



Published in final edited form as:

*Complement Health Pract Rev.* 2009 January 1; 14(1): 10–18. doi:10.1177/1533210108329862.

## Mindfulness Research Update: 2008

**Jeffrey M. Greeson, Ph.D., M.S.**

Duke Integrative Medicine, Duke University Medical Center, Durham, NC

### Abstract

**Objective**—To briefly review the effects of mindfulness on the mind, the brain, the body, and behavior.

**Methods**—Selective review of MEDLINE, PsycINFO, and Google Scholar databases (2003–2008) using the terms “mindfulness”, “meditation”, “mental health”, “physical health”, “quality of life”, and “stress reduction.” A total of 52 exemplars of empirical and theoretical work were selected for review.

**Results**—Both basic and clinical research indicate that cultivating a more mindful way of being is associated with less emotional distress, more positive states of mind, and better quality of life. In addition, mindfulness practice can influence the brain, the autonomic nervous system, stress hormones, the immune system, and health behaviors, including eating, sleeping and substance use, in salutary ways.

**Conclusion**—The application of cutting-edge technology toward understanding mindfulness – an “inner technology” – is elucidating new ways in which attention, awareness, acceptance, and compassion may promote optimal health – in mind, body, relationships, and spirit.

### Keywords

mindfulness; meditation; mental health; physical health; quality of life; stress reduction

## INTRODUCTION

There is rapidly accumulating evidence in the field of complementary health practices that greater mindfulness can not only reduce stress and stress-related medical symptoms, but can also enhance positive emotions and quality of life. Moreover, studies are beginning to show a relationship between (a) how much people practice meditation, (b) how much more mindful they become, and (c) the positive effects they experience in terms of mental and physical health. This brief, selective review presents some of the most recent scientific findings that demonstrate how practicing mindfulness meditation can impact the mind, the brain, the body, and behavior in ways that may promote whole-person health.

## METHODS

Articles were retrieved by searching MEDLINE, PsycINFO, and Google Scholar databases between the years 2003–2008 using the terms “mindfulness”, “meditation”, “mental health”, “physical health”, “quality of life”, and “stress reduction.” Fifty-two exemplars of empirical and theoretical work were selected by the author for review. Articles were selected to represent a cross-section of research that spanned four domains: The Mind, The Brain, The Body, and

---

\*Corresponding author: Jeffrey M. Greeson, Ph.D., M.S., Duke Integrative Medicine, Duke University Medical Center, DUMC Box 102904, Durham, NC 27710, Tel: 919.660.6773, Fax: 919.684.6445, Email: jeffrey.greeson@duke.edu.

Behavior. Priority was given to studies that were not included in previous quantitative or qualitative reviews of the scientific literature.

## RESULTS

### Mindfulness Meditation and The Mind

Research on mindfulness supports the idea that cultivating greater attention, awareness and acceptance through meditation practice is associated with lower levels of psychological distress, including less anxiety, depression, anger, and worry (cf. Baer, 2003; Brown, Ryan, & Creswell, 2007; Greeson & Brantley, in press; Grossman et al., 2004). Furthermore, studies have begun to elucidate *how* mindfulness training can reduce distress. One observational study found that more time spent on formal meditation practices (body scan, yoga, sitting meditation) at home during an 8-week intervention led to increased mindfulness, which, in turn, explained decreased psychological distress and increased psychological well-being (Carmody & Baer, 2008). A recent randomized controlled trial (RCT) in students showed that 4 weeks of mindfulness meditation training, relative to somatic relaxation training or a non-intervention control group, reduced distress by decreasing rumination, a cognitive process associated with depression and other mood disorders (Jain et al., 2007). Another clinical study found that 8 weeks of mindfulness meditation training significantly reduced ruminative thinking in persons with a history of depression (Ramel et al., 2004). Together, these studies indicate that one salutary mechanism of mindfulness appears to involve reshaping ways of thinking that engender improved emotional well-being.

Mindfulness scale development research has found that people with higher natural levels of mindfulness – irrespective of formal meditation training – report feeling less stressed, anxious and depressed, and more joyful, inspired, grateful, hopeful, content, vital, and satisfied with life (Baer et al., 2006; Brown & Ryan, 2003; Cardaciotto et al., 2008; Feldman et al., 2007; Walach et al., 2006). In addition to the mental health benefits of meditation practice and cultivating mindful awareness in daily life, simply being in a mindful state momentarily is associated with a greater sense of well-being (Lau et al., 2006).

Research further suggests that people with higher levels of mindfulness are better able to regulate their sense of well-being by virtue of greater emotional awareness, understanding, acceptance, and the ability to correct or repair unpleasant mood states (Baer et al., 2008; cf. Brown, Ryan, & Creswell, 2007; Feldman et al., 2007). The ability to skillfully regulate one's internal emotional experience in the present moment may translate into good mental health long-term.

Finally, a number of different mindfulness-based training programs – including Mindfulness-Based Stress Reduction (MBSR), Mindfulness-Based Cognitive Therapy (MBCT), Acceptance and Commitment Therapy (ACT), Dialectical Behavior Therapy (DBT), and Mindfulness-Based Eating Awareness Training (MB-EAT) – can effectively treat more serious mental health conditions, including anxiety disorders (MBSR; ACT), recurrent major depression (MBCT), chronic pain (MBSR; ACT), borderline personality disorder (DBT), and binge eating disorder (MB-EAT) (Baer, 2006). Although additional well-designed studies using active control groups are needed to replicate and verify the mental health benefits of mindfulness meditation training (Toneatto & Nguyen, 2007), the body of evidence to date supports a relationship between cultivating a more mindful way of being on the one hand, and a tendency to experience less emotional distress, more positive states of mind, and better overall quality of life on the other.

## Mindfulness Meditation and The Brain

A number of studies have demonstrated that systematic mindfulness training, as well as brief meditation practices in novices, can influence areas of the brain involved in regulating attention, awareness, and emotion (cf. Cahn & Polich, 2006; Lutz et al., 2008a). One key element of mindfulness is the ability to pay attention to the present moment, on purpose (Kabat-Zinn, 2003). A recent clinical study found that 8 weeks of mindfulness meditation training (MBSR) led to an increased ability to orient one's attention to the present moment, as measured by a laboratory attention test (Jha, Krompinger, & Baime, 2007). Another experimental study found that compared to a relaxation training control group, 5 days of integrative meditation training – including mindfulness – significantly improved the efficiency of executive attention during a computerized attention test (Tang et al., 2007).

A second key element of mindfulness is the ability to recognize and accurately label emotions (Analayo, 2003). Brain imaging research has found that more mindful people appear to have a greater ability to control emotional reactions in the middle part of the brain (the amygdala and the dorsal anterior cingulate cortex [ACC]) by engaging the front part of the brain (the prefrontal cortex [PFC]), which is associated with attention, concentration and emotion regulation (Creswell, Eisenberger, & Lieberman, 2008; Creswell et al., 2007). Another study found that employees in a corporate setting showed changes in front brain electrical activity (EEG) following 8 weeks of MBSR that were consistent with the experience of positive emotions like joy and content (Davidson et al., 2003).

A third key element of mindfulness is more refined self-awareness (Kabat-Zinn, 2003). One recent functional magnetic resonance imaging (MRI) study on this topic found that 8 weeks of MBSR was associated with greater neural activity in two brain regions believed to partially subserve self-awareness – the dorsolateral PFC and the medial PFC – during experiential and narrative self-focus tasks, respectively (Farb et al., 2007). A structural MRI study reported that experienced mindfulness meditators, relative to demographically matched controls, had increased grey matter in brain regions that are typically activated during meditation, such as the right anterior insula, which subserves interoceptive awareness (Hölzel et al., 2007a).

Researchers are also exploring the effect of specific meditation practices on the brain. For example, in adept meditators versus non-meditators, mindful breathing practice (contrasted to mental arithmetic) was associated with increased rostral ACC and dorsomedial PFC activation, which may reflect stronger processing of distracting events and emotions, respectively (Hölzel et al., 2007b). Another functional brain imaging study found that practicing a brief loving kindness meditation activated regions of the brain associated with positive feelings toward others (Hutcherson, Seppala, & Gross, 2008). Loving kindness meditation – traditionally included as part of mindfulness training – is a contemplative practice designed to foster acceptance and compassion for oneself and others (Kabat-Zinn, 1990; The Dalai Lama, 2001). Finally, some studies suggest that greater meditation expertise is related to an increased ability to experience shifts in brain activity associated with positive emotions like compassion (Lutz et al., 2008b).

Overall, it appears that focused, concentrative meditation practices can increase one's ability to maintain steady attention on a chosen object, like the breath or another person, whereas open awareness meditation practices can increase one's ability to flexibly monitor and redirect attention when it becomes distracted (Lutz et al., 2008a). Based on these findings, not only is it possible to train the mind to change the brain, but, in fact, one's ability to do so may get stronger as one gains meditation experience.

## Mindfulness Meditation and The Body

There is increasing scientific evidence to support the therapeutic effect of mindfulness meditation training on stress-related medical conditions, including psoriasis (Kabat-Zinn et al., 1998), type 2 diabetes (Rosenzweig et al., 2007), fibromyalgia (Grossman et al., 2007), rheumatoid arthritis (Pradhan et al., 2007; Zautra et al., 2008), chronic low back pain (Morone, Greco & Weiner, 2008), and attention-deficit hyperactivity disorder (Zylowska et al., 2008). In addition, research has consistently shown that mindfulness training reduces symptoms of stress and negative mood states, and increases emotional well-being and quality of life, among persons with chronic illness (cf. Brown, Ryan, & Creswell, 2007; Grossman et al., 2004; Ludwig & Kabat-Zinn, 2008; Shigaki, Glass, & Schopp, 2006). The use of mindfulness training in treating specific pain conditions, hypertension, myocardial ischemia, weight control, irritable bowel syndrome, insomnia, human immunodeficiency virus (HIV), and substance abuse is presently under investigation in research supported by the National Institutes of Health (Ludwig & Kabat-Zinn, 2008).

The beneficial physical effects of mindfulness training may occur, in part, by learning how to better cope with the inevitable stresses of daily life, and to remember that there is usually more right with the body than wrong. Theoretical models of mindfulness have endeavored to explain empirical observations of salutary effects by articulating the role of improved meta-cognitive skills, like decentering (Teasdale et al., 2002) or re-perceiving (Shapiro et al., 2006), and adaptive coping processes, like positive reappraisal (Garland, Gaylord, & Park, in press). It has specifically been postulated that mindfulness may preempt stress-related illness through a number of psychological, biological and behavioral pathways, including: (a) clarifying primary appraisal of stressors, (b) facilitating accurate secondary appraisal of stressor demands and coping resources, (c) mitigating dysfunctional coping styles, such as catastrophizing and ruminating, (d) enhancing adaptive coping processes, such as positive reappraisal, and (f) reducing distress and psychophysiological activation (Garland, 2007).

Cutting-edge laboratory research is beginning to reveal some of the biological pathways through which mindfulness training may positively impact physical health and healing processes. For example, the 8-week MBSR study by Davidson and colleagues (2003) showed that individuals who had the largest shifts in frontal brain activity also had the strongest antibody responses to a flu vaccine. That study was the first to show that mindfulness training can change the brain and the immune system in a way that might bolster resistance to disease. More recent MBSR studies in people with serious medical conditions, including breast cancer, prostate cancer, and other types of cancer, have documented lower levels of cortisol – a primary stress hormone – and normalized immune function, measured by natural killer cell activity and pro-inflammatory cytokine levels (Carlson et al., 2007; Witnek-Janusek et al., 2008). Research on patients with HIV infection further indicates that MBSR may produce beneficial effects on the immune system, including increased natural killer cell activity – an important first line of defense against viral infection – as well as increased production of  $\beta$ -chemokines, molecules that block HIV from infecting healthy immune cells (Robinson, Mathews, & Witnet-Janusek, 2003). A different study on adults with HIV infection suggested that MBSR may protect against the loss of “helper” T-cells over time – a primary measure of HIV disease progression (Creswell et al., in press).

Initial laboratory studies suggest that mindfulness meditation practices can alter autonomic and neuroendocrine system functioning, both at rest and when stressed. For example, one RCT found that a mindful body scan meditation produced greater increases in parasympathetic nervous system activity, indexed by cardiac respiratory sinus arrhythmia (RSA), than progressive muscle relaxation – a standard relaxation training technique (Ditto, Eclache, & Goldman, 2006). Another RCT showed that 5 days of meditation training, including mindfulness, significantly reduced the cortisol response to acute mental stress relative to a

relaxation training control group that did not receive mindfulness or meditation instruction (Tang et al., 2007). Finally, a third RCT found that adults who reported home practice times above the median during a 6-week compassion meditation training program exhibited significantly lower stress-induced levels of negative emotion and inflammation (interleukin-6) post-intervention compared to individuals below the home practice median, who did not differ from controls (Pace et al., 2008). Taken together, these experimental studies indicate that mindfulness practices may promote health, in part, by attenuating stress reactivity and stimulating parasympathetic tone, perhaps more strongly than relaxation techniques.

### **Mindfulness Meditation and Behavior**

Another key element of mindfulness is the cultivation of equanimity, or non-reactivity. Specifically, mindfulness meditation teaches one to pay attention to and acknowledge both one's inner experience and the outer world, without necessarily reacting. The ability to simply observe and accurately sense thoughts, emotions, and physical sensations – without having to change them, or act on them – can be instrumental in breaking habitual behavior patterns that can harm one's health, such as smoking a cigarette when feeling stressed, eating comfort food when feeling sad or “empty”, or turning to alcohol or other substances to “numb out” when feeling overwhelmed. Promising findings from behavioral research suggest that mindfulness training may help people to experience stress and negative emotions without acting impulsively and self-destructively in their attempt to self-soothe (cf. Brown, Ryan, & Creswell, 2007). For example, some of the studies to date have found that people trained in mindfulness show a better ability to quit smoking (Davis et al., 2007), decrease binge eating (Kristeller, Baer, & Quillian-Wolever, 2006), and reduce alcohol and illicit substance use (Bowen et al., 2006). At least one study has shown that reduced substance use following mindfulness training was partially explained by acceptance, rather than avoidance, of unwanted thoughts (Bowen et al., 2007). Mindfulness may also promote better health, in part, by improving sleep quality, which can be disrupted by stress, anxiety and difficulty turning off the mind (Winbush, Gross, & Kreitzer, 2007).

### **Conclusion**

The latest scientific research on mindfulness has demonstrated beneficial effects on several aspects of whole-person health, including the mind, the brain, the body, and behavior. Clinical trials and laboratory studies alike suggest that the mechanisms of mindfulness involve not only relaxation, but important shifts in cognition, emotion, biology, and behavior that may work synergistically to improve health. There is also emerging evidence that mindfulness training is associated with greater meaning and peace in one's life (spirituality), as well as enhanced relationships with others (Carmody et al., 2008; Carson et al., 2004). A number of cutting-edge technologies, including brain imaging, are being used to examine the potential health benefits of mindfulness, an “inner technology” we all possess. Finally, research is beginning to prove what mindfulness practitioners have known for centuries ... that greater attention, awareness, acceptance, and compassion can facilitate more flexible, adaptive responses to stress, which, in turn, can help free us from suffering and realize greater health & well-being.

### **Acknowledgments**

The author gratefully acknowledges Jeffrey Brantley, M.D., and Sasha Loring, M.Ed., LCSW, for providing intellectual support and for reviewing an earlier version of this manuscript. This work was supported by a career development award (K99AT004945) from the National Center for Complementary & Alternative Medicine (NCCAM). The content is solely the responsibility of the author and does not necessarily represent the official views of NCCAM or the National Institutes of Health.

## References

- Analyo. Satipatthana: The direct path to realization. Birmingham, UK: Windhorse Publications; 2003.
- Baer RA, Smith GT, Lykins E, Button D, Krietemeyer J, Sauer S, Walsh E, Duggan D, Williams JM. Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. *Assessment* 2008;15:329–342. [PubMed: 18310597]
- Baer, RA. Clinician's guide to evidence base and applications. San Diego, CA: Academic Press; 2006. Mindfulness-based treatment approaches.
- Baer RA, Smith GT, Hopkins J, Krietemeyer J, Toney L. Using self-report assessment methods to explore facets of mindfulness. *Assessment* 2006;13:27–45. [PubMed: 16443717]
- Baer RA. Mindfulness training as clinical intervention: A conceptual and empirical review. *Clinical Psychology: Science and Practice* 2003;10:125–143.
- Bowen S, Witkiewitz K, Dillworth TM, Marlatt GA. The role of thought suppression in the relationship between mindfulness meditation and alcohol use. *Addictive Behaviors* 2007;32:2324–2328. [PubMed: 17300875]
- Bowen S, Witkiewitz K, Dillworth TM, Chawla N, Simpson TL, Ostafin BD, Larimer ME, Blume AW, Parks GA, Marlatt GA. Mindfulness meditation and substance use in an incarcerated population. *Psychology of Addictive Behaviors* 2006;20:343–347. [PubMed: 16938074]
- Brown KW, Ryan RM, Creswell JD. Mindfulness: Theoretical foundations and evidence for salutary effects. *Psychological Inquiry* 2007;18:211–237.
- Brown KW, Ryan RM. The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology* 2003;84:822–848. [PubMed: 12703651]
- Cahn BR, Polich J. Meditation states and traits: EEG, ERP, and neuroimaging studies. *Psychological Bulletin* 2006;132:180–211. [PubMed: 16536641]
- Cardaciotto L, Herbert JD, Forman EM, Moitra E, Farrow V. The assessment of present-moment awareness and acceptance: The Philadelphia mindfulness scale. *Assessment* 2008;15:204–223. [PubMed: 18187399]
- Carlson LE, Speca M, Faris P, Patel K. One year pre-post intervention follow-up of psychological, immune, endocrine and blood pressure outcomes of mindfulness-based stress reduction (MBSR) in breast and prostate cancer patients. *Brain, Behavior, and Immunity* 2007;21:1038–1049.
- Carmody J, Baer RA. Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program. *Journal of Behavioral Medicine* 2008;31:23–33. [PubMed: 17899351]
- Carmody J, Reed G, Kristeller J, Merriam P. Mindfulness, spirituality, and health-related symptoms. *Journal of Psychosomatic Research* 2008;64:393–403. [PubMed: 18374738]
- Carson JW, Carson KM, Gil KM, Baucom DH. Mindfulness-based relationship enhancement. *Behavior Therapy* 2004;35:471–494.
- Creswell JD, Myers HF, Cole SW, Irwin MR. Mindfulness meditation training effects on CD4+ T lymphocytes in HIV-1 infected adults: A small randomized controlled trial. *Brain, Behavior, and Immunity*. in press.
- Creswell, JD.; Eisenberger, N.; Lieberman, M. Neural correlates of mindfulness during social exclusion. Los Angeles: University of California; 2008. Unpublished manuscript
- Creswell JD, May BM, Eisenberger NI, Lieberman MD. Neural correlates of dispositional mindfulness during affect labeling. *Psychosomatic Medicine* 2007;69:560–565. [PubMed: 17634566]
- Davidson RJ, Kabat-Zinn J, Schumacher J, Rosenkrantz M, Muller D, Santorelli SF. Alterations in brain and immune function produced by mindfulness meditation. *Psychosomatic Medicine* 2003;65:564–570. [PubMed: 12883106]
- Davis JM, Fleming MF, Bonus KA, Baker TB. A pilot study on mindfulness based stress reduction for smokers. *BMC Complementary and Alternative Medicine* 2007;7:2. [PubMed: 17254362]
- Ditto B, Eclache M, Goldman N. Short-term autonomic and cardiovascular effects of mindfulness body scan meditation. *Annals of Behavioral Medicine* 2006;32:227–234. [PubMed: 17107296]
- Farb NAS, Segal ZV, Mayberg H, Bean J, McKeon D, Fatima Z, Anderson AK. Attending to the present: Mindfulness meditation reveals distinct neural modes of self-reference. *Social Cognitive and Affective Neuroscience*. 200710.1093/scan/nsm030

- Feldman G, Hayes A, Kumar S, Greeson J, Laurenceau JP. Mindfulness and emotion regulation: The development and initial validation of the Cognitive and Affective Mindfulness Scale-Revised (CAMS-R). *Journal of Psychopathology and Behavioral Assessment* 2007;29:177–190.
- Garland E, Gaylord S, Park J. The role of mindfulness in positive reappraisal. *Explore (NY)*. in press.
- Garland EL. The meaning of mindfulness: A second-order cybernetics of stress, metacognition, and coping. *Complementary Health Practice Review* 2007;12:15–30.
- Greeson, J.; Brantley, J. Mindfulness and anxiety disorders: Developing a wise relationship with the inner experience of fear. In: Didonna, F., editor. *Clinical handbook of mindfulness*. New York, NY: Springer; p. 171-188. in press
- Grossman P, Tiefenthaler-Gilmer U, Raysz A, Kesper U. Mindfulness training as an intervention for fibromyalgia: evidence of postintervention and 3-year follow-up benefits in well-being. *Psychotherapy & Psychosomatics* 2007;76:226–233. [PubMed: 17570961]
- Grossman P, Niemann L, Schmidt S, Walach H. Mindfulness-based stress reduction and health benefits. A meta-analysis. *Journal of Psychosomatic Research* 2004;57:35–43. [PubMed: 15256293]
- Hölzel BK, Ott U, Gard T, Hempel H, Weygandt M, Morgen K, Vaitl D. Investigation of mindfulness meditation practitioners with voxel-based morphometry. *Social Cognitive and Affective Neuroscience* 2007a;3:55–61.
- Hölzel BK, Ott U, Hempel H, Hackl A, Wolf K, Stark R, Vaitl D. Differential engagement of anterior cingulate and adjacent medial frontal cortex in adept meditators and non-meditators. *Neuroscience Letters* 2007b;421:16–21.
- Hutcherson, CA.; Seppala, EM.; Gross, JJ. I don't know you but I like you: Loving kindness meditation increases positivity toward others; Paper presentation at the 6th annual conference Integrating Mindfulness-Based Interventions into Medicine; Worcester, MA: Health Care & Society; 2008 Apr.
- Jain S, Shapiro SL, Swanick S, Roesch SC, Mills PM, Bell I, Schwartz GER. A randomized controlled trial of mindfulness meditation versus relaxation training: Effects on distress, positive states of mind, rumination, and distraction. *Annals of Behavioral Medicine* 2007;33:11–21. [PubMed: 17291166]
- Jha AP, Krompinger J, Baime MJ. Mindfulness training modifies subsystems of attention. *Cognitive, Affective & Behavioral Neuroscience* 2007;7:109–119.
- Kabat-Zinn J. Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice* 2003;10:144–156.
- Kabat-Zinn J, Wheeler E, Light T, Skillings A, Scharf MJ, Cropley TG, Hosmer D, Bernhard JD. Influence of a mindfulness meditation-based stress reduction intervention on rates of skin clearing in patients with moderate to severe psoriasis undergoing phototherapy (UVB) and photochemotherapy (PUVA). *Psychosomatic Medicine* 1998;60:625–632. [PubMed: 9773769]
- Kabat-Zinn, J. *Using the wisdom of your body and mind to face stress, pain, and illness*. New York, NY: Delacorte Press; 1990. Full catastrophe living.
- Kristeller, JL.; Baer, RA.; Quillian-Wolever, R. Mindfulness-based approaches to eating disorders. In: Baer, RA., editor. *Mindfulness-Based Treatment Approaches: A Clinician's Guide to Evidence Base and Applications*. San Diego, CA: Academic Press; 2006. p. 75-91.
- Lau MA, Bishop SR, Segal ZV, Buis T, Anderson N, Carlson L, Shapiro S, Carmody J. The Toronto Mindfulness Scale: Development and validation. *Journal of Clinical Psychology* 2006;62:1445–1467. [PubMed: 17019673]
- Ludwig DS, Kabat-Zinn J. Mindfulness in medicine. *Journal of the American Medical Association* 2008;300:1350–1352. [PubMed: 18799450]
- Lutz A, Slagter HA, Dunne J, Davidson RJ. Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences* 2008a;12:163–169. [PubMed: 18329323]
- Lutz A, Brefczynski J, Johnstone T, Davidson RJ. Regulation of neural circuitry of emotion by compassion meditation: Effects of meditative expertise. *PLoS ONE* 2008b;3(3):e1897. [PubMed: 18365029]
- Morone NE, Greco CM, Weiner DK. Mindfulness meditation for the treatment of chronic low back pain in older adults: a randomized controlled pilot study. *Pain* 2008;134:310–319. [PubMed: 17544212]
- Pace TW, Negi LT, Adame DD, Cole SP, Sivilli TI, Brown TD, Issa MJ, Raison CL. Effect of compassion meditation on neuroendocrine, innate immune and behavioral responses to psychosocial stress. *Psychoneuroendocrinology*. in press. 10.1016/j.psyneuen.2008.08.011

- Pradhan EK, Baumgarten M, Langenberg P, Handwerger B, Gilpin AK, Magyari T, Hochberg MC, Berman BM. Effect of Mindfulness-Based Stress Reduction in rheumatoid arthritis patients. *Arthritis and Rheumatism* 57:1134–1142. [PubMed: 17907231]
- Ramel W, Goldin PR, Carmona PE, McQuaid JR. The effects of mindfulness meditation training on cognitive processes and affect in patients with past depression. *Cognitive Therapy and Research* 2004;28:433–455.
- Robinson FP, Mathews HL, Witek-Janusek L. Psycho-endocrine-immune response to mindfulness-based stress reduction in individuals infected with Human Immunodeficiency Virus: A quasi-experimental study. *The Journal of Alternative and Complementary Medicine* 2003;9:683–694. [PubMed: 14629846]
- Rosenzweig S, Reibel DK, Greeson JM, Edman JS, Jasser SA, McMearty KD, Goldstein BJ. Mindfulness-based stress reduction is associated with improved glycemic control in type 2 diabetes mellitus: a pilot study. *Alternative Therapies in Health and Medicine* 2007;13:36–38. [PubMed: 17900040]
- Shapiro SL, Carlson LE, Astin JA, Freedman B. Mechanisms of mindfulness. *Journal of Clinical Psychology* 2006;62:373–86. [PubMed: 16385481]
- Shigaki CL, Glass B, Schopp LH. Mindfulness-based stress reduction in medical settings. *Journal of Clinical Psychology in Medical Settings* 2006;13:209–216.
- Tang YY, Ma Y, Wang J, Fan Y, Feng S, Lu Q, Yu Q, Sui D, Rothbart MK, Fan M, Posner MI. Short-term meditation training improves attention and self-regulation. *Proceedings of the National Academy of Sciences* 2007;104:17152–17156.
- The Dalai Lama. *An open heart: Practicing compassion in everyday life*. New York, NY: Little, Brown and Company; 2001.
- Teasdale JD, Moore RG, Hayhurst H, Pope M, Williams S, Segal ZV. Metacognitive awareness and prevention of relapse in depression: empirical evidence. *Journal of Consulting and Clinical Psychology* 2002;70:275–287. [PubMed: 11952186]
- Toneatto T, Nguyen L. Does mindfulness meditation improve anxiety and mood symptoms? A review of the controlled research. *Canadian Journal of Psychiatry* 2007;52:260–266.
- Walach H, Buchheld N, Buittenmuller V, Kleinknecht N, Schmidt S. Measuring mindfulness – the Freiburg Mindfulness Inventory. *Personality and Individual Differences* 2006;40:1543–1555.
- Winbush NY, Gross CR, Kreitzer MJ. The effects of mindfulness-based stress reduction on sleep disturbance: A systematic review. *Explore (NY)* 2007;3:585–591. [PubMed: 18005910]
- Witek-Janusek L, Albuquerque K, Rambo Chroniak K, Chroniak C, Durazo-Arvizu R, Mathews H. Effect of mindfulness based stress reduction on immune function, quality of life and coping in women newly diagnosed with early stage breast cancer. *Brain, Behavior, and Immunity* 2008;22:969–981.
- Zutra AJ, Davis MC, Reich JW, Nicassario P, Tennen H, Finan P, Kratz A, Parrish B, Irwin MR. Comparison of cognitive behavioral and mindfulness meditation interventions on adaptation to rheumatoid arthritis for patients with and without history of recurrent depression. *Journal of Consulting and Clinical Psychology* 2008;76:408–421. [PubMed: 18540734]
- Zylowska L, Ackerman DL, Yang MH, Futrell JL, Horton NL, Hale TS, Pataki C, Smalley SL. Mindfulness meditation training in adults and adolescents with ADHD: a feasibility study. *Journal of Attention Disorders* 2008;11:737–746. [PubMed: 18025249]

## Biography

Jeffrey Greeson, Ph.D., M.S., is an Assistant Professor of Psychiatry & Behavioral Sciences at the Duke University School of Medicine in Durham, North Carolina. Dr. Greeson currently works as a Clinical Health Psychologist and researcher at Duke Integrative Medicine, a leading center for the science and practice of whole-person health care. Dr. Greeson earned a Masters degree in Biomedical Chemistry in 2001, and he has conducted research in the fields of integrative medicine, mindfulness meditation, and stress physiology since 1998. His work has been recognized at national and international conferences, and his studies have been published in several peer-reviewed academic journals.