Self-Monitoring in Clinical Practice: A Challenge for Medical Educators

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Recent literature has described how the capacity for concurrent self-assessment—ongoing moment-to-moment self-monitoring—is an important component of the professional competence of physicians. Self-monitoring refers to the ability to notice our own actions, curiosity to examine the effects of those actions, and willingness to use those observations to improve behavior and thinking in the future. Self-monitoring allows for the early recognition of cognitive biases, technical errors, and emotional reactions and may facilitate self-correction and development of therapeutic relationships. Cognitive neuroscience has begun to explore the brain functions associated with self-monitoring, and the structural and functional changes that occur during mental training to improve attentiveness, curiosity, and presence. This training involves cultivating habits of mind such as experiencing information as novel, thinking of "facts" as conditional, seeing situations from multiple perspectives, suspending categorization and judgment, and engaging in self-questioning. The resulting awareness is referred to as mindfulness *and the associated moment-to-moment self-monitoring as* mindful practice*—in contrast to being on "automatic pilot" or "mindless" in one's behavior. This article is a preliminary exploration into the intersection of educational assessment, cognitive neuroscience, and mindful practice, with the hope of promoting ways of improving clinicians' capacity to self-monitor during clinical practice, and, by extension, improve the quality of care that they deliver.*

Key Words: *medical education, assessment, self-assessment, students, residents, physicians, self-awareness, mindfulness, self-regulation, self-monitoring, reflection, physician-patient relations*

While some of the social responsibility of the medical profession to self-regulate is assumed by professional organizations, the majority of this responsibility still rests with the our individual capacity, as clinicians, to self-assess our strengths, deficiencies, and learning needs to maintain a level of competence commensurate with our clinical roles. As physicians, when we self-assess we engage in a process of interpreting data about our own performance and comparing them to an explicit or implicit standard. Self-assessment can be summative (by engaging in periodic formal self-assessments), predictive (by anticipating future needs), and concurrent (by self-monitoring during everyday tasks).[1]

Self-monitoring is characterized by an ability to attend, moment to moment, to our own actions; curiosity to examine the effects of those actions; and willingness to use those observations to improve behavior and patterns of thinking in the future. While most clinicians would agree that self-monitoring is essential to good practice, only recently have psychological theory and cognitive neuroscience research provided avenues for further characterizing and improving the capacity for self-monitoring. Furthermore, although research has characterized some aspects of summative and predictive self-assessment, there has been little empirical study of self-monitoring in health professions education.

This article builds on previous efforts to describe a "basic science" of the clinical act, in this case, a preliminary exploration of self-monitoring in clinical settings, drawing from and linking three separate domains of inquiry—educational assessment, cognitive neuroscience, and mindful practice. Initially, we outline some neurocognitive barriers to self-assessment in general (including self-monitoring). The second section explores the psychology of self-monitoring, its component elements, and how self-monitoring can enhance clinical practice and learning. In the third section, we describe how to cultivate an "observing self." The final section addresses the assessment of self-assessment and self-monitoring.

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As practicing physicians, we recognize the tension between theory and practice. In this article we will try to advance the theoretical underpinnings of a basic science of self-monitoring, leaving practical and case examples for future articles. We have tried to describe the complexity of the process of self-monitoring and avenues for further research, recognizing that some of the links may still be speculative. While we reference some original research, in the interest of brevity, we have cited reviews of recent developments in cognitive neuroscience that contain extensive references to the primary research.[2]

Neurocognitive Barriers to Self-Assessment

There is compelling evidence that students' and clinicians' summative self-assessments are flawed, but the reasons for this have only been explored recently.[1,3] In this section, we will focus on the typically unconscious biases in the acquisition and interpretation of data about our own clinical performance.

Accurate self-assessment depends on high-quality data. High-quality external data, such as formal standardized assessments, mortality data, and patient surveys can help clinicians formulate summative and predictive self-assessments when the data are presented in a coherent, timely, nonthreatening, and digestible format.[4,5] However, as physicians, we receive very little external feedback about our performance, and thus our imagination is often free to attend to (or generate) internal "data" that are concordant with our own self-image. For example, experienced clinicians probably make assumptions about the effectiveness of communication styles based on their self-image and the reactions of others.[6] Thus, it is understandable that we are often surprised by our speech, posture, and gestures when viewing ourselves on video.

Self-assessment requires the ability to distinguish high-quality data from imagination or projection. This task is difficult because the mind itself is ultimately both the object and the instrument of assessment, and our mental processes embed idealization directly within our self-perceptions. External data can offer insight into our clinical performance. However, these data rarely provide the detailed contextualized feedback that can guide ongoing self-monitoring. A motivated and astute tutor can provide useful feedback, but opportunities for close clinical mentoring are too uncommon. Thus, much of the responsibility for self-monitoring still falls on the untrained mind of the novice.

Self-assessment is also confounded by intermittent reinforcement and paradoxical data. Even poorly functioning clinicians get some positive feedback about their performance that reinforces their self-image as a competent practitioner. Perhaps their patients adore them, perhaps they are good test takers but lack clinical judgment, and perhaps the areas in which they fail (eg, ethics, teamwork, communication) or the relevant outcomes (eg, patient understanding, adherence, enablement) are simply not being measured. Patient surveys can yield paradoxical data because patients and physicians accommodate each others' styles and dissatisfied patients tend to leave the practice.[7] Absent or flawed data may reinforce self-deception and shut off deeper inquiry into our cognitive and technical competence.

High-quality internal data—self-awareness of thoughts, feelings, emotions, and sensations—facilitate access to cognitive processes, and therefore the ability to change behavior. Neurocognitive research suggests that access to such internal data is essential for effective and flexible reasoning.[8] These studies suggest that an earlier view—that our brains engage in reasoning in a logical, computational way—is only part of the picture. Instead, our subcortical regions—especially those involved in emotion and reactions to threat[9]—process information beneath conscious awareness, and the input from these areas directly shapes reasoning, often without our knowledge. In the next two paragraphs, we briefly outline some of the neural pathways that seem to be engaged during perception and self-monitoring.

The subcortical limbic areas appraise the meaning of events, color them with affective tone, shape how memory is encoded, and influence our interpersonal relationships with others.[10–12] The subcortical brainstem region is important for establishing states of alertness, motivational drive, and essential processing of the fight-flight-freeze response to threat. In addition, input from the body proper—including neural input from the viscera, musculature, and hormonal milieu—also influences these subcortical processes mediated by limbic and brainstem regions.[8] Taken together, the subcortical input of body proper, brainstem, and limbic areas creates an affective and motivational state that shapes higher cortical processes—how we feel, think, reason, make decisions, and interact with others—typically without our explicit knowledge or conscious awareness.[13–15] These subcortical processes especially influence the right neocortex,[10] which processes information in a nonrational, nonverbal manner; is involved in retrieval of memory involving strong emotions; and helps in the modulation of stress.[16] Our logical, linear, language-based more literal left hemisphere is later influenced by these subcortical and right hemisphere forms of information processing.[10,11]

Although the right neocortex is associated with nonlinear, nonlogical, impressionistic thinking,[8,17] damage to the right neocortex impairs the ability to make sound decisions. This phenomenon has relevance for self-monitoring and self-awareness because clinical learning tends to be associated with emotionally powerful experiences—such as death of a patient or delivering bad news. Thus, knowledge acquisition may also be mediated by the right hemisphere and involve bodily reactions and emotional responses we find difficult to understand because we do not have an internal sensation that something is being evoked from the past.[18] Awareness that previous experiences can implicitly affect our actions in certain contexts, even when we cannot access any specific explicit memory of them, can allow us to raise a "red flag" when those topics arise. Such knowledge of the distinction between the neural processing of implicit

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and explicit memory can offer an important conceptual framework for making sense of these subcortically driven reactions.

Thus, memories appear to be "packaged" with associated sensory experiences and emotions;[8] it is likely that those same sensory/affective correlates comprise parts of the scripts and heuristics that guide clinical judgment.[19] However, these internal data are private and therefore difficult for an external observer to scrutinize "objectively." Although these internal data normally are unconscious, with training, they can be accessed and utilized. Through practice, clinicians can adopt a habit of paying ongoing attention to bodily sensations, images, feelings/emotions, and thoughts,[20,21] enabling assessment of our internal state and external actions and allowing us to change them. For trainees, one way to recall this approach is with the mnemonic *SIFT*: The clinician SIFTs her/his mind by reviewing the sensations, images, feelings, and thoughts that arise during interactions with patients. Later, we will discuss how to enhance "mindful learning" by exercising the ability to attend and respond to inner data—for example, to become aware of a tendency toward premature closure, annoyance, or alarm in certain clinical situations.[2,22]

Self-deception, denial, and delusion are impediments to self-monitoring. These internal mechanisms serve a purpose—to reduce the anxiety that may naturally emerge when a clinician faces the uncertainty inherent in the clinical process—but can distort perception and judgment. The seemingly infinite human capacity for self-deception is caused by "the very nature of our brains—evolved to guess the most plausible interpretations of the limited evidence available,"[23] in which the mind "imposes a definition on things and then mistakes the definition for the actual experience"[24]—and also ignores disconfirming data. For example, a patient of one of the authors (RME) was suspected of having adrenal insufficiency on the basis of low blood pressure and hyperpigmentation in the setting of an acute infection. Soon thereafter, it was revealed that the blood pressure was at baseline, and the hyperpigmentation was only in sun-exposed areas. Yet, several physicians involved in her care persisted in "ruling out" adrenal insufficiency with series of blood tests of her cortisol level and did not realize that they had made a diagnostic error. Clinicians may believe that the data are flawed and may invoke cognitive alibis—"the patient was uncooperative," or "the nursing staff is poorly trained"—to attribute poor outcomes to patient and institutional factors rather than their own limitations.

Neurocognitive research suggests that there is no "immaculate perception."[25] Rather, descending pathways from the higher cortical areas concerned with interpretation and self-regulation can actually inhibit input to the primary sensory cortices, creating a "perceptual tension" between seeing what "is" and what is in accordance with how we think the world should be.[26] However, we discuss later that it is possible to develop awareness of these mental activities that cloud judgment and impair self-assessment.

The Psychology of Self-Monitoring

Self-monitoring refers to the ongoing habit of seeking, integrating, and responding to both external and internal data about one's own performance. Schön and others have emphasized the importance of "reflection-in-action"[27] yet have not specified how to achieve a state of active self-observation during everyday tasks. Our point here is that now modern cognitive neuroscience can help us understand the self-reflective processes that have always been characteristic of excellent clinical practice and can help guide the ways in which self-monitoring is incorporated into the training of physicians.

Self-monitoring requires several elements:

Motivation. Self-assessment will always fail for unmotivated learners; they might adopt or reject assessments by others but tend not to formulate assessments of their own. A teacher can reinforce a learner's motivation to self-assess by engaging in autonomy-supportive behaviors, such as taking the learner's perspective, acknowledging feelings, providing choices, and minimizing the use of pressure and control.[28] For some clinicians, knowledge about the role of subcortical and right-hemisphere processing in the linear and logical processing of the left hemisphere's decision-making and word-based thought processes may provide empirical justification for the practice of "reflection on action"[29] and attending to internal sensations, images, and feelings.

Attentiveness. Self-monitoring requires cultivating an "observing self" within otherwise chaotic and distracting environments in which clinicians and learners work. Part of the training of physicians involves learning how to regulate their attention while multitasking and prioritizing among competing demands. Attention consists of three fundamental dimensions: alerting, orienting, and executive.[2] *Alerting* refers to vigilance and readiness to respond to anticipated stimuli, whereas *orienting* refers to selecting certain information as relevant and ignoring other information. *Executive attention* refers to the management of *un*anticipated stimuli—conflicts, errors, decisions—that reach conscious awareness and require the overcoming of habitual actions. Each of these types of attention is processed in a different circuit of the brain; neurocognitive research suggests that these circuits can be cultivated and reinforced.[30,31]

As clinicians, we learn to regulate our own state of attentiveness in two ways. First, we can make choices about what data to attend to. For example, looking at the same patient, a neurologist may first note a tremor whereas a dermatologist might first note a skin lesion characteristic of neurological disease. Second, we can observe the process of paying attention itself, otherwise known as *meta-awareness*

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(awareness of awareness), which helps us recognize when we are distracted, fatigued, or biased and may help to recalibrate the alerting, orienting, or executive functions.

Meta-awareness appears to be mediated via specific regions of the frontal lobe of the brain (the medial prefrontal cortex).[30] This region seems to serve an "executive function" in enabling self-monitoring; it senses our own mental activity and thus regulates our internal and external responses. Developing the prefrontal executive circuits of the brain, then, might be a neural correlate of effective clinical training.

Curiosity. Curiosity—an openness to novelty—facilitates self-awareness and, by extension, the ability to self-assess. Maintaining curiosity depends on an ability to self-regulate reactions to unpleasant thoughts, feelings, and sensations. This is challenging because being presented with feedback information about oneself is rarely comfortable[32] because self-regulation helps us recognize our tendencies to engage in self-deception[33] and instead find ways to restore an open-minded, curious, attentive stance in which new data are welcomed even if disconfirming of an initial hypothesis or discordant with our self-concept.

Here we have a paradox, as noted by Eva and Regehr.[1] Openness is much easier to achieve when one's self-concept and sense of self-efficacy are strong. But openness to novelty is most important at exactly those moments when we feel the most insecure, vulnerable, ignorant, and powerless. Thus, an important mark of our capacity for self-assessment is being able to cultivate sufficient mental stability to be open, curious, flexible, and present when faced with anxiety, uncertainty, and chaos. Interestingly, the same region of the brain (the prefrontal cortex) is fundamental for both self-monitoring of our own mental processes as well as the ability to stay calm in the face of distressing experiences (by inhibiting excessively firing limbic areas). The midline areas of the prefrontal cortex are also essential for empathy;[2] thus it is not surprising that exercising this capacity through mindfulness practice is associated with increased empathy in medical students.[34,35] With practice, these executive circuits can be strengthened[36] and regulate emotional arousal[37,38] and thus may improve both well-being and quality of care.[39–41] Overall we can view this convergence of self-regulation, attentional control, meta-awareness, and empathy within the self-regulatory functions of the brain itself. At the same time, such mindful awareness also helps dissolve top-down mental processes that diminish our capacity to see novelty and maintain curiosity even in situations that seem familiar.[2,22]

Habits of mind. Three habits of mind for effective learning have been outlined by Langer.[22] Using a series of elegant studies, she has determined that learning is more effective—and reflective—when learners can see information as novel, adopt the ability to see "facts" as conditional, and see situations from multiple perspectives. In addition, we propose two other habits: suspending categorization and judgment and self-questioning.

The first habit—experiencing novelty—is the ability to experience information or sensory input as novel, and thus describe it before applying judgments, heuristics, or interpretations.[42] This is more difficult than it might initially seem, because the brain is wired to make initial judgments based on previous experiences and because of the primacy of text and authority over direct observations. A stunning example of the primacy of text is a case reported by Fitzgerald in which a trainee on rounds reported that a patient had "BKA [below knee amputation] times 2."[43] However, Fitzgerald pointed out to the trainee that the patient in fact had two feet. The transcription error had occurred several admissions previously and remained unquestioned in the chart ever since: the diabetic patient had been admitted for "DKA [diabetic ketoacidosis]," but the discharge diagnosis had been mistranscribed as *BKA*. As difficult as it is to notice things about others (eg, feet), it can be even more challenging to notice things about oneself (eg, misjudgment, lack of empathy). It sometimes takes surprises like the one this student experienced to "wake up" to a lack of awareness.

The second habit is using the conditional when referring to what might otherwise be considered fact. This habit builds on the first by training the mind to be flexible. For example, rather than saying (to oneself or a learner), "This is a patient with BKA times 2," one would start by saying, "This patient is reported to have had BKA times 2," leaving open a possibility that even when things appear to be so, one's senses can be deceptive. It uncouples primary sensory data (ie, examining the patient) from the interpretation of those data (suggesting diagnostic possibilities). The mind has a natural push to explain with certainty, and learning to embrace uncertainty in our cognitive processing is an important aspect of conditional thinking.

The third habit derives from the first two—the habit of seeing a situation from multiple perspectives, even taking two opposing views simultaneously[44]—without the need for premature resolution.[44] While experienced clinicians often generate first impressions automatically and effortlessly,[45] they should be able, at the same time, to consider other possibilities in a more conscious way, without needing to discard the initial impressions. Consider a case of a patient of one of the authors (RME) who entered the emergency room with decreased urination and abdominal pain. The emergency room physician, nurses, and house staff all accepted a provisional diagnosis of dehydration, even though they knew that he had just been treated for bladder cancer and the Foley catheter had been removed the previous day. When intravenous (IV) fluids failed to increase his urination, they increased the rate of the drip, even though his abdominal pain had increased. Only 18 hours later did another physician recognize the error. After placing another catheter, more than 2 liters of urine

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drained. In this case, the clinicians involved could have avoided premature closure by being alert to disconfirming data before committing to a hypothesis.

The fourth habit—suspending categorization and judgment—is derived from the perspectives of contemplative science.[2] Premature categorization impairs the ability of the mind to see situations as novel, context-dependent, and contingent—rather, the category becomes more "real" than the experience itself. In many ways, tolerating ambiguity can be seen as a movement away from the "digital" information processing dominant in the left-hemisphere toward a more integrated "analogic" form of information flow involving the more holistic processing of the right hemisphere. To welcome uncertainty, as clinicians, we need an internal "ballast"—the ability to stay calm in the face of not knowing. Clinicians need mental tools to be able to see things "as they are," letting go of a drive to have things perceived "as we think they should be."

The fifth is a habit of self-questioning. Using reflective questions (TABLE 1) enhances the ability to see familiar situations with new eyes and to self-monitor one's actions during actual practice. George Engel, a well-known master clinician, indicated to one of the authors (RME, personal communication 1989) that he trained himself to question every diagnostic formulation habitually before seeing a patient. By saying, "If this could not be [pneumonia], what else would it be?" he consciously became aware of the tendency of the mind to develop heuristics that are often efficient and helpful but also can trap the clinician into a single, and potentially erroneous, view of the clinical issues at hand and prematurely close off further thinking. Evidence suggests that this approach is one of few tools that effectively decrease bias in human reasoning.[46] This approach is another example of metacognition—the art of understanding and monitoring how one's own mind works. Such questions and other strategies that evoke this metacognitive awareness involve the executive functions of the prefrontal cortex that enable us to pull our minds away from "automatic" and make mindful states a trait of our information processing. In this way, we can consciously sense our tendency to draw rapid conclusions to quell our anxiety and have a conscious choice to inhibit such automatic reactions from controlling our decision-making processes.

As clinicians, applying reflective questions to our own cognitive processes can help us prevent mistaking our own self-concept (eg, level of knowledge, capacity for empathy) for our actual behavior or capabilities. By considering self-assessments of our own attributes as tentative hypotheses pending empirical verification, we can adopt a more nuanced and contextualized understanding of our own mental states, level of competence, and empathic capacity.

TABLE 1. Reflective Questions (Examples)

If there were data that I ignored, what might they be?
What about this situation was surprising or unexpected?
What am I assuming that might not be true?
Did I avoid premature closure?
Is there another way in which I can formulate this patient's story and/or my response?
What are important aspects of the present situation that differ from previous situations? How might prior experiences be affecting my response to this situation?
What would a trusted peer say about how I am managing or feeling about this situation?
Can I SIFT my mind and examine Sensations, Images, Feelings, and Thoughts that are relevant to this clinical situation?

Mindful Practice

At this point, we would like to make the link between a particular extension of reflective practice—mindful practice[34,47–49]—and the process of self-assessment. For summative and predictive assessments, post hoc reflection (reflection on action)[27] is necessary to integrate and act upon data derived from assessments of a variety of clinical skills and behaviors; cultivating mindfulness may help reduce reactivity and premature categorization and enhance openness to new data, formulations, and planned action. However, for self-monitoring, moment-to-moment self-awareness (reflection in action)[29] is necessary for the acquisition data as well as interpretation and response to moment-to-moment experiences in clinical settings.

Mindful practice can be considered the essential stance underlying the self-monitoring function. Mindful practice is the cultivation of the observing self in the midst of the complexity and chaos of everyday work—not in some space removed from practice. It is a process of observing the observer observing the observed. Mindful practice is conscious and intentional attentiveness to the present situation—the raw sensations, thoughts, and emotions as well as the interpretations, judgments, and heuristics that one applies to a particular situation.[2,20,49] Mindful awareness appears to stabilize our attention and make the contents and processes of the mind more available for understanding.[50,51] It helps to avoid going on "automatic pilot"—and thus become more reflective and more flexible in our responses (TABLE 2).[52] Educators, practitioners, and researchers have attempted to describe and measure facets of mindfulness (TABLE 3), such as lowered reactivity, active observation, acting with awareness, naming, curiosity, presence, and adopting a nonjudgmental stance.[47,53,54] These facets are mutually reinforcing: for example, adopting multiple perspectives tends to lower reactivity.[33]

Various streams of awareness, such as direct sensory perception ("bottom-up" perceptions) and perceptions colored by narrative interpretations, biases, and judgments ("top-down" perceptions), are often intertwined in the untrained mind. Studies have suggested that mindful practice can lead to the capacity to separate bottom-up from

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TABLE 2. The "Tripod of Reflection"*

1. Observation: The capacity for self-observation in which the individual monitors his or her own internal mental processes and outward directed behavior.
2. Objectivity: The skill of seeing the activity of the mind as a product of mental processes, not the totality of one's identity. Seeing the mind objectively enables awareness to become relatively independent of other cognitive activities. This might be manifested as a "pause before acting" that permits more flexibility in both thinking and responding.
3. Openness: The active avoidance of premature closure in which the individual's mind strives to see things as they are, rather than cling to images of things as he or she wishes them to be.

*Each of the three legs of the "tripod of the mind" stabilizes attention and enables the internal processes of the mind to gain clarity and stability. This enhanced perception of one's own mind creates a functional mental spaciousness in which reflection is possible and more flexible self-assessment and self-monitoring can become a part of daily life.

Source: Siegel DJ. *Mindsight*. New York; NY: Bantam; 2007.

top-down perceptions.[55] This capacity to distinguish raw data from interpretations may be one link that connects mindful awareness with mental flexibility,[56] which is one characteristic of expert clinical problem solving and reflection in action. As noted previously, the sensory cortex receives raw, bottom-up data, which are also further processed by parietal and prefrontal regions. In turn, higher layers of the cortex responsible for conscious decision making, judgments, and interpretation of the meaning of the stimulus can be trained to enable us to "look back" at the raw sensory experience and separate it from our ideas, interpretations, and judgments.[57] Mindful awareness appears to involve the ability to distinguish these distinct streams of information processing and then incorporate them "mindfully" in the ongoing interplay between bottom-up input and top-down evaluative processing. The ability to self-regulate these neural processes can improve reasoning, well-being, and empathic relationships with others.[2]

TABLE 3. Qualities of Mindful Self-Monitoring

Access to internal and external data
Lowered reactivity to inner experiences such as thoughts and emotions
Active and attentive observation of sensations, images, feelings, and thoughts
Curiosity
Adopting a nonjudgmental stance
Presence, acting with awareness (not being on autopilot)
"Beginner's mind," openness to possibility
Adopting more than one perspective
Ability to describe one's inner experience

Cultivating the Observing Self

Self-monitoring requires practice—although it is a natural function of the mind, self-monitoring is a latent skill in need of awakening. Educational methods to become more self-observant are borrowed from psychotherapy[2,51,58,59] and secular contemplative practice.[20] One of the premises of cognitive and behavioral therapies,[58,59] for example, is the ability to uncouple events from our interpretation of them.

William James remarked that "the faculty of voluntarily bringing back a wandering attention, over and over again, is the very root of judgment, character and will. . . . An education which should improve this faculty would be the education par excellence" (p 401).[60] Contemplative practice provides a group of methods for training the mind in these ways to pay attention, on purpose, to achieve a level of mental stability that facilitates compassion and focused action.[21] While there are many ways to practice attentiveness, one common way involves paying attention to the breath, without trying to change or alter it in any way, and, when the mind wanders, to return to paying attention to the breath—again and again. This process results in a stabilization of attention and an ability to sustain the focus of awareness. At that point, the practitioner can then focus on whatever arises in the field of awareness and attend to those processes with curiosity, openness, acceptance, and kind regard. Mindfulness practice can be thought of as a process of "falling awake" by making visible that which had previously been transparent.[54] In these ways mindful awareness is a way of becoming more familiar with our own internal mental life, strengthening the focus of attention, and enhancing the ways in which we can self-observe our own internal mental processes as they unfold.

Preliminary steps in enhancing the capacity for self-monitoring involve introducing the fact that it is possible to regulate one's own level of attention, reactivity, curiosity, and openness. To foster moment-to-moment self-awareness, tutors and learners can report not only what they observe about patients, but also what they observe about themselves—their internal experience and their interpersonal responses—while interacting with the patient. We have not yet met a learner who is not capable of doing this. Tutors can make their thinking more visible to the learner by thinking out loud, articulating cognitive "traps" in the form of misapplied heuristics[42] and emotional "traps" in the form of unmonitored reactivity to patients or their problems. The tutor and the learner can observe how they can use their executive alerting function to recognize unanticipated situations earlier.

Just as finger exercises for pianists build muscle and coordination, self-awareness practices exercise those parts of the brain that are most closely linked with attentiveness and curiosity.[2] These functions appear to be mutable during adulthood. Recent evidence suggests that consciously directing attention is a skill that can be developed with practice,[61] and that effortful control of one's behavior can enhance control of attention.[55,62] Even differences in cortical thickness, more-

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over, can be noted on structural magnetic resonance imaging (MRI) after repeated meditative practice of quietly attending to the breath and other sensory input.[36] These regions are postulated to have been stimulated during mindful practice and the neural connections in these circuits to have grown on the basis of the neuroscience principle "neurons that fire together, wire together."[63] The notion here is that as we intentionally create states of mindful awareness in practice, we activate specific neural pathways involving the ability to perceive our inner world and then alter its mechanisms of information flow—what is called *attentional regulation*.[55] With practice, such intentionally created effortful states will lead to synaptic growth and these states will then become traits of the individual. This is the neural underpinning suggested for how effortful states become effortless traits of mindfulness in an individual. Integrating moments of mindfulness into daily work—such as stopping to take a breath before entering a patient's room—can make the mind less reactive, more alert to novel data, and less likely to categorize prematurely. Small cues during the day might be reminders to notice oneself and one's surroundings in a curious nonjudgmental way. Learning these practices has been formalized into courses on mindfulness-based stress reduction at many medical schools.[34,64–66]

Habits of mind can be taught, recognized, and validated. A clinical tutor can use reflective questions such as those in TABLE 1 to enhance the learner's capacity to attend, notice, be curious, suspend judgmental attitudes, and be present. Learners can then begin to assimilate and integrate habits of self-questioning into their daily clinical work. Elsewhere, we have described more formally a method for using reflective questions to promote mindful practice.[48,67]

Reflection on action after the fact, away from the clinical setting, may bring issues to light that then later make it easier to self-monitor in the moment. For example, self-awareness groups appear to improve communication skills,[68] presumably by heightening learners' attentiveness in real clinical settings. Written narratives[69] may help the writer reexperience some of the sensory richness of clinical situations as if they were present. However, it should not be assumed that reflection activities some time after the actual event in a setting apart from the clinic will actually improve self-monitoring during clinical practice. The interface between post hoc reflection and moment-to-moment self-monitoring remains to be studied in greater detail.

Both post hoc reflection and moment-to-moment self-monitoring may also help clinicians attend to positive experiences that, according to emerging research, are less memorable. They are processed with less depth than negative experiences[70] and thus are more likely to be overlooked. Cultivating awareness of one's own lucid reasoning, enthusiasm, positive affect, and other positive experiences may reveal the conditions that promote these experiences. For example, a physician might learn to apply feelings of enthusiasm when working with specific populations to others which do not elicit similar feelings.

Assessing Self-Monitoring

How do we know whether self-assessment is accurate? Whether it is helpful? How can individual practitioners justify their claim to self-regulation by demonstrating that their own self-monitoring processes are effective? Currently, the failure of self-monitoring might often only become apparent when medical errors or ethical lapses result in complaints or obvious harm.

Learning, assessment, and values are mutually reinforcing.[71] Thus, organized attention should be paid to how to value clinicians' capacity for self-monitoring. Sometimes judicious self-monitoring may be apparent to others and, like any clinical behavior, is deserving of praise. But how can we assess what is fundamentally an internal process? Will the external manifestations of self-monitoring be apparent enough to a tutor so that he or she can comment and offer feedback? Can patients notice when clinicians are mindful? Can peers? Also, self-monitoring is probably highly context-dependent, so that sampling in multiple contexts will be important.

Domains in which self-monitoring is central to training (eg, music and athletics) often involve long-term and trusting relationships between teacher (or coach) and learner, in which the teacher monitors the trainee's self-monitoring. We call this *relationship-based assessment*, in which the tutor has a deep knowledge of the learner as a person and how his or her skills evolve within the context of this relationship. Apprenticeship models may help achieve some of this deeper assessment.

Portfolios, in which learners assemble a body of external data and personal reflections, may be helpful. Learners might demonstrate their ongoing self-monitoring through reflective narratives, and thus develop a habit of reflection and considering reflection to be a core aspect of clinical training. One report suggests that organized reflection on peer feedback, for example, has had a transformative effect on a substantial proportion of medical students.[72]

Conclusion

The power of self-assessment lies in two major domains—the integration of high-quality external and internal data to assess current performance and promote future learning, and the capacity for ongoing self-monitoring during everyday clinical practice. Self-monitoring enables clinicians to assess their own mental processes during clinical practice. This article has outlined some of the complex cortical pathways involved in what appears to be a natural ability of humans to self-monitor. While the neurocognitive complexity may seem daunting, the implied actions—noticing, suspending judgment, cultivating curiosity, habitually self-questioning—are skills that can be practiced and learned. Basic principles of cognitive neuroscience and techniques to foster mindfulness can be readily learned by clinicians and then applied in daily practice.[64,65]

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Lessons for Practice

- Self-monitoring is an aspect of self-assessment that may contribute to quality of care and reduction in errors.
- Self-monitoring depends on the ability to regulate attention, maintain curiosity, and be flexible during daily work, especially when under stress and multitasking.
- Self-deception, denial, and delusion are common barriers to self-assessment and self-monitoring.
- Self-monitoring can be improved by cultivating the "observing self": adopting a "beginner's mind," seeing "facts" as conditional, considering multiple perspectives, suspending categorization and judgment, and developing habits of self-questioning.

Self-monitoring involves reflecting on both external, observable actions and subjectively experienced internal states. The links between cognitive neuroscience and self-assessment proposed in this article are, at this point, speculative. However, it is clear that the convergence of psychology, cognitive neuroscience, and educational research is the territory in which the nature of self-assessment and self-monitoring can be explored further, and that now we have the technologies (eg, functional neuroimaging, psychological assessments) to conduct further empirical research in this domain. Some medical schools now include self-awareness as an explicit competency, with institutional investment in faculty and curricular time and foundation support.[34,64,65,73,74] While some educational strategies have been studied systematically,[22,34,64,75,76] most have not. The elusiveness of assessing the effectiveness of self-assessment on an individual level should not deter efforts to promote a more mindful practice in which there is explicit focus on developing the reflective capacity of the practitioner to self-monitor and self-regulate.

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