The Journal of Mind and Behavior
Spring 2011, Volume 32, Number 2
Pages 123–134
ISSN 0271–0137

Attention and Working Memory in Mindfulness–Meditation Practices

Heather Buttle

Massey University

The construct of "mindfulness" has increasingly become a focus of research related to meditation practices and techniques. There is a growing body of research indicating clinical efficacy from therapeutic use, while cognitive neuroscience has provided an insight into the brain regions and mechanisms involved. Significantly, these approaches converge to suggest that attention is an important mechanism with trainable sub-components. This article discusses the role of attention and argues that memory has been neglected as a potential key mechanism in mindfulness–meditation practices. Specifically, it proposes that working memory offers a useful model for integrating and understanding the different mental devices that are used in meditation and suggests a model with the potential to provide a comprehensive account of how the apparent benefits of these practices arise. This call for a more comprehensive and integrated approach is necessary if the study and application of meditation are to become more than a parochial concern.

Keywords: attention, working memory, mindfulness, meditation

Attention and working memory have long been of interest to psychologists and cognitive scientists. In general terms, the study of attention investigates how we are able to select discrete stimuli from the environment while inhibiting irrelevant stimuli. This can be in the form of endogenous stimuli, where we intend to select items based on task characteristics; or it can be exogenous, where stimuli are selected through more automatic processes (e.g., something falls towards you and captures your attention). Hence, our ability to function efficiently is very much linked to attention and working memory, where the latter allows information selected (either from the environment or from long term memory) to be held and manipulated in order to perform a task or decision.

I am grateful to a number of people for comments on earlier versions of this article: Bobbie Spellman, Ian M. Evans, John Hodgson, and anonymous reviewers. Requests for reprints should be sent to Heather Buttle, Ph.D., School of Psychology, Massey University, Private Bag 102 904, North Shore Mail Centre, Auckland, New Zealand. Email: h.buttle@massey.ac.nz

The involvement of attention and working memory in various cognitive tasks has been of interest to both basic and applied psychologists. Recently, this interest has been engaged in investigating practices of mindfulness meditation, where researchers from clinical, cognitive, and neuroscience fields have been trying to understand how cognitive techniques (e.g., counting the breath) can lead to improved health outcomes. There is now a growing body of research that is experimentally pursuing a cognitive understanding of mind–body medicine.

In her historical account of mind–body medicine, Harrington (2008) identifies six accounts of how people view and experience mind–body connections. These accounts highlight a somewhat cyclical trend where, initially, a mind–body phenomenon is viewed skeptically by science only for it to later be embraced and then to fall once again to scientific skepticism. For instance, Mesmer helped discredit certain sensational practices of exorcism, but his animal magnetism explanation for behaviors seen in the possessed was also in turn dismissed (Harrington, 2008). A similar cycle can be observed to some extent in the study of meditation, where emphasis has moved from the relaxation response to mindfulness.

However, over time and across a varied selection of phenomena (e.g., placebo effects, mantra chanting, positive thinking, relaxation response, mindfulness), scientific data have shown that such mind–body experiences have some clinical efficacy (see again Harrington, 2008 for a review). For example, the placebo effect, where patients' treatment expectations lead to experience of improvements, has been observed at the neuronal level. Placebo effects in depression, pain, and Parkinson's disease may share common circuitry involved in neural systems mediating expectancy and appraisal (Wager, 2005). Chiesa, Brambilla, and Serritti (2010) report that an overlap exists between cerebral areas activated by placebo and areas activated during psychotherapy, pharmacotherapy, and mindfulness meditation.

More recently, evidence indicates that the central mechanism involved in meditation is attention (e.g., Lutz, Slagter, Dunne, and Davidson, 2008). Here, I hope to extend this focus to review mindfulness and other related meditation techniques in relation to attention and working memory. Moreover, I propose that Baddeley's (1986, 2000, 2001) working memory model provides a rationale for integrating our understanding of these techniques, and offers an explanation for how meditative techniques may benefit the practitioner.

Mindfulness

Mindfulness and its associated meditation techniques have a long history in spiritual traditions. For instance, Hinduism, Buddhism, Judaism, Christianity, and Islam (in particular Sufism) have contemplative and meditational aspects. Earlier studies on transcendental meditation and the use of mantras led to

research on the relaxation response (Benson, 1975). Much of the focus of current studies into the benefits of mindfulness come from Buddhist traditions, which themselves date back approximately 2,500 years to the time of the historic Buddha (Buddha Shakyumuni). The utilization and adaption of these Buddhist techniques may come from a pragmatic connection with Western psychology in that Buddhism is non-theistic; this may make its presentation to a secular Western context more amenable.

In general, mindfulness refers to a broad set of meditative style techniques that brings awareness into the current moment. Awareness in this context means there is recognition of stimuli and rising mental activity, though the mind does not necessarily elaborate the experience with discursive thoughts. For example, there may be awareness of a bright light without the need to think, "Oh, there is a bright light, I should turn it off." The techniques used range from bringing attention to objects, bodily sensations and the breath, feelings and thoughts. Hence, the aim is to simply observe rather than discursively analyze the object of focus. However, it is inevitable, especially for a beginner, that thoughts will intrude and disrupt the focused concentration. In this case, the intention is not that someone should try to actively suppress the thoughts nor that the thoughts should be followed and indulged. Instead, the practitioner simply acknowledges the presence of the thought and then redirects attention back to the object of focus.

Relevant to these techniques is Wegner, Schneider, Carter III, and White's (1987) negative cueing hypothesis. Wegner et al. showed that more thoughts occurred about a cue the participants were not supposed to think of (a white bear) than did when participants were free to think of it. However, the use of a focused distractor (a red Volkswagen) with the instruction that "if you happen to think of a white bear, please try to think of a red Volkswagen instead" (p. 10) attenuated this effect. Wegner et al. concluded, "it appears that when suppression is transformed into an active interest in a single distracter, the longer term dangers of a rebounding pre-occupation with the suppressed thought may be prevented" (p. 12). In the case of mindfulness meditation, the focus helps the practitioner avoid all discursive thoughts. These techniques are not passive as there is an active task of remembering the object of focus.

Mindfulness in Therapy

Currently, these techniques have been incorporated into a number of psychological therapies, such as mindfulness-based stress reduction, mindfulness-based cognitive therapy, dialectical behavior therapy, acceptance and commitment therapy, and relapse prevention (Hayes, Strosahl, and Wilson, 1999; Kabat–Zinn et al., 1992; Linehan, 1993a, 1993b; Marlatt and Gordon, 1985; Segal, Williams, and Teasdale, 2002). For example, mindfulness-based cognitive therapy incorpo-

rates cognitive therapy principles and practice into a mindfulness framework (Segal et al., 2002). While thoughts may be a focus of the therapy, there is a broader scope that extends to feelings and bodily sensations. For example, Segal et al. detail an eight-session program that includes activities such as body scan meditation (where attention is given to the physical sensations occurring in different parts of the body) and mindfulness of the breath, while activities relating to thoughts take the form of recognizing that "thoughts are not facts" and being open to them by holding ". . . them in awareness, with a gentle interest and curiosity . . ." (p. 266). In essence, the techniques alleviate problems due to rumination over negative events and hopelessness towards the future. Moreover, there is encouraging evidence to show that they are effective. In the case of mindfulness-based cognitive therapy, a number of studies have shown that it is effective in preventing a relapse in those who have repeated episodes of major depression (e.g., Bondolfi et al., 2010; Coelho, Canter, and Ernst, 2007; Kuyken et al., 2008; Segal et al., 2002).

Mechanisms of Mindfulness

Researchers have embarked on discussing the operational definition of mindfulness and in general, attention has been the core focus. Bishop et al. (2004) proposed two key components to mindfulness: self-regulation of attention (i.e., the ability to sustain attention), and orientation towards present moment experiences (e.g., curiosity, openness, and acceptance). These components are quite broad in their scope, and in the case of attention there is a failure to capture its multifaceted nature. For example, three key attentional mechanisms are attentional orienting, engaging attention, and monitoring (Lutz et al., 2008). Moreover, there is more to the techniques than just sustaining attention, as all "minds" will tend to wander from the task as thoughts intrude. Thus, remembering the task (what should be the focus) and returning attention to it is also a key skill. This is something that is recognized in Buddhist psychology but is yet to be fully acknowledged by Western psychology. For example, the Tibetan Buddhist scholar Thrangu Rinpoche (2001, pp. 105–106) states, "By applying the faculty of memory as mindfulness, one's meditation remains free from error or deviation."

Other models such as that of Shapiro, Carlson, Astin, and Freedman (2006) suggest the mechanisms of mindfulness include intention and attitudes as well as attention but do not specifically incorporate types of memory processing into these constructs. Therefore, any cognitive description of mindfulness should take into account both concentration and remembering. This should include the working memory model (Baddeley, 2000, 2001; Baddeley and Hitch, 1974) which offers not only a good description of mindfulness practice as currently employed and understood in Western psychology, but also suggests that techniques which have not been adapted or incorporated, yet are part of

Eastern spiritual mindfulness practices, may well offer further benefit in therapeutic settings. In particular, I am referring to visualization and recitation (mantra) practices that also incorporate positive affective content and focus on compassion. While there has been a skillful transformation of terminology from those used in Eastern spiritual traditions to those used in Western medicine, not all components of the Eastern tradition have been equally emphasized in Western psychological practice. Along with visualization and mantra, ethics and compassion training are rarely considered, and yet they form a fundamental core of Eastern (Buddhist) practice (see Fredrickson, Cohn, Coffey, Pek, and Finkel, 2008 for an example). This may have important implications for the level of effectiveness of the mindfulness techniques employed.

Attention and Working Memory in Mindfulness–Meditation Techniques

Working memory manipulates information held in short term and long term memory. For example, the process of solving an equation requires remembering the equation (short term memory) and how to solve it (long term memory). Working memory consists of a supervisory attentional system (central executive) that is assisted by two slave systems, one for verbal information (phonological loop) and one for visual–spatial information (visuospatial sketch pad), while an episodic buffer incorporates this information (Baddeley, 2000, 2001; Baddeley and Hitch, 1974). The distinction between the visual and verbal aspects has been demonstrated in a large body of classic experiments and is consistent with neuroimaging evidence that shows different patterns of brain activation for verbal versus visual working memory tasks (Hwang et al., 2005). More specifically, Hwang et al. note that the following areas are implicated in subvocal rehearsal: the left prefrontal cortex, the bilateral occipital cortex, Broca's region, the premotor cortex, the supplemental motor areas, the left posterior parietal cortex, and the cerebellum, while areas implicated in visual memory processes include the right dorsal prefrontal cortex, the right parietal cortex, and the right middle frontal gyrus.

Attention

There is already widespread acceptance that attention is a core process in mindfulness–meditation practice. This comes both from the operational definitions and models offered from clinical psychology (as mentioned earlier) and also from cognitive neuroscience (e.g., Carter, Presti, Callistemon, Ungerer, Liu, and Pettigrew, 2005). For example, Lazar et al. (2005) found that brain regions associated with attention as well as introspection and sensory processing were thicker in participants who meditate than matched controls. Most of the regions identified were in the right hemisphere. In fact, there is a growing body

of literature that indicates meditation requiring focused attention is associated with changes in attentional processing and brain structures (Brefczynski–Lewis, Lutz, Schaefer, Levinson, and Davidson, 2007; Carter et al., 2005; Lazar et al, 2005; Pagnoni and Cekic, 2007; Slagter et al., 2007; Srinivasan and Baijal, 2007). Lutz et al. (2008, p. 165) summarized this body of research as underscoring "the view that at least several subcomponents of attention are best regarded as the product of trainable skills."

Working Memory

Apart from attention, other aspects of working memory have been somewhat neglected in terms of understanding the mechanisms involved in meditation and mindfulness practice. Not only has the need for remembering the task been neglected, but so has the relevant use of visuo-spatial and verbal aspects of working memory in mindfulness practices. This is surprising given the wide use of visual and verbal techniques in meditation and that these have been recognized in Western therapeutic techniques since at least the 1970s. For example, Benson (1975) described four basic elements of meditation: a quiet environment, a mental device (an object to dwell upon), a passive attitude, and a comfortable position. The second element, an object to dwell upon, can include verbal or visual content such as a word or sound repetition or a symbol to gaze at. Similarly, in Vajrayana Buddhism (often associated with Tibetan Buddhism) complex visualizations and mantra recitations are frequently used (e.g., Thrangu Rinpoche, 2001). While Buddhist psychology has detailed the uses and benefits of these techniques, little attention has been directed at them from the Western psychological perspective despite its relevance to working memory. Some preliminary attempts have been made and are summarized below.

Verbal Techniques

Regarding verbal aspects of meditation techniques, Benson (1975) studied mantra use and provided physiological evidence of its benefits. He concluded that verbal repetition as a mental device permits a shift away from logical, externally originated thought by disrupting the flow of distracting thoughts. While Benson's studies focused on practitioners of transcendental meditation who used mantras as a mental device, he was careful to note that there is no one specific device that must be used. Evidence that the benefit of these verbal techniques is connected with working memory comes from Fabbro, Muzur, Bellen, Calacione, and Bava (1999). In their study they compared a group of participants with meditation experience with a group that had no experience. Three key conditions were tested: a standard working memory task (digit span), a prayer task (Ave Maria), and a quiet control condition. At requested intervals,

participants were asked about the presence of verbal, visual, or other thoughts. Results revealed that both the working memory task and the prayer condition led to fewer spontaneous thoughts than the quiet condition. Results also showed that the working memory task produced the greater reduction. Moreover, this occurred for both the meditators and controls, although there was a main effect for group with meditators reporting fewer thoughts overall than the controls. Fabbro et al. highlighted the role of the phonological loop, suggesting that prayer may suppress spontaneous thoughts and that the reduction of spontaneous thoughts obtained by praying may depend on modes similar to articulatory suppression since both act on working memory.

Visual Techniques

Research relating to visualization-based meditation indicates that such practices enhance visuospatial processing efficiency (Kozhevnikov, Louchakova, Josipovic, and Motes, 2009). In Kozhevnikov et al.'s study, deity meditation (visualizing oneself in the form of a deity) was compared to other non-visual meditation and imagery techniques with observation of participants' performance pre- and post-test on visual memory and mental rotation tasks. The results indicated that while all groups performed similarly at pre-test, deity practitioners demonstrated a dramatic increase in performance on imagery tasks compared with the other groups. It was suggested that this effect might be due to focused visual attention, as such attention is critical in facilitating control over the contents of visuospatial working memory (Awh and Jonides, 2001; Jha, 2002). Hence, Kozhevinkov et al. concluded that this particular meditation improves the capacity to access heightened visuospatial processing resources.

Combining Techniques

While research is beginning to deal with these issues of technique, the research is preliminary and often narrow in focus. For example, mantras and visualization techniques are often used simultaneously in practice and are typically followed by a phase of meditation where the visualization/mantra is dissolved and the mind is left to rest in an uncontrived state (Thrangu Rinpoche, 2001). This type of meditational state is without an object of focus and no discursive thoughts take place; however, the mind is still experiencing awareness (unlike our usual sleep state). The concurrent use of mantra and visualization is likely to involve visuospatial working memory and the phonological loop conjointly. Moreover, it might be the case that the loading of the working memory slave systems allows the attentional supervisory system (central executive) to come to rest. For example, having sufficiently designated key tasks to the slave systems (through mantra recitation and visualization), the central executive comes to

a pause. Hence, when the tasks are dissolved there is a momentary lull in discursive thinking before the general stream of thoughts return. In Buddhist psychology, this state is sometimes described as "lucid yet nonconceptual" and offers the practitioner an opportunity to recognize the mind's nature and to understand that thoughts are just fleeting manifestations. For example, Tangtong Gyalbo (2007, p. 299) instructed, "Right after the previous thought has ceased and the next one not yet arisen, that's the gap!" While this may be somewhat speculative, Lutz et al. (2008) note that on a focused meditation task, experts (more than 19,000 hours) showed a stronger pattern of activation implicated in attention: monitoring (dorsolateral prefrontal cortex), engaging attention (visual cortex), and attentional orienting (the superior sulcus and intraparietal sulcus). However, for those who had much higher levels of practice hours (more than 44,000 hours), there was actually less activation, indicating that after extensive practice minimal effort is needed to sustain attentional focus. Hence, this may indicate that a relaxed attentional state can be achieved.

Although not addressing the subject of mindfulness specifically, Van Dillen and Koole (2007) provide evidence that working memory can be utilized as a tool for overcoming negative emotions. In their series of experiments, participants viewed images that varied in affective content (e.g., positive and negative). After viewing an individual image, the participant would either be given a working memory task (i.e., arithmetic) or no task at all. Participants would then rate their mood. What was observed was that on negative image trials where there was a working memory task, there was a less negative rating of mood compared to when there was no task. That this working memory task seemed to alleviate negative mood is in accordance with Fabbro et al.'s (1999) finding that prayer and other working memory tasks reduced the occurrence of spontaneous thoughts. Similarly, other attention-demanding tasks have alleviated the emotional impact of negative stimuli (Erber and Tesser, 1992; Erthal, De Oliveriera, Mocaiber, Pereira, Machado–Pinheiro, and Volchan, 2005; Glynn, Christenfeld, and Gerin, 2002; Morrow and Nolen–Hoeksema, 1990; Pessoa, McKenna, Gutierrez, and Ungerleider, 2002; Van Dillen, Heslenfeld, and Koole, 2009). One explanation for these findings, which is consistent with results from functional magnetic resonance imaging studies, is that cognitive task load can down-regulate emotional circuits even after these circuits have been mobilized (Van Dillen et al., 2009). In relation to meditation practices, it has previously been observed that expert meditators showed less activation in the amygdala (an affective area) during focused meditation and that hours of practice negatively correlated with activation in this area (Brefczynski–Lewis et al., 2007). Furthermore, Wenk–Sormaz (2005) reported that meditation can reduce habitual responding (e.g., reduced Stroop interference). Lutz et al. (2008) suggested that these studies indicated that focused attention training may be associated

with a significant decrease in emotionally reactive behaviors that are incompatible with stability of concentration.

Emotional Valence of Techniques

However, it should be noted that, as with simultaneous use of verbal and visual tasks, these tasks are rarely content neutral. Generally, there is positive imagery and symbolism involved. Inclusion of such content may enhance the general tendency to distract from negative thoughts and bring about a more positive mood. For example, there are many practices in Vajrayana Buddhism that involve individuals visualizing that they are in deity form and many of these deities embody loving kindness and compassion (Thrangu Rinpoche, 2001). This also has particular relevance to the discussion of working memory, as research suggests that just as there are separable visual and verbal processes in working memory, affective information may also be mediated by separable processes (Davidson and Irwin, 1999; Mikels, Larkin, Reuter–Lorenz, and Cartensen, 2005; Mikels, Reuter–Lorenz, Beyer, and Fredrickson, 2008). In particular, the online maintenance of information about affect intensity may have specialized mechanisms (Mikels et al., 2008): Mikels and Reuter–Lorenz (in press) report that regions of activation in the lateral orbitofrontal cortex seem to be unique to affect maintenance. Hence, it may be necessary to reconfigure the current model of working memory to include affect.

Conclusion

It seems necessary to not only systematically examine the role of verbal and visual techniques in meditation but also to consider the emotive value of the mental devices used. Converging evidence should be sought not just from established meditative techniques (which are often connected with religious symbolism, such as the form of a deity) and experienced meditators, but also from novel tasks designed for experimental investigation with novice meditators. Such work could evaluate the effects of visual and verbal tasks both in isolation from one another and in combination and this could include the examination of the mental device's affective valance. However, as an area of investigation with potential therapeutic benefits, it is important that the mindfulness–meditation literature does not become too fragmented; a structured approach needs to be adopted. At present, the clinical interest in mindfulness seems to hang somewhat apart from cognitive and neuroscientific interests, which are often narrow in scope. The overall research literature needs to become more integrated if the study of mindfulness–meditation practices is to avoid being just a "parochial concern" (Harris, 2006). As highlighted in this article, the well-

established model of working memory may be one useful approach for linking these different aspects of knowledge into a more cohesive understanding.

References

Awh, E., and Jonides, J. (2001). Overlapping mechanisms of attention and spatial working memory. *Trends in Cognitive Sciences, 5,* 119–126.

Baddeley, A.D. (1986). *Working memory.* Oxford, United Kingdom: Oxford University Press.

Baddeley, A.D. (2000). The episodic buffer: A new component of working memory. *Trends in Cognitive Sciences, 4,* 417–423.

Baddeley, A.D. (2001). Is working memory still working? *American Psychologist, 56,* 851–864.

Baddeley, A.D., and Hitch, G. (1974). Working memory. In G.H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 8, pp. 17–90). Orlando, Florida: Academic Press.

Benson, H. (1975). *The relaxation response.* New York: Morrow.

Bishop, S.R., Lau, M., Shapiro, S., Carlson, L., Anderson, N.D., Carmody, J., Segal, Z.V., Abbey, S., Speca, M., Velting, D., and Devins, G. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice, 11,* 230–241.

Bondolfi, G., Jermann, F., Van der Linden, M., Gex–Fabry, M., Bizzini, L., Weber Rouget, B., Myers–Arrazola, L., Gonzalez, C., Segal, Z., Aubry, J.M., and Bertschy, G. (2010). Depression relapse prophylaxis with mindfulness-based cognitive therapy: Replication and extension in the Swiss health care system. *Journal of Affective Disorders, 122,* 224–231.

Brefczynski–Lewis, J.A., Lutz, A., Schaefer, H.S., Levinson, D.B., and Davidson, R.J. (2007). Neural correlates of attentional expertise in long-term meditation practitioners. *Proceedings of the National Academy of Sciences U.S.A., 104,* 11483–11488.

Carter, O.L., Presti, D.E., Callistemon, C., Ungerer, Y., Liu, G.B., and Pettigrew, J.D. (2005). Meditation alters perceptual rivalry in Tibetan Buddhist monks. *Current Biology, 15*(11), R412–R413.

Chiesa, A., Brambilla, P., and Serritti, A. (2010). Functional neural correlates of mindfulness meditations in comparison with psychotherapy, pharmacotherapy, and placebo effect. Is there a link? *Acta Neuropsychiatrica, 22,* 104–117.

Coelho, H.F., Canter, P.H., and Ernst, E. (2007). Mindfulness-based cognitive therapy: Evaluating current evidence and informing future research. *Journal of Consulting and Clinical Psychology, 75,* 1000–1005.

Davidson, R.J., and Irwin, W. (1999). The functional neuroanatomy of emotion and affective style. *Trends in Cognitive Sciences, 3,* 11–21.

Erber, R., and Tesser, A. (1992). Task effort and the regulation of mood: The absorption hypothesis. *Journal of Experimental Social Psychology, 28,* 339–359.

Erthal, F. S., De Oliveriera, L., Mocaiber, I., Pereira, M. G., Machado–Pinheiro, W., and Volchan, E. (2005). Load-dependent modulation of affective picture processing. *Cognitive, Affective, and Behavioral Neuroscience, 5,* 388–395.

Fabbro, F., Muzur, A., Bellen, R., Calacione, R., and Bava, A. (1999). Effects of praying and a working memory task in participants trained in meditation and controls on the occurrence of spontaneous thoughts. *Perceptual and Motor Skills, 88,* 765–770.

Fredrickson, B.L., Cohn, M.A., Coffey, K.A., Pek, J., and Finkel, S.M. (2008). Open hearts build lives: Positive emotions, induced through loving-kindness meditation, build consequential personal resources. *Journal of Personality and Social Psychology, 95,* 1045–1062.

Glynn, L.M., Christenfeld, N., and Gerin, W. (2002). The role of rumination in recovery from reactivity: Cardiovascular consequences of emotional states. *Psychosomatic Medicine, 68,* 64–72.

Harrington, A. (2008). *The cure within: A history of mind–body medicine.* New York: Norton.

Harris, S. (2006). Killing the Buddha. *Shambhala Sun, July, 69,* 73–75.

Hayes, A.C., Strosahl, K., and Wilson, K.G. (1999). *Acceptance and commitment therapy.* New York: Guildford Press.

Hwang, G., Jacobs, J., Geller, A., Danker, J., Sekuler, R., and Kahana, M.J. (2005). EEG correlates of verbal and nonverbal working memory. [Electronic version]. *Behavioral and Brain Functions,* 1:20, doi:10.1186/1744–9081–1–20.

Jha, A. (2002). Tracking the time-course of attentional involvement in spatial working memory: An event-related potential investigation. *Cognitive Brain Research, 15,* 61–69.

Kabat–Zinn, J., Massion, A.O., Kristellar, J., Peterson, L.G., Fletcher, K.E., Pbert, L., Lenderking, W.R., and Santorelli, S.F. (1992). Effectiveness of a meditation-based stress reduction program in the treatment of anxiety disorders. *American Journal of Psychiatry, 149,* 936–943.

Kozhevnikov, M., Louchakova, O., Josipovic, Z., and Motes, M.A. (2009). The enhancement of visuospatial processing efficiency through Buddhist deity meditation. *Psychological Science, 20,* 645–653.

Kuyken, W., Byford, S., Taylor, R.S., Watkins, E., Holden, E., White, K., Barrett, B., Byng, R., Evans, A., Mullan, E., and Teasdale, J.D. (2008). Mindfulness-based cognitive therapy to prevent relapse in recurrent depression. *Journal of Consulting and Clinical Psychology, 76,* 966–978.

Lazar, S.W., Kerr, C.E., Wasserman, R.H., Gray, J.R., Greve, D.N., Treadway, M.T., McGarvey, M., Quinn B.T., Dusek J.A., Benson, H., Rauch, S.L., Moore, C.I., and Fischl, B. (2005). Meditation experience is associated with increased cortical thickness. *NeuroReport, 16,* 1893–1897.

Linehan, M.M. (1993a). *Cognitive–behavioral treatment of borderline personality disorder.* New York: Guildford Press.

Linehan, M.M. (1993b). *Skills manual for treating borderline personality disorder.* New York: Guildford Press.

Lutz, A., Slagter, H.A., Dunne, J.D., and Davidson, R.J. (2008). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences, 12,* 163–169.

Marlatt, G.A., and Gordon, J.R. (1985). *Relapse prevention: Maintenance strategiess in the treatment of addictive behaviours.* New York: Guildford Press.

Mikels, J., Larkin, G.R., Reuter–Lorenz, P.A., and Cartensen, L.L. (2005). Divergent trajectories in the aging mind: Changes in working memory for affective versus visual information with age. *Psychology and Aging, 20,* 542–553.

Mikels, J., and Reuter–Lorenz, P. A. (in press). Affective working memory: Converging evidence for a new construct. In S. Yoshikawa (Ed.), *Emotional mind: New directions in affective science.* Tokyo: Springer Verlag Tokyo.

Mikels, J., Reuter–Lorenz, P.A., Beyer, J.A., and Fredrickson, B.L. (2008). Emotion and working memory: Evidence for domain-specific processes for affective maintenance. *Emotion, 8,* 256–266.

Morrow, J., and Nolen–Hoeksema, S. (1990). Effects of responses to depression on the remediation of depressive affect. *Journal of Personality and Social Psychology, 58,* 519–527.

Pagnoni, G., and Cekic, M. (2007). Age effects on gray matter volume and attentional performance in Zen meditation. *Neurobiological Aging, 28,* 1623–1627.

Pessoa, L., McKenna, M., Gutierrez, E., and Ungerleider, L.G. (2002). Neural processing of emotional faces requires attention. *Proceedings of the National Academy of Science, 99,* 11458–11463.

Segal, Z.V., Williams, J.M.G., and Teasdale, J.D. (2002). *Mindfulness-based cognitive therapy for depression.* London: The Guildford Press.

Shapiro, S.L., Carlson, L.E., Astin, J.A., and Freedman, B. (2006). Mechanisms of mindfulness. *Journal of Clinical Psychology, 62,* 373–386.

Slagter, H.A., Lutz, A., Greischar, L.L., Francis, A.D., Nieuwenhuis, S., Davis, J.M., and Davidson, R.J. (2007). *Mental training affects distribution of limited brain resources.* PLoS Biol 5(6): e138. doi:10.1371/journal.pbio.0050138

Srinivasan, N., and Baijal, S. (2007). Concentrative meditation enhances preattentive processing: A mismatch negativity study. *Neuroreport, 18,* 1709–1712.

Tangtong Gyalbo (2007). Meeting Deleg bal and other monks at Riwoche. In K. Brunnholzl (Ed.), *Straight from the heart: Buddhist pith instructions.* New York: Snow Lion.

Thrangu Rinpoche (2001). *The essence of creation and completion.* Auckland, New Zealand: Zhyisil Chokyi Ghatsal Publications.

Van Dillen, L.F., Heslenfeld, D.J., and Koole, S.L. (2009). Tuning down the emotional brain: An fMRI study of the effects of cognitive load on the processing of affective images. *NeuroImage,* doi: 10.1016/j.neuroimage.2009.01.016

Van Dillen, L.F., and Koole, S.L. (2007). Clearing the mind: A working memory model of distraction from negative mood. *Emotion, 7,* 715–723.

Wager, T.D. (2005). The neural bases of placebo effects in pain. *Current Directions in Psychological Science, 14,* 175–179.

Wegner, D.M., Schneider, D.J., Carter III, S.R., and White, T.L. (1987). Paradoxical effects of thought suppression. *Journal of Personaility and Social Psychology, 53,* 5–13.
Wenk–Sormaz, H. (2005). Meditation can reduce habitual responding. *Alternative Therapies in Health Medicine, 11,* 42–58.