Published in final edited form as:

Ann N Y Acad Sci. 2016 June ; 1373(1): 96–113. doi:10.1111/nyas.13171.

The brain on silent: mind wandering, mindful awareness, and states of mental tranquility

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Abstract

Mind wandering and mindfulness are often described as divergent mental states with opposing effects on cognitive performance and mental health. Spontaneous mind wandering is typically associated with self-reflective states that contribute to negative processing of the past, worrying/fantasizing about the future, and disruption of primary task performance. On the other hand, mindful awareness is frequently described as a focus on present sensory input without cognitive elaboration or emotional reactivity, and is associated with improved task performance and decreased stress-related symptomology. Unfortunately, such distinctions fail to acknowledge similarities and interactions between the two states. Instead of an inverse relationship between mindfulness and mind wandering, a more nuanced characterization of mindfulness may involve skillful toggling back and forth between conceptual and nonconceptual processes and networks supporting each state, to meet the contextually specified demands of the situation. In this article, we present a theoretical analysis and plausible neurocognitive framework of the restful mind, in which we attempt to clarify potentially adaptive contributions of both mind wandering and mindful awareness through the lens of the extant neurocognitive literature on intrinsic network activity, meditation, and emerging descriptions of stillness and nonduality. A neurophenomenological approach to probing modality-specific forms of concentration and nonconceptual awareness is presented that may improve our understanding of the resting state. Implications for future research are discussed.

Keywords

mindfulness; meditation; awareness; mind wandering; resting state

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At the still point of the turning world. Neither flesh nor fleshless; Neither from nor towards; at the still point, there the dance is, But neither arrest nor movement.

–T.S. Eliot^a

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Conflicts of interest: The authors declare no conflicts of interest.

^aEliot, T.S. 1943. *Burnt Norton. Four Quartets*. Orlando: Harcourt.

Introduction

What are the phenomenological characteristics of a restful mind? With eyes closed, removed from external distraction, a state of wakeful relaxation may easily be cultivated. Yet, left to its musings, it is common for the mind to experience a relentless stream of evaluative thoughts, emotions, or feelings without much effort. “Monkey mind” is a metaphor for the mind’s natural tendency to be restless— jumping from one thought or feeling to another, as a monkey swings from limb to limb. Given the heavy demand of modern life on cognitive load, managing the onslaught of ongoing sensory and mental events throughout daily life and improving efficiency of mental processing is of high concern. Tranquility and stillness of mind, as described in the Buddhist *Nikayas*,^b are believed to reflect a natural settling of thoughts and emotions, in which there is stability of attention, sensory clarity, and equanimity of affect and behavior.¹ This state is believed to develop through systematic mental training involving a combination of concentration, nonconceptual observation, and discernment.^{2–4}

Although the majority of research on brain function has focused on task-evoked activity, current research focusing on the task-unrelated resting mind–brain is beginning to reveal the critical importance of this largely ignored part of human life. Since the advent of neurophysiological recording, it has been determined that the brain is never truly resting. Hans Berger first observed that all states of wakefulness and sleep reveal a spectrum of mixed amplitudes and frequencies of electrical activity that does not cease. According to thought-sampling studies during mind wandering,^{5–7} the content of the restless mind is often incredibly rich and self-relevant, characterized by spontaneous thoughts and emotions concerned with the past and hopes, fears, and fantasies about the future, often including interpersonal feelings, unfulfilled goals, unresolved challenges, and intrusive memories. With respect to cost and benefit, research on the “resting state” is demonstrating how task-unrelated or stimulus-independent thought (SIT) may adaptively organize brain function⁸ and how the intrinsic neural activity supporting SIT affects brain metabolism and neuroplasticity.^{8–11} Although there are certainly benefits to having access to the rich landscape of spontaneous thoughts for the purpose of creative incubation,^{7,12} problem solving,⁶ and goal setting,¹³ an inability to focus attention in the face of irrelevant distraction by such thoughts can be problematic. Unfortunately, humans have been shown to experience this intrinsic undercurrent of spontaneous, self-generated thought during ongoing task demands as a form of interference, distraction, or rumination approximately 50% of each waking day.^{5,14} SIT often interferes with the ability to remain externally vigilant,^{15,16} remain focused or concentrate on the task at hand,¹⁶ properly encode external information,¹⁷ listen,¹⁸ perform,^{16,19} or even sleep.²⁰ In addition to the apparent inefficiency that SIT contributes to daily life, there is now a large literature linking a majority of self-generated thought to negatively valenced content and negative mood states,^{21,22} future unhappiness,⁵ and the maintenance of psychopathology, such as generalized anxiety disorder^{23–25} or major depressive disorder.^{26,27} Most recently, there has been interest in exploring how particular forms of mental training that include a state of mindful awareness allow individuals to

^bEarly schools of Theravada Buddhism describe a collection of scriptures and suttas in the P li Canon.

change the relationship with the resting state and experience the stream of stimulus-independent mental content in an adaptive way.^{28–30}

Mindfulness and mind wandering are often described as two divergent mental states;^{31,32} yet, both are frequently referenced in the context of mental rest. There is a subtle difference in both awareness and engagement with the flow of mental objects that may determine the adaptive or maladaptive nature by which the mental content influences one's current mood and future behavior (Fig. 1). Currently, there is great interest in better understanding the neural mechanisms that support resting-state dynamics, states of mindful awareness, and their respective contributions to mood and cognition (see Refs. 31 and 32). In this article, we examine a more nuanced perspective on particular mental states that reflect “rest,” mental quiet, stimulus independence, and the neurobiological and physiological circuitry supporting the various flavors of what may constitute a “restful mind.” Occasionally, references are made to the historical Buddhist literature for the purpose of exploring an epistemology of mind as it relates to contemporary secular adaptations of the construct mindfulness.

The (not-so) resting state: mind wandering, evaluation, and self-referential processing

The resting state is commonly referred to as the baseline state of mind in quietly awake individuals and in the context of no particular task. Given its task-negative orientation, the resting state has been used as a functional contrast for most active task-positive conditions in functional neuroimaging studies.^{33,34} In fact, this state has been used as a control or baseline condition against conditions of interest in an overwhelming number of neuroimaging studies, since such methods were introduced in the early 1980s.³³ The instructions for this passive baseline state are frequently given in some variation of, “let your mind freely wander without thinking of anything in particular,” “relax,” or “stay still and do nothing,” and involve either eyes opened or closed; however, to avoid the occurrence of sleep, many protocols have encouraged the use of open eyes, with (and without) a fixation cross as a visual stimulus on which to rest one's eyes.

Interest in the resting state has mostly reflected the interest in the methodological function by which to probe spontaneous low-frequency (<0.1 Hz) blood oxygen level-dependent (BOLD) fluctuations (LFBF) that demonstrate consistent spatially and temporally coherent connectivity among large-scale functional brain networks.^{35–38} Across each of the variations in the above-mentioned instructions, there is robust consistency in detection of these networks, suggesting that low-level physiological noise, task load (fixation), eye movement, or the presence of visual input cannot influence the results.³⁹ Furthermore, these large-scale intrinsic resting-state networks (RSNs) appear to reflect a fundamental aspect of the brain's organization and are consistently apparent across waking states, including task performance, sleep,⁴⁰ and even general anesthesia.⁴¹ At least 10 organized RSNs have been identified during rest, including the default mode network (DMN; Fig. 2), with each one reflecting specific functions that cohere to the intrinsic connectivity patterns (i.e., language, attention, executive functioning, salience, sensorimotor activity, or mind wandering).^{42–45}

A critical consideration in the interpretation of spontaneous LFBF is the extent to which it is due to specific functional behavior or mentation. There is evidence that varied mental content during the resting time period can modulate functional activity across RSNs, suggesting content has an effect on functional variations in LFBF.^{46,47} This would seem plausible given that people are engaged in unconstrained mind wandering while laying quietly awake in a magnetic resonance imaging (MRI) scanner, with a variety of mental content to account for low-level task activation.⁴⁷ Yet, there are a number of arguments³⁸ supporting the idea that mentation during mind wandering is unlikely to be the dominant source of LFBF.³⁸ Nevertheless, task relevance is often difficult to determine with SIT, unless it is in direct contrast to some attentionally demanding task. Mental content during mind wandering may indeed be of critical importance to task-related processing (e.g., memory consolidation, prospection) or to other ongoing processes that are fundamental to self-specificity.^{14,48,49} Spontaneous fluctuations found in RSNs are believed to be regulated differently than task- or stimulus-driven brain activity. One popular theory holds that the intrinsic activity from LFBF may be more closely related to long-range coordination of higher frequency electrical activity that facilitates coordination and organization of information processing across several spatiotemporal ranges.^{50,51} Metabolic demands at rest also do not suggest a strong correlation with cellular activity;^{8,10,51} yet, the resting state does not reflect a zero-activity physiological baseline from which attention manifests.

The resting state has historically been referred to as the default mode, because it has been thought to reflect the dominant mode by which coordinated intrinsic activity ongoing at rest is defaulted to, and to which it returns when attentional demands cease.⁸ Despite its regular occurrence, not all minds wander to the same degree; there are stable differences among individuals in the propensity to experience SIT and engage the DMN.^{14,52} Nevertheless, the reciprocal relationship between the passive task-negative state of rest and the active task-positive states is thought to support two fundamentally different modes of information processing—one serving internally oriented attention and another serving externally oriented attentional demands. The DMN shows the most robust anticorrelation with attentional networks, apparent during externally oriented tasks, suggesting that it is fueling task-negative internally directed functional activity.

The DMN, also described as the hippocampal–cortical memory system,^{53,54} has most consistently been shown to include the ventral posteromedial cortex (vPMC; including posterior cingulate cortex (PCC) and retrosplenial cortex), ventral medial prefrontal cortex (vmPFC), posterior inferior parietal lobe (pIPL), hippocampus, and lateral temporal lobe.^{36,39,55,56} The DMN has occasionally been reported to also include the dorsomedial/rostromedial PFC (including BA 8, 9, and 10), rostral anterior cingulate cortex (rACC, or anterior medial PFC), insular cortices, and temporal pole.^{52,57,58} Interestingly, these additional regions have been implicated in task-positive networks and goal-directed activity, suggesting possible overlap of networks with potential functional relevance, and apparent nonstationarity or change over time seen in typical functional connectivity (fc) analyses.⁵⁸ Such observations of nonstationarity also suggest a problem with implicating one network supporting a rapidly changing mental state at rest.⁴⁷ In fact, some recent work has suggested that the DMN may be broken into multiple subsystems that subserve different dimensions of stimulus-independent or stimulus-oriented mentalizing during the resting state.^{52,59,60}

Notably, core DMN regions have been reported to support active states associated with self-reflective, evaluative processes in addition to supporting passive mental states of rest, further suggesting that the resting state involves internally oriented evaluative processing.^{36,52,61–63} Self-referential processing involves taking one's self as the object of attention and making judgments or evaluations of one's own thoughts, emotions, or character.^{34,57} These functional roles have provided the basis for the characterization of the DMN as an evaluative network and has implicated the network in both spontaneous and volitionally mediated mind wandering.⁴⁹ The primary nodes of the DMN (PCC and vmPFC) are particularly noteworthy because of their anatomical connections and corresponding functional roles. For example, the vmPFC has direct anatomical connections to the hypothalamus, amygdala, striatum, and brainstem, providing input necessary to process emotion, motivational states, and arousal.⁶⁴ Its functional role in coordinating and evaluating basic drives associated with mood, reward, and goal-directed behavior is also strongly supported by the abovementioned anatomy and by its activity in functional brain imaging studies, animal experiments, and behavioral observations in patients with vmPFC lesions.^{65,66} The PCC is considered to be a network hub with dense anatomical connections across the brain and in particular with the medial temporal lobe, making it and neighboring regions of the vPMC well suited for mediating autobiographical memory retrieval and self-referential processing.^{43,67} Recent studies have suggested that vPMC activity may be functionally reduced to being “attached to” and “getting caught up in” one's experience, whether it be self- or other-focused, or negatively or positively valenced.⁶⁸ In this context, self-reflective processing consumes one's cognitive resources and interferes with ongoing task demands and/or embodied behavior.

A large body of research on the resting state now supports the involvement of the DMN in a diverse array of cognitive processes that are associated with negative or maladaptive mood states, such as rumination, craving, or distraction.^{14,34,68} There is evidence that, in most forms of psychopathology, the DMN is hyperactivated and hyperconnected, showing abnormally high activation during goal-directed tasks.³⁴ These data suggest that task-dependent downregulation is not as apparent and that patients suffering from psychiatric disorders may be more easily distracted by internal ruminations.⁶⁹ Furthermore, greater suppression of the DMN during task performance has been shown to improve accuracy, memory encoding, retrieval, and consolidation.^{70–72} Greater DMN activation just prior to a stimulus predicts attentional lapses and decreased accuracy, further providing evidence for its potential role in distraction.⁷² However, despite the predominant interpretation that DMN activity is indicative of maladaptive functional processes, this interpretation may be overly simplistic. SIT and associated DMN activity have been characterized by content that is adaptive and constructive.^{6,57} For example, in healthy individuals, SIT has been shown to facilitate insight, creative problem solving, cognitive control, and prospection for simulating future possible outcomes.^{12,22,73,74} The critical point here is that the costs and benefits of DMN activation are context dependent.^{14,75} Indeed, Smallwood and Andrews-Hanna¹⁴ proposed the context-regulation hypothesis, which states that self-generated thought under conditions that demand continuous attention is unproductive because it can be a source of error, but under nondemanding conditions, it has the potential for benefit.

Although some may argue that there is no apparent functional relationship associated with spontaneous, intrinsic activation of the DMN, an argument can clearly be made claiming the

benefit of spontaneous or intentional DMN activation as it reflects our sense of self-identity. DMN activation supports conceptual, linguistic, and symbolic forms of self-representation involving a form of “mental time travel,” which explicitly provides a sense of coherence and continuity with our sense of self in the present moment by allowing one to project representations of self into the future and retrospectively to the past.^{14,76} Tulving⁷⁶ described this mnemonic process involving episodic forms of autobiographical memory as “autonoetic consciousness,” suggesting a conceptual knowing and awareness of self in real time. Tulving and others^{77–80} argued that this uniquely human ability^c provides the necessary cognitive structure for advancing intelligence, building on existing knowledge, discriminating ethical and adaptive behavioral responses to the environment, and “day dreaming” for advanced forms of cognition. One could then imagine that, without opportunities to cultivate autonoetic consciousness, mistakes would be repeated, decisions would be poorly informed, and a sense of identity would be lacking. Mind wandering and the associated DMN activity may, therefore, reflect intrinsic capacities that are necessary to navigate the complex social environment in which humans exist.^{14,81} Indeed, maintaining a sense of continuity of the self, with reliance on mnemonic processes and DMN activation, contributes to the highest functional and metabolic demands of the brain during waking states.

Mindful awareness: stillness in concentration

From the classical Buddhist Abhidharma perspective, stability and stillness of mind provide freedom from destructive types of emotion and cognition (e.g., anger, craving, greed, lethargy, hyperexcitability) that are rooted in excessive self-absorption or perseveration.^{4,82} The following metaphor is commonly used to describe how the foundation of mindfulness may contribute to the benefits of a still mind, focusing on cultivating attentional stability and reduced unintentional mind wandering. If a stone is tossed into a still lake, the ripples are clearly visible. Yet, when that lake is unsettled, a single stone's effect is barely noticeable. The same is true of the mind,⁸³ in that a restless mind that is fraught with many thoughts and emotions is easily distracted, inefficient, and unable to adequately encode information for later retrieval. Furthermore, if one leaves a glass of muddy water still, without moving it, the dirt will settle to the bottom, and the clarity of the water will shine through. Similarly, in mindfulness-based meditation, in which attention is trained to continually return to a single point of concentration, thoughts and emotions settle into what is described as the mind's natural state of stillness, ease, equanimity, and sensory clarity.^{3,84}

In the text *Stages of Meditation*, an 8th century Indian Buddhist contemplative, Kamalasila describes 10 sequential stages of attention training, referred to as “taming the mind” or “calm abiding” (P li: *samatha*) that begins with an effortful form of focused attention (FA) and progressively advances toward a state of effortless and objectless awareness.⁸² Stability of attention refers to sustained concentration and vigilance that remain unperturbed by distraction or interference from discursive mind wandering, while clarity refers to the

^cAlthough Tulving argues that mental time travel is uniquely human, there is good evidence to suggest that scrub jays can cache food in a manner that reflects both planning for the future and some form of mental time travel to retrieve detailed information on when and where the food was cached.⁷⁹

phenomenal intensity with which sensory or mental content is experienced.^{82,85} Insight practice (P li: *vipassana*), a form of open monitoring (OM) meditation, typically follows calm abiding training with the goal of facilitating meta-awareness of one's own mental habits, increasing the aperture of awareness to all sensory and mental objects that naturally arise and pass. Mindfulness meditation is often taught as an interplay between calm abiding and insight meditation. Therefore, according to the classical Buddhist Abhidharma, one depiction of a restful mind is one that requires concentration, but is calm, alert, and holding an object or stream of objects in effortless awareness.

Although the breath is the most commonly described object of focus in historical Buddhist contexts (e.g., *Satipatth na sutta*), concentration may be on any internal or external sensory object across modalities, the temporal flow of objects arising and passing through space/time, or the restful state where no objects are present (Table 1). One particular contemporary mindfulness system, the Basic Mindfulness system,⁸⁶ was developed by Shinzen Young with multiple Buddhist traditions in mind and uses an algorithmic approach that teaches individuals to note and label any experience in three modalities (visual, auditory, or somatic). Sensory objects can be noted and labeled as they arise and pass in OM meditation, or there can be a concentrated focus on one particular modality and experience (i.e., subjective, objective, rest, or flow). A focus on rest is one particular concentration method for cultivating a quiet mind with specificity in each modality, such that absence of the sensory object becomes the object of focus and any impulse to engage with external or internal sensory objects is regulated. Young⁸⁶ describes “see rest” as a focus on the “gray-scale blank” with eyes closed or “into image space but not at an image” with eyes open; “hear rest” is described as “mental quiet” or “physical silence” around the practitioner; “feel rest” is referred to as a focus on the “physical relaxation and absence of emotion in one's body.” The different levels of absorption, modalities of concentration, and associated objective neurophysiology have yet to be fully characterized.

Meditative concentration is sometimes referred to as “one-pointedness” (Sanskrit: *sam dhi*) or “absorption” (P li: *jh na*). In Tibetan, *sam dhi* is translated as *ting nge dzin*, where the syllable *dzin* means “to hold” and the syllable *nge* is an adverb meaning “to hold something unwaveringly.” The *Nik yas* mention variations of *sam dhi* and give descriptions of deepening levels of absorption on the object of attention. Four stages of absorption on form (Sanskrit: *rupa jh nas*), four on formless (*arupha jh nas*), and total cessation of perception and feeling (*nirodha-samapatti*) are described in progressive stages of concentration and stillness. At the fourth stage of the *rupa jhanas*, the mind is focused on a “material” object with equanimity and a narrow aperture of awareness (Fig. 1), such that no other sensory stimuli can enter awareness. By the first formless stage, the meditator achieves insight that there is no longer an object, but rather infinite empty space. The formless states and nondual awareness appear to have similar characteristics, none of which have yet been clearly distinguished in cognitive neuroscience. Stages of *jh na* practice have been observed in one functional MRI (fMRI)/electroencephalography (EEG) case study of a long-term Sri Lankan *Khema* practitioner who was able to progressively move through each of the eight stages of form and formless absorption practice.⁸⁷ This study found decreased BOLD activity relative to the resting state and a basic state of concentration (access concentration) across visual, auditory, language, and premotor regions of interest; slight increases in the rACC and ventral

striatum; and a shift to lower frequency α and θ bands in EEG.⁸⁷ Interestingly, the study suggested that ventral striatal activity corresponds to the subjective experience of joy during early stages. In the historical Hindu context of the yoga suttas, *sam dhi* is believed to represent nondual or transcendent states of conscious awareness and absorption where the sensory or mental object is known directly, beyond name and form, and a feeling of unity or oneness is experienced with the object of meditation.^{88–91} These descriptions of concentration practice suggest that, through practice and depth of concentration, mental quiet shifts from stable perception of an object to a state of nondual awareness where there is a dissolution of self–object distinctions.

In contemporary contexts, comparisons have been drawn between states of mindfulness in concentration and experiences of “flow,” “the zone,” peak states of performance, and the opposite domain—“zoning out.” Although there are clear similarities of *sam dhi* with states of flow, distinctions can be made. Critically, *sam dhi* is described to involve intentional blocking of sensory information and yet allowing motivationally relevant information to enter conscious awareness.⁴ Without volitional control, absorption in an object with focal awareness may also be maladaptive, such that inhibitory processes prevent pertinent sensory information from arising to conscious awareness, potentially leading to an overwhelming sensation and maintenance of emotional reactivity related to the object of focus.⁹³ Furthermore, the experience of zoning out, as is commonly experienced during a temporally extended, exogenous attentional process that involves low arousal or does not require analytical or critical discernment (e.g., watching television), has also been described as an “intense immersion in the moment;” yet, the individual “typically loses touch with the socially, culturally, and historically constructed world in which he or she lives.”⁹⁴ This has been described as “meditation sickness” in Zen traditions that heavily emphasize methods that focus on achieving “inner stillness” over those that engage with the scriptures or discriminate right from wrong in an analytical or critical way.⁹⁴

Mindful awareness: stillness in nonduality

Later stages of both *jh na* and *samatha* practice place less emphasis on engagement and disengagement with objects of attention and more with nonduality, which refers to the eventual dissolution of subject–object distinctions, nonconceptual awareness, and a phenomenology described as the true nature of mind—an ultimate form of stillness.^{82,85} Nonduality is most commonly equated with the concept of reflexive awareness (Sanskrit: *svasamvitti*)⁹⁵ or “bare attention,” coined by the German-born monk Nyanaponika Thera in his book, *The Heart of Buddhist Meditation*.³ This nonconceptual emphasis on living in the here and now is believed to have contributed to the foundations of contemporary mindfulness and of the therapeutic recipe for well-being.^{94,96} In traditional nondual practices of mindfulness (e.g., Chan, Zen, Mahamudra, Dzogchen),⁹⁷ there is emphasis on the subject–object distinction as the root of suffering. The Sanskrit author Santideva describes this state of stillness as “remaining like a piece of wood,” such that any impulse toward a particular thought, emotion, or behavior can be heedfully detected but denied full engagement before the mental event requires cognitive resources.^{97,98} The general instructions for Mahamudra practice are, “Do not chase the past; do not invite the future; rest the awareness occurring now in a clear and nonconceptual state.”⁹⁷ There is clear instruction

to avoid self-reflective processing and maintain focus in the present; yet, the idea in this practice is not to cultivate a state of *sam dhi*, but rather to release any effort, let go, and not engage with any object. In contrast to the stillness derived from focused concentration, the nondual emphasis is believed to cultivate stillness through an objectless focus. The nondual state has been referred to in Tibetan styles of Dzogchen as “open presence” (Tibetan: *rigpa chogzhag*) and also as “awakening” (P li: *bodhi*) or “nibbana.” Many Buddhist traditions see this as a goal state, where there is a cessation of all “unwholesome” states and all phenomena, including space and time.⁹⁹ Understandably, this state of awakening is highly contextualized in the schools of Buddhism from which they are originally described, and there has yet to be objective evidence for the reproducibility of this state. However, the state of open presence has been most closely associated with a nonreferential form of compassion that has been shown to dramatically increase γ -band activity in advanced meditators across frontal and temporoparietal regions.¹⁰⁰ This activity was also found to correlate very closely with subjective reports of clarity during the practice and remain high in amplitude even after the meditation was complete.¹⁰⁰ γ -Band synchrony is believed to reflect control and temporal binding of local neural activity by distributed neural networks.¹⁰¹ Theories of attention specify that continuous activation of task-relevant brain areas is driven by high-frequency γ -band activity, and greater magnitude of activity reflects stronger links between attention and sensory inputs.¹⁰¹ Other neuroimaging experiments on nondual states have demonstrated unique, weak anticorrelations between the attentional networks and the DMN in comparison to stronger anticorrelations during FA practice, suggesting less inhibitory tone over other incoming sensory or mental input.¹⁰² Although both concentration and nondual approaches appear to cultivate stillness in unique ways, the qualitative phenomenology may indeed be similar.

Mindful awareness and discernment versus mind wandering and evaluation

Recently, a number of studies have suggested a therapeutic role of mindfulness-based therapies in neuropsychiatric settings, in which symptoms are reduced explicitly through the reduction of persistent DMN activity and associated narrative self-processing interfering with goal-directed tasks.^{103–108} This is particularly emphasized in contemporary mindfulness settings where nonconceptual awareness or nonjudgment is emphasized. Indeed, the practice of various styles of mindfulness-based meditation purportedly involve a decrease in self-reflective processing and evaluation.^{28,30} It is therefore not surprising that, across styles of practice, meditation is found to inhibit activity of nodes within the DMN, similarly to any goal-directed task.^{104,109–114} Furthermore, reports of improved quality of the meditation state¹¹⁵ or greater meditative experience¹¹⁶ have been associated with greater decreases in magnitude of activation in primary nodes of the DMN. The PCC, a major node in the DMN, has specifically been targeted for real-time neurofeedback, with the goal of improving one's stability of attention across styles of meditation.^{115,117} Such results support the idea that meditation practice is undeniably an active cognitive process, and with greater expertise, the magnitude of the inverse correlation with DMN activity becomes greater,¹⁰⁹ suggesting that greater levels of effortless concentration may more robustly reduce activation in the DMN. Generally, one would expect such deactivation of the DMN during any goal-directed task, especially in contrast to a nonmeditative state following instructions to the

mind wander³⁸ or in contrast to a task that specifically recruits self-reflective processing.¹¹⁸ However, without any explicit instruction to process internal information in a discursive, narrative self-focus, a nonmeditative rest condition may no longer reflect the same mental content, process, or valence for an advanced meditator as in a novice practitioner. In fact, recent data have suggested that meditative expertise may transform the resting state into one that is more similar to a meditative state.^{109,119} Furthermore, recent studies have demonstrated that spontaneous mind wandering that engages the DMN may still be apparent, but less frequent, during meditation or during nonmeditative states.^{105,120} Yet, the contrast between a traditional nonmeditative resting state and particular styles of meditation provides considerable insight into the restful mind and how it engages with mental objects with and without awareness.

Although these results appear to suggest that mindfulness is involved in suppressing the DMN and associated self-reflective processing, this interpretation may be an oversimplification for the explanation of meditative expertise. Mindfulness is not merely the opposite of mind wandering, nor is it necessarily always present focused (see Refs. 94 and 96). Upon closer inspection of the meaning of mindfulness from the Sanskrit, P li, or Tibetan translations, there is a controversial emphasis on cognitive processes “to recollect,” “to bear in mind,” and “to remember.”^{2,94,96} This is in contrast to the typical instruction to stay in the present moment of awareness without judgment.¹²¹ Across schools of Buddhism, two aspects of mindfulness are often described, one in which there exists a nonconceptual state of awareness (P li: *sati*) and another that involves discernment (Pali: *sampaja a*),^d requiring active reflection, judgment, and action in relation to the sensory or mental objects observed.^{2,4} In fact, the compound *sati-sampaja a* is often found in the classical Abhidharma or Nikayas to describe a state of mindfulness.⁸⁴ Discernment is a cognitive process that reflects continuous access to, and appraisal of, the objects of attention as they arise, so that no thought can be developed into action unchallenged.² It facilitates recollection of Dharmic teachings and primes prosocial motivations. It is a process described to help eradicate mental afflictions and motives that potentially affect self-development on a moment-to-moment basis.¹²² Without such discernment, the Abhidharma continues to explain that the mind begins to wander toward afflictive thoughts and emotions. Mindfulness and discernment are also described to develop a self- or meta-monitoring faculty that can detect when the goal state of concentration on a particular object has shifted and support a reorientation of attention to the goal-relevant object. 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.¹²³

Given such descriptions, we hypothesize that a state of mindful awareness critically involves rapid flexibility between brain networks that are contextually driven by specific mind states of the practitioner. Building on previous models of mindfulness-based meditation processes,^{28,30,124} we propose that a frontoparietal control network (FPCN) is appropriately situated to couple with, and integrate information across, other contextually relevant networks. The

^d*Sampaja a* is also described in nondual traditions as a form of “monitoring,” rather than “clear comprehension” in Theravadin texts. Thus, this aspect of mindfulness may reflect a state of meta-awareness, decentering, or dereification that reflects an interaction between task-set retention and background awareness.⁹⁷

FPCN has the potential to support a volitional focus of stable attention and nonconceptual meta-awareness across bodily systems with a high level of sensory clarity and facilitate rapid discernment and evaluation of each object without strong engagement as mental objects arise and pass in the practitioner's phenomenological space (Figs. 1 and 3). As described by Cole *et al.*,⁴⁵ the FPCN is believed to act as a hub to enhance connectivity between all other RSNs.

The dorsal attention network (DAN) is associated with externally directed cognition, including covert and overt shifts of attention, eye movements, and hand–eye coordination.¹²⁵ It increases in activation at onset of search, maintains activity while awaiting a target, and further increases when targets are detected.^{73,125,126} It is bilaterally represented and includes frontal eye fields (FEFs), ventral premotor cortex, superior parietal lobe, intraparietal sulcus (IPS), and motion-sensitive middle temporal area (MT+).⁵⁴ The DAN facilitates orientation in the sense that it is engaged by cues that prime the system for forthcoming stimuli.¹²⁶ In contrast, the ventral attention network (VAN) is not engaged by predictive cues and, in fact, is kept under inhibitory control, likely by top-down regions, such as the dorsolateral prefrontal cortex (dlPFC), for the purpose of reducing distraction or allowing unintended information from flooding conscious awareness.¹²⁵ The VAN is strongly right-hemisphere dominant and includes the temporoparietal junction (TPJ) and ventrolateral PFC (vlPFC) as major nodes. The VAN continues to direct attention to salient and behaviorally relevant sensory stimuli outside the focus of processing maintained by the DAN.¹²⁶ The FPCN has been shown to have extensive connectivity with both the DMN and attentional networks (DAN, VAN), supporting the potential to flexibly couple with either network, depending on task demands.⁷³ The FPCN includes the VAN, nodes of salience (dorsal anterior cingulate (dACC) and AIC) and executive control networks (dlPFC), as well as the anterior inferior parietal lobe (aiPL), frontopolar cortex (FPC), and dmPFC.^{54,73} Together, this circuit is believed to link sensory representations to motor maps and facilitate the critical meta-awareness function that then engages a circuit breaker for sustained attention and reorientation of attention as new objects arise and pass.¹²⁶ Although frontal areas are responsible for voluntary executive control, parietal regions in concert with frontostriatal circuitry are more involved in stimulus–response associations and would likely become more critical as effort decreases.¹²⁶ The DAN and VAN may communicate through the FPCN when there is an intention to actively manipulate the information for some purpose. For example, the VAN is critical for semantic retrieval in the context of inhibitory control.¹²⁷ Through a relatively short temporal window, it has been proposed that the FPCN may help link active attentional processes associated with sustained vigilance and alerting with the semantic retrieval and reorientation of attention to task-relevant, but currently unattended, stimuli facilitated through the VAN.¹²⁶ The FPC takes up a uniquely large volume of space in the human brain,¹²⁸ is a critical node of the FPCN, and is thought to be differentially sensitive to changes in demands for stimulus-oriented or stimulus-independent attention along a lateromedial dimension.⁷⁴ This may be why this region is sometimes included in the DMN and at other times included with the frontoparietal or executive control network.^{52,60,63} One study observed the recruitment of both rostromedial and lateral FPC during mind wandering with a lack of awareness; whereas, mind wandering with awareness was found to recruit nodes of attentional networks (lateral PFC and dACC) in addition to the

PCC/precuneus, TPJ, insula, and temporal pole, suggesting a processing overlap that could account for poor task performance.⁶³ Yet, future research will have to clarify whether this type of retrospective experience-sampling method represents a form of nonconceptual meta-awareness that is likely in meditative practice or meta-cognition to involve some level of “mental stickiness” and contributes to distraction and future planning.

Although some methodological challenges remain in interpreting some of the existing initial findings for network interactions (see Ref. 31), recent cross-sectional fc studies of meditators have generally demonstrated increased connectivity between the two main nodes of the DMN (PCC and vmPFC) and between nodes of the DMN and salience and executive networks during a nonmeditative resting state.^{109,111,114,129–132} These studies reflect changes that are sustained in nonmeditative states. In a small number of studies, increased fc has been found between DMN nodes and task-positive regions (e.g., dACC, dlPFC) during and across styles of meditation practice (Fig. 3). Although some of the methodological discrepancies are difficult to interpret, these preliminary studies support the hypothetical flexible switching between networks and the potential functional relevance between nonconceptual awareness and discernment.

There is now evidence to suggest that the FPCN may be actively recruited through both OM and FA meditative practice.^{133–135} Recent meta-analyses of both morphometric and functional neuroimaging studies of FA and OM have demonstrated increased size and activity in regions of the brain associated with the FPCN (FPC, dACC, dmPFC, dlPFC), areas also associated with the salience and executive networks.^{133,135} Parts of the DMN (PCC, pIPL) have been shown to decrease in activity during OM and FA mindfulness-based practices.^{134,135} These data suggest mindful awareness may not only contribute to a quiet mind embedded in concentration, but may also be critical for allowing individuals to flexibly switch between externally and internally driven processes in a volitional manner, drawing from inner reflection and focusing externally with more control than a control population.³⁰

Thus, a more nuanced reflection on the state of mindfulness, especially in the context of OM meditation, demonstrates significant similarities, and an interaction, with a state of mind wandering. Both mind wandering and OM meditation involve attentional orientation to mental objects arising and passing with each moment (Fig. 1). Yet, subtle differences in attentional engagement, task relevance, emotional reactivity, and perceptual clarity determine the extent to which each state, and the content associated with each state, contributes adaptively (or not) to current mood or future behavior. In the context of OM meditation,^{30,124,136} thoughts or emotions may arise, but the practitioner is typically instructed to refrain from engaging purposely with the content and to rather remain a witness as a nonattached observer to the content as it arises and passes without any form of appraisal. Such attentional processing will reduce cognitive elaboration and, thus, increase the speed at which one may disengage from objects of attention or reduce mental stickiness—a concept often described in contemporary mindfulness^{137,138} as a disengagement deficit, more often found in SIT, and as a natural tendency to dedicate resources to an object of attention, such that few resources remain to capture any other pertinent environmental information until one is able to disengage and reorient. 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.^{139–141}

There is some evidence suggesting that intensive training in meditation techniques reduces mental stickiness by enhancing monitoring of attention,¹⁴² increasing a distributed attentional focus,^{143–145} enhancing speed of attention allocation, engagement, and subsequent disengagement from serially presented objects of attention.¹⁴⁶ One of the best examples of this decrease in stickiness, or faster disengagement, in the extant meditation literature is shown by data from an attentional blink task¹⁴⁷ by practitioners who completed 3 months of intensive meditation training.¹⁴⁶ A smaller attentional blink and reduced brain-resource allocation to an object of attention (the first target) were found, as reflected by a smaller target 1 (T1)-elicited P3b, a brain-potential index of resource allocation peaking around 300–450 ms (Fig. 4).¹⁴⁶ Those individuals with the largest decrease in brain-resource allocation to T1 generally showed the greatest reduction in attentional-blink size, and improved detection of T2. These observations provide strong support for the view that the ability to accurately identify T2 depends on the efficient deployment of resources to T1. Such data are also suggestive of reduced elaborative processing in the context of goal-directed activity. It should be clear that this process of discernment and evaluation may be operating below conscious awareness, at the level of nonconscious perceptual processing—an aspect of attentional filtering that has previously been described as a potential source for affective and attentional bias.^{29,148,149}

Discussion

In this article, we illustrated how the phenomenology of a restful mind can take adaptive or maladaptive forms that are context and content dependent. A sense of peace and quiet in the mind is proposed to arise through mental training in concentration, nonconceptuality, and discernment, in contrast to the untrained frenetic restlessness of mental time travel that is characteristic of daily activity in the postmodern setting. The frenetic resting state and associated brain network dynamics are believed to help scaffold attention and emotion throughout everyday waking life, but with the potential to interfere with cognitive performance, mood, and affect when mind wandering occurs in the context of cognitive demand. Mindfulness-based meditation is often viewed as the antidote for mind wandering, positing an overly simplistic polarization of mind wandering as bad and mindfulness as good. However, building on existing efforts to introduce a more nuanced perspective on the relationship between mindfulness and mind wandering,³² we describe a potential neurocognitive framework in which mental training associated with mindfulness allows the practitioner to more skillfully gain volitional control, flexibility, and awareness over mind wandering, evaluation, and associated DMN activity without necessarily suppressing or avoiding the flow of mental content. Considering the functional role and dynamics between RSNs is complex, and, thus, the exact role played by the DMN and other attentional networks is likely to be context specific and modulated by the specific practices in which an individual engages. As a function of the situational demands, the FPCN is specifically proposed to rapidly and flexibly couple with the DMN and other attentional networks for contextually appropriate engagement and disengagement with relevant objects in the ongoing stream of mental and sensory content. Thus, a sense of tranquility or stillness of

mind involves the elimination of distortions and distractions in an effortless and sustained form of awareness and can have lasting effects on one's mental habits, biases, and worldview in relation to the surrounding world. It is likely that a highly developed meta-awareness in the context of mindfulness-based practice may offer a key mechanism for rapid discernment of what is relevant at early stages of attentional processing while also providing sensory clarity and emotional stability through each moment of experience.

Unfortunately, there is a particular rhetoric surrounding the emphasis of nonconceptuality, nonjudgment, and present-moment focus that continues to lead to ethical, social, and developmental passivity in the contemporary mindfulness movement. Given the secular emphasis of mindfulness on the present moment, there is regrettably less emphasis on the benefits from an efficient ability to draw consciously from past experiences and the capacity to reflect inwardly. On closer inspection of the state of mindfulness, we discuss here the benefits of judgment, evaluation, conceptuality, and DMN activity to provide a more nuanced description of brain network interactions and the benefits delivered by these meditation techniques that are continuing to emerge in contemporary society. More broadly, these skills are not emphasized for personal gain, but rather to ultimately nurture the human connection and sense of meaning and purpose that provides the foundation for the benefits of realizing stillness.

Although the current theoretical analysis remains speculative, continued consideration of the resting state in comparison to meditation practice is likely to reveal specialized insights into brain function, energy metabolism, conscious awareness, and therapeutic relevance for psychiatric conditions. Future research investigating differences between FA and OM practices may help clarify critical differences between focal and ambient awareness, and the ability for individuals to volitionally modulate types of information that enter awareness through engagement and disengagement processes. Other considerations for future research should include tracking phenomenology using qualitative empathetic interviewing skills¹⁵⁰ with explicit second-person methods built into the neuroimaging studies, in addition to correlating first-person reports with third-person measures of brain activity. This method could involve independent, unbiased interviewers who may help participants explicate their experiences in order to direct them toward phenomenological aspects of their experience and away from theorizing about it. Examining the stability of RSNs across meditation states, axiological frameworks, and across a phenomenology of clarity and mind wandering, may better reflect consistent therapeutic targets that are context specific. More consistency across fc analyses will have to involve choosing consistent seeds for analyses and tracking functional changes across states and rest in both clinical samples and meditation-naïve subjects who do not have a self-selection bias. As research progresses in this field, it is likely that differences between novice and advanced meditators will become apparent and may account for discrepancies in the ability to sustain/maintain nonconceptual forms of awareness during meditation and the speed with which practitioners can make discerning judgments. Indeed, even the greatest meditators report fluctuations in level of clarity with which meditative quality is experienced over time. Thus, future research would benefit from having closer measurements of neurophysiological changes as they directly relate to first-person reports on phenomenology of experiences, such as clarity in the context of meditation and throughout daily life.

Acknowledgments

The authors express gratitude to A.P. for the constructive feedback. F.Z. and D.R.V. wrote the paper.

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Figure 1.

Variations in awareness during meditation and mind-wandering rest. Visual (V), auditory (A), and somatic (S) modalities of experience are depicted. Awareness in the present moment is depicted by the blue band around mental objects arising and passing through time. Width of the band represents the temporal focus of awareness. The more temporally extended awareness is in time, the more mental stickiness and disengagement delays are apparent. Wider bands refer to difficulty disengaging from mental or sensory objects, greater projection into past or future experience, and a resulting smaller aperture. FA meditation focuses on only one mental/physical object in experience (somatic object is depicted here). All modalities of experience enter awareness in OM meditation and mind wandering (MW). Variations in qualities of object orientation (engagement/disengagement), clarity, and aperture in experience are depicted. These three qualities are represented, respectively, by the width of the circles for each mental object, brightness of the fill color, and diameter of the ring of awareness that sits in the present moment of time. Adept meditators are believed to experience higher clarity (phenomenal intensity) in both forms of meditation, whereas MW is believed to represent low clarity or dullness. Low object orientation or engagement represents less mental stickiness and rapid disengagement, leaving available more cognitive resources. Aperture (scope of awareness) is believed to be intentionally narrow for a concentration practice and high for OM practice. In MW, the spotlight of attention is typically narrow and unintentional because of increased engagement with each mental object; resources are subsequently depleted. Adapted, with permission, from Farb *et al.*²⁷ and Lutz *et al.*¹²⁴ See Lutz *et al.*¹²⁴ for more extensive descriptions of clarity and aperture, as well as for other potential experiential descriptors relevant to mindfulness.

Figure 2. RSN partition and global fc variability of other networks with the frontoparietal network (FPN). (A) Shown is the network partition of 264 putative functional regions in 10 major RSNs identified at rest through independent component analysis. (B) The connectivity between the FPN and all other RSNs and associated mean variable connectivity are shown. The FPN is believed to act as a hub to enhance connectivity between all other RSNs. Adapted, with permission, from Cole *et al.*⁴⁵

Figure 3.

Comparison between mind wandering and OM meditation. Evaluative processes and associated DMN activity process visual, auditory, and somatic modalities and inhibit FPCN, VAN, and DAN attentional networks from gaining meta-awareness. The VAN (vIPFC and TPJ) is critical for reorienting, while the DAN (FEF and IPS) is critical for sustaining attention. Mind wandering and OM meditation process the same inputs (visual, auditory, somatic). OM has increased activation of attentional networks and flexible switching between networks. Mind wandering has less connectivity across networks and therefore lacks the meta-awareness to detect unintentional self-reflective or evaluative processing. The FPCN not only acts as a hub for detecting irrelevant mind wandering, but also for facilitating rapid discernment and evaluation when contextually appropriate. Thickness of lines represents proposed strength of connectivity between networks. SMA/PMA, supplementary and premotor areas; IPS, inferior parietal sulcus; pIPL/aIPL, posterior/anterior inferior parietal lobe; PI, posterior insula; AI, anterior insula; dmPFC, dorsomedial prefrontal cortex; vmPFC, ventromedial prefrontal cortex; r/dACC, rostral/ dACC cortex; S1, primary sensory cortex; PCC, posterior cingulate cortex; RSP, retrosplenial cortex; FPCN, frontoparietal control network; VAN, ventral attention network; DAN, dorsal attention network; FEF, frontal eye field; FPC, frontopolar cortex; dlPFC, dorsolateral prefrontal cortex; vlPFC,

ventrolateral prefrontal cortex; MT+, middle temporal visual area; TPJ, temporoparietal junction; RSP, retrosplenial cortex; sc, superior colliculus; sgACC, subgenual anterior cingulate cortex; HF, hippocampal formation.

Figure 4. Brain potentials from electrode Pz, time-locked to T1 onset on short-interval trials (220–440 ms) as a function of session, T2 accuracy, and group. Selective reduction in T1-elicited P3b amplitude in no-blink trials is evident in meditation practitioners. Adapted, with permission, from Slagter *et al.*¹⁴⁶

Table 1
Objects of focus and modalities of mindful awareness (based on the Basic Mindfulness system)

	Subjective sensory activity	Objective sensory activity	Sensory rest	Sensory flow
Visual	Image	Sight	Blank	Visual flow
	“See in”	“See out”	“See rest”	“See flow”
Auditory	Talk	Sound	Quiet	Auditory flow
	“Hear in”	“Hear out”	“Hear rest”	“Hear flow”
Somatic	Feeling	Touch	Relaxation	Somatic flow
	“Feel in”	“Feel out”	“Feel rest”	“Feel flow”

Note: The subjective labels “see in,” “hear in,” or “feel in” allow for noting internal sensory experience; “see out,” “hear out,” or “feel out” allow for noting objective sensory experience; “see rest,” “hear rest,” or “feel rest” allow for noting sensory rest; and “see flow,” “hear flow,” or “feel flow” allow for noting the flow of sensory objects across time.⁸⁶