Chapter 5
Scientific Literacy as a Foundational Competency for Teachers of Mindfulness-based Interventions

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Introduction: Standards of Excellence

Maintaining the highest standards of excellence among MBI teachers is one of the most pressing issues of the field (McCown, Reibel, & Micozzi, 2017). Well-delineated MBI teacher excellence criteria include sustained and ongoing personal mindfulness practices, knowledge of Buddhist maps, and a wide range of definitions and discourses about mindfulness (Kabat-Zinn, 2011a, 2011b; Kabat-Zinn et al., 2014; McCown et al., 2010). This chapter addresses another dimension of teacher excellence, a foundational scientific literacy for MBI teachers which includes:

- An understanding of the interdependence of MBIs and scientific research
- A foundational knowledge of the science of meditation
- Practical methods to integrate science-based didactic material into the MBI curriculum
- Skills for evaluating the ever-changing evidence base of scientific research
- Evidence-based practice beyond the classroom

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The Interdependence of MBIs and Scientific Research

The success of MBIs in gaining a foothold in mainstream medicine has been largely due to the close coupling of MBIs with scientific research and the establishment of MBSR as an “evidence-based treatment” (Dryden & Still, 2006). The continued success of MBIs in maintaining credibility and continued traction with public institutions will depend in part on the ongoing partnership with scientific and empirical investigation. One side of this partnership includes academic scientists who conduct research on the effects of meditative practices, which help establish MBIs as evidence-based treatments. On the other side of the partnership are the MBI teachers—clinicians and educators. MBI teachers uphold their end of the partnership by engaging in evidence-based practice (EBP) (Spring, 2007), which includes ongoing knowledge and implementation of the scientific research in the field. Scientific literacy and EBP are especially important for MBI teachers as “stewards” or protectors of MBI longevity. Teacher literacy can protect against the formation of a “scientist–practitioner gap,” which is a well-known prognostic indicator of loss of public trust in a treatment (Tavris, 2003). MBI teachers are key in maintaining public trust, as they have the most direct interface with the public and are therefore the most immediate representatives of MBIs.

Basic Foundations in the Science of Meditation

Science-Based Homiletics in MBIs

As a general principle, MBI teachers draw from a deep well of experience and knowledge to weave teaching points into participants’ ongoing experiences. An equally deep, lived, and embodied experiential understanding of the various scientific concepts, models, and research findings allows MBI teachers to weave the scientific or didactic pieces seamlessly into the curriculum. These models are essentially about experience and about the very topics that are explored in practice: attention and distraction, thinking, emotions, and motivations. Didactic material can be sprinkled throughout the curriculum in many forms, ranging from handouts, videos, slides, and exercises to spontaneous responses to participants’ ongoing experience. But again, when these models are ingrained in the teachers’ understanding of experience, the information flows naturally. Of course, as with depth of practice, or knowledge of maps, scientific literacy is a lifelong learning skill and requires commitment as well as guidance and support, of which this chapter and book provide first steps.

Weaving science into the MBI curriculum serves the multilayered purpose of creating a universal language and framework of understanding and enhancing credibility, confidence, and trust in the programs, which in turn translates into enhancing motivation to practice.

The chapter addresses these topics roughly in the order that they might appear in an 8-week program, accompanied by supplemental material that can be found at the end of this chapter.

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Science as a universal language. Since the people receiving MBIs represent a range of worldviews, religions, cultures, and subcultures with different languages and metaphors, finding a common framework is a central challenge. Since the practice of science is an international endeavor with some common language, the language of science, particularly biology and neuroscience, can serve as a unifying framework to describe experience. Indeed, once scientific language is introduced, participants readily adapt it to describe their experiences, for example, "the sympathetic nervous system is on overdrive today," or "the amygdala is causing a negative bias in both attention and memory."

Neuroplasticity. Experience-dependent neuroplasticity means that our brains change with experience and practice, which has radical and inspiring implications for MBI participants. Rather than being fixed entities with unchangeable traits and behaviors, our brains and psychological tendencies are actually quite malleable. Just as exercise and training strengthens physical muscles, mental habits construct and become entrenched in corresponding brain networks. For example, neural networks related to spatial processing grow in taxi drivers as they develop interior maps of city streets (Maguire, Woollett, & Spiers, 2006). Other corresponding networks change in response to playing music (Rodrigues, Loureiro, & Paulo Caramelli, 2010) or juggling (Draganski et al., 2004). Whether we know it or not, we are *always* practicing something, so *choosing* what qualities or abilities to cultivate and which ones to weaken or abandon is a fundamental principle of contemplative practices.

This principle of intentional neuroplasticity is worth bringing up in the first class, as a "meta-framework" for the entire course. It may be as simple as just saying "you get good at what you practice" and then asking, "What are you practicing or cultivating? Is that something you want to grow and strengthen?" This kind of inquiry can bring awareness to participants' intentions and values, while simultaneously generating motivation to notice and stop actively reinforcing unskillful habits.

Resources for Neuroplasticity

TED Talk; http://www.ted.com/tedx/events/2672

Motivation to practice: mindfulness as an investment. Participant motivations and expectations are addressed explicitly in the first class under the question of "What brought you here?" Expectations and motivations to practice are inextricably tied, but not always beneficially. If participants have high hopes for fast results, violations of these expectations may undermine their confidence and lead to drop out (Sears & Stanton, 2001). Of course, fast effects are unlikely, and premature attrition can be thwarted by orienting toward mindfulness practice as a form of self-care and an investment in well-being. For example, the teacher might say:

> *When you go to the gym to lose weight or build muscle, we don't do a couple pushups or sit-ups, then immediately check to see if our arms are bigger, or our bellies are flatter. We know that it takes time and repetition. We may not feel anything right away, but that doesn't mean that it's not changing us. Mindfulness is the same way. It's fine to have hopes and goals of what benefits the practice might have, but I recommend checking in with those hopes at the end of the program and not to gauge your progress by how you feel during each meditation session. Sitting on the cushion once a day is like doing your push ups: you do it for long-term benefits.*

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Motivation to practice: frequency and duration. By the second class, many MBSR/CT participants report difficulty fitting in the 45 minutes per day of home practice into their busy lives. They ask if they can split up the meditations into smaller bits rather than one 45-minutes block to better fit into their schedules. The truth is that *no one knows what pattern of practice will yield the best outcomes*. However, there is some evidence that practicing less than the prescribed 45 minutes per day can still yield psychological benefits (Jain et al., 2007; Reibel, Greeson, Brainard, & Rosenzweig, 2001) and even changes in physiology (Davidson, Irwin, Anderle, & Kalin, 2003, Davidson et al., 2003). In addition, another study in drug-abusing adolescents found that more frequent short sessions were more powerful than the same total duration in a single session (Britton et al., 2010). Teens who practiced as little as 5–10 minutes per day 2–3 days per week increased their total sleep time by more than an hour per night compared to teens that just came to class but did not practice at home. Furthermore, the frequency, but *not* the duration, of practice was correlated with improvements in sleep. Participants report that knowing that even 5 minutes could make a difference encouraged them to practice every day, so I make sure to report this study on the second class, in the handouts, and also mention that "daily practice is more important than finishing the recording" at the beginning of each meditation recording.

Stress Physiology and Neurobiological Models of Meditation

MBIs typically include educating participants about stress physiology as well as the various neurobiological models of how meditation may be helpful to their specific conditions. There are many neurobiological models of how meditation might work to alleviate distress and promote well-being. Many Buddhist (Goleman, 1984; Grabovac, Lau, & Willet, 2011) and Hindu (Travis, 2014) models of meditation are in use, and many participants may be open to them. But they may also be unpalatable to the 90 % of Americans or Europeans who currently identify as either Christian or nonreligious (Lugo, 2012), as well as to the mainstream scientific establishment and public institutions that legally cannot support activities which promote religious frameworks (Wilson & Drakeman, 2003). Thus, in order to be consistent with both EBP and a "wholly secular" approach recommended by the Center for Mindfulness (Kabat-Zinn et al., 2014), MBI teachers can use biological models that are not only universally palatable but also empirically supported by, and in active use, within mainstream neuroscience and medicine.

Considering the above concerns, the hypo-frontality model can be a good choice when teaching MBSR/CT because it (1) is fairly easy to understand and weave into the ongoing experience of the participants, (2) can be delivered in a short amount of time, (3) has broad applicability to a wide range of different populations with different complaints, and (4) is well-supported by ongoing mainstream clinical neuroscience research, i.e., it is consistent with evidence-based practice.

The hypo-frontality model. Very simply put, the hypo-frontality model posits that a wide range of psychological and physiological symptoms can result from an

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underactive prefrontal cortex (PFC), and that these symptoms can be addressed through strengthening the PFC. The metaphors of "brain training" or "mental fitness" or other references to weight lifting, or going to the gym, can bridge both the principle of neuroplasticity and the hypo-frontality model.

Hypofrontality and the Neuroanatomy of Suffering

The prefrontal cortex. The PFC is an area of the brain, located just behind the forehead, that underlies a wide range of complex functions, including thinking, planning, and control of behavior (Miller & Cohen, 2001). One of the most commonly discussed functions of the PFC is executive functioning (EF) which includes different aspects of types of self-control and self-regulation, especially around attention and action (Wood & Smith, 2008).

As part of its regulatory role, the PFC is responsible for modulating three other brain systems: the limbic system, the default mode network (DMN), and the brain reward system. If the PFC is underactive, then the system that it is supposed to regulate becomes "disinhibited" or out of control, leading to a number of different problems, including depression (Baxter et al., 1989; Bench, Friston, Brown, Frackowiak, & Dolan, 1993), bipolar disorder (Blumberg et al., 2004; Clark, Iversen, & Goodwin, 2002; Meyer et al., 2004), obsessive compulsive disorder (van den Heuvel et al., 2005), schizophrenia (Carter et al., 1998; MacDonald et al., 2005), and addiction (Goldstein et al., 2009; Hester & Garavan, 2004).

The limbic system. The limbic system is a set of interconnected brain areas that include the hippocampus, amygdala, and nucleus accumbens (NAC) (among others). These areas are involved in memory, emotion, motivation, and reward (Morgane, Galler, & Mokler, 2005). The amygdala, which is involved in detecting emotional salience, particularly threat, is tightly coupled with the endocrine and sympathetic nervous systems involved in the "fight or flight" response and therefore is often associated with the bodily expression of emotional reactions (Davidson, Jackson, & Kalin, 2000). A pounding heart, a sinking feeling, a rush of anger, a feeling of being frozen with fear, all of these common expressions are examples of the limbic and sympathetic nervous systems activating.

The PFC exerts inhibitory control on limbic structures such as the amygdala (Davidson et al., 2000; Ochsner & Gross, 2005). Lack of such inhibitory control results in a hyperactive amygdala (Siegle, Steinhauer, Thase, Stenger, & Carter, 2002; Siegle, Thompson, Carter, Steinhauer, & Thase, 2007) and an associated increase in emotional reactivity and sympathetic hyperarousal commonly seen in anxiety, depression, and other kinds of disorders with high levels of negative emotions (Baxter et al., 1989; Clark et al., 2002; Mayberg et al., 1999). Participants will be experientially very familiar and probably quite distressed with signs and symptoms of both acute and chronic sympathetic nervous system hyperactivity (see handout at end of chapter), so reframing these experiences as the impersonal consequences of the stress response can be a relief.

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The default mode network. The DMN is a network of midline brain structures that are active during "rest" or when the brain is not otherwise engaged and is thought to be involved in self-referential thought and mind wandering (Qin & Northoff, 2011). The DMN is responsible for a self-narrative, "the story of me" (Gallagher, 2000), and other forms of social cognition, like imagining what other people are thinking or feeling (Schilbach, Eickhoff, Rotarska-Jagiela, Fink, & Vogeley, 2008). While some degree of self-narrative and social cognition promotes cohesion and functioning, often the stories we tell about ourselves or imagine that other people are telling about us are excessively critical, negative, or excessive. Therefore, a default mode that is overactive because it is insufficiently regulated by the PFC can be associated with distress, anxiety, rumination, and depression (Buckner & Vincent, 2007; Farb et al., 2007; Gentili et al., 2009; Hamilton et al., 2011; Sheline et al., 2009; Whitfield-Gabrieli et al., 2009). The handout "Two Arrows" (found at end of chapter) shows the difference between simple pain or loss (i.e., first arrow) and the default mode's contribution of unnecessary, negative, evaluative, self-referential rumination, or worry about the first arrow (i.e., the second arrow).

The brain reward system and addiction. Structures in the limbic system, DMN, and the mesolimbic dopamine system including the ventral tegmental area (VTA) and NAC together comprise the brain reward system, which is also regulated by the PFC (Feil et al., 2010). Poor prefrontal control over the brain reward system is associated with a number of features of addiction, including impulsivity, compulsivity, risk taking, impaired self-monitoring, "denial" of illness, and attentional biases toward substance or reward-related stimuli (Goldstein & Volkow, 2011).

Cognitive and emotional biases. Poor prefrontal control and an overactive amygdala can cause biases in attention and memory away from positive stimuli and toward negative stimuli which are a common feature of both anxiety and depression (Disner, Beevers, Haigh, & Beck, 2011). Conversely, poor PFC control over the brain reward system is associated with biases toward positive or rewarding stimuli that are linked to compulsive action and addictions (Garland, Froeliger, Passik, & Howard, 2013). Similar to the computerized therapy called "Cognitive Bias Modification" (Hoppitt, Mathews, Yiend, & Mackintosh, 2010), a few studies suggest that mindfulness training may improve distress by decreasing cognitive biases and contributing toward a more "evenhanded attention" (Alberts & Thewissen, 2011; Roberts-Wolfe, Sacchet, Hastings, Roth, & Britton, 2012; Vago & Nakamura, 2011).

Everyone has cognitive biases and may be unaware, although consistently "half-full" or "half-empty" tendencies may be very apparent to others. Because unconscious attentional biases occur early in sensory processing, they are not always addressed by instructions to attend to "whatever is happening." Exercises that deliberately investigate cognitive biases empower participants to identify their own patterns of biases and to tailor their practices toward a more balanced and evenhanded awareness. For example, individuals with a negative bias may benefit from learning

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to notice pleasant events and sensations, while individuals with a positive bias may benefit from touching into unpleasant or painful parts of experience that have been avoided. The topic of cognitive biases arises naturally when discussing the pleasant and unpleasant event calendars, or in group discussions of experiences arising out of MBI meditation practices more generally.

Evidence Base for MBIs

Rationale for cognitive training of the PFC. Positive responses to both pharmacological and behavioral treatments involve restoration of PFC functioning (Davidson, Irwin, et al., 2003, Davidson, Kabat-Zinn, et al., 2003; Hugdahl et al., 2007; Liotti & Mayberg, 2001; Liotti, Mayberg, McGinnis, Brannan, & Jerabek, 2002). In adults, restoration of the PFC can be achieved through cognitive training. Many clinical neuroscientists use neurocognitive exercises derived from neuropsychological tasks to strengthen the PFC and subsequently improve emotion regulation and dysfunction that are associated with PFC impairment. For example, Penades et al. (2006) employed multicomponent attention training in schizophrenic patients and found improved performance on PFC-dependent tasks and decreased hypo-frontality and psychological distress. Similarly, Siegle, Ghinassi, and Thase (2007) used two types of focused attention tasks to increase prefrontal functioning and mood disturbance in unipolar depression. Papageorgiou and Wells (2000) found that PFC-dependent attention training improved depressive symptomatology, emotion regulation, and normalized hypoactivation of the PFC and hyperactivation of the amygdala.

Meditation strengthens the PFC. The heterogeneous family of mental training techniques known as collectively as “meditation” can be viewed as neurocognitive training that is aimed at increasing prefrontal cognitive control and increasing affective regulation and emotional well-being. Many studies in adults have found that meditation practices increase activation of the PFC; decrease limbic and default mode activity; improve attention, emotional reactivity, and rumination; and help to alleviate addiction and mood disorders. Buddhist-derived meditation practices have been found to be associated with increased activity in the dorsolateral PFC (Allen et al., 2012; Baerentsen, 2001; Baron Short et al., 2010; Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007; Farb et al., 2007, 2010; Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012; Ritskes, Ritskes-Hoitinga, Stodkilde-Jorgensen, Baerntsen, & Hartman, 2003) and larger frontal gray matter volumes (Holzel et al., 2008; Lazar et al., 2005; Luders, Toga, Lepore, & Gaser, 2009).

Attention and executive function. More than a dozen controlled studies have assessed the effects of MBIs on objectively measured cognitive abilities such as attention and memory (Chiesa, Calati, & Serretti, 2011). Most RCTs found positive effects of MBIs on PFC-mediated cognitive abilities (Hargus, Crane, Barnhofer, &

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Williams, 2010; Ortner, Kilner, & Zelazo, 2007; Wenk-Sormaz, 2005; Williams, Teasdale, Segal, & Soulsby, 2000), while a few found no improvements (Anderson, Lau, Segal, & Bishop, 2007; MacCoon, MacLean, Davidson, Saron, & Lutz, 2014). Similar (mixed) conclusions can be found in recent reviews of meditation for improving cognition in aging (Gard, Holzel, & Lazar, 2014) or cognitive decline in the context of neurodegenerative conditions (Marciniak et al., 2014).

Amygdala. A number of studies have found decreased amygdala response or activation following different forms of meditation (Brefczynski-Lewis et al., 2007; Desbordes et al., 2012; Farb et al., 2007; Holzel et al., 2010; Taylor et al., 2011).

Default mode network. Multiple studies have found that various forms of meditation training are associated with decreased DMN activity (Baerentsen, 2001; Baerentsen et al., 2009; Berkovich-Ohana, Glicksohn, & Goldstein, 2012; Brewer et al., 2011; Farb et al., 2007, 2010; Goldin, Ramel, & Gross, 2009; Hasenkamp et al., 2012; Taylor et al., 2011; Travis et al., 2010), although other studies have found increased DMN activity (Goldin & Gross, 2010; Goldin et al., 2009, Goldin, Ziv, Jazaieri, & Gross, 2012; Hölzel et al., 2011).

Sympathetic nervous system hyperarousal. A number of studies using various meditation practices have found decreased sympathetic hyperarousal in meditators (Barnes, Treiber, & Davis, 2001; Carlson, Speca, Faris, & Patel, 2007; Maclean et al., 1994; Ortner et al., 2007; Sudsuang, Chentanez, & Veluvan, 1991; Tang et al., 2007), but increases in arousal have also been reported (Britton, Haynes, Fridel, & Bootzin, 2010; Creswell, Pacilio, Lindsay, & Brown, 2014; Holmes, 1984).

Emotional reactivity. In adults, a number of studies have suggested a relationship between mindfulness and reduced emotional and stress reactivity, including attenuated emotional responses to threatening situations or faster recovery from transient negative affect (Arch & Craske, 2006; Brewer et al., 2009; Britton, Shahar, Szepsenwol, & Jacobs, 2012; Broderick, 2005; Campbell-Sills, Barlow, Brown, & Hofmann, 2006; Erisman & Roemer, 2010; Goldin & Gross, 2010; Kuehner, Huffziger, & Liebsch, 2009; Ortner et al., 2007).

Anxiety and depression. Several meta-analyses of mindfulness meditation in adults have found overall support for the claim that mindfulness training can lead to decreased levels of negative affect, anxiety, and depression (Goyal et al., 2014; Hofmann, Sawyer, Witt, & Oh, 2010), with similar (medium) effect sizes to other treatments (AHRQ, 2012). For individuals with clinically diagnosed anxiety or depression, one recent meta-analysis found that MBIs, particularly MBCT, could be beneficial for major depression, but cautioned against using MBIs as a first-line treatment for anxiety disorders (Strauss, Cavanagh, Oliver, & Pettman, 2014).

Addiction. Findings that mindfulness may enhance prefrontal control over the limbic system, DMN and reward systems have strong implications for the use of mindfulness to treat addictions (Brewer, Elwafi, & Davis, 2013; Witkiewitz et al., 2014). However, as recently as 2009, conclusive data for mindfulness as a treatment for

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addiction was deemed “lacking” (Zgierska et al., 2009). A more recent meta-analysis of a handful of randomized controlled trials yielded slightly more positive results and suggested that MBIs that are specifically tailored for use in addictions are superior to nonspecific programs. For example, mindfulness-based relapse prevention (MBPRP) was found to perform as well or better than standard treatments or 12-step programs (Bowen et al., 2014), while MBSR can sometimes be equivalent to no treatment (Alterman, Koppenhaver, Mulholland, Ladden, & Baime, 2004) or “be slightly less efficacious in comparison with established treatments such as CBT” (Chiesa & Serretti, 2014, p. 506). Chiesa and Serretti (2014) also note that “it is unclear, however, to what extent these null findings are related to the ineffectiveness of the intervention for the condition under investigation, or simply to methodological shortcomings” (p. 506).

Making Your Own Evidence-Based Models

The hypo-frontality model and related exercises comprise just one example of many possible evidence-based models (Brown, Creswell, & Ryan, 2015; Holzel et al., 2011). MBI teachers can use the scientific research base in any number of ways that may serve as a foundation for both their didactic material specifically and their EBP more generally. However, the prospect of engaging with the science of meditation can be daunting. An endless procession of studies reports a dizzying array of findings and claims, some circulated and often exaggerated in the media and others overlooked but important. How can we possibly evaluate the validity of these claims? Where do we even start? The next section is aimed at developing skills for evaluating scientific research, so that all dimensions of practice are both informed and evidence based.

Reliable and unreliable sources of information. Not all sources of information are reliable. Popular press articles, magazines, newspapers, and webpages are not valid sources of information. Trade books or book chapters are not peer reviewed and are generally not considered empirical sources, unless they are aggregations of referenced, peer-reviewed journal articles. However, there are many scholarly books and handbooks that can be reliable sources of information. Look for edited volumes, especially by academic presses, or look in the Appendix for a list of recommendations. In general, valid claims are accompanied by a reference to the original peer-reviewed journal article, so readers (or participants) can always check for themselves.

Types of research studies. There are many different types of meditation studies, and different types of studies are associated with different levels of evidence. The following section describes each type of study and the corresponding level of evidence or types of claims that can be supported by each.

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Cross-sectional studies. When meditators are compared to non-meditators on a given outcome like attention or well-being, the study design is called "cross-sectional" or "case–control." The meditators already know how to meditate, so meditation training is not part of the study, nor can these studies be "blinded" in the traditional sense. Instead, this type of design assumes that whatever differences are found between the meditators and non-meditators are due to meditation. These types of studies are easy and less expensive to employ because they don't require multi-week classes or repeated measurements. While cross-sectional studies can often provide exciting initial hypotheses about potential effects of meditation, these studies are considered low in terms of evidence. It is impossible to know whether the differences between groups are really due to meditation, rather than some other associated factor that happens to be different between meditators and non-meditators. For example, if a study found that meditators were generally healthier than non-meditators, were less obese, and had lower blood pressure, it would be tempting to conclude that meditation makes people healthy. But it may also be what epidemiologists call the "healthy volunteer effect," that health-conscious people tend to eat more vegetables, exercise more, and better manage stress with meditation; therefore the effects are really due to a preexisting health conscientiousness rather than the meditation practice per se. Thus, when you see claims from a cross-sectional study, take them with several grains of salt.

A second issue with cross-sectional studies is that they often involve differences that may not generalize to the effects of MBIs. For example, many cross-sectional studies involve experienced meditators with more than 10 or 20 years of experience. Research suggests that the effects of meditation practice may differ dramatically depending on the stage and type of practice (Britton, Lindahl, Cahn, Davis, & Goldman, 2014), and caution should be exercised in implying that such effects are generally readily available to all MBI participants. For example, while studies of experienced meditators have found positive effects on experimentally induced pain intensity (Grant, 2014), MBIs have not been found to improve pain ratings (Chiesa & Serretti, 2011; Rajguru et al., 2014). Furthermore, expert practitioners in cross-sectional studies are often trained in contemplative systems that differ substantially from MBIs. In the past, it has been a common practice to draw from a wide range of available research on contemplative practices to promote the scientific credibility of MBIs. Citations often included interchangeable references to Hindu-based meditations like TM and the Relaxation Response, Zen, Vipassana, yoga, Qigong and Tai chi, mindfulness self-report scales, and the effects of a brief (20 minutes) mindfulness session. However, the research has progressed enough to begin to differentiate these different approaches, allowing us to be more precise and accurate in both our knowledge base and our pedagogy.

Mindfulness scales and correlation studies. Mindfulness self-report questionnaires are purported to reflect changes associated with formal meditation practices. However, one may find studies that claim "mindfulness is associated with …" greater well-being, brain changes, empathy, or any number of scientific findings. But if you look more closely at the method sections of such papers, you might dis-

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cover that the study did not actually investigate any type of meditation practice at all. Instead, a group of people, often college students, completed a paper and pencil scale and their score on that survey is called "mindfulness." While there are many different "mindfulness" scales, they are often measuring different constructs that are not correlated with each other or consistently correlated with meditation practice (Bergomi, Tschacher, & Kupper, 2013). Beware of making any statements about the effects of mindfulness meditation based on "mindfulness" studies that use mindfulness scales without any associated meditation practice.

Longitudinal studies. A better but more burdensome alternative is a longitudinal study, which takes measures both before and after a set of individuals learns to meditate. There are many different types of longitudinal studies, each with its own level of rigor or ability to provide evidence.

Pre-post designs. These studies assess the effects of a meditation course, like MBSR, by comparing the score a person has before they start meditating to the one they have at the end of the class. This approach seems like a straightforward way to assess the effect of meditation, but it isn't. Just deciding (intending) to do something, *anything*, about one's stress or anxiety can cause a person's score to change. Think back to the moment when you first signed up for your first mindfulness class or retreat. Just in that moment, without meditating, you may have felt a sense of hope and optimism, a brief break in what may have been a long stretch of depression, anxiety, or other distress. Even just filling out the questionnaires without doing anything else can cause a person's scores to change. Although it looks like meditation is having the effect, pre-post studies are not necessarily evidence of a specific effect of meditation.

Control groups. In order to control for a person's hopes, expectations, the effect of filling out questionnaires, or simply the passage of time, more rigorous studies use control groups, which can also vary in quality or "rigor."

Randomized controlled trials. While many types of studies may have control groups, it is important that they are "randomized controlled trials" (RCT), which means that neither the participants nor the researchers get to choose what treatment each participant received. Randomization helps ensure that the participants in the meditation group and control group are roughly equal, which helps protect against bias.

Waitlist controls. In a waitlist controlled study, half of the participants are randomized to a meditation class, and half are put on the waitlist. Both groups are measured at the beginning and at the end of the meditation class or waitlist period, in order to control for the effects of time and completing questionnaires. However, the waitlist group does not receive anything, so the effects of the treatment could be due to any number of factors that are part of the treatment but are not necessarily meditation. For example, individuals in the meditation group get to take a 3-hour break from their lives, work, and children once a week. They meet people who have similar symptoms of anxiety and depression and therefore feel less alone and deficient. They also meet an inspiring teacher that also once suffered from anxiety and depression but has learned techniques that have helped her.

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These factors inspire hope and decrease depression, but they are not meditation. Thus, while waitlist controls are better than no control group, they are easy to "beat," and they are essentially comparing the meditation group and all that it entails to doing nothing.

Active control groups. The only way to determine if the meditation practice itself is the active ingredient, above and beyond any hope or expectation or social support, is to control for all of those factors with an active control group. There are three general types of active controls: those designed to be more passive, like "health education"; well-established treatments, like pharmacotherapy or cognitive behavioral therapy (CBT); or controls tailor-made to match the intervention. To control for the effects of meditation, the tailor-made matched control condition should have all the same factors as the meditation group except the meditation. For example, the control group meets for 8 weeks, for 2.5 hour, and has daily homework, handouts, and an inspiring teacher who believes in her (non-meditation) treatment. In reality, very few active control studies go to these lengths, and the ones that have (MacCoon et al., 2012; Williams et al., 2014) tend to find little difference between groups. Similarly, meditation tends to be superior to most inert active controls and comparable to standard therapies like CBT or SSRIs (Goyal et al., 2014).

Meta-analyses. Meta-analyses compile the results of many research studies and evaluate the cumulative outcome across all studies. Meta-analyses review the quality of each study and take that into account when evaluating the evidence. Meta-analyses are the best available way to assess the strength of evidence as they should provide a systematic (unbiased) review of all studies, many of which are hard to find. Because the evidence base keeps changing, recent meta-analyses are preferable to older ones (Eberth & Sedlmeier, 2012; Fox et al., 2014; Goyal et al., 2014; Khoury et al., 2013; Sedlmeier et al., 2012).

Some Useful Tips for Evaluating Research

In addition to types of studies, there are other ways to evaluate the strength of the evidence.

Significance and effect size. There are two sets of numbers in the result section that deserve special attention, the p-value and the effect size. The *p*-value confers a "significant" positive finding if it is less than .05 (i.e., the chance of the positive finding happening by chance alone is 1 out of 20), but is considered "nonsignificant" or a non-finding if it is greater than .05. While *p*-value-based significance testing is a common practice, it is actually quite problematic and is being phased out in favor of other metrics (Cumming, 2014). A better estimate of whether meditation "works" is the effect size, which is often called "Cohen's d" (also "Hegde's g"). Effect sizes range from small to large, with corresponding values for small ($d=0.2$), medium ($d=0.5$),

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Table 5.1 Types of research studies and levels of evidence

Type of study	Description	Level of evidence
Meta-analyses	Analysis of many studies together	Very high
RCT active control	MBI vs. CBT or health education	High
RCT waitlist	MBI compared to waitlist	Medium
Controlled study	Has control group but not randomized	Low
Pre-post	Measuring outcome before and after an MBI; no control group	Low
Cross-sectional/case–control	Experienced meditators vs non-meditators at a single time point	Low
Mindfulness scale correlational studies	Score on "mindfulness" self-report scale correlated with another outcome	Very low

and large (d=0.7). Meditation tends to have a medium effect size for anxiety and depression symptoms, which is similar to most other treatments (Goyal et al., 2014).

Post hoc or subgroup analysis. Sometimes, when researchers find no difference between the meditation and control group, instead of just concluding that, they do more analyses until they find an effect. For example, they may divide the sample into "subgroups" such as males and females, or people who attended a certain number of meditation classes, or have a certain baseline score. According to the Consolidated Standards of Reporting Trials (CONSORT) guidelines, these types of "post hoc" or after-the-fact subset analyses lack credibility (Moher et al., 2010), so beware of conclusions that are based on subgroup analyses.

Study limitation section. Most research papers include a section at the end about the limitations of the study, which can help you determine the rigor of the study and how much weight to put into the findings. All studies have flaws and limitations, so a good metric of honest and thorough disclosure is the presence and extent of the section on study limitations.

Methodological quality. The most common criticism of meditation research is poor "methodological quality," but what does that mean exactly? The CONSORT guidelines describe the expected standards of clinical trials (Moher et al., 2010) and the Jadad score is a numerical metric of study quality (Jadad et al., 1996).

Evidence-Based Practice Beyond the Classroom

Understanding the different types of research and corresponding levels of evidence empowers MBI teachers to create their own evidence-based models for use in class. But the application of the scientific research base in MBIs extends well beyond the

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in-class didactic material into all aspects of EBP, informing ethical and clinical decision-making that maximizes benefits and minimizes harm (McCown, 2013; Nutely, Walters, & Davies, 2007). The process of informed consent, decisions about inclusion and exclusion criteria, suitability, and risk all depend on an MBI teacher's scientific literacy.

Informed Consent

Scientific literacy is the foundation of an ethical dimension of the teacher–participant relationship known as "informed consent." Informed consent extends beyond the legal right of the patient to be provided with sufficient information to make informed decisions about engaging in an MBI. The process of informed consent is an embodiment of friendship, which includes a respect for a participant's autonomy and right to self-determination, as well as the highest wishes for their well-being. In order to honor this friendship, the MBI teacher provides honest and thorough information about the potential benefits and potential harms of the MBI they are offering and any alternative treatments that might be more suitable (Berg, Appelbaum, Lidz, & Parker, 2001). The elements of informed consent are listed on a legal document called a consent form, which the participant reads and signs before treatment. The informed consent process is also ongoing, beginning with the initial MBI advertisements on websites or brochures and continuing throughout the treatment.

Thorough and honest disclosure. Thorough and honest disclosure includes descriptions of the nature, probability, and magnitude of both benefits and harms. Because these potentials differ among different participants with different conditions, thorough disclosure often requires a face-to-face consultation tailored to each participant. For any given ailment, the available evidence base varies, so providing accurate information about the nature, likelihood, and magnitude of benefit for a specific ailment can be challenging. In terms of harm prevention, the disclosure of potential harms or lack of benefits is more important than benefits. This may simply involve being forthright about the early and mixed nature of the scientific evidence base, the possibility of a "less-than-complete cure," and the simple fact that MBIs may not benefit everyone or may even be contraindicated (Dobkin, Irving, & Amar, 2012).

Avoiding harm. Keeping abreast of the scientific literature is a Herculean task that can only be aspirational and a lifelong learning goal. Rather than focusing on a wide breadth of knowledge, it is more important to focus efforts on not causing harm (Kabat-Zinn, 2011a, 2011b). According to directors of the National Center for Complementary and Alternative Medicine (NCCAM) at the National Institutes of Health (NIH), the biggest potentials for harm are "unjustified claims of benefit, possible adverse effects,… and the possibility that vulnerable patients with serious diseases may be misled" (Briggs & Killen, 2013). For example, a patient may fail to receive appropriate treatment because of the belief that mindfulness is a viable alternative to standard medical or psychological treatment. Being forthright about

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the uses and limits of MBIs can protect against potential harm. For example, The Center for Mindfulness clearly states in their advertising brochures that MBSR is not a replacement for standard treatments, “MBSR is not offered as an alternative to traditional medical and psychological treatments, but as a complement to these treatments” (Santorelli & Kabat-Zinn, 2014).

Languaging. The way that scientific research is “languaged” is also a dimension of ethical responsibility and integrity. Small changes in our choice of words can make the difference between “unjustified claims” that are “misleading” and fulfillment of honest and thorough disclosure. The scientific evidence for the effects of meditation is far from established, “confirmed,” or “proven.” Instead, the state of the research may best be described as “promising but inconclusive, tentative, or suggestive” at this stage. In addition to issues of honesty and accuracy, certain word choices are likely to evoke resistance, especially from skeptics who are wary of exaggerated claims. For example, words like “proof” or “proven” can feel more like an attempt to persuade than to inform and will likely have the effects of inflating rather than deflating skepticism. Skeptics can actually be our greatest allies in this respect, as they keep us mindful of unconscious agendas that may manifest in our speech. Table 5.2 lists some examples of more reified vs. flexible language choices.

Resources for assessing potential benefits and harms. Scientific literacy informs decisions about the potential benefits and harms of MBIs, including what type of person is most or least suitable for an MBI. In addition to ongoing research, the assessment of suitability and risk can also be informed by the existing evidence-based guidelines for MBI inclusion and exclusion. For example, current exclusion criteria for both MBSR and MBCT include most psychiatric diagnoses, including acute depression, substance abuse, suicidality, PTSD, psychosis, and some forms of anxiety (Kuyken, Crane, & Williams, 2012; Santorelli, 2014). Of course, as the evidence base changes, these guidelines also change, both becoming more and less inclusive. For example, MBCT is currently only approved for individuals who have had three or more prior episodes of depression but are currently in remission (NICE, 2009). However, new evidence suggests that MBCT may be helpful for individuals with residual depression symptoms (Geschwind, Peeters, Huibers, van Os, & Wichers, 2012; van Aalderen et al., 2012). Alternatively, recent meta-analyses have

Table 5.2 Reifying vs. flexible language

Over-general, reifying language	Open-ended, flexible, and specific language
Proof, proven, proves	Suggests
Heals, cures, fixes, gets rid of, works	May help; may decrease
Demonstrates, shows, confirms	May indicate; is associated with
Example: *Science has proven that meditation works*	*Scientific studies suggest that some kinds of meditation may be helpful for anxiety and depression*
We know from science that…	*Scientific studies suggest that…*

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reported that MBIs have not been found to be helpful for relieving the primary diagnosis of anxiety disorders (Strauss et al., 2014), or chronic pain (Chiesa & Serretti, 2011; Rajguru et al., 2014), so being informed about these potential limitations helps participants and their healthcare providers make informed decisions about their care. Integrity around the possible limitations of MBIs may also mean respecting a participant's autonomy in decision-making and honoring their doubt as a manifestation of their own wisdom instead of "doubting the doubt" (Sears et al., 2011).

Adverse effects. The concern that meditation may be contraindicated under certain conditions has been raised repeatedly by the American Psychiatric Association (Shapiro, 1982), the NIH (NCCAM/NIH, 2014), and leading researchers in the field (Dobkin et al., 2012; Greenberg & Harris, 2012; Lustyk, Chawla, Nolan, & Marlatt, 2009). Indeed there have been more than a dozen articles reporting serious adverse effects of meditation including psychosis, depersonalization, mania, and other forms of psychological deterioration (see Lustyk et al., 2009 for a review). Participant risks such as increased depression, suicidality, and meditation-induced flashbacks are listed in MBCT teacher resources (Kuyken et al., 2012). Potential adverse effects are typically conveyed to participants in more general terms such as "you might find that taking the course is challenging for a number of different reasons" (Segal, Williams, & Teasdale, 2011). The degree of disclosure that constitutes adequate informed consent is still a matter of debate, especially since there is a lack of research about the nature, likelihood, and magnitude of MBI-related adverse effects. At the very least, inaccurate, misleading statements that meditation "is 100 % safe" or "has no side effects" should be avoided.

Conclusion and Further Resources

Scientific literacy is a basic MBI teacher competency and is the foundation of all aspects of EBP and pedagogy. Scientific literacy informs our ethical and clinical decision-making, extending to inclusion and exclusion criteria, assessment of risk, and the ongoing process of informed consent, in order to maximize benefits and minimize harm. This chapter has provided some basic foundations of scientific literacy, including the evidence base for some neurobiological models of meditation, as well as skills for evaluating scientific research. This chapter only provides an early step in a much larger commitment to lifelong learning. A number of resources are provided for further self-development, including a resource page of books, articles, and websites for further reading (see section below). A self-inquiry practice provides an experiential aspect of scientific literacy. Similar to the "investigation of cognitive biases in attention and memory" exercises that are provided to participants, the self-inquiry investigates a specific type of bias that impairs EBP called "confirmation bias" (Lilienfeld, Ritschel, Lynn, Cautin, & Latzman, 2013). (see Part IV Chapter 24A).

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Resources and Further Reading

Scientific Models of Mindfulness

Holzel, B. K., et al. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science, 8*(6), 537–559.
Note: Models include effects on attention and emotion regulation, body awareness, and change in perspective on the self, and is recommended for further inquiry or a reference for participants.

Brown, K. W., Creswell, J. D., & Ryan, R. M. (Eds.). (2015). *Handbook of mindfulness: Theory, research, and practice*. New York, NY: Guilford.
Note: A survey of basic research from neurobiological, cognitive, emotion/affective, and interpersonal perspectives of MBIs for behavioral and emotion dysregulation disorders, depression, anxiety, addictions, and physical health conditions.

Shapiro, S. L., & Carlson, L. E. (2009). *The art and science of mindfulness: Integrating mindfulness in psychology and the helping professions*. Washington, DC: American Psychological Association.
Note: Contains reviews of MBI research for physical and mental conditions, possible mechanisms of action. Includes a section on clinician self-care.

Willoughby Britton TEDTALK. http://www.ted.com/tedx/events/2672 (video)
Note: 15 minute overview of neuroplasticity, hypofrontality and the effects of meditation.

Evidenced-Based MBI Resources (online)

Mindful experience.org
Note: Provides reviews and meta-analyses of MBI evidence base, a list of MBI research centers and providers, and a monthly newsletter about new MBI articles and trials.

http://mbct.co.uk/about-mbct/
http://www.bangor.ac.uk/mindfulness/

Skills to Evaluate Scientific Evidence for Treatment Effects

Lilienfeld, S., Ruscio, J., & Lynn, S. J. (Eds.). (2008). *Navigating the mindfield: A guide to separating science from pseudoscience in mental health*. New York, NY: Prometheus.
Note: A practical guide for evaluating mental health treatments. Exposes common misconceptions.

Sears, S. R., Kraus, S., Carlough, K., & Treat, E. (2011). Perceived Benefits and Doubts of Participants in a Weekly Meditation Study. *Mindfulness, 2*, 167–174.

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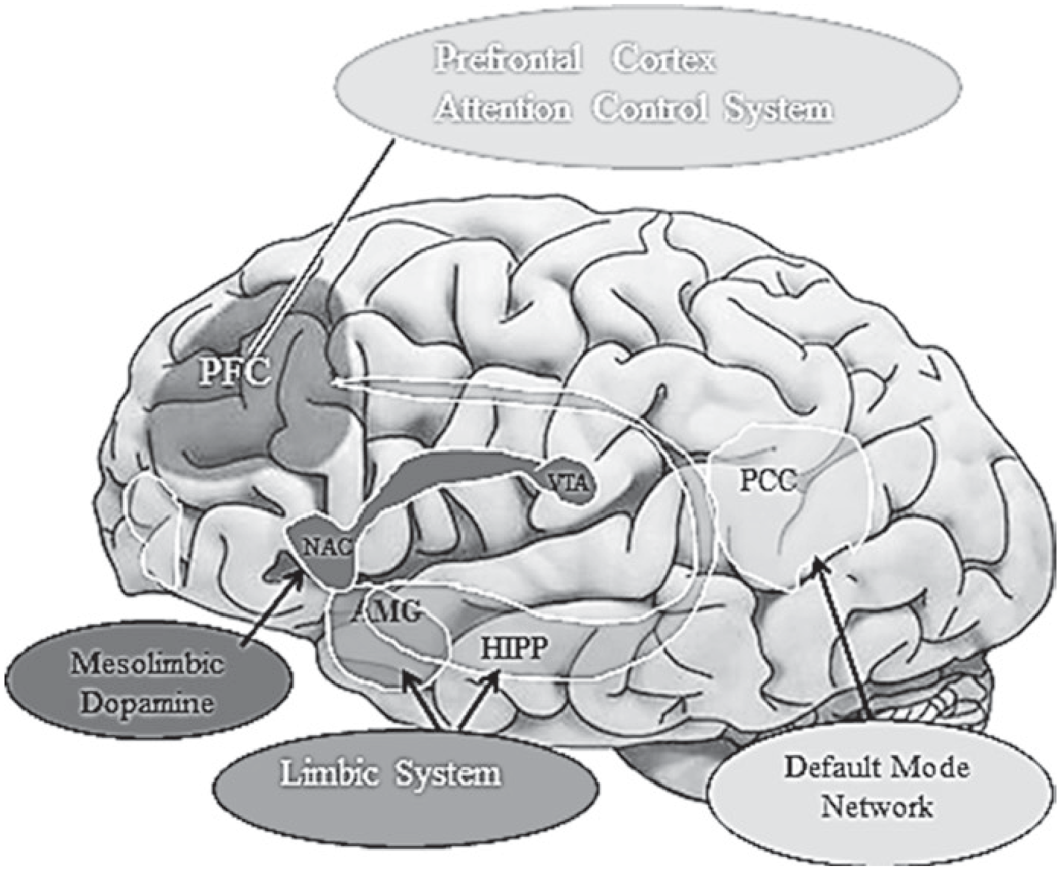
Handouts

HANDOUT: Key Brain Areas in the Hypofrontality Model



	Affective	Cognitive	Conative
Domain	Body + emotions	Thinking	Reward/motivation/action
Brain areas	Limbic system	Default mode network	Brain reward system
	Amygdala (AMG)	Cortical midline structures	Mesolimbic dopamine
	Hippocampus	Medial PFC	Ventral tegmental area (VTA)
	Sympathetic nervous system	Posterior cingulate (PCC)	Nucleus accumbens (NAC)
			Striatum
			DMN, limbic system
Experience when overactive or poorly regulated	High negative affect	Self-referential processing	Craving
	Emotional reactivity	Mind wandering	Rumination
	Stress sensitivity	Craving	Self-thought-affect fusion
		Rumination	Impulsivity
		Social cognition	Poor self-regulation
Disorders	PTSD	Schizophrenia, OCD	All addictions, ADHD
	Anxiety, panic	Social anxiety	Bipolar disorder
	Depression	Depression	Borderline PD

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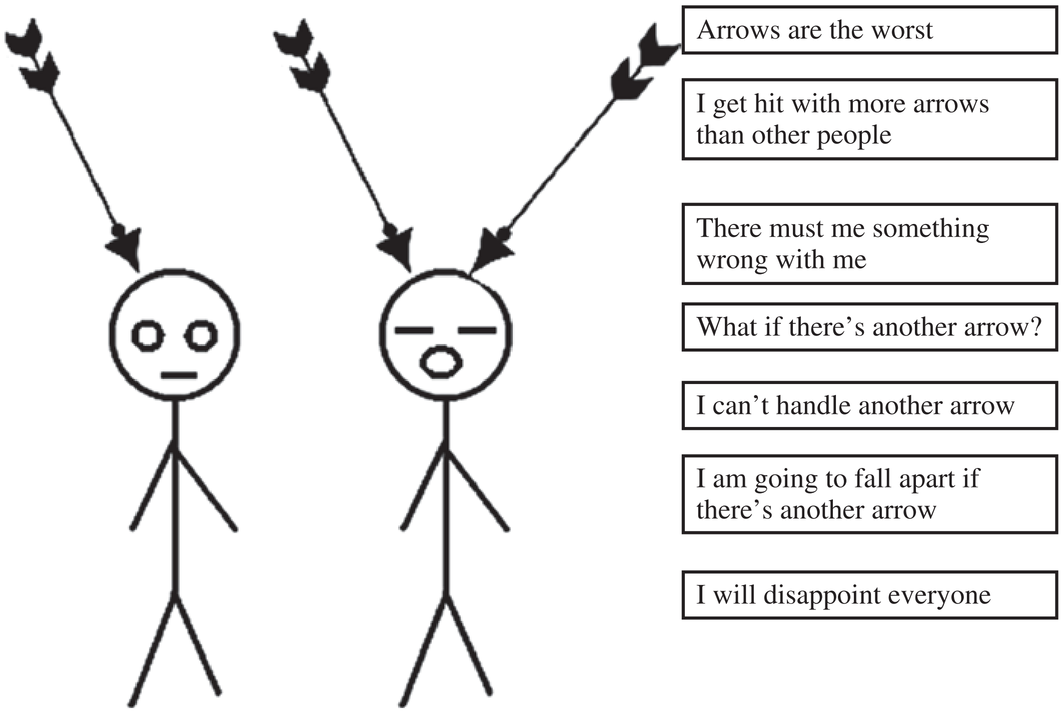
HANDOUT: Two Arrows



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