doi:10.1093/scan/nsm034 SCAN (2007) 2, 259–263

In this Issue

Mindfulness training and neural integration: differentiation of distinct streams of awareness and the cultivation of well-being[1]

In recent years, the ancient practice of being aware of one's sensory experience in the present moment—of 'being mindful'—has taken a prominent place in discussions among clinicians, educators and the general public (Epstein, 1999; Kabat-Zinn, 2003; Bishop *et al.*, 2004; Germer *et al.*, 2005). Found in most cultures throughout history and now resurfacing in modern times, in both the East and in the West, the practice of living in the present has been offered as a way to cultivate well-being in our minds, our bodies, and even in our relationships with each other (Kornfield, 2008). Science has taken note of these suggestions and a number of investigators have focused their objective lens on this form of subjective, inner focus of the mind on present experience. Evidence from these studies supports the notion that being mindful, being aware of the present moment without grasping on to judgments, does indeed improve immune function, enhance a sense of equanimity and clarity and may even increase empathy and relational satisfaction (Davidson *et al.*, 2003, and see Siegel, 2007, for a summary of these research studies).

Why would the way we focus our attention matter for the quality of our lives? How does the process of developing an awareness of the present moment that is filled with COAL—curiosity, openness, acceptance and love toward our ongoing experience—improve the functioning of our bodies, our minds and our relationships? One important clue to answering these questions comes from the exciting findings of Farb *et al.* in this month's issue of *SCAN*.

The authors of 'Attending to the present: Mindfulness meditation reveals distinct neural modes of self-reference' have provided an intriguing insight illuminating the nature of mindful awareness and of our experience of self. In their study the researchers compare the brain imaging findings of two groups, one trained in mindfulness meditation and the others awaiting such training—the novices. Mindfulness meditation as taught through the Mindfulness-Based Stress Reduction approach (Kabat-Zinn, 1990) is a specific form of mental training that involves a series of exercises that enable the student to focus awareness on present experiences and return the attentional focus to the target of attention repeatedly as the mind becomes distracted by other objects of attention, such as discursive thoughts or preoccupations with memory or plans for the future. Subjects with MBSR training and those awaiting such an experience were then compared in a task designed to elucidate the impact of such training on the practice of momentary attentional focus. The task administered attempted to tease apart the neural correlates of a fundamental aspect of mindfulness: How we differentiate between two distinct streams of awareness. Let us first examine why the capacity to distinguish components of mental functioning might be such a useful ability and then explore the researcher's fascinating findings.

A present view of neuroscience suggests that when energy and information flow in the various circuits of the brain, we generate the neural correlates of mental experience. We can propose that one possibility for a mechanism by which mindful awareness may lead to enhanced well-being is in the way this state of attentional focus alters our relationship—our internal stance—toward our own mental processes. When individuals refine the ways in which they see the fabric of the mind itself it becomes possible to intentionally alter the flow of mental experience. In this way, seeing the mind with more depth and clarity of focus would allow the mind—the regulation of the flow of energy and information—to be transformed. For example, if we can disengage old habits of neural firing from creating their automatic and engrained emotional reactions, such as depression or anxiety, we can reduce mental suffering and enhance the growth in our internal world toward mental health. This shift in the focus of attention—the way we use the mind to channel the flow of energy and information through the various circuits of the brain—changes the pattern of activity in the brain. With repetition, such mindful practice can create intentional states of brain activation that may ultimately become traits of the individual. In neuroplasticity terms this is how new patterns of repeated neural circuit activation strengthen the synaptic connections associated with those states that then lead to synaptic strengthening and synaptic growth. This is the mechanism by which practice harnesses neural plasticity to alter synaptic connections in a way that transforms a temporary state into a more long-lasting trait of the individual. The developmental trajectory from effortful

[1]Commentary on Farb *et al.*, this issue.

state to effortless trait can be seen as a fundamental component of how mindfulness can alter engrained patterns of psychopathology. This may be the comon mechanism underlying the burgeoning of studies that suggest that mindfulness-based approaches are effective in the treatment of obsessive-compulsive disorder (Baxter *et al.*, 1992) and anxiety (Hayes, 2004) and in the prevention of relapse in depression (Segal *et al.*, 2002; Mayberg, 2005; Segal *et al.*, 2007) and drug addiction (Marlatt *et al.*, 1985; Parks *et al.*, 2001).

But why would seeing the mind more clearly, of sensing the previously coupled aspects of mental flow as in fact separable elements, actually help? Learning the 'mindsight' skill of seeing the mind in oneself and in others enables the individual to discern different streams of awareness. With such a new ability, the capacity to intentionally alter the direction of information flow—to use the skilled focus of attention to change the mind—enables us to amplify the activity of certain pathways and inhibit others. Without this refined inner view of the mind itself, such discrimination among specific patterns of neural firing is not possible. With the acquisition of a stabilized and refined focus on the mind itself, previously undifferentiated pathways of firing become detectable and then accessible to modification. It is in this way that we can use the focus of the mind to change the function and ultimately the structure of the brain.

When we achieve new skills of self-observation through mindful practice, it becomes possible to disengage automatically coupled pathways. With this new skill, the mind may create an important ability to free itself from the enslavements of prior learning. Before mindfulness training, an individual may be unaware that there are distinct energy and information paths within awareness. Instead, the mind is experienced as an amalgam of busy thoughts and feelings and automatic reactivity and habitual responses. The notions that one can 'change one's mind' or to even not identify with these mental activities as the totality of who one is are ideas often not even in one's worldview prior to immersion in mindfulness training. With such training, the ability to distinguish different streams of information flow becomes possible. Noticing the differences between sense and story, between primary experience-dependent 'bottom-up' input and the secondary 'top-down' chatter of prior learning becomes a fundamental tool of the mindfulness approach. Once this distinction, this noticing of the contents of the mind, is readily accessible through intentional practice, the capacity to alter habitual patterns is created and the possibility becomes available for relief from self-preoccupied rumination, self-defeating thought-patterns, negative autobiographical narratives and maladaptive patterns of emotional reactivity. Discerning the mind, seeing the mind with a more refined inner eye, allows the individual to not become lost in these top-down mental processes that often enslave awareness in preoccupations derived from the past and worried about the future. This is how we are kept from 'living in the present'. The first step in mindfulness training is to learn to become aware of the difference between bottom-up sensory experience and the top-down chatter of our narrative minds.

Farb and colleagues beautifully advance our understanding of this crucial first step in mindfulness training. Their approach to these fascinating and important issues is to create a paradigm that asks the two groups of subjects to engage in one of two mental approaches to presented stimuli. The stimuli are adjectives reflecting the subject's self-traits. In one condition, the task is to focus on the self-referential meaning of the presented word. This is a condition that evokes a sense of the extended self across time, our narrative sense of self that engages mental time travel linking past, present and future (Tulving, 1993). Meaning is a core aspect of this narrative process and the meaning-condition is designed to evoke activity in the story-telling circuits of our human neural architecture. The second condition is to become aware of the experience of the present moment. The instructions of this condition are not just about one's sensing of the external world through the five senses or even just being aware of the bodily sensations present at that moment. Instead, this experiential condition invites the subject to be aware of whatever arises as it arises—perceptions, thoughts and feelings. This is our 'momentary self-awareness'. The notion is to create a condition that evokes a non-narrative focus of the mind on here-and-now mental processes.

The results reveal that in all subjects during the meaning-condition, the medial prefrontal regions (mPFC) were activated, consistent with numerous prior studies suggesting that our 'narrative circuitry' includes these midline structures, just behind the forehead. For the second condition, to just focus on the experience and not the meaning of the presented words, those untrained in mindfulness—the novices—showed mPFC activation along with some increased activity in a posterior right-lateralized area. The coupling of these two regions suggests that without training, we are often unable to remove ourselves from the narrative chatter of our busy minds and distinguish ongoing story narration and mental time travel from immediate experience of the present moment. This narrative neural activity suggests that without mindfulness training people may naturally continue to be unable to 'just live in the present' and instead are filled with ruminations and self-referential judgments.

In contrast, the mindfulness meditation trained individuals during the momentary experience condition revealed a diminishment in mPFC activation along with enhanced right lateralized posterior findings. This result suggested that (i) The mPFC could possibly be more inhibited with mindfulness training and thus release primary bottom-up experience from narrative top-down enslavement; (ii) The capacity to differentiate these two distinct streams of narrative knowing from awareness of the present moment was now available and (iii) The possibility that with this

condition there may have been a 'quieter' mind, naturally devoid of mPFC mediated chatter. In this way, a stabilized focus of the mind for those trained in mindfulness may have become a generalized trait, not a time-dependent intentionally created state of the person requiring active inhibition.

This study's findings establish an important basic step in the illumination of the possible mechanisms by which mindfulness training may help cultivate well-being. With mindfulness practice, the intentional creation of a state of mindful awareness enables the individual to differentiate previously inseparable streams in the flow of information of the mind. The authors' note that such ability may help in 'objectifying' the mind, a process in which individuals are able to dis-identify from mental activities as being the totality of who they are. This differentiation enables the discrimination between present-focused experience on sensation, images, feelings and thoughts—SIFTing the mind-from the narrative chatter of previously created categories and concerns. This distinction enables one to disengage from the top-down influences of prior learning and create new avenues by which the mind's energy and information can be regulated.

Farb *et al.*' s study provides an intriguing window into the nature of our multidimensional flow of awareness. We can suggest that the mind may have more than just these two delineated streams of present-focus and narrative discourse. Self-observation may be another flow of awareness that may entail embedding a map of the self as experiencing present sensation: We sense the self sensing the present moment. This aspect of a witnessing—but not narrating—self broadens the focus of awareness to include a sense of the 'I' that experiences simultaneously with the 'me' that is the historian of lived experience. Such an observational stream of awareness may activate unique but overlapping midline prefrontal regions. In this way, we may actually utilize an observational stream of awareness that harnesses medial as well as dorsolateral prefrontal circuitry within mindful awareness. Though the present study emphasizes the importance of separating midline prefrontal from more right-lateralized posterior activity in this experimental paradigm, mindful awareness as a whole—beyond just this experimental paradigm's conditions—likely involves many aspects of prefrontal activity. The correlates of the outcome measures for mindfulness training that likely utilize those functions mediated in part by midline prefrontal regions include the regulation of emotion (Tucker *et al.*, 1995; Bush *et al.* 2000; Davidson *et al.*, 2000; Phan *et al.* 2002; Critchely *et al.*, 2003), executive attention (Carter *et al.*, 1999; Gehring and Fensik, 2001; Schoenbaum and Setlow, 2001; Gottfried *et al.* 2003; Chambers *et al.*, 2006) and the aspects of insight and empathy that map the mind of self and others in reflections (Turken and Swick, 1999; Decety and Chaminade, 2003; Carr *et al.*, 2003; Decety and Jackson, 2004; Beitman and Nair, 2005; Beer *et al.*, 2006; Heisel and Beatty, 2006) and moral reasoning (Anderson *et al.*, 1999; Bechara *et al.*, 2000; Moll *et al.*, 2002; Greene *et al.* 2004).

Mindful awareness entails more than sensing present experience as it generates an awareness of awareness and attention to intention. These fundamental aspects of mind-fulness can be seen as forms of meta-cognition that are known to involve activity in the middle prefrontal regions, including the medial prefrontal and anterior cingulate areas. Studies of mindful awareness reveal anterior cingulate activation consistent with this executive monitoring during mindfulness of the breath (Cahn and Polick, 2006). Of note also are the preliminary findings of superior temporal activation as well, consistent with neural mapping of states of intention that may involve circuitry related to the mirror neurons and insula (Carr *et al.*, 2003) The possible activity and strengthening of circuits of the middle prefrontal regions during mindfulness practice, Brodman's area 9 and 10, is supported by the findings that aspects of this region are thicker in those with decades of mindfulness meditation practice (Lazar *et al.*, 2005). As the authors point out, Lazar and colleagues' study also revealed right-lateralized increased thickness in more posterior regions associated with intero- and exteroception: the insula, somatosensory cortex and parietal regions. Here we see the supportive data suggesting that mindfulness practice is not just about being aware of sensory experience in the moment but also involves executive and metacognitive prefrontal functions as well.

Ruth Baer and colleagues (Baer *et al.*, 2006) have noted four facets of mindfulness in the general population, and the distinction of a fifth independent facet in those trained in mindfulness meditation. These facets include being non-judgmental, non-reactive, acting with awareness of present sensory experience, labeling and describing with words the internal world, and self-observation. We can see that these facets, especially the latter two, involve more than the immersion of oneself in sensation devoid of executive prefrontal functions alone. The essential capacities to monitor one's own intentional states and the focus of awareness onto itself are central features of mindful practice. These prefrontal abilities, combined with the additional frontal use of linguistic centers to describe internal experience as one observes ongoing states, are fundamental to mindful awareness. In these ways, mindfulness is clearly an integrated state of mental processing that involves a wide range of attentional, emotion regulating, conceptual and observational processes that are harnessed in a flexible and adaptive manner. The ability to bring back a wandering attention over and over again, as the authors note in William James' comments, is the education 'par excellence'. Such an educated mind involves the executive functions of an integrating prefrontal cortex that monitors the self as lived, has a map of the mind itself and alters attentional flow as needed.

The present research findings help us see the essential distinction of primary sensing of ongoing mental events

from a narrative meaning-making stream of awareness. In addition we have suggested that we may have an observational stream that maps the self as experiencing yet does not link such observations of the present to memories of the past or plans for the future. In this way, the linguistic output derived from such an observational stream would be a description, not a narrative explanation. This observational self is consistent with the memory studies in which we can recall autobiographical details from a witness or from a participant perspective, the latter having more richness of emotional and sensory detail (Schacter, 1996). The 'witnessing self' may reveal a core stream of observation independent from both narrative and primary sensing. Yet another stream of awareness may exist beyond sensing the moment, observing ourselves and the constructed categories and concepts of our explanatory narrative selves. This stream is described by mindfulness practitioners as a non-conceptual awareness, a kind of 'knowing' before and beyond constructions, observations and even sensations. It may be that differentiating these four, and perhaps even more, streams of awareness from each other can then permit an individual to link them together in new ways as a mechanism for becoming free from top-down prisons of prior learning and habit.

The ability to differentiate previously coupled and automatic elements of the mind enables these components of information flow to be linked in new combinations. The overall process of linkage of now differentiated elements is the formal definition of the term, integration. Farb *et al.*' s study illuminates an important step in how the mind can come to be trained to discern dissociable streams of awareness into differentiated components of mental experience. When we link differentiated parts we create an integrated state. Integration can be seen as an essential process in the movement toward mental well-being (Siegel, 2001). By examining the mathematical field of complexity theory, it is possible to propose that the creation of such an integrated state enables a system to move toward 'maximizing complexity' which has the described features of being flexible, adaptive, coherent, energized and stable. This integrated flow may be at the heart of how mindful awareness creates well-being. The present study powerfully illustrates one step in which mindfulness training may enhance neural differentiation by decoupling two previously intertwined streams of awareness. Mindful awareness may also be seen as a way to alter our relationship with the self, with our own mind, so that we can create new states of information flow in the course of daily life. Discerning different components of the mind, and developing the capacity to actively engage some activities and disengage others, is an essential aspect of mindfulness that this study powerfully reveals. Future investigations can build on this important present work by further delineating the mechanisms of this ancient and effective means of developing well-being in our lives.

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