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Meditation and Health: The Search for Mechanisms of Action

Bethany E. Kok[1]*, Christian E. Waugh[2], and Barbara L. Fredrickson[3]
[1] *Max Planck Institute for Human Cognitive and Brain Sciences*
[2] *Wake Forest University*
[3] *University of North Carolina*

Abstract

Psychological interest in the impact of mental states on biological functioning is growing rapidly, driving a need for new methods for inducing mental states that last long enough, and are sufficiently impactful, to have significant effects on physical health. The many traditions of meditative practice are one potential pathway for studying mind-body interactions. The purpose of this review is to introduce personality and social psychologists to the field of meditation research. Beginning with a brief introduction to meditation and the heterogeneity of meditative practices, we showcase research linking meditative practice to changes in immune and cardiovascular functioning and pain perception. We then discuss theoretical and empirical evidence that meditation works by inducing changes in psychological capacities such as emotion regulation and self-regulation or through repeated induction of specific mental states such as love or meta-cognitive awareness. At the frontier of the science of meditation is the need to empirically test whether meditation-driven changes in cognitive and affective processes are the cause of improvements in physical health. Emerging challenges in meditation research include a need for large studies using randomized controlled and dual-blind designs with active control groups and an increased focus on measuring mechanisms of action as well as outcomes. Meditation represents a potentially powerful tool for generating new knowledge of mind-body interactions.

Introduction

Psychological interest in the interaction between mental states and health is growing, as evinced by the establishment in 2009 of the Social Personality and Health Network and annual Society for Personality and Social Psychologists preconference. As part of this burgeoning interest, scholars are turning for inspiration to non-Western traditions with a history of contemplating the intertwined nature of the mind and body. The many traditions of meditative practice are one potential pathway for studying mind-body interactions. Meditative traditions, many honed over millennia, can serve as a source of inspiration for new hypotheses regarding mind-body interactions, and may also provide new ways of inducing mental states. The purpose of this review is to introduce the interested novice to a selection of meditation and health research and the potential role of psychological mechanisms of action,[1] to evaluate the current state of research methods in the study of meditation as it pertains to determining mechanisms of action, and ultimately to highlight the vast, unexplored potential of meditation for researchers interested in understanding mind-body relationships.

There are hundreds, if not thousands, of different types of meditative practices, leading to considerable diversity in the scientific literature on meditation. Given the heterogeneous nature of meditative practices, it is perhaps unsurprising that the literature has yet

to achieve a comprehensive definition of meditation, though many have been proposed (Bond et al., 2009; Cahn & Polich, 2006; Walsh & Shapiro, 2006). For the purpose of this review, we conceptualize meditation as ''a family of complex emotional and attentional regulatory strategies developed for various ends'' (Lutz, Slagter, Dunne, & Davidson, 2008; p. 163). This definition provides a loose and decontextualized interpretive framework for aggregating the results of many studies. The philosophical, spiritual and cultural roots of a meditative practice, however, are integral to understanding the mechanisms of that practice. In an attempt to present an organized introduction to the psychological study of meditation while simultaneously respecting the diversity and long cultural histories of meditative practices, we subdivide scientifically-studied meditative practices into three broad categories, and use these categories to orient our exploration of the literature (Lutz et al., 2008)[2]. When discussing individual studies, we will also describe the unique features of various meditative practices.

Focused attention

The ability to control attention is considered fundamental to many other types of meditative practice; thus, focused attention meditation is often used as a stepping stone to other, more complex practices, as well as an end in itself. Focused attention is included in Vipassana, Shamatha and Transcendental Meditation, among other practices. As the name suggests, the practitioner focuses her attention on a particular sensation or object, such as her breath, to the exclusion of other stimuli. By trying to sustain attention for long periods of time, practitioners learn to monitor attention in order to determine when the focus of attention has wandered, to effectively disengage from distractors, and to re-orient on the intended object of attention (Lutz et al., 2008). Over time, less energy is required to maintain focus and the attention monitoring capacity increases in sensitivity, detecting distraction more quickly. The target of attention may be of substantive import, such as the individualized mantras chanted by practitioners of transcendental meditation (Canter & Ernst, 2003), or incidental to the practice of attention, such as the focus on the breath in Vipassana (Hart, 1987).

Open monitoring

The meta-cognitive capacity to monitor attention is central to open monitoring practices, where practitioners strive to achieve moment to moment awareness of internal and external experiences, as they occur, without prioritizing or rejecting particular elements of experience. Typically practitioners begin with focused attention, and only gradually shift from monitoring directed attention to monitoring experience as a whole. In open monitoring, no one aspect of experience receives more attention than any other. Open monitoring is not the same thing as having an ''empty'' mind (Lutz et al., 2008). During open monitoring, thoughts, feelings and sensations occur and are observed, but the practitioner does not react to or engage with them. For example, during a session of open monitoring the practitioner may spontaneously recall an argument he had with a friend the night before. Rather than being 'pulled into' the memory and its attendant emotions, the practitioner observes the memory as it passes by but remains focused on the moment.

Kindness and compassion

Both focused attention and open monitoring practices are individual and internal- the focus is on the practitioner's experiences and mental abilities. In kindness-and-compassion-based

practices, the practitioner's focus turns to connections with others. As in open monitoring, these practices begin by learning how to focus attention on a neutral source such as the breath. After the practitioner has developed the ability to sustain attention, the focus of attention is shifted from passively observing a neutral target to focusing on a person or group, which can include the self. In some compassion practices, a specific target is not selected and compassion is elicited non-referentially (Lutz, Dunne, & Davidson, 2007). The goal is to cultivate feelings of closeness and benevolence (Salzberg, 2005).

Forms of kindness-and-compassion meditation differ in the identity of the target and the way that closeness is achieved. Loving-kindness can be offered to any person, including the self, regardless of whether the target is experiencing good or bad fortune. If the target suffers bad fortune, the compassion meditation is appropriate. The meditator may attempt to empathize by imaginatively engaging in the person's suffering. Alternatively, the meditator may concentrate on their love for the target and their desire to alleviate the target's suffering. The first target of loving-kindness or compassion meditation is often the practitioner or someone close to her, facilitating feelings of care and empathy. Over time, the meditator learns to extend empathy, love, care and the desire to alleviate suffering toward more distant or hostile others, with the eventual goal of feeling kindness and compassion for all beings (Salzberg, 2005).

Effects of Meditation and Potential Mechanisms of Action

The wide range of meditative traditions and practices means there is great potential for the researcher to induce diverse mental states – from mindful attention to meta-cognitive awareness to compassion to positive emotions – in order to test hypotheses concerning the effects of these states on health. In addition to inducing momentary states, when practiced, meditation can induce long-lasting changes in mental states – similar to other types of cognitive skills training.

The following review of the literature is intentionally selective. We have chosen to focus on the effects of various meditative practices on three indicators of physical health: Immune system activity, cardiovascular health and pain perception. For each, we first summarize the literature linking the health-related indicator to meditative practice, then suggest potential psychological mechanisms of action that might drive the effects of various meditative practices. Throughout, we focus on recently published studies of particular conceptual or methodological interest.

Immune system

Effects of meditation. Meditative practices have been linked to a number of aspects of immune functioning in healthy adults, including immune cell stability, inflammation in response to stress and responsiveness to a vaccine. Adults with previous meditation experience were recruited for a 3-month-long study on the effects of combined open monitoring and kindness-and-compassion meditation training on telomerase activity in immune cells. Telomerase is an enzyme that maintains the protective ''end caps'' on DNA that promote genomic stability and prevent mutation; higher levels of telomerase are linked to lower levels of stress and better health (Epel, 2009). Meditators showed greater immune cell telomerase activity at the end of the study relative to age, sex and BMI-matched control participants (Jacobs et al., 2011). Other evidence also links open monitoring and loving-kindness to immune functioning. Healthy college students were randomly assigned to 10 weeks of either loving-kindness training or, as an active control,

a health education discussion group. At the end of the study, all participants completed the Trier Social Stress Test and blood plasma samples were taken to measure changes in interleukin-6 (IL-6), a marker of inflammation, in response to the stressor. The two groups did not differ in IL-6 responses; however, within the meditation group, more time spent meditating predicted lower levels of IL-6 in response to the stressor (Pace et al., 2009). In a more direct measure of immune functioning, 8 weeks of mindfulness-based stress reduction (MBSR) training, which involves open monitoring and focused attention practices, predicted a greater rise in antibody titers in response to the influenza vaccine for adult meditators relative to participants in a wait-list control group (Davidson et al., 2003).

Potential psychological mechanisms of action. One element of many meditative traditions is learning to control previously automatic cognitions and behavioral responses. In open monitoring practices, for example, meditators learn to inhibit automatic patterns of behavior (habits) and to observe positive and negative thoughts as they occur, without reaction or judgment. Behavioral inhibition and non-reactivity to thoughts are forms of self-regulatory behavior, which is associated with more adaptive responses to stress (Tangney, Baumeister, & Boone, 2004). Immune system function is adversely affected by stress (Segerstrom & Miller, 2004), suggesting that open monitoring may work by improving the capacity for self-regulation.

In the intensive 3-month meditation study described previously, meditation training not only raised the level of circulating blood telomerase, but also improved meditators' ability to inhibit dominant responses, an index of self-regulatory ability (Jacobs et al., 2011). Response inhibition, measured at the beginning, middle and end of the retreat, as well as in a 5-month follow-up, mediated the link between assignment to the meditation condition and circulating blood telomerase, suggesting that the meditative practices taught at the retreat benefit health in part by improving self-regulatory ability. In a 10-day nonrandomized trial comparing mindfulness meditation with treatment as usual in a prisoner population, meditation resulted in decreased use of drugs and alcohol 3 months later. This change was partially mediated by increases in meditators' tendency to face, rather than avoid, their thoughts (Bowen, Witkiewitz, Dillworth, & Marlatt, 2007; Bowen et al., 2006). These mediational results suggest that meditation-driven changes in self-regulatory capacity may be a mechanism of action driving the positive effects of open monitoring practices on immune system functioning.

Kindness-based practices, on the other hand, may improve immune functioning by increasing the proportion of positive subjective experiences, such as positive emotions and social closeness, that are known to predict resistance to the common cold (Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997; Doyle, Gentile, & Cohen, 2006). One longitudinal study tracked the effect of 8 weeks of loving-kindness meditation on participants' self-reports of positive emotions. Results showed that, relative to participants in a wait-list control group, meditators reported steady increases in daily positive emotions, which in turn predicted growth in a range of resources, including mindfulness, positive social relations, environmental mastery, and self-reported physical health (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008). Additional studies show that only 7 minutes of loving-kindness meditation is enough to elicit feelings of social connection in naïve participants (Hutcherson, Seppala, & Gross, 2008).

Cardiovascular health

Effects of meditation. A number of different meditative practices have been linked to positive cardiovascular outcomes. Three months of MBSR training for healthy

African-American adolescents led to significantly greater decreases in blood pressure relative to both life-skills training and health education control conditions (Gregoski, Barnes, Tingen, Harshfield, & Treiber, 2011). In a meta-analysis of the effects of meditation on adults diagnosed with hypertension, transcendental meditation, a form of focused attention involving chanting a personalized mantra, was more effective than progressive muscle relaxation in producing a clinically significant reduction in blood pressure, but was not more effective than a health education program (Ospina et al., 2007). A separate meta-analysis focusing on transcendental meditation in non-hypertensive adults also linked TM to clinically significant decreases in the blood pressure (Anderson, Liu, & Kryscio, 2008). In the same meta-analysis, Qi Gong practice, which incorporates elements of open monitoring, focused attention and specific physical movements, was more effective than a wait list control in reducing blood pressure, though it was unclear whether the reduction was clinically significant (Ospina et al., 2007). Finally, 8 weeks of loving-kindness training led to increases in cardiac vagal tone, a measure of efficient parasympathetic functioning, relative to participants in a wait-list control (Kok, Coffey, Cohn, Catalino, Vacharkulksemsuk, Algoe, and Fredrickson, forthcoming).

Potential psychological mechanisms of action. Improvements in emotion regulation may work as a mechanism of action for mindfulness meditation by decreasing emotional reactivity to negative events and speeding recovery from stress, leading to improved cardiovascular functioning. Because mindfulness training involves focused attention as well as open monitoring, however, it is unknown whether it is open monitoring, focused attention or both that influence emotion regulation. A recent review of psychotherapeutic approaches to mindfulness found that mindfulness meditation was associated with improved emotion regulation, decreased rumination, and decreased emotional reactivity to negative stimuli (Davis & Hayes, 2011). One study compared the effects of 7 weeks of mindfulness meditation, relaxation meditation, or a waitlist control on emotional reactivity to unpleasant pictures and psychological well-being. While both meditative practices led to increases in well-being relative to the waitlist control, only those in the mindfulness training condition showed decreases in emotional reactivity to unpleasant pictures (Ortner, Kilner, & Zelazo, 2007).

Kindness-based meditative practices may act on cardiovascular functioning by increasing the likelihood of positive emotional experiences and promoting feelings of social closeness, which are associated with faster cardiovascular recovery from stress (Fredrickson & Levenson, 1998) and decreased likelihood of cardiovascular disease (Kok & Fredrickson, 2010; Uchino, 2009), respectively. The effect of 8 weeks of loving-kindness meditation on vagal tone, for example, was mediated by changes in daily self-reported positive emotions, which in turn predicted changes in daily social closeness ratings. Increased social closeness, in turn, led to improvement in cardiac vagal tone (Kok et al., forthcoming).

Pain perception

Effects of meditation. A variety of meditation practices have been studied as treatments for pain, both chronic and acute. In a meta-analysis of 22 studies of open monitoring practices as a treatment for chronic pain, the decrement in self-reported pain intensity for open monitoring was comparable to the effect size of standard treatment (Veehof, Oskam, Schreurs, & Bohlmeijer, 2011). Kindness-and-compassion based practices may also influence the experience of pain. A pilot test of loving-kindness meditation as a treatment for chronic lower back pain found that, relative to participants receiving treatment

as usual, participants who had completed an 8-week training program in loving-kindness reported decreased pain; in addition, participants reported lower pain ratings on days when they practiced loving-kindness.

There have been fewer studies of the effect of meditation on acute pain, and the studies that exist have focused on open monitoring practices such as mindfulness (Zeidan, Grant, Brown, McHaffie, & Coghill, 2012). In two studies comparing the pain perception of long-term meditation practitioners (more than 10,000 hours of lifetime practice) and participants naïve to meditation, the long-term practitioners reported less pain in response to a pain stimulus administered while engaging in open monitoring meditation (Grant & Rainville, 2009; Perlman, Salomons, Davidson, & Lutz, 2010). Brief mindfulness training may also be effective in reducing feelings of acute pain. Both 6 days of 1-hour mindfulness training sessions (Kingston, Chadwick, Meron, & Skinner, 2007) and 3 days of 20 minute mindfulness training sessions (Zeidan, Gordon, Merchant, & Goolkasian, 2010) led to increased pain tolerance relative to pre-training tolerances and to pain tolerance in the control group.

Potential psychological mechanisms of action. Mindfulness-driven emotion regulation may dampen feelings of chronic pain by decreasing the tendency to focus on painful bodily sensations while anticipating future pain, also called catastrophising, in favor of present-focused, non-judgmental awareness. One study of adults with chronic lower back pain found that self-reported mindfulness increased following a cognitive-behavioral intervention, while catastrophising and reports of difficulty functioning due to chronic pain decreased (Cassidy, Atherton, Robertson, Walsh, & Gillett, 2012). Mediational analyses showed that changes in catastrophising mediated the relationship between changes in self-reported mindfulness and difficulty functioning. Unfortunately, it is unclear to what extent self-reported mindfulness (measured here using the Mindful Attention Awareness Scale (Brown & Ryan, 2003) is similar to the cognitive effects of mindfulness meditation (Grossman, 2008).

Neural mechanisms of action

In addition to the potential effects on physical health, there is a great deal of interest in the interaction of meditative practice and neuroplasticity. Although a full review of studies examining the effects of meditation on neural structure and functioning is beyond the scope of this article, it is important to note the potential of this research for understanding the impact of meditation on psychological mechanisms and thus health (Cahn & Polich, 2006; Chiesa & Serretti, 2010; Holzel et al., 2011; Lutz, Brefczynski-Lewis, Johnstone, & Davidson, 2008). Neural plasticity involves, in part, the reorganization of cortical representations of the perceptual, motor, and cognitive information employed when practicing some skill, resulting in improvements in that skill (Buonomano & Merzenich, 1998). Interest in meditation-based neural changes is particularly acute because meditative practices stimulate core cognitive and emotional processes that support a wide range of related skills (Slagter, Davidson, & Lutz, 2011), making meditation a potentially powerful way to induce lasting behavioral and emotional change. Although promising, more research is needed to map out the pathways between meditation-induced changes in specific neural regions and the associated changes in behavior.

Summary

In sum, there is promising evidence that various meditation practices influence immune functioning, cardiovascular functioning and pain perception, all markers of physical health

and predictors of longevity (Alonso-Fernandez & De la Fuente, 2011; American Heart Association, 2007; Torrance, Elliott, Lee, & Smith, 2010). In addition, the meditative practices discussed here have been empirically linked to a variety of psychological changes that also predict health-relevant outcomes, and thus represent potential mechanisms of action. Some studies even combined measures of health-relevant outcomes and psychological changes, in order to assess psychological mediation of meditation effects (Bowen et al., 2006, 2007; Jacobs et al., 2011; Kok et al., forthcoming), a critical step toward identifying psychological mechanisms of action.

There is great potential in meditation research for understanding mind-body interactions. The psychological changes wrought by meditative practice are of interest both as opportunities to explore specific psychological states and as potential mechanisms of action for the health-related effects of meditation. Unlocking the full potential of meditation research, however, will require a particular set of methodological skills.

Methodological Issues and Best Practices

The greatest potential for advances in the science of meditation lies in combining psychological and health-related meditation research; this combination also holds the greatest challenges to researchers in the form of methodological issues that must be addressed. Methodological challenges in the study of meditation include finding effective control groups for experimental work, cross-study consistency in the implementation of particular meditative practices, selection bias in recruiting participants and self-selection effects when studying long-term meditators. Many of these issues will be familiar to experimental social and personality psychologists, for whom such challenges are an integral part of research and whose skills are sorely needed as the field of meditation research moves into the study of mechanisms.

A recent publication by the National Institutes of Health (NIH) concludes that the biggest challenge to further progress in the scientific study of meditation is the lack of adequate control groups (Ospina et al., 2008). The majority of meditation studies, including those reviewed here, use a waitlist control design, in which control participants complete the same measures as meditators but do not otherwise change their behavior (but see (Gregoski et al., 2011; MacCoon et al., 2012; Pace et al., 2009) for examples of studies using active controls). After data collection is complete, individuals in the waitlist control are offered the opportunity to receive meditation training as well. While the use of a waitlist control design does improve adherence and reduce drop-out rates in control participants, it also introduces a number of confounds that make it difficult to accurately interpret the results of meditation research (Fredrickson et al., 2008). In response to the concerns raised by the NIH, researchers are beginning to explore potential active control conditions that will help isolate the active ingredients in meditative practice. One potential control is to compare different types of meditation that are believed to utilize different mechanisms of action. Other possible controls include progressive muscle relaxation or cognitive-behavioral therapy, which possess many traits in common with meditation, including directed attention to one's body and thoughts and guidance from a skilled teacher, but are different from meditation in their cognitive components.

Because meditation is a complex process, potential control conditions should be closely evaluated to ensure they are a good match. For example, the Health Enhancement Program (HEP) was developed as an active control for MBSR (MacCoon et al., 2012). HEP was designed to match MBSR in four criteria: (a) positive expectations of success by teacher and participant, (b) an ongoing relationship between teacher and participant, (c) a

conceptual framework supporting the participant's actions and (d) specific actions and instructions for the participants to follow. In an initial comparison of HEP and MBSR, MBSR participants reported decreases in pain over the course of the study while HEP participants did not; the tightness of the match between this active control and MBSR suggests that the mindfulness element of MBSR may be driving the changes in pain perception (MacCoon et al., 2012).

In the past, many meditation studies asked meditation trainers to collect data as well as teach meditation, which introduced the possibility of expectancy effects in the participants. The nature of meditation makes double-blind designs impossible, as the meditation teacher will always know which participants are receiving each type of training. In order to decrease the likelihood of bias, however, meditation research can utilize dual-blind designs. In a dual-blind study, the participants are blind to their condition (unless they are in a waitlist control) and those collecting data are blind to hypotheses (Caspi, Millen, & Seechrest, 2000). While the possibility of bias from the meditation teachers still exists, dual-blind designs reduce bias in assessment by keeping meditation teachers out of any data collection role.

Participant selection is another challenge for those studying meditation. Participants in Western cultures who are willing to participate in a meditation study differ from the average population: They are more likely to have tried at least one type of meditative practice before enrolling in the study, and are more likely to be white, female, well-educated and of higher socioeconomic status (Bair et al., 2002; Ni, Simile, & Hardy, 2002). In addition, participants are likely to come into the study already believing in the benefits of meditation. At present, it is difficult to know whether the beneficial effects of various meditative practices would also occur for individuals who are skeptical of the idea of meditative practice. These selection effects intensify in studies that require more intensive meditation (daily meditation, attending a week-or-months-long meditation retreat, etc.). One way to address this issue is through stratified random sampling by age, race, gender and/or socioeconomic class. Recruitment of skeptical participants may be the greater challenge, though designs that randomly assign participants to a variety of different treatment conditions, only one of which is meditation, may prove helpful.

Another difficulty related to participant-selection comes from studies that focus on long-term or lifelong meditators. Because many types of meditation continue to evolve and increase in difficulty as the meditator becomes more skilled, extremely long-term meditative practice can have effects that are very different from those experienced by a novice meditator. A great deal can be learned from extremely long-term meditators, but the same issues apply as in the participant selection section above. In addition, extremely long-term meditators are more likely to come from Eastern cultures, introducing the additional confound of culture. Comparisons between meditative traditions may be most useful in this case, particularly comparisons between long-term meditators whose meditative practices are derived from the same root. Such is the case with loving-kindness and mindfulness meditations, which are both part of the Buddhist spiritual and meditative tradition and thus may attract similar individuals to long-term practice. Another possibility is a matched-control design where the non-meditating participant is drawn from the same culture as the expert practitioner, or comparing the expert to novice meditators in the same tradition.

Finally, while some meditation-based interventions, such as MBSR, are codified and described in detail, the majority of research articles on meditation do not give sufficient information concerning the content of the meditation being taught to participants. For this reason, it is difficult to compare results across studies, even if both report using MM.

We encourage researchers either to describe their meditation in as much detail as possible, either in the article or in an online supplement, or to refer readers to an outside source that describes that meditative approach; for example, the approaach to loving-kindness meditation used in Fredrickson et al. (2008) was based on work by Sharon Salzberg, a well-known meditation teacher whose approach to loving-kindness meditation is described in detail elsewhere (Salzberg, 2010).

New Horizons in Meditation Research

Rising interest in meditation research has led to increasing methodological and conceptual sophistication, allowing researchers to more precisely address questions of interest. In addition, the continuing conversation between Western scientists and meditation practitioners, both Eastern and Western, for example those sponsored by the Mind and Life Institute since 1987, has led to an increasingly complex understanding of the philosophical basis of meditative practice, with implications for research on the interrelationships among the many different types of meditative practice (Walsh & Shapiro, 2006). This conversation has also led to the design of meditation interventions such as the Shamatha Project that more smoothly combine scientific goals with the active core of meditative practice (Jacobs et al., 2011; MacLean et al., 2010; Saggar et al., 2012; Sahdra et al., 2011).

The new frontier in meditation research is to discover the mechanisms of action of meditative practices. Mechanisms of action are mediators that play a causal role in the practice of interest; in other words, if directly manipulating a mediator causes change in the outcome of interest, that mediator can be considered a mechanism of action. Identifying the mechanisms of action of various meditative practices is an important step in providing theoretical structure to the wide-ranging field of research on meditation, which encompasses a variety of meditative practices most often studied in isolation. A number of theoretical models have been published that posit various psychological and neural mechanisms of action for specific meditative practices and invite testing (Baer, 2009; Bishop et al., 2004; Holzel et al., 2011).

Social and personality psychologists, who possess specific training in measuring and manipulating internal states, are urgently needed to identify and test potential mechanisms of action that may be identified as part of a meditation study. In a previously-described study, social connectedness was identified as a mediator and potential mechanism of action for the beneficial effects of loving-kindness meditation on physical health, as measured by vagal tone (Kok et al., forthcoming). In a randomized, controlled double-blind follow-up, social connectedness was directly manipulated via daily emails to participants that either asked participants to focus on their social interactions or to focus on their daily tasks. Over 8 weeks, participants in the social connectedness condition increased in attention to social stimuli, daily positive emotions and vagal tone, providing supporting evidence for social connectedness as a mechanism of action for loving-kindness meditation (Kok & Fredrickson, in prep).

Increased public interest in meditation, in combination with a widening community of scientists and scholars studying meditation and the promise shown by early meditation work, has created a climate of lively growth and potential for researchers interested in pursuing the scientific study of meditation. Studying meditation can be challenging, requiring a combination of intensive assessment of potential mechanisms during meditation training and tightly-designed follow-up studies that manipulate these mechanisms. Social and personality psychologists, however, are uniquely well-situated to meet the

needs of this new and burgeoning field of research; in return, they will gain an unparalleled opportunity to illuminate the intricate dance between mind and body.

Short Biographies

Bethany Kok was a William R. Kenan Graduate Fellow at the University of North Carolina at Chapel Hill before accepting a postdoctoral fellowship at the Max Planck Institute for Human Cognition and Brain Sciences in Leipzig. She received both the inaugural Christopher R. Agnew Research Innovation Award and the Outstanding Research Award from the Society for Personality and Social Psychology in 2010 for her article on the reciprocal relationships between social connectedness, positive emotions and autonomic regulation as expressed in change over time, published in *Biological Psychology*. For more information on Kok's work, please visit http://www.bethanykok.com.

Christian Waugh is an Assistant Professor in the Neuroscience graduate program at Wake Forest University. He received his Ph.D. in Social Psychology at the University of Michigan, Ann Arbor and completed a postdoc with Dr. Ian Gotlib at Stanford University. Christian's research on the pscyhophysiology of emotions and personality and the neural underpinnings of socio-emotional processes has been published in numerous journals including, *Neuroimage*, *The Journal of Personality and Social Psychology* and *Biological Psychology*.

Barbara Fredrickson is Kenan Distinguished Professor and Director of the Positive Emotions and Psychophysiology Laboratory (a.k.a. PEP Lab, http://www.PositiveEmotions.org) at the University of North Carolina at Chapel Hill, where she holds appointments in Psychology and the Kenan-Flagler School of Business. She earned her undergraduate degree from Carleton College and her doctorate from Stanford University and has previously held faculty positions at Duke University and the University of Michigan. She is most known for her broaden-and-build theory of positive emotions, which she and her students have tested in laboratory and field experiments, using self-report, behavioral, and physiological measures. She has received numerous honors for her research on the benefits of positive emotions, including the American Psychological Association's Templeton Prize in Positive Psychology and the Society for Experimental Social Psychology's Career Trajectory Award. Her work has also received more than fifteen consecutive years of research funding from the National Institute of Health. She is co-author of a leading Introductory Psychology textbook, and with the publication of Positivity (2009) she has written about her research for general audiences as well. For more information on Fredrickson's work, please visit http://www.PositivityRatio.com.

Endnotes

* Correspondence address: Max Planck Institute for Human Cognitive and Brain Sciences, Postoffice BOX 500355, 04303 Leipzig, Germany. Email: bethkok@cbs.mpg.de

[1] Mechanisms of action are mediators that play a causal role in the practice of interest; in other words, if directly manipulating a mediator causes change in the outcome of interest, that mediator can be considered a mechanism of action.

[2] These categories together do not encompass all meditative practices: Other categories are likely to exist (Travis & Shear, 2010) but are as yet loosely defined or not widely accepted.

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