 (0.49)</td>
<td>2.05 (0.52)</td>
<td>Condition</td>
<td>F(2,75)=0.29, ns</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.12 (0.70)</td>
<td>2.15 (0.72)</td>
<td>Interaction</td>
<td>F(2,75)=0.62, ns</td>
</tr>
<tr>
<td>Non-virtuous index</td>
<td>Compassion</td>
<td>1.70 (0.36)</td>
<td>1.63 (0.32)</td>
<td>Time</td>
<td>F(1,75)=3.70, p&lt;.06</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>1.67 (0.42)</td>
<td>1.64 (0.38)</td>
<td>Condition</td>
<td>F(2,75)=0.22, ns</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.74 (0.43)</td>
<td>1.71 (0.45)</td>
<td>Interaction</td>
<td>F(2,75)=0.39, ns</td>
</tr>
<tr>
<td>Mindfulness index</td>
<td>Control</td>
<td>2.92 (0.23)</td>
<td>3.00 (0.35)</td>
<td>Time</td>
<td>F(1,75)=6.61, p=.01</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>2.97 (0.33)</td>
<td>2.97 (0.33)</td>
<td>Condition</td>
<td>F(2,75)=0.09, ns</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.91 (0.24)</td>
<td>2.99 (0.23)</td>
<td>Interaction</td>
<td>F(2,75)=0.04, ns</td>
</tr>
<tr>
<td>Positive emotion index</td>
<td>Compassion</td>
<td>2.21 (0.50)</td>
<td>2.29 (0.68)</td>
<td>Time</td>
<td>F(1,75)=1.86, p=.18</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>2.16 (0.51)</td>
<td>2.24 (0.55)</td>
<td>Condition</td>
<td>F(2,75)=0.17, ns</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.26 (0.54)</td>
<td>2.31 (0.69)</td>
<td>Interaction</td>
<td>F(2,75)=0.16, ns†</td>
</tr>
<tr>
<td>Negative emotion index</td>
<td>Compassion</td>
<td>1.62 (0.35)</td>
<td>1.58 (0.32)</td>
<td>Time</td>
<td>F(1,75)=2.35, p=.13</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>1.62 (0.42)</td>
<td>1.59 (0.40)</td>
<td>Condition</td>
<td>F(2,75)=0.31, ns</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.70 (0.43)</td>
<td>1.67 (0.46)</td>
<td>Interaction</td>
<td>F(2,75)=0.43, ns</td>
</tr>
</tbody>
</table>

Note. †indicates the result of a contrast analysis.
Table 5.
Mean (SD) ratings of physiological variables at baseline (i.e., rest) before and after eight-week training.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group</th>
<th>Pre-training</th>
<th>Post-training</th>
<th>Effect</th>
<th>F-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compassion</td>
<td>876.60 (122.76)</td>
<td>823.57 (129.85)</td>
<td>Time</td>
<td><em>F</em>(1,87)=13.23, <em>p</em>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>885.40 (119.31)</td>
<td>854.69 (119.98)</td>
<td>Condition</td>
<td><em>F</em>(2,87)=1.73, <em>p</em>=.18</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>831.25 (123.84)</td>
<td>799.71 (130.77)</td>
<td>Interaction</td>
<td><em>F</em>(2,87)=0.48, <em>p</em>=.62</td>
</tr>
<tr>
<td>IBI</td>
<td>Compassion</td>
<td>6.59 (0.95)</td>
<td>6.35 (1.03)</td>
<td>Time</td>
<td><em>F</em>(1,87)=9.72, <em>p</em>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>7.17 (0.89)</td>
<td>6.89 (0.93)</td>
<td>Condition</td>
<td><em>F</em>(2,87)=2.96, <em>p</em>&lt;.06</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>6.98 (0.98)</td>
<td>6.76 (1.25)</td>
<td>Interaction</td>
<td><em>F</em>(2,87)=0.04, <em>p</em>=.96</td>
</tr>
<tr>
<td>RSA</td>
<td>Compassion</td>
<td>16.05 (2.48)</td>
<td>15.46 (2.05)</td>
<td>Time</td>
<td><em>F</em>(1,87)=0.80, <em>p</em>=.38</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>14.97 (2.40)</td>
<td>15.50 (2.61)</td>
<td>Condition</td>
<td><em>F</em>(2,87)=0.59, <em>p</em>=.56</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>15.38 (2.40)</td>
<td>16.06 (2.15)</td>
<td>Interaction</td>
<td><em>F</em>(2,87)=2.95, <em>p</em>&lt;.06</td>
</tr>
<tr>
<td>RR</td>
<td>Compassion</td>
<td>4.27 (2.58)</td>
<td>4.93 (3.20)</td>
<td>Time</td>
<td><em>F</em>(1,85)=10.87, <em>p</em>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>3.31 (2.52)</td>
<td>4.36 (3.45)</td>
<td>Condition</td>
<td><em>F</em>(2,85)=3.30, <em>p</em>=.04</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>4.72 (3.24)</td>
<td>6.90 (5.38)</td>
<td>Interaction</td>
<td><em>F</em>(2,85)=1.24, <em>p</em>=.29</td>
</tr>
<tr>
<td>SCRs</td>
<td>Compassion</td>
<td>4.29 (2.15)</td>
<td>4.93 (3.20)</td>
<td>Time</td>
<td><em>F</em>(1,85)=10.83, <em>p</em>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>3.87 (1.91)</td>
<td>4.36 (3.45)</td>
<td>Condition</td>
<td><em>F</em>(2,85)=2.12, <em>p</em>=.13</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>4.17 (2.21)</td>
<td>6.90 (5.38)</td>
<td>Interaction</td>
<td><em>F</em>(2,85)=3.21, <em>p</em>=.04</td>
</tr>
<tr>
<td>SCL</td>
<td>Control</td>
<td>104.22 (10.99)</td>
<td>104.67 (9.13)</td>
<td>Time</td>
<td><em>F</em>(1,86)=2.45, <em>p</em>=.12</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>101.85 (6.97)</td>
<td>104.66 (11.36)</td>
<td>Condition</td>
<td><em>F</em>(2,86)=1.03, <em>p</em>=.36</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>106.36 (11.67)</td>
<td>107.22 (11.63)</td>
<td>Interaction</td>
<td><em>F</em>(2,86)=0.74, <em>p</em>=.48</td>
</tr>
<tr>
<td>SBP</td>
<td>Compassion</td>
<td>66.33 (6.18)</td>
<td>67.03 (6.02)</td>
<td>Time</td>
<td><em>F</em>(1,86)=0.46, <em>p</em>=.50</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>65.64 (6.20)</td>
<td>66.97 (7.15)</td>
<td>Condition</td>
<td><em>F</em>(2,86)=1.29, <em>p</em>=.28</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>69.26 (7.73)</td>
<td>68.36 (7.59)</td>
<td>Interaction</td>
<td><em>F</em>(2,86)=1.37, <em>p</em>=.26</td>
</tr>
</tbody>
</table>
Table 6a.
*Mean (SD) ratings of physiological reactivity at pre- and post-testing*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group</th>
<th>Compassion</th>
<th>Math (neutral) – Baseline</th>
<th>Math* (harassment or feedback) - Baseline</th>
<th>Recovery – Math</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-training</td>
<td>Post-training</td>
<td>Pre-training</td>
<td>Post-training</td>
</tr>
<tr>
<td>IBI</td>
<td></td>
<td>-137.29 (85.64)</td>
<td>-108.17 (87.73)</td>
<td>-130.23 (90.90)</td>
<td>-158.87 (104.91)</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>-133.89 (83.34)</td>
<td>-116.06 (105.97)</td>
<td>-132.05 (89.03)</td>
<td>-166.44 (117.40)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>-101.10 (77.77)</td>
<td>-74.32 (83.02)</td>
<td>-105.59 (84.44)</td>
<td>-138.74 (86.60)</td>
</tr>
<tr>
<td>RSA</td>
<td>Compassion</td>
<td>-0.33 (0.70)</td>
<td>-0.22 (0.77)</td>
<td>-0.25 (0.63)</td>
<td>-0.67 (1.01)</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>-0.43 (0.69)</td>
<td>-0.46 (0.77)</td>
<td>-0.51 (0.64)</td>
<td>-0.83 (1.03)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>-0.33 (0.86)</td>
<td>0.01 (0.71)</td>
<td>-0.38 (0.90)</td>
<td>-0.68 (1.50)</td>
</tr>
<tr>
<td>SCRs</td>
<td>Compassion</td>
<td>7.82 (2.93)</td>
<td>7.28 (3.79)</td>
<td>6.90 (3.18)</td>
<td>7.19 (3.70)</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>7.89 (4.00)</td>
<td>7.57 (3.46)</td>
<td>8.08 (3.34)</td>
<td>7.55 (4.55)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>7.02 (4.04)</td>
<td>5.92 (5.28)</td>
<td>6.67 (3.80)</td>
<td>6.06 (5.55)</td>
</tr>
<tr>
<td>SBP</td>
<td>Compassion</td>
<td>18.19 (9.53)</td>
<td>14.04 (12.63)</td>
<td>17.87 (9.51)</td>
<td>17.94 (13.74)</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>18.09 (11.56)</td>
<td>13.59 (8.54)</td>
<td>17.28 (11.05)</td>
<td>13.78 (8.88)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>17.38 (9.76)</td>
<td>11.63 (8.42)</td>
<td>16.49 (8.82)</td>
<td>15.99 (11.76)</td>
</tr>
<tr>
<td>DBP</td>
<td>Compassion</td>
<td>13.69 (6.37)</td>
<td>10.15 (7.12)</td>
<td>13.53 (6.32)</td>
<td>11.78 (7.83)</td>
</tr>
<tr>
<td></td>
<td>Mindfulness</td>
<td>12.06 (6.40)</td>
<td>10.03 (5.06)</td>
<td>11.57 (5.98)</td>
<td>10.70 (5.81)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>10.73 (5.88)</td>
<td>9.08 (6.62)</td>
<td>10.32 (5.61)</td>
<td>11.16 (7.86)</td>
</tr>
</tbody>
</table>
Table 6b.
Significance tests of physiological reactivity at pre- and post-testing

<table>
<thead>
<tr>
<th>Measure</th>
<th>Math (neutral) – Baseline</th>
<th>Math*(harassment or feedback) - Baseline</th>
<th>Recovery – Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBI</td>
<td>Time</td>
<td>$F(2,81)=1.85, p=.16$</td>
<td>Condition</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>$F(2,81)=0.29, p=.75$</td>
<td>Interaction</td>
</tr>
<tr>
<td>RSA</td>
<td>Time</td>
<td>$F(1,81)=3.00, p&lt;.09$</td>
<td>Condition</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>$F(2,81)=1.77, p=.18$</td>
<td>Interaction</td>
</tr>
<tr>
<td>SCRs</td>
<td>Time</td>
<td>$F(1,85)=1.72, p=.19$</td>
<td>Condition</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>$F(2,85)=0.21, p=.81$</td>
<td>Interaction</td>
</tr>
<tr>
<td>SBP</td>
<td>Time</td>
<td>$F(2,83)=21.09, p&lt;.001$</td>
<td>Condition</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>$F(2,83)=0.25, p=.78$</td>
<td>Interaction</td>
</tr>
<tr>
<td>DBP</td>
<td>Time</td>
<td>$F(1,83)=12.68, p=.001$</td>
<td>Condition</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>$F(2,83)=0.93, p=.40$</td>
<td>Interaction</td>
</tr>
</tbody>
</table>
Table 7a.
Study 2: Observed and expected frequencies of helping behavior across conditions with two bystanders.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Compassion-group</th>
<th>Mindfulness-group</th>
<th>Control-group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Expected</td>
<td>Observed</td>
<td>Expected</td>
</tr>
<tr>
<td>Did not help</td>
<td>13</td>
<td>14.1</td>
<td>21</td>
<td>20.7</td>
</tr>
<tr>
<td>Help</td>
<td>2</td>
<td>0.9</td>
<td>1</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Note. $\chi^2(2)=2.56, p=.28, \phi=0.22.$

Table 7b.
Study 2: Observed and expected frequencies of helping behavior across conditions with zero bystanders.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Compassion-group</th>
<th>Mindfulness-group</th>
<th>Control-group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Expected</td>
<td>Observed</td>
<td>Expected</td>
</tr>
<tr>
<td>Did not help</td>
<td>9</td>
<td>9.8</td>
<td>10</td>
<td>9.1</td>
</tr>
<tr>
<td>Help</td>
<td>4</td>
<td>3.2</td>
<td>2</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Note. $\chi^2(2)=0.68, p=.71, \phi=0.14.$

Table 7c.
Study 2: Observed and expected frequencies of helping behavior by number of bystanders.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Zero bystanders</th>
<th>Two bystanders</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed</td>
<td>Expected</td>
<td>Observed</td>
</tr>
<tr>
<td>Did not help</td>
<td>30</td>
<td>34.2</td>
<td>55</td>
</tr>
<tr>
<td>Help</td>
<td>9</td>
<td>4.8</td>
<td>3</td>
</tr>
</tbody>
</table>

Note. $\chi^2(1)=6.90, p<.01, \phi=0.27.$