Published in final edited form as:
Mindfulness (N Y). 2013 March 1; 4(1): . doi:10.1007/s12671-012-0164-8.

Why is it so hard to pay attention, or is it? Mindfulness, the factors of awakening and reward-based learning

Judson A. Brewer,
Department of Psychiatry, Yale University School of Medicine, 300 George St. Suite 901, New Haven, CT, 06511

Jake H. Davis, and
Department of Philosophy, City University of New York, Graduate Center, New York, NY, USA

Joseph Goldstein
The Insight Meditation Society, 1234 Pleasant St., Barre, MA, 01005

Judson A. Brewer: judson.brewer@yale.edu

Abstract

Though relatively new to Western psychological and spiritual cultures, mindfulness training is becoming more widespread in the general public and is beginning to show promise therapeutically for maladies ranging from generalized stress to specific addictions. However, difficulties remain both with individuals being able to learn core concepts and techniques, such as concentration meditation, and more broadly, with treatment interventions not being optimized to helping individuals learn these. In this manuscript, we examine possible contributing factors to these difficulties. We bring together what is known scientifically about basic learning processes such as operant conditioning with some inspirational suggestions drawn from the early Buddhist dialogues collected in the Theravada Buddhist cannon, in particular the description of seven psychological factors known as “the factors of awakening”. Bringing together scientific and textual suggestions, we give an overview of how primary operant conditioning processes lead to stress, and importantly, how a minor shift in emphasis in providing mindfulness training may indeed co-opt these very processes for the reduction and cessation of stress and suffering. Finally, we provide suggestions as to how these can be tracked individually and clinically over time.

Keywords

Mindfulness; Pali Canon; associative learning; operant conditioning; meditation; neurofeedback; fMRI

Introduction

Core to many clinical and spiritual practices ranging from stress reduction to self-actualization to self-transcendence is the ability to pay attention in a non-distracted manner. Yet, many, perhaps even a preponderance of people who wade into these waters quickly return to shore as soon as they become even a little muddied, saying to themselves and others, “this is too hard,” or “I can’t concentrate,” or “how can this possibly lead to happiness, it feels quite the opposite.” On my (JAB) first weeklong meditation retreat, two to three days in, I found myself literally crying on the shoulder of the retreat manager, choking out these exacts words between sobs. The teacher, Bhante Gunaratana, well-

Correspondence to: Judson A. Brewer, judson.brewer@yale.edu.

respected and seasoned in such matters, had even met individually with me and given suggestions such as “start with counting the breaths up to seven” when I couldn’t keep my mind still. The problem was that my mind would have none of it. No matter how much I tried, my mind could not be convinced that paying attention to my breath, of all things, was worth its time. And in retrospect, I can’t blame it. Who wants to pay attention to a seemingly uninteresting and certainly not exciting object such as the breath, when happiness is just a few moments away – pleasant memories, fantasies about what I was going to do as soon as I left retreat etc. It was a no-brainer.

The problem with forcing concentration: it isn’t naturally rewarding

In Western mindfulness teaching, the emphasis has been on paying attention to the breath, and returning one’s attention to the breath when the mind has wandered. This is straightforward enough, but runs counter to our natural reward-based mechanisms of learning. Human beings learn best through operant conditioning, pairing action with outcome. We suggest one traditional Buddhist theoretical framework that might be used to inspire and guide practice in ways more directly in line with current scientific understanding of reward-based learning. Indeed, this framework is in some cases already being incorporated into mindfulness training in modern clinical contexts. We draw here in particular from the early Buddhist dialogues that are collected in the Theravada tradition in a set of texts known as the Pali Nikayas (see e.g. Gethin 1992). These dialogues portray the Buddha as over and over admonishing us to notice cause and effect, to see clearly what we are actually getting from our actions. What types of behaviors are we reinforcing?

One central suggestion of the texts seems to be that mostly we are reinforcing habits that perpetuate rather than lead away from stress – we are looking for happiness in all the wrong places. Perhaps this is the basis for the radical statement, “What others call happiness, that the Noble Ones declare to be suffering. What others call suffering, that the Noble Ones have found to be happiness” (Sn.3.12 in Ireland 2010). How did the Buddha know the difference between authentic happiness and suffering? The texts suggest that he began from a close and sobering observation of basic reinforcement learning processes at work: “The more [people] indulge in sensual pleasures, the more their craving for sensual pleasures increases and the more they are burned by their fever for sensual pleasures, yet they find a certain measure of satisfaction and enjoyment in dependence on … sensual pleasure” (MN.75 in Ñanamoli and Bodhi 1995). Action (indulgence in sensual pleasures) leads to outcome (enjoyment), which sets up the desire to repeat the experience (craving). Because the cycle of wanting and getting only reinforces the habit of wanting more, it does not bring lasting happiness.

What can be inspirational about the Buddhist teachings is the suggestion that we don’t have to stop there. we don’t have to stop with the craving cycle. In textual accounts of the Buddha’s own spiritual journey, he follows gratification to its end: “I set out seeking the gratification in the world. Whatever gratification there is in the world, that I have found. I have clearly seen with wisdom just how far the gratification in the world extends” (AN.III. 101 in Bodhi 2005). It wasn’t until he had explored gratification to its end that he realized how to step out of this process: “So long, monks, as I did not directly know, as they really are, the gratification in the world as gratification…I did not claim to have awakened to the unsurpassed perfect enlightenment in this world…But when I directly knew all this, then I claimed to have awakened. The knowledge and vision arose in me: ‘Unshakeable is the liberation of my mind…’” (AN.III.101 in Bodhi 2005). According to this account, it wasn’t until the Buddha had clearly seen what he was actually getting from gratifying his wants — seeing which actions led to happiness and which perpetuated stress and suffering—that he could see how to change them. Once one experiences for oneself which actions lead to happiness and which perpetuate suffering, the method of change can be remarkably simple,

following the basic principles of habit formation through operant conditioning that have now been known in Western scientific circles for over a century: drop the action that is causing stress and you feel better immediately; in other words, pair action with outcome, cause with effect (Thorndike 1898; Skinner 1938).

Hot coal or happiness?

From a personal and clinical standpoint, mindfulness instructors may be able to emphasize that perhaps many of us, too, have been mistaking stress and suffering for happiness, perpetuating cycles of wanting and getting, and getting and wanting. How could we know? One way would be simply to notice the number of times a day that we find ourselves lashing out at other people, mindlessly consuming our favorite comfort food, or compulsively buying something when stressed. Advertisements all around us promote happiness through consumerism, feeding the concept that if only we do X, then we will be happy. These work so well because they take advantage of reward-based learning: action leads to outcome, which shapes and reinforces behavior. We have conditioned ourselves to deal with stress in ways that ultimately perpetuate stress rather than release us from it.

This predicament, of seeking happiness in ways that lead towards suffering, can be likened to holding on to a hot coal. It is as if we are standing outside in sub-zero temperature without a coat, and someone throws us a burning ember, saying, “This will warm you up!” We catch it and hold onto it without carefully looking to see how good of a job it does to warm us, and if it has unintended consequences as well. Similar to smoking a cigarette or eating chocolate when stressed out, at first it seems like a relief from the cold – such warmth compared to the icy wind. A short while later, we might smell burning flesh, but do not feel the pain of holding on. Someone might even come by and say, “Hey, your hand is burning,” or “Why don’t you put on a coat instead, or step inside,” but we do not listen. Rather, we trust the advice that holding this hot coal is a good way to get warm – after all, it seems to be working, doesn’t it?

We can only be motivated to continue this ineffective strategy to escape suffering, however, when we don’t see clearly what we are actually getting from our actions. It is as if we have thick callouses that prevent us from being sensitive enough to feel the pain of holding on to the coal. Similarly, lack of awareness and emotional distortions of attention and memory may prevent us from being aware of the pain from habits that actually cause suffering for us. The textual account of the Buddha’s spiritual journey highlights this type of cognitive distortion in comparing his pre-awakening times of mistaking stress for happiness: “In the past sensual pleasures were painful to touch, hot, and scorching; in the future sensual pleasures will be painful to touch, hot, and scorching; and now at present sensual pleasures are painful to the touch, hot, and scorching. But these beings who are not free from lust for sensual pleasures, who are devoured by craving for sensual pleasures, who burn with fever for sensual pleasures, have faculties that are impaired; thus, though sensual pleasures are actually painful to touch, they acquire a mistaken perception of them as pleasant” namoli and Bodhi 1995).

If the states of desire that perpetuate the search for gratification are this painful, how could we possibly hold on to them or even pick them up in the first place? And how could present-centered attention help us to let go? Mindfulness practice helps us to see more clearly how hot the coal is. Cultivating attention to present experience may function to counter the lack of awareness and emotional distortions of attention and memory that prevent us from seeing clearly the pain of habits that actually cause suffering for us (Davis and Thompson 2012; Brewer et al. 2012).

This is important, since the dialogues in the Nikayas are explicitly aimed at describing the ways in which we cause ourselves suffering, for the purpose of providing a comprehensive therapeutic intervention. The approach outlined in these dialogues targets craving in particular. It is through the "relinquishment, release, and letting go" of craving that we can cure the psychological habits that cause us suffering (SN.56.11 in B. Thanissaro, trans. 2010). From this perspective, to the degree craving is the motivation behind a certain action, including undertaking meditation, the cycles of suffering caused by craving will continue to perpetuate themselves. One who meditates with the aim of becoming more successful, attractive, or wealthy, for example, will still experience the effects of cultivating habits of craving. The same is true of craving to be rid something, which is the state of aversion. Some have noted that one could cultivate the alert attentiveness to external stimuli that is one aspect of mindfulness (Pali: *sati*) in the service of being a better sniper (Dunne 2007; Wallace 2008). From the perspective of the Nikayas, to the degree one does cultivate specific psychological skills motivated by hatred or aversion, this too will give rise to suffering, for oneself as well as others.

It is important in this regard that mindfulness meditation as prescribed by "The Discourse on Establishing Mindfulness" (MN.10) involves not only the factor of mindfulness, but also the removal of desire and discontent (Analayo 2003, 31ff). On this account, then, it seems that mindfulness meditation involves removing the craving and aversion that would motivate training in meditation for the purposes of obtaining sensual pleasures or killing more effectively. Increasing awareness of internal as well as external stimuli may help us to see clearly the suffering we cause ourselves by perpetuating states of craving and aversion. In this way, the establishing of mindfulness may, through reward-based learning, itself serve to purify the motivation with which we meditate. While it may be useful to have a theoretical understanding of which sorts of habits create suffering, the basic motivation away from suffering does not depend on theoretical understanding. When we are fully and accurately aware of the pain involved in the search for gratification, we do not have to think about what is the right thing to do. We do not have to positively reappraise the situation, or suppress our feelings or do anything cognitive, besides knowing for ourselves what is painful and what is not. We feel that our hand is burning, and we instantly drop the coal. We just have to pay attention.

Reward-based learning and the seven factors of awakening

The critical components for habit formation are threefold: 1) trigger; 2) behavior; and 3) clearly defined "reward" that reinforces the behavior. These three components shape behavior in the animal kingdom, spanning from the most primitive nervous systems in the sea slug, Aplysia (which has just a few thousand neurons) to human beings suffering from addictions (whether crack cocaine or Facebook), to even societal movements (Duhigg 2012; Hawkins et al. 1983). As first hypothesized by Thorndike and refined later by Skinner and others, operant conditioning is a form of associative learning in which an organism's behavior is modified by the results of its behavior (Skinner 1938; Thorndike 1898; Skinner 1953). According to Skinner, "Events which are found to be reinforcing are of two sorts. Some reinforcements consist of presenting stimuli, of adding something — for example, food, water, or sexual contact—to the situation. These we call positive reinforcers. Others consist of removing something — for example, a loud noise, a very bright light, extreme cold or heat, or electric shock—from the situation. These we call negative reinforcers. In both cases the effect of reinforcement is the same—the probability of response is increased" (Skinner 1953, 73). Simply put, organisms learn to engage more in activities that result in positive outcomes, and less in those that result in negative outcomes. Perhaps not surprisingly, these reinforcement models were observed as far back as the early Buddhist dialogues. These teachings describe a learning process remarkably similar to operating

conditioning, called “dependent co-arising” (Brewer et al. 2012). While the way “dependent co-arising” plays out in Buddhist theory is complex, a number of dialogues in the Nikayas suggest that the principle can be realized “simply by witnessing the operation of conditionality in the present moment, within one’s own subjective experience” (Analayo 2003, 109–110). These dialogues employ the causal theory of “dependent co-arising” in order to suggest methods for removing the psychological conditions that give rise to suffering. In particular, they suggest ways in which we can transform the basic habit of pursuing pleasure and avoiding pain. If this is our natural tendency, why not co-opt it to learn how to move from temporary “happiness” to states of joy and contentment as the reinforcers that result from being mindful?

The list of seven factors of awakening found the dialogues of the Nikayas seems to provide an intuitive guide to this very process, employing our natural reward seeking in ways that lead away from suffering rather than perpetuating it. Mindfulness (*sati*) comes first on this list, followed by interest and investigation (*dhamma-vicaya*), energy (*vīriya*), joy and rapture (*pīti*), relaxation and tranquility (*passaddhi*), unification and concentration of mind (*samadhi*), and equanimity and equipoise (*upekkha*) (e.g. MN.118). These seven factors of awakening serve as an important theoretical framework for meditative development in the dialogues of the Nikayas (Gethin 1992). This framework may also fruitfully inform how mindfulness is taught in modern secular contexts.

With regard to operant conditioning, perhaps as important as the list itself is the order of the seven factors. A number of texts describe how each of these factors creates the conditions for the next, in a virtuous cycle of increasing mindfulness, investigation, energy, joy, tranquility, concentration, and equipoise (Gethin 1992, 163). If the processes of reward-based learning mediates this particular developmental order, then teaching and applying these psychological factors in the order suggested should prove more effective than teaching and applying them randomly. Moreover, we hypothesize that to the degree an individual is able to establish the initial factor of mindfulness through a comprehensive attentiveness to internal as well as external stimuli, the subsequent factors will arise without further intervention. Returning to action/outcome, cause/effect models, the seven factors of awakening framework suggests that when we become mindful of present-moment experience, interest in seeing cause and effect naturally arises. Since as human beings we share the basic motivation away from suffering, we need merely direct attention to our experience, and the interest in seeing whether we are perpetuating or decreasing stress in that moment naturally arises. We do not have to do anything else but look.

Some crucial aspects of this progression through the factors of awakening can be illustrated with the everyday example of reading a good book. As we start to “get into” the book, energy naturally arises. When the book gets really good, we become enraptured, even finding ourselves reading until 3 AM. Once enraptured, we can sit and read for hours, as tranquility naturally arises. So too with mindfulness practice. When we pay attention to how often we are holding on to the hot coal, see how painful it actually is, and feel the reward of letting go, we become more interested in investigating this process, paying more careful attention and investigating more and more precisely what conditions the cycles of suffering and what conditions the cycles of release. And at this stage, with the previous factors in place, concentration naturally arises. This is a critical point, because concentration is often the emphasis of meditation instruction in Western training. Pay attention, and when the mind wanders, bring it back. Repeat. The factors of awakening, in contrast, seem to emphasize the use of cause and effect. Create the conditions for X and X will naturally arise. Bring mindfulness to the fore, become interested, and *five steps later* concentration will naturally arise. As with the personal example at the beginning of this paper, anyone who has tried to force themselves to concentrate on something they are not interested in knows how difficult

it is, whether studying for a test, listening to a lecture or reading an academic paper. They also know all too well how hard it is to concentrate when they are restless and distracted (i.e. not tranquil). Once concentration arises, this creates the proper conditions for the final factor of awakening, equanimity, to arise. Reading a good book on the subway is not a problem – no matter what the commotion around, one is unflappable.

So it seems that bringing mindfulness to the fore is the spark that ignites the rest of the factors of awakening. How does this line up with current scientific definitions of mindfulness? Quite well, in fact. Paying attention, and bringing a non-judgmental *interest and curiosity* to the present moment line up with the first two factors of awakening (Bishop et al. 2004). The factors of awakening model has the added virtue of clearly demarcating the originating factor of mindfulness (*sati*) from interest and curiosity. Nonetheless, in both models attention can build on itself, being both a crucial factor for the momentum of practice to get going, and also one of the most rewarding outcomes of the practice. At times when concentration is not yet strong, we can incline the mind towards a curious interest in whatever is happening, thereby creating the conditions that allow joy, relaxation and then concentration to arise. Concentration in turn functions to protect the mind from emotional reactivity, allowing equanimity to arise.

When mindfulness and the subsequent factors of awakening become strong, the practice rolls on with its own momentum. As the Burmese teacher U Pandita explains, “mindfulness becomes extremely agile, picking up objects quickly before the mind can be perturbed by pleasantness or unpleasantness” (Pandita 1995, 272). Even for advanced practitioners, unpleasant feelings can arise. Yet one can be present for reactions to these feeling tones themselves without fueling them. Dipa Ma, a highly respected teacher and exceptionally advanced practitioner described how emotions manifested in her experience: “A lot of incidents happen in daily life which are undesirable… Sometimes I experience some irritation, but my mind remains cool. Irritation comes and passes. My mind isn’t disturbed by this. Anger is a fire. But I don’t feel any heat. It comes and it dies right out” (Dipa Ma, quoted in Schmidt 2005, 133).

So how do we make this our habit? How do we clearly point out the reward, such that all we need to do is see if we are holding the hot coal to ignite the habit of interest/curiosity, which naturally stokes the fire for the arising of the remaining factors? Perhaps we start by simply noticing what it feels like when we are fascinated with something, and point that out to ourselves. There is an inherent open, energized, joyful quality. This clearly defines the reward that is intrinsic in bringing the first two factors together. To see this more distinctly, we can contrast it to moments when we have been stressed or are judging ourselves, others or a situation. Seeing the contrast between these situations is relatively easy to do. Which of these feels more open, energized and joyful? We can even contrast a moment of joyous fascination to moments when we have experienced some type of momentary “happiness” based on getting something that we want, though seeing the subtle contrast between these two may be a bit more difficult because excitement is often confused with or taken as happiness. The critical difference between these types of rewards is that getting what we want is often not within our control. In contrast, simply being attentive and fascinated can be done in any moment. It requires only mindfulness, which gives rise to the subsequent factors of awakening. To learn this process, we can notice triggers (stress), perform a behavior (become mindful and interested/fascinated with what is causing the stress) and reward ourselves (notice the joy, peace, equanimity, etc.) every moment. And the more we do this, the more we set up a habit pattern to transform the psychological roots of suffering, using our own reward-based learning processes.

For our benefit, and the benefit of others?

To novice meditators, it may seem counter-intuitive or even paradoxical to think that we can use our own reward-based habit learning systems to move beyond reward-based happiness. We have to use what we know in the project of transforming the mind (B. Thanissaro 2008). Still, if the suggestion of the factors of awakening model is to become interested to the point of fascination and becoming enraptured, students may legitimately wonder how one can differentiate skillful practice that is joyful from being excited in a selfish manner. In other words, how can we tell if we are on the right track when practicing? The short answer here is that it can be tricky to differentiate these, especially early in mindfulness training when we may not have had experience with non-reactive modes of being. But we can follow the Buddha's advice to his son Rahula and reflect on our actions (both with formal meditation, and during daily life) to see if they are leading toward or away from our own stress/suffering and that of others (MN.61). Moreover, the more we are attentive to our own habits, the more clearly we can see/recognize which motivations cause us suffering, and which do not. For example, does it feel good (i.e. is it rewarding) when we are selflessly generous?

Perhaps we can even peek into our minds, integrating first-person reports with brain imaging to see, when we are becoming interested in an object, which neural networks become relatively more active or quiet down. For instance, what do regions of the brain implicated in self-referential processing (the 'me' centers) do when we pay attention to our breath (Brewer et al. 2011)? For example, figure 1a shows brain activity monitored by realtime functional magnetic resonance imaging (fMRI) in a novice meditator who was given the instruction to: "Pay attention to the physical sensation of the breath wherever you feel it most strongly in the body, and follow the natural and spontaneous movement of the breath, not trying to change it in any way." Subsequently, this novice reported relative difficulty in concentrating, showing consistently increased activity in the posterior cingulate cortex, an area linked to networks implicated in self-referential processing and mind-wandering (Whitfield-Gabrieli et al. 2011). She also reported a strong correlation between her subjective experience and a graph of this brain activation pattern viewed immediately after meditating (Scheinost et al. 2012). Using the same instructions, an experienced meditator showed a more stable pattern of deactivation in this brain region, which is consistent with prior studies of experienced meditators (fig. 1b) (Brewer et al. 2011). To provide a proof-of-concept test of the hypothesis that focusing on the first several factors of awakening, mindfulness, interest and joy instead of concentrating on the breath would also decrease activity in self-referential regions of the brain, we instructed another experienced meditator to aim for "focusing on the breath and *in particular the feeling of interest, wonder, and joy* that arises in conjunction with subtle, mindful breathing." Interestingly, he showed a large drop in the relative activation of this brain region that correlated with his experience of "feeling interested and joy" even when "being curious about the draft on [his] hands and feet" (fig. 1c). Though these are just examples of a single brain region that is likely part of a larger network constituting these experiences (Andrews-Hanna et al. 2010), they suggest that fostering the factors of awakening may at least be helpful in "not feeding" or adding fuel to the fire of self-referential processes (Brewer et al. 2012). Of course, it will be critical to follow individuals who emphasize these factors of awakening over time to see if they change with regard to self-reported and behavioral measures of stress/suffering. It may also be fruitful for researchers to work to more clearly operationalize these factors such that they can be studied as predictors of treatment response (e.g. individuals who are high in "trait curiosity" may be better at changing habits), and followed over time with treatment (e.g. does "trait curiosity" increase after mindfulness training and does this increase mediate treatment outcomes?). From a personal and clinical standpoint, instructors may be able to emphasize the early factors of awakening such as curiosity as conditions that can naturally lead to concentration, rather than overly relying on instructions that may not be as clearly

linked to our natural reward-based learning processes: notice the trigger (stress), perform the behavior (become interested and curious), reward yourself (notice joy, tranquility, concentration and equanimity). Repeat.

Acknowledgments

We would like to thank Leigh Brasington, Alice Brewer, Nikolai Haylay, Bill Hale, Stephanie Hertz, and Mahri Leonard-Fleckman for feedback on the manuscript. This work was funded by the following grants: NIDA K12-DA00167, 1R03DA029163-01A1, and the U.S. Veterans Affairs New England Mental Illness Research, Education, and Clinical Center (MIRECC).

References

Anālayo. Satipatthāna: the direct path to realization. Birmingham: Windhorse; 2003.

Andrews-Hanna JR, Reidler JS, Sepulcre J, Poulin R, Buckner RL. Functional-Anatomic Fractionation of the Brain's Default Network. Neuron. 2010; 65(4):550–562. [PubMed: 20188659]

Bishop SR, Lau M, Shapiro S, Carlson L, Anderson ND, Carmody J, et al. Mindfulness: A proposed operational definition. Clinical Psychology-Science and Practice. 2004; 11(3):230–241.

Bodhi, B. In the Buddha's Words: An Anthology of Discourses from the Pali Canon. Wisdom Pubns; 2005.

Brewer JA, Elwafi HM, Davis JH. Craving to Quit: psychological models and neurobiological mechanisms of mindfulness training as treatment for addictions. Psychology of Addictive Behaviors. 2012 in press.

Brewer JA, Worhunsky PD, Gray JR, Tang YY, Weber J, Kober H. Meditation experience is associated with differences in default mode network activity and connectivity. 2011

Davis, JH.; Thompson, E. From the Five Aggregates to Phenomenal Consciousness: Toward a Cross-Cultural Cognitive Science. In: Emmanual, S., editor. A Companion to Buddhist Philosophy. Wiley-Blackwell; 2012.

Duhigg, C. The Power of Habit: Why We Do What We Do in Life and Business. New York: Random House; 2012.

Dunne, JD. Mindfulness & Buddhist Contemplative Theory. Paper presented at the 5th Annual 5th Annual Conference for Clinicians, Researchers, and Educators: Integrating Mindfulness-Based Interventions into Medicine, Health Care & Society; Worcester, MA. March 29 – April 1, 2007; 2007.

Gethin, RML. The Buddhist path to awakening: a study of the Bodhi-Pakkhiyā Dhammā (Brill's Indological library). Vol. 7. Leiden; New York: E.J. Brill; 1992.

Hawkins R, Abrams T, Carew T, Kandel E. A cellular mechanism of classical conditioning in Aplysia: activity-dependent amplification of presynaptic facilitation. Science. 1983; 219(4583):400–405.10.1126/science.6294833. [PubMed: 6294833]

Ireland, JD., translator. [Accessed April 23, 2012] Dvayatanupassana Sutta: The Noble One's Happiness (Snp 3.12). 2010. http://www.accesstoinsight.org/tipitaka/kn/snp/snp.3.12.irel.html

Ñānamoli, B.; Bodhi, B., translators. The middle length discourses of the Buddha: a translation of the Majjhima Nikā*ya*. Boston: Wisdom Publications; 1995.

Pandita, SU. In This Very Life: The Liberation Teachings of the Buddha. Boston: Wisdom Publications; 1995.

Scheinost D, Worhunsky PD, Elwafi HM, Thornhill TA, Kober H, Hampson M, et al. Real-time fMRI links 1st and 3rd person experience: correlation between meditation and PCC activity. Social Cognitive Affective Neuroscience. 2012 under review.

Schmidt, A. Dipa Ma: the life and legacy of a Buddhist master. New York: BlueBridge; 2005.

Skinner, BF. The behavior of organisms: An experimental analysis. 1938.

Skinner, BF. Science and human behavior. Free Press; 1953.

Thanissaro B. Mindfulness Defined: Street Smarts for the Path. Insight Journal. 2008 Summer;:11–15.

Thanissaro, B., translator. [Accessed October 7, 2011] Dhammacakkappavattana Sutta: Setting in Motion the Wheel of Truth (SN 56.11). 2010. http://www.accesstoinsight.org/tipitaka/sn/sn56/sn56.011.than.html

Thorndike EL. Animal intelligence: An experimental study of the associative processes in animals. Psychological Monographs: General and Applied. 1898; 2(4):1–8.

Wallace, BA. Tricycle. 2008. A Mindful Balance; p. 60-63.p. 109-111.

Whitfield-Gabrieli S, Moran JM, Nieto-Castan A, Triantafyllou C, Saxe R, Gabrieli JDE. Associations and dissociations between default and self-reference networks in the human brain. Neuroimage. 2011; 55(1):225–232.10.1016/j.neuroimage.2010.11.048 [PubMed: 21111832]

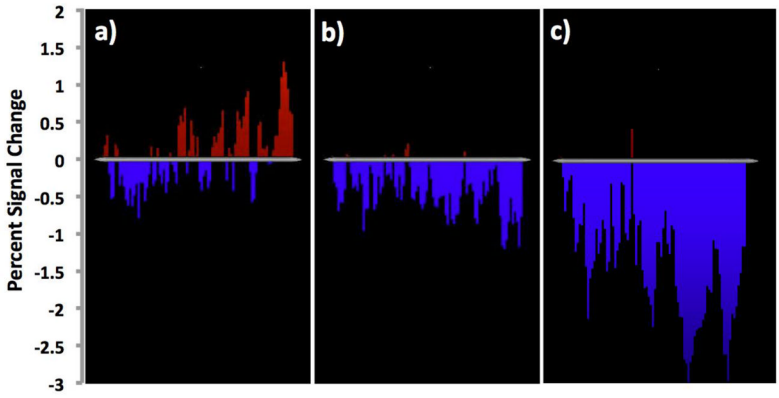

Fig. 1.

Examples of fMRI Blood Oxygenation Level Dependent percent signal change in a) a novice meditator who was instructed to pay attention to the breath, b) an experienced meditator who was instructed to pay attention to the breath; and c) an experienced meditator who was instructed to pay attention to the breath and in particular any related feeling of interest, wonder, and joy. Percent signal change (calculated relative to an active baseline) in a subregion of the posterior cingulate cortex was displayed after a processing delay of roughly 0.5 seconds (see Scheinost et al for methodological details). Each meditation period lasted three minutes.