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Mapping modalities of self-awareness in mindfulness practice: a potential mechanism for clarifying habits of mind

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To better understand the neurobiological mechanisms by which mindfulness-based practices function in a psychotherapeutic context, this article details the definition, techniques, and purposes ascribed to mindfulness training as described by its Buddhist tradition of origin and by contemporary neurocognitive models. Included is theory of how maladaptive mental processes become habitual and automatic, both from the Buddhist and Western psychological perspective. Specific noting and labeling techniques in open monitoring meditation, described in the Theravada and Western contemporary traditions, are highlighted as providing unique access to multiple modalities of awareness. Potential explicit and implicit mechanisms are discussed by which such techniques can contribute to transforming maladaptive habits of mind and perceptual and cognitive biases, improving efficiency, facilitating integration, and providing the flexibility to switch between systems of self-processing. Finally, a model is provided to describe the timing by which noting and labeling practices have the potential to influence different stages of low- and high-level neural processing. Hypotheses are proposed concerning both levels of processing in relation to the extent of practice. Implications for the nature of subjective experience and self-processing as it relates to one's habits of mind, behavior, and relation to the external world, are also described.

Keywords: mindfulness; meditation; awareness; self; habit; bias

Introduction

The nature by which the human mind takes shape and creates a sense of self can be likened to a field in which every kind of seed can be sown. From birth to death, every seed planted represents everything we have ever done, experienced, perceived, or felt with emotion. We can understand the *Self* by examining the types of seeds we sow as individuals every day, becoming aware of those seeds that are beneficial and those that are harmful to ourselves and others. (*Self*, in the sense of importance to one's identity, is capitalized herein.) Every thought, action, and perception become the habits of our mind, and what these seeds generate represent the subjects and objects of our experience of Self. The Vietnamese Buddhist Zen master, Thich Nhat Hanh, explains that in order to transform the seeds of suffering into seeds of happiness, one must only "look deeply

and see clearly that both are manifestations of our own consciousness. . . we need only to water the seeds of happiness, and avoid watering the seeds of suffering."¹

Advances in neurobiology have provided a clearer understanding of the relationship between dispositional and experiential factors in the development of a sense of Self and the nature by which the Self interacts with the world. Current research suggests that one's reflective knowledge of him/herself and how others perceive one's Self is often inaccurate and consequently contributes to negative outcomes for one's health and well-being.²⁻⁵ In the last century, cognitive and neuroscientific research has advanced in its attempts to provide functional maps of our habits of mind, including the neural substrates driving our fears, desires, expectations, memories, inferred knowledge of others, and general world

view. There are clear scientific and social implications for clarifying the nature of mind through the use of neuroscientific tools in a comprehensive way. Here we examine how mapping the meditative mind provides a window of opportunity to identify the critical neural elements of self-processing associated with awareness, habit formation, and perceptual and cognitive bias. We provide both Buddhist and Western psychological perspectives to suggest that habitual processing biases prevent one from seeing the world and the Self accurately and are thus the root of unhealthy thinking patterns in relation to oneself and the world. We hypothesize that specific forms of mindfulness practice have the potential to reduce such biases and result in wide-ranging benefits across a number of sensory, emotional, and cognitive domains. The rigor with which adept meditators can sustain volitional states of introspection provides a promising context for this research initiative. Moreover, this research will allow us to explore the relationship between practitioner expertise and changes in plasticity across brain networks thought to be modulated by mindfulness. It is further proposed that mapping modalities of awareness in meditators may provide the potential explicit and implicit mechanisms by which specialized meditative techniques can contribute to transforming maladaptive habits of mind and perceptual and cognitive biases, improving efficiency, facilitating integration, and providing the flexibility to switch between systems of self-processing. Such a map could be used as a diagnostic tool to assess progress by the practitioner and to develop targeted interventions for therapeutic purposes.

We emphasize that insight into the nature of our minds and embodied notion of Self benefits from a cross-cultural science of consciousness integrating traditional Buddhist theoretical constructs and more contemporary cognitive neuroscience models.^{6–8} Although there is some discrepancy in describing the mind in the Buddhist literature, a popular model^{6,9} breaks the mind down into five aggregates (Pali: *khandhas*) that are rooted in self-observation and contemplation: physical form, feelings, cognitive access/perceptions, volitions/dispositional formations, and phenomenal consciousness. Contemplative practice, in this context, refers to a particular form of observation in which there is a total devotion to revealing, clarifying, and making manifest the nature of reality.¹⁰ The

word meditation (Pali: *bhāvāna*; Tibetan: *sgoms*) literally translates to cultivation and familiarity, respectively, and refers to mental development and the cultivation of familiarity with one's inner mental landscape or one's patterns of behavior (i.e., nature of mind).^{11,12} Modeling the Self in more contemporary neuroscientific terms has broadly focused on biological substrates that mediate mental attributions of features that distinguish Self from Other,^{13–15} while other models have focused on the phenomenological experience of agency^{16,17} and implicit processes that specify the Self through non-conscious sensory–motor integration.⁸ In attempts to synthesize traditional and contemporary models of mind, the emerging field of contemplative science is beginning to rigorously investigate the underlying processes of contemplative practices that are core to the construct of mindfulness. This research initiative should prove useful for clarifying the therapeutic relevance of mindfulness and providing a more comprehensive understanding of self-processing. Furthermore, mapping modalities of awareness on to neural systems supporting self-processing may improve our understanding of one's modest ability to accurately evaluate his/her own patterns of cognition, emotion, trait dispositions, and behavior, as well as self-knowledge from the perspective of others.

Bias and habit formation: targets for mindfulness

In the Buddhist context, craving and attachment or aversion to particular sensory or mental events, along with ignorance of the impermanent, interdependent nature of phenomena, including one's sense of Self, is what continually reinforces distortions of reality. These distortions are conceptualized as biased perceptions and cognitions of an individual's own physical or mental state and the external world. The biases can influence the present state of awareness, memory for the past, or the imagined future, and sustain a cycle of mental habit that is self-conditioning and self-perpetuating. These biases and habits of mind are described as the source of suffering in the traditional theoretical Buddhist context, and are the primary target for Buddhist meditative practice.^{18,19} The developmental model of psychopathology similarly views enduring cognitive structures and schemas of the Self and worldview as persistent negative feedback loops of

negatively-biased constructions of experience, which lead to a variety of errors in interpretation (e.g., overgeneralization, selective abstraction, personalization) and an inhibition of the possibility for positive interpretation of experience.²⁰

Based in part on Buddhist canonical sources and in part on the extant contemplative and neuroscientific literature, a theoretical framework of self-awareness, self-regulation, and self-transcendence (S-ART) has been proposed²¹ to illustrate the impact of mindfulness-based mental training techniques on reducing biases related to self-processing and sustaining a healthy mind. In this context, mindfulness broadly refers to the method of systematic mental training using a core set of meditative practices. Specific formal-sitting meditation practices [(focused attention, open monitoring (OM), ethical enhancement)] and movement-based practices (Hatha yoga) are emphasized as embodied techniques with the potential to modulate neural systems of self-specifying and narrative self-processing in a fashion that improves efficiency, integration, and the flexibility to switch between systems of processing. Here, we refer to the S-ART framework and existing literature on meditation to illustrate potential maps for improving accuracy of self-awareness as it relates to our general habits of mind and behavior in relation to others. It is hypothesized that all three of the core meditative practices and underlying neurocognitive and psychological skills thought to arise in support of the practices facilitate such changes. A focus of this manuscript is on the OM practice (described in Ref. 22) and the mental noting and labeling techniques originally described in the Burmese Theravada tradition (e.g., Mahasi Sayadaw) and popularized in Western contemporary traditions, such as in Goenka-style Vipassana, Insight practice popularized by Joseph Goldstein and Sharon Salzberg, and the Basic Mindfulness System developed by Shinzen Young. Noting and labeling practice is often taught at early stages of practice and, in some cases, for advanced practice.^{23,24} As we achieve a finer resolution of the levels of processing and characterize how modalities of awareness map onto neurobiological systems, it is hypothesized that a unique developmental trajectory of plasticity among networks of self-processing may be revealed between novices and advanced meditators. Furthermore, research at this level that includes a neurophenomenological

approach should provide insight into the neurobiological underpinnings of mindfulness and the development of a highly developed, nonconceptual form of self-awareness that manifests as a witnessing perspective not entangled in the contents of awareness. This form of meta-awareness is a concept that points to the possibility of taking awareness itself as an object of attention leading to the development of psychological processes, such as decentering, re-perceiving, or psychological distancing, often cited in the contemplative science literature.^{25–27} Decentering refers to a shift from identifying personally with thoughts and feelings to relating to one's experience in a wider field of awareness, and in which one can engage with an object of attention without avoiding it or becoming entangled (as in rumination). A decentered perspective allows one to disengage from one's self-focused thinking, thereby facilitating release from ruminative thinking and providing a space between one's perception and response.^{25,26} Through the development of models that account for changes in meta-awareness across levels of experience, we can contribute to our understanding of the dynamic relationship between awareness and habits of mind.

Habits refer to the fourth aggregate (Pali: *samkhāras*) in the Buddhist model of mind, a defining feature of dispositional mental formations or volitions that make up oneself and the contents of mind.^{9,28} Through repeated manifestations, particular mental formations (e.g., desires, fears, values, prejudices) triggered by an object, whether wholesome and desirable (e.g., love, concern, sympathetic joy) or unwholesome and undesirable (e.g., greed, anger, jealousy, or resentment), accumulate and have the potential to shift the trajectory of how the other aggregates and the Self develop. Similarly, in the cognitive model, habits refer to an incrementally acquired pattern of perceiving, feeling, thinking, or behavior that often occurs automatically in association with a particular stimulus or set of stimuli.^{29–32} Automaticity reflects the stability of reinforcement between past and future behavior and the circular structure of repeated patterns, such that each element of the pattern is associated through a causal, temporally contiguous, feedback loop that is self-referencing and self-conditioning.^{6,9,21,31} Accumulation of habits manifest as dispositional traits, implicit knowledge, and are revealed only through task performance without any corresponding

phenomenal awareness of the act itself or conscious access to previous episodes in which the habit was learned. Automaticity can be achieved through extended training and is associated with improved efficiency and speed of processing along with decreased cognitive effort and control.^{31,33–35} Furthermore, automaticity is adaptive so that resources are conserved for processing environmental stimuli that are more salient or threatening,³⁴ and can occur for simple sensory processing and behaviors, as well as for higher order evaluations, complex decisions, emotions, and social impression formation.^{31–33} Although the rapid analysis and computational functioning of automaticity is adaptive in many contexts, there exists the notable consequences of inflexibility and inhibition difficulty.^{32,33} Automaticity and frequency of habitual mental processes also makes it more difficult to extinguish,³¹ thus perpetuating the inevitability of expressing conditioned responses to broad and generalizable stimuli across many contexts in one's life. In essence, automaticity at both sensory–perceptual and conceptual levels refers to biased attention from the early stages of nonconscious perceptual analysis through top-down strategic influences.

According to learning theory^{36,38} and recent cognitive and neuroscientific studies on memory,^{30,32,36,39–42} higher-order, goal-directed mental habits are formed through competition between parallel, but independent, systems of processing. Implicit stimulus–response (S–R) associations are supported by cortico–basal ganglia circuitry (primary sensory, premotor, supplementary motor, cerebellum, and dorsal striatum), and explicit (declarative) contextual memories are dependent upon frontotemporal-parietal brain networks. It is well known that the implicit perceptual, affective, attentional, and motor processes that result from S–R associations are less accessible and have more potential to influence (bias) future processes at both implicit and explicit levels.^{36–38} There is increasingly competitive interference from frontotemporal-parietal brain networks for increasingly complex, explicit memory operations.^{36,41} There is now evidence that such competition between frontotemporal-parietal and cortico-basal ganglia networks can actually interfere with learning efficiency.^{32,41,42} Because of strong feedback and feed-forward projections between basal ganglia and frontal circuits, there is a suggestion that the dor-

sal striatum trains the frontal circuitry to respond more automatically in the presence of particular contextual stimuli.⁴³ Furthermore, with low novelty and/or arousal (factors that typically modulate the explicit nature of awareness), there is evidence that brain networks shift toward stimulus-driven, non-conscious, sensory–perceptual analysis and motor output without any feedback from more explicit, conscious centers of processing.^{44–46} For example, explicit awareness of any particular object may be fleeting and give way rapidly to idling patterns associated with rumination and mind wandering. One very habitual (default) pattern of the mind is one of narrative self-processing (also associated with mind wandering).^{21,47,48} Although not the only network of neural processing in the resting mind, the network underlying narrative self-processing is the default because it is the dominant pattern in the majority of people for the majority of the time. For example, in one study that created a database of over 250,000 samples from about 5000 subjects (aged 18–88 years) from 83 different countries and that assessed thoughts, feelings, and daily activity,⁴⁹ mind wandering occurred 47% of the time no matter what the subjects were doing. Furthermore, mind wandering was actually causally linked to unhappiness regardless of whether the topics of mind wandering were positive, negative, or neutral.⁴⁹ Other studies have found rumination and mental proliferation, also associated with mind wandering, to play a critical role in exacerbating negative affect, maintaining or heightening anxiety, and increasing cognitive vulnerability to psychopathology.⁵⁰ The implications here reflect the relationship between habits of mind and well-being. Whether they may be perceptual, cognitive, emotional, social, or motoric in nature, the content of those mental habits have implications for psychological health.

An individual's biased self-image (i.e., self-knowledge) is reified and identified with over the course of development. Habitual patterns of processing internal and external environmental input at both sensory–perceptual (e.g., seeing, hearing, touching, tasting, smelling, interoceptive, and proprioceptive) and conceptual–linguistic (e.g., evaluating, elaborating, analyzing, judging, planning, remembering, and self-reflecting) levels influence each other in adaptive or maladaptive trajectories, producing a particular biased interpretation of oneself, relations to others, and the world (i.e., world

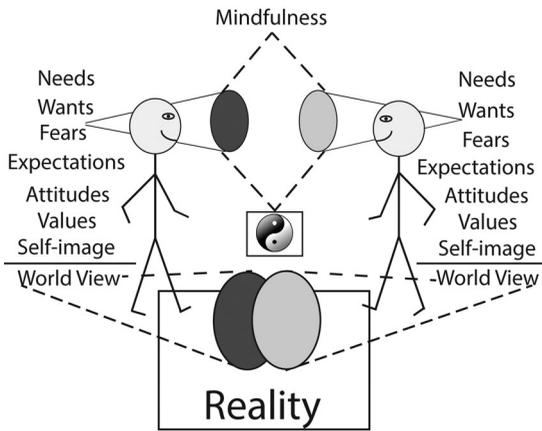


Figure 1. World view of Self and other are conditioned over time and automatized into enduring habitual schemas limited in scope and awareness outside one's perspective. Through mindfulness-based practice, it is proposed that perspectives of Self and other are more integrated (as depicted by yin–yang symbol), a larger proportion of reality is more accurately perceived, and biases related to one's limited world view are decreased.

view) that does not necessarily reflect reality and likely varies from individual to individual. This biased world view is depicted in Figure 1.

Cognitive models of psychopathology propose maladaptive habits, and emotion-congruent biases arise when a particular event or series of events is processed in a dysfunctional way that skews information processing systems toward distorted negative self-relevance or world view.^{20,51} The developmental model of depression proposed by Beck explains how depressive symptoms manifest from dysfunctionally negative views of oneself, one's life experience (and world view), and one's future.^{20,52} For example, individuals who experience feelings of sadness, hopelessness, loss of motivation, or social withdrawal implicitly associate such feelings with benign contextual features in the environment, leading to future generalizability across similar contexts repeatedly until the negative pattern becomes habitual, leading to a depressive disorder. Similarly, an aversive childhood event (e.g., in which one is knocked down by a large dog) can lead to a maladaptive fear (phobia) (of dogs) that manifests at the implicit level.³⁶ In this instance, as with most phobias, even if there is explicit awareness of irrational thoughts and fears, the automaticity is so overlearned that changing physiological reactivity is quite difficult. These habits refer to emotion-

congruent biases, describing the particular types of feelings that make up the content of one's habitual thought and which color one's self-experience.⁵¹ For example, depressed individuals repeatedly ruminate with a negative self-focus and world view about the present and future; individuals with anxiety disorders continually worry about possible future harm; people with panic disorder repeatedly think they are going to die or "go crazy" during an episode; those with posttraumatic stress disorder (PTSD) relive traumatic experiences repeatedly in the form of intrusive thoughts, nightmares, or flashbacks.⁵¹ Furthermore, the individual's constructions of his or her experiences are systematically distorted through each emotion-congruent lens and lead to negative consequences for oneself and one's relations to others.^{5,20} Underlying these distorted interpretations are dysfunctional beliefs incorporated into relatively enduring cognitive structures or schemas that are limited in scope and perspective.^{20,53} This model is also dependent upon adverse developmental experiences, such as trauma, and an ineffectively managed or prolonged stress response associated with that trauma. Without the necessary skills to manage difficult or challenging emotions, neuroendocrine and physiological consequences that jeopardize physical and mental health will result.⁵⁴ In some individuals, pathophysiological outcomes manifest immediately following a traumatic event and dramatically shift self-processing networks into maladaptive trajectories, such as dominance of limbic reactivity over prefrontal function, metabolic syndrome, or vulnerability toward future PTSD.⁵⁴ Maladaptive habits and biased perception and cognition may manifest in psychopathology at one extreme, but the assumption is that every individual's perceptions and cognitions related to ordinary experience, including fears, expectations, attitudes, values, and self-image, are distorted or biased to varying degrees. Therefore, in adult brains (pathological or healthy), there are highly automatized, habitual forms of implicit and explicit processing that can manifest in dispositional ways and, thus, require much effort to change.

It has been proposed that mindfulness-based practices may operate mechanistically through extinction learning—extinguishing maladaptive representations of Self and one's world view and replacing them with implicit and explicit perceptions and evaluations that have become associated

over time with novel, more accurate assessments and decreased bias.^{5,21,55} The development of self-awareness through core practices is proposed to provide a method for bracketing experience in real time such that crystalized cognitive schemas and action tendencies are clearer in the phenomenal levels of momentary conscious experience. By facilitating conscious access, or meta-awareness, to our limited world view and self-narrative, there is an opportunity for novel, adaptive stimulus–outcome associations and for reducing bias at both implicit and explicit levels. Mindfulness is often described as providing a clear picture of what is taking place in the present moment and is thus able to enhance capacity for the practitioner to act congruently with one’s right intentions, direct perceptions, and intention-focused goals.^{56,57} What that clear picture is should appear evident from our elaboration below on mindfulness-based contemplative practices.

Mindfulness-based contemplative practices

From its etymological Buddhist origins, mindfulness (Pali: *sati*) is translated as memory and, in the verb tense, is the act of remembering (Pali: *sarati*). Although the literal translation is misleading, it refers to the continuous direction of attention toward objects in the present moment of experience or close repetitive observation of the objects that arise and pass through each moment of experience.^{12,58} The state of mindfulness is thus conceptualized in both the Buddhist and secular contexts as a fundamental discriminative attentional capacity informing awareness of what is taking place in the present moment (both externally and internally).^{12,21} The discriminative nature of the state is thought to capture a quality of continuous discernment that provides sensory clarity and equanimity, frees up access to cognitive resources, and is free from attentional bias. Over time and practice, the phenomenological experience of the meditator moment-to-moment gains an efficient form of continued awareness that is alert and informed through other supportive mental faculties. This state of mindful awareness, or discriminative attentional capacity, is further described as one of four essential mental factors that co-arise through the prescribed meditative practices essential for progressing along the Buddhist spiritual path: (1) mindfulness;

(2) balanced application of effort (Pali: *ātāpi*); (3) an equanimous state of concentration (Pali/Sanskrit: *samādhi*) free of desire (Pali: *abhijhā*) and discontent (Pali: *domanassa*); and (4) the presence of clearly knowing (Pali: *sampājana*). Apart from being a basic mental factor, the state of mindfulness is also thought to have the critical quality of monitoring the development and balance of the other three faculties.^{12,18} Together, these factors are mutually supportive and describe a method for psychological transformation and *awakening* to the true nature of mind^{12,21} (for a more in-depth discussion of the term, see Refs. 12, 58, and 59).

Core mindfulness-based contemplative practices provide the opportunity to nurture these essential mental skills and dispositions believed to cultivate familiarity with one’s habitual patterns of thought, assumptions about identity, behavior, and relation to the world. Improved perspective of one’s own and other’s world view is therefore proposed to result from increased dispositional mindfulness, as well as an increased percentage of the total field of awareness in reality (Fig. 1). Furthermore, the practices provide a framework for discerning the factors that may cause (or remove) distortions or biases referred to above, maintain the motivation for achieving such goals, and preventing the presence of qualities that are destructive and irrelevant to skillful means associated with mindfulness. The method described through the core practices refers to the *Satipatthāna Sutta*, a highly influential discourse by the Buddha, of which the term *satipatthāna* can refer to the act of establishing the presence of mindfulness as a method for awakening, realization, or psychological transformation.^{12,58} The method refers to applications of mindfulness in four domains, including mindfulness of (1) bodily states (Pali: *kāyā*); (2) affective valence and the ethical context of its arising (Pali: *vedanā*); (3) the current mental state (e.g., anger, lust, delusion, distraction) and its opposite state (Pali: *citta*); and (4) all mental phenomena (Pali: *dhammas*), including the application of all Buddhist teachings toward all objects of the mind that arise and pass. These areas of contemplation are applied during formal practice and throughout one’s daily life; furthermore, they serve as the bases for maintaining a state of mindful awareness from moment to moment, on and off the cushion (for a more in-depth discussion of the four domains of *satipatthāna*, see Refs. 12, 18, 58 and 59).

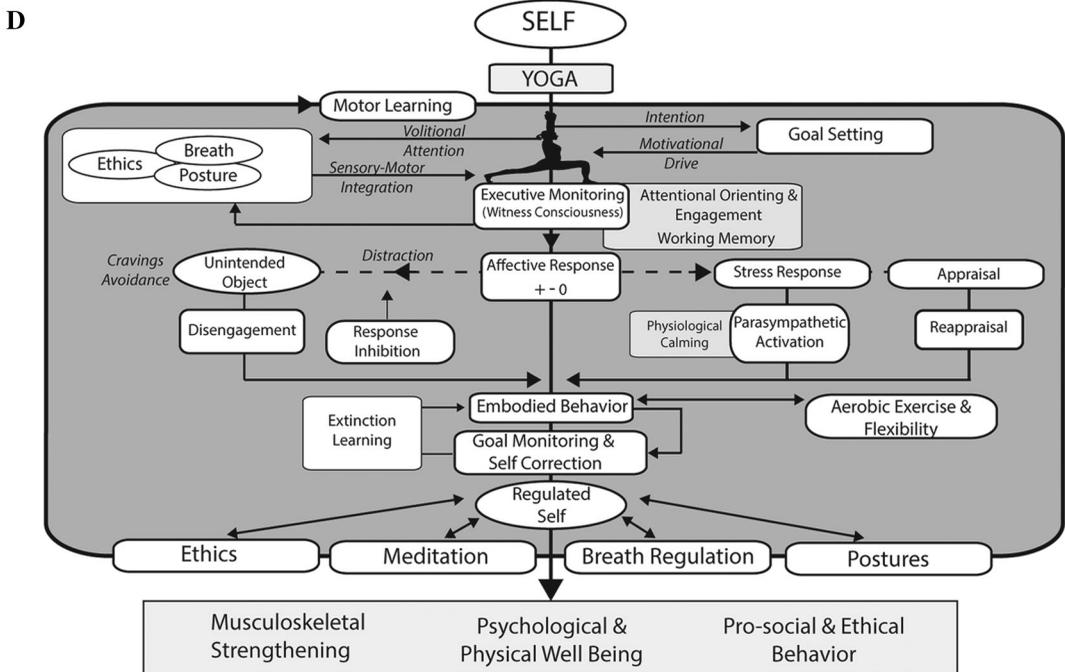
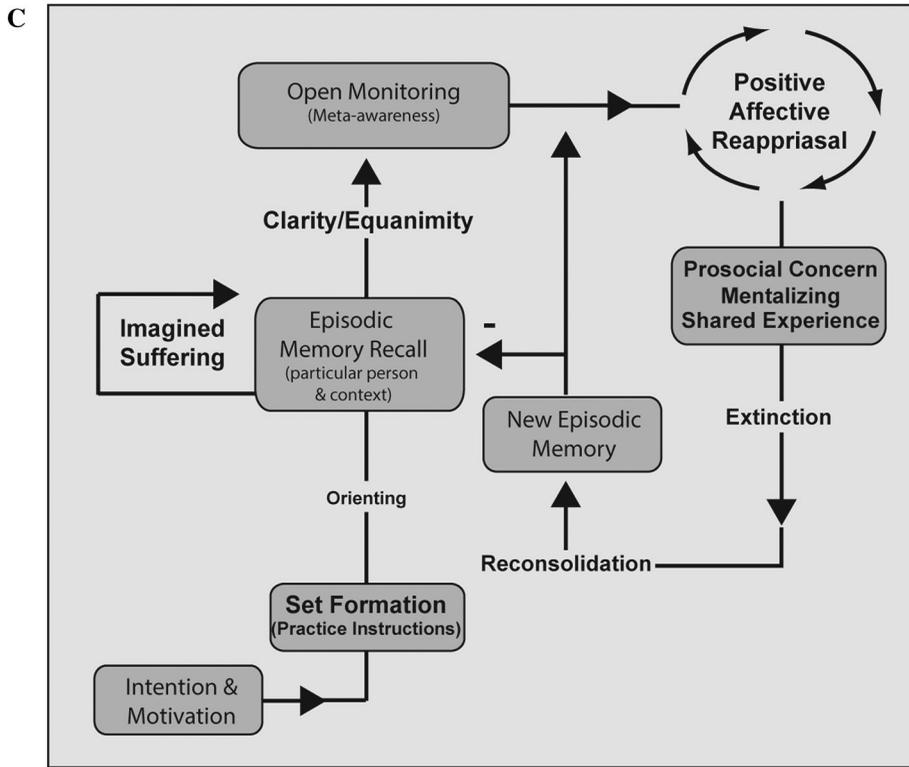


Figure 2. Continued

Process models of four contemplative practices typical in a mindfulness-based intervention (MBI) and the underlying processes (cognitive, neurobiological, and psychosocial) by which they impact S-ART are illustrated in Figure 2. The formal practices involve three specific types of meditation practice (focused attention, open monitoring, and ethical enhancement) and a movement-based practice (Hatha yoga) that provide systematic maps for transformation.¹² Transformation implies change in habit and bias across systems of sensory, emotional, and cognitive processing for oneself and in relation to others. Not only is there some evidence for this already,^{60–63} but there may be evidence that also supports this method of training as a means for improving resilience to developing pathological habits of mind as a prophylactic in the face of stress.^{64–68} The neurocognitive and psychosocial processes underlying the S-ART framework and mindfulness-based practices include intention and motivation, attention and emotion regulation, memory extinction and reconsolidation, prosociality, nonattachment, and decentering. These processes are described in detail elsewhere;²¹ however, it is worth noting that across all mindfulness-based contemplative practices, there are common elements of motor learning and intention/motivation that are critical to change. Motor learning implies competition with older forms of habitual learning and automatization of adaptive processing over time and practice. Intentional and motivational drive, goal monitoring, and continued self-correction are aspects of the practice that help maintain regulatory control over attentional brain networks throughout practice and facilitate extinction of maladaptive, crystalized cognitive schemas, and attentional and affective bias. The framework proposes that over time and continued practice, systems of self-processing are influenced to maintain efficient communication, such that the practitioner is able to flexibly (and rapidly) move between each form of self-processing (i.e., narrative, phenomenological, enactive) during context-appropriate moments of experience.²¹ The ongoing sense of Self is thus conditioned to respond more adaptively and efficiently, reacting to the environment in a way that is constructive rather than destructive, with equanimity and clarity of sensations, thoughts, emotions, and behaviors.

Noting and labeling modalities of awareness

During OM practice, a common method used to stay focused on objects of awareness without being carried away by distraction is mental noting and labeling.^{23,24,69} This involves using a simple mental note to calmly and equanimously label what one is experiencing without getting caught up in the emotional reaction to that object. The technique can be done with eyes open or closed. Noting is described to be a form of perceptual acknowledgement that both clarifies sensory experience and penetrates it as a nail may penetrate a piece of wood, while the label uses a word to describe the acknowledgement.^{24,69} Aside from providing the mind with something to do, which supports a nonreactive form of sustained attention, it is also useful for interrupting the incessant flow of discursive thoughts and emotions that fuel our habitual states of mind. The practice based in the tradition of Mahasi Sayadaw encouraged the noting of any thought, perception, feeling or action related to momentary experience.²⁴ For example, sensations (e.g., warmth, coolness, pressure, and tightness), emotions (e.g., happiness, sadness, excitement, and fear), or mental activity (e.g., wanting, planning, and resisting) could be noted.⁷⁰ The four *satipathānas* (body, feelings, mind, and dhammas) have also been used in a similar way for noting and labeling practice.¹² Another function of noting is to strengthen recognition of one's patterns of thoughts and emotions, when often we are quite blind to self-knowledge and the consequences such unawareness may have on the Self and others.⁵ Noting is also believed to help with decentering, to prevent preoccupation or overidentification with experience.²³ For example, repeatedly noting "wanting" may facilitate awareness of the wanting without being caught by it.⁷⁰

Although this form of interoception may be incredibly helpful in meditation, the plurality of interoceptive experience makes it difficult to study in a laboratory setting. We therefore describe a similar refined method (i.e., the Basic Mindfulness System) developed by Western meditation teacher Shinzen Young that focuses on three modalities: visual, auditory, and somatic, each with five options for noting.⁶⁹ The sensory object can be noted as (1) external, (2) internal, (3) restful, (4) changing, or (5) having changed or dissolved. In the visual

domain, one can note external objects (“see out”), internal imagery (“see in”), darkness/brightness behind the eyelids (“see rest”), morphing or animated image (“see flow”), or the moment some visual object dissolves from the mental landscape (“gone”). Noting “flow” (representing a dynamic changing object) or “gone” (representing “dropping off” or dissolution of the object) is the same across modalities. In the auditory domain, one can note external sound (“hear out”), internal talk (“hear in”), or silence (“hear rest”). In the somatic domain, one can note external physical sensation (“feel out”), a strong emotion with a clear, detectable body sensation (“feel in”), or physical and emotional relaxation (“feel rest”). One can focus, with eyes open or closed, on any one particular modality individually or collectively on any modality that arises. For example, “focus in” can note all internal activity that arises.

There is an explicit distinction between engagement and disengagement with an object early on in the practice. Engagement of attention typically increases focal awareness and is modulated by bottom-up sensory mechanisms sensitive to salience, intensity of emotion, and arousal in relation to that object.⁷¹ For example, a primary function of emotion is to facilitate attention toward salient or threatening objects in our environment. If the intensity of the emotion is beyond a particular threshold, engagement on the object of attention is likely to reduce conscious awareness of other objects in one’s phenomenal field. There is a level of “mental stickiness,” which refers to a disengagement deficit, and describes our natural tendency to dedicate resources to an object of engagement to the extent that few resources remain to capture any other pertinent environmental information until one is able to disengage and re-orient. Over time, this form of mental stickiness on particular emotional stimuli can become habitual, contextually dependent, and highly automatized into the sensory–affective–motor scripts and schemas that dictate tendencies toward behavior.^{72–74} Eventually, through training, the active noting can cease, and the process of mental noting becomes effortless. At this point, efficiency of the attentional system has improved, resulting in decreased allotment of attentional resources toward any particular feeling, image, or thought. In the Tibetan Dzogchen tradition, this nondualistic state of awareness that emerges through advanced OM

practice is described by the Tibetan word *rig pa*. In this tradition, awareness of awareness remains and the mediator is thus able to observe and gain insight into the constant flow of experience without interfering with the clarity of phenomenological experience. This advanced stage of OM is described as open presence (see Ref. 22 for a more detailed description) and is hypothesized to no longer use the noting and labeling technique given that subject–object relationships are no longer relevant.

The limited and explicit instructions for performing this form of mental noting and labeling provides a comprehensive neurophenomenological map that can potentially reveal distinct functional–anatomical correlates for modality-specific states of conscious awareness, either at the volitional or spontaneous level. The practitioner can either identify and label the stimulus input that arises spontaneously or sustain focus in any of the 12 states that combine three stimulus types and four possible characteristic qualities (minus “gone,” which is more transient). Such combinations can be contrasted to each other, to default states, or other attention-demanding states. Modulatory input could be manipulated and speed of processing at both implicit and explicit levels could be interrogated. The clarity of the phenomenal sensory experience can also have an intensity that can be noted.

Neural mechanisms for change: mapping modalities of awareness on networks for self-processing

Neural systems of self-processing have been delineated to account for the unique forms of processing information in both explicit and implicit means. For example, the S-ART framework refers to an integrative fronto-parietal control network (FPCN)^{75,76} that explicitly functions to flexibly switch ongoing processing between autobiographical retrieval from a narrative self-network (NS; i.e., hippocampal-cortical memory system), an experiential enactive self-network (EES) that accounts for the implicit sensory–affective–motor processing of information, and an experiential phenomenological self-network (EPS) that accounts for the sensory, motivational, social, and cognitive processes that are in present-moment awareness for ongoing task demands. The latter three systems functionally reflect habits of mind without necessarily having a strong interaction between them, while the FPCN is thought to

facilitate rapid shifts between each network to implement cognitive control and accessibility.^{75,76}

Although there is no discrete object of intentional, sustained focus in spontaneous noting and labeling, focused attention is oriented toward an object in volitional forms. At a very low level of sensory processing, our focal awareness is very small relative to the rest of the context around that focus. There is ample evidence that early stages of attentional processing and fleeting perceptual traces of sensory information exist before there is conscious awareness.^{77,78} These forms of early, nonconscious, low-level processing can be measured in precategorical, high-capacity sensory memory stores⁷⁸ or attentional biases.⁷⁹ Early features of the object (contrast, brightness, movement, temperature, and pressure) are detected by sensory organs and primary sensory cortex typically between 75 and 80 ms poststimulus onset as measured by event-related potentials (ERP). Although the categorization of a visual object occurs within the 75–80 ms window, the correlation with subject behavior does not occur until 150 ms poststimulus.⁸⁰ The conscious awareness threshold is variable, but is typically around 100–300 ms poststimulus with temporoparietal positivity in the 325–600 ms range, followed by identification, evaluation, and labeling up to 500 ms poststimulus with temporoparietal positivity in the 600–1000 ms range.^{80–82} Everything below the conscious threshold is also being coordinated by the sensory feedback and feed-forward interactions with the EES network, which is thought to operate in parallel with the NS network, suggesting such an interaction may coordinate biased perceptions and stored memory representations. Existing evidence supports the idea that EES–EPS connectivity likely reflects self-specifying processes through integration of efferent and re-afferent sensory information. Threat detection and pattern separation are automatized computations originating in the limbic areas, and manifest in response to emotion-congruent bias along with an initial valence appraisal.^{51,83} Noting utilizes the EPS network and likely occurs very early on after conscious awareness, followed by identification/labeling, strategic evaluating and assessment of valence through NS activity, and finally attentional output.

During spontaneous noting, a new object may arise during mind wandering or mental proliferation in which tangential thoughts arise and perse-

verate. Although distraction and discursive thinking may arise often early in training, the practitioner is encouraged to continually rest in awareness and avoid any cognitive forms of appraisal. One of the mental factors, *sampājana*, that arises with mindful awareness is thought to act as a self (meta)-monitoring faculty and detect when the goal state of concentration on the particular object has shifted, and to support the attentional processes related to the return of focus. This form of meta-awareness implies a nonconceptual, second-order, embodied reflection on experience as a form of experience itself, and that is not entangled in the contents of awareness.⁹ The S-ART framework hypothesizes the FPCN is critical for strengthening the meta-monitoring and executive processes involved in sustained concentration and response inhibition as well as integration of information from EPS with stored representations and evaluations by NS. The FPCN is especially known for integrating information from the external environment with internal representations.⁷⁵ Such activation improves the efficiency in which one can actively switch between each system of self-processing. Furthermore, the frontopolar cortex, a critical node in the FPCN, has specifically been shown to be important for sustained attention, facilitating management of multiple goals, and orchestrating planned action, based on both episodic and prospective memory function.^{84,85} If executive monitoring or response inhibition functions fail, intentional/motivational drive, thought to be supported by EES network activity, facilitates decentering and disengagement from distraction/perseveration and a return to focus on a new object. Dynamic network changes among the self-networks are likely in relation to expertise and proficiency of the meditator. Novice meditators may not activate FPCN regions as strongly as more advanced practitioners but may demonstrate activation across networks of brain function that represent effortful control and attention (see Ref. 86). There is a clear temporal sequence in which the object of meditation is noted, evaluated, and labeled. A model describing the levels of processing, time course, and networks of self-processing involved during noting and labeling practice is depicted in Figure 3.

Once lower and higher level processing has resulted in a stable conscious percept, deeper states of absorption are possible, reducing cognitive resources to other external sensory objects in one's

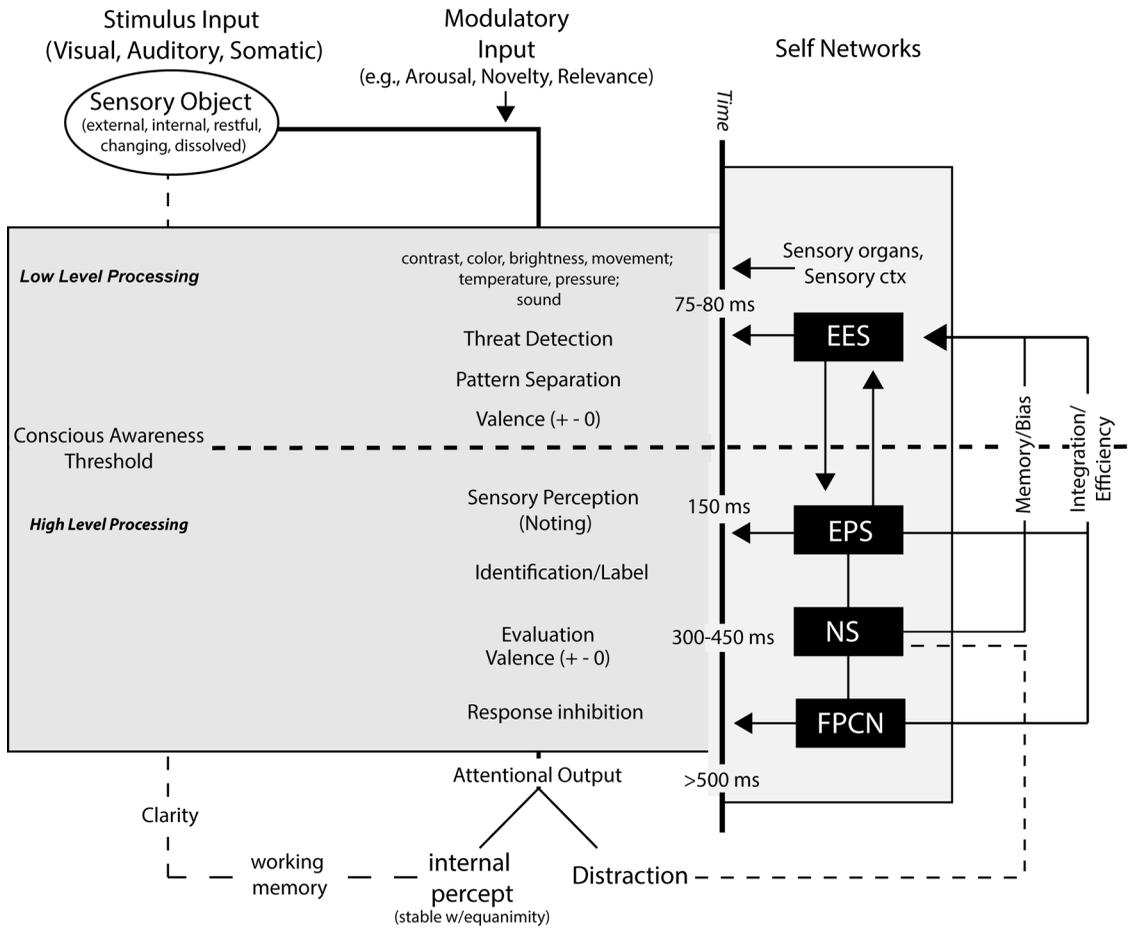


Figure 3. A process model for the noting and labeling practice in OM meditation. Visual, auditory, and somatic modalities of awareness with external, internal, restful, changing, or dissolved qualities represent the input. Visual input is associated with real or imagined visual input, auditory input can represent physical sound or inner mental speech, and somatic input represents viscerosomatic states. These specific domains provide the scaffolding for meta-awareness to develop in each domain and in relation to each other. The input can be modulated by characteristics such as arousal, novelty, and self-relevance. Very low-level processing is likely to occur below the threshold for conscious awareness, including basic feature detection at the level of the retina and experiential enactive self (EES) network activity. Threat detection and pattern separation are automatized computations along with an initial valence appraisal. Noting happens very early on after conscious awareness, followed by identification/labeling, strategic evaluation and assessment of valence, executive processing of inhibitory control, and attentional output. The experiential phenomenological self (EPS) is involved in noting; whereas, the narrative self (NS) is involved in identification and labeling. Interaction between the NS and EES fuel habitual biases. The frontal-parietal control network (FPCN) is critical for executive processes involved in sustained concentration and response inhibition as well as integration of information from EPS with stored representations and evaluations by NS. The output of the attentional process is a phenomenally conscious, internal percept that can be stable/present, changing (either arising or passing), or absent. For details for each network of self-processing, see Vago and Silbersweig.²¹

phenomenal field of attention. The deep form of concentration, referred to above as *samādhi*, is further described as a nondualistic state in which the consciousness of the experiencing subject is united with the experienced object.⁸⁷ This state may sound similar to the popular notion of *flow*, described by Csikszentmihalyi as a fully absorbed, effortless feel-

ing of energized focus, deep involvement, and enjoyment in the process of activity.⁸⁸ Critically, states of *samādhi* may be distinct from flow states in that motivationally relevant information may continue to enter conscious awareness. Furthermore, *samādhi* is accompanied by nonreactivity, noncraving, and no aversion. Mindful awareness in association with

this form of deep concentration, equanimity, clarity, and clear knowing is proposed to provide the essential stability across self-networks to modify any habitual processing that typically arises during such stimulus input.

Conclusions

To summarize, we have detailed the definition, techniques, and purposes ascribed to mindfulness training as described in its Buddhist tradition of origin and in contemporary neurocognitive models. We have provided theory for how maladaptive mental processes become habitual and automatic, both from the Buddhist and Western psychological perspective. Specific noting and labeling techniques in open monitoring meditation, originally described in the Burmese Theravada tradition (e.g., Mahasi Sayadaw) and popularized in Western contemporary traditions, are highlighted as providing unique access to multiple modalities of awareness (without conceptual evaluation) of explicit and implicit states of perception, attentional bias, habit, and self-knowledge as it relates to maladaptive behaviors in the face of physical or mental stress, cognitive or emotional challenge, or world view in general. We propose that such awareness reflects a capacity to regulate or manage those processes in ways that promote personal well-being and social harmony. A model is provided to describe the timing by which the noting and labeling practice has the potential to influence different stages of both low- and high-level neural processing. In the context of mindfulness practice, it is hypothesized that noting and labeling objects in one's internal and external experience sharpens perceptual faculties, facilitates rapid engagement and disengagement processes of attention, and enhances executive functioning responsible for inhibitory control, conflict monitoring, and emotional equanimity. In addition to more explicit changes across networks of self-processing, we predict that advancement in noting and labeling practice can produce changes in nonconscious, early stages of perceptual and attentional processing that can reflect reductions in bias, more efficient allocation of attentional resources, and a more accurate world view and reflection of reality. Such research may provide empirical connections between mindfulness and self-awareness with practical clinical significance for targeted therapeutics and insight into psychopathology.

Conflicts of interest

The author declares no conflict of interest.

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