Aging and Cognitive Performance: Challenges and Implications for Physicians Practicing in the 21st Century

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The demands of physician practice are growing. Some specialties face critical shortages and a significant percentage of physicians are aging. To improve health care it is paramount to understand and address challenges, including cognitive issues, facing aging physicians. In this article, we outline several issues related to cognitive performance and potential implications associated with aging. We discuss important findings from other fields and draw parallels to the practice of medicine. In particular, we discuss the possible effects of aging through the lens of situated cognition theory, and we outline the potential impact of aging on expertise, information processing, neurobiology, intelligence, and self-regulated learning. We believe that work done in related fields can provide a better understanding of physician aging and cognition, and thus can inform more effective approaches to continuous professional development and lifelong learning in medicine. We conclude with implications for the health care system and areas of future research.

Key Words: *aging, cognition, clinical performance, medical education*

Background

The demands of medical practice are growing. Knowledge about diseases and their therapies is rapidly expanding, and the number of specialty journals and articles in the health sciences are emerging at a frantic pace. The quantity of patients seen by providers, acuity of illness for hospital admissions, and complexity of problems in outpatient practice have all increased dramatically over the past decade. Additionally, there has been an explosion of new technologies, such as electronic medical records (EMRs), Internet resources for physicians and patients, and new diagnostic or therapeutic devices. Further compounding the demands of medical practice are the growing number of elderly patients and the critical shortage in primary care clinicians.[1] For example, the United States population is expected to increase to 349 million by 2025, and 1 in 5 adults in the United States will be age 65 or older by 2030.[2] These and other phenomena arguably make the practice of medicine more challenging than in previous decades.

Unless substantial changes to the physician workforce occur, the average age of the remaining physicians in several specialties will also continue to rise. For instance, in the United States, interest in primary care has declined sharply and nearly 1 in 5 physicians who started their careers in primary care are planning to either enter other specialties or go into other careers altogether within 10 years.[3,4] In Australia, about 25% of the medical workforce is at least 55 years of age, and the percentage of physicians age 65 or above is expected to reach 20% in the next 20 years.[5]

Given these practice realities, older physicians will remain an essential part of the physician workforce. Accordingly, we must understand the implications of aging on cognitive performance, particularly because physicians' medical practices remain largely autonomous. Moreover, consumers, who count on medical practitioners to self-regulate their profession, are not medical experts and may be inadequately informed about the quality of their diagnostic and therapeutic outcomes.

It is important to highlight that aging, per se, does not necessarily result in cognitive performance decrements. Indeed, a consistent finding from empirical literature outside of medicine is that cognitive performance is more variable as one ages.[6,7] This variability suggests that important individual differences exist, that aging is just 1 of several factors that may impact performance,[6,7] and that performance might

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be broadly determined by characteristics ranging from intelligence to personality.[8–10] Additionally, some physician cognitive performance characteristics may actually *improve* with age.[11,12] Taken together, the impact of aging on cognitive performance cannot be assumed to affect all physicians equally, and frameworks that can account for complex interactions between factors contributing to cognitive performance are needed.

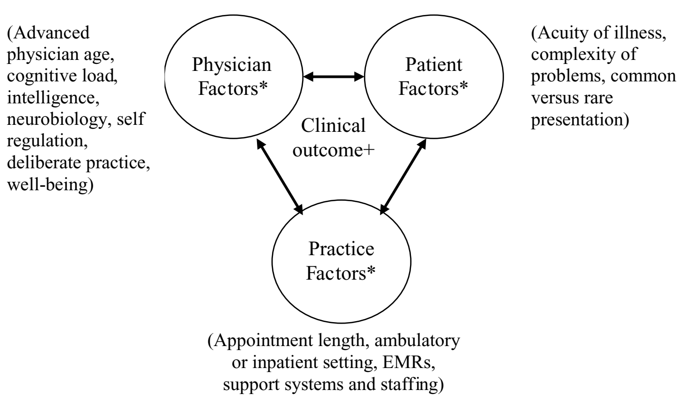
In this article we will outline some of the issues facing aging physicians' cognitive performance, discuss important findings from fields outside of medicine, and draw parallels to medical practice. To do this, we conducted a thematic review of articles addressing aging and cognitive performance, searching the MEDLINE and ERIC literature to identify articles of relevance and also reviewing the bibliographies of articles identified to address this topic. Furthermore, in this article, we discuss the effects of aging through the lens of situated cognition theory, which places the physician's cognition within the larger physical and social context of interactions, a perspective that can help to explain the potential impact of aging on expertise, neurobiology, information processing, and self-regulated learning. Importantly, the situated cognition framework does not assume that aging inexorably leads to reduced cognitive performance. Instead it argues that individual factors in the physical and social context of interactions must also be considered.

Situated Cognition Theory

Situated cognition seeks to place an individual's cognition (thinking) within the larger physical and social context of human interactions. It provides a "person plus" framework, with individual thinking and knowing (or processing) in the setting of social action. In other words, the individual's thoughts and actions are uniquely tied to (and cannot be completely separated from) the specific social situation within which those thoughts and actions occur.[13,14] Thinking (cognition) occurs in specific social settings, and situated cognition argues that failing to acknowledge the contributions of the setting results in a perspective on thinking that does not fully capture the construct; situated cognition argues that thinking (and acting) are context specific. For example, an individual's thoughts while playing cards or Scrabble, writing a paper, or seeing a patient are fundamentally shaped by their environment. Therefore, thinking is not simply determined by what's stored inside one's brain. This vantage point introduces the importance of the physician's environment to our understanding of cognitive frameworks, such as information processing theory.

Information processing theory focuses on what happens inside an individual's head, and as such, it largely downplays the influence of the setting (or environment) and the other participants in the interaction. Situated cognition, on the other hand, puts emphasis on the environment, which, in the case of the clinical encounter, would include patients, practice settings, physicians, and their related interactions (see FIGURE 1). In doing so, situated cognition builds upon and expands existing cognitive theories.[5,15–20]

As shown in FIGURE 1, situated cognition places or "situates" the "physician factor" in a social context—underscoring how unique patient, physician, and practice factors can interact in dynamic ways. Situated cognition highlights the notion that each physician, patient, and practice factor has the potential to contribute to the outcome of the clinical encounter. We see advanced physician age as an important "physician factor." Furthermore, by identifying these 3 factors (physician, patient, and practice), and their potential (and myriad) interactions, situated cognition provides a perspective that may not arise when studying the more classic cognitive theories (outlined below) that address



Notes:
** = factors that interact as shown by arrows; parentheses next to each factor are examples. Situated cognition takes the approach of the individual and the environment and all of the above interactions can and do influence the outcome (patient care) in such a model.*
+ = clinical outcome is dependent upon these 3 factors, their interactions, and possibly other inputs.

FIGURE 1. Situated Cognition Theory and the Aging Physician.

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individual patient, physician, or practice factors in isolation (if at all).

In the remainder of this article, we introduce several other theoretical frameworks to address how physician age may impact cognitive performance, as well as how it might interact with patient and practice factors (FIGURE 1).

Aging and Information Processing Theory

Information processing theories focus on cognitive structures or mental models inside of one's head (the individual's brain). This class of theories largely emerged in the early days of computer processing, and indeed computers were a driving metaphor.[16] Studies[17–20] suggest that physicians use multiple cognitive models in practice. These cognitive models are often broadly grouped into 2 types: analytic (actively collecting and analyzing data to make diagnostic decisions, which involves mental effort) and nonanalytic (automatic decisions, which are based on prior experiences).

Previous papers[5,6] have explored this topic from the standpoint of aging and have yielded conflicting findings. Some studies have found a strong negative correlation between cognitive performance and age,[21,22] whereas others[23] have observed a positive correlation between cognitive performance and age. Eva[6,7] has suggested that analytic processing declines with age, whereas nonanalytic processing (experience-based and automatic) remains stable. This interpretation by Eva is consistent with studies from multiple fields outside of medicine, which support the idea that as age increases, fluid intelligence or "mental efficiency" decreases, and crystallized intelligence, which is domain-specific and experiential, increases.[8,24] Eva[6,7] found that many errors made by older physicians would be expected to correlate with "premature closure." These errors involve the failure to engage analytic processing and suggest that older physicians are more prone to "go from the gut" (stress prior experience) in the decision-making process. For instance, in a study of ability to assess transfusion decision making, older physicians had the lowest knowledge scores but the greatest confidence in their knowledge.[25] This study suggests that older physicians place high value on confidence (due to prior experience), and that such confidence outweighs analytic processing (knowledge scores). If Eva's hypothesis is correct, then a situated cognition perspective would also suggest that, for example, the additional interaction of practice pressures (for example, shorter appointment length or unfamiliar computer systems) and patient factors (for example, disease acuity, classic versus atypical presentation, and/or suggestion of diagnosis) could further increase the impulse to *not* invoke effortful, time-consuming, analytic processing.

Cognitive load theory,[26–28] a contemporary information processing theory, deals with the limits of working memory capacity and the benefits of long-term memory and automation; it provides another approach to the question of age and its effects on the physician factor. Cognitive load, or the overall cognitive burden on working memory, is typically divided into intrinsic and extraneous load. Intrinsic cognitive load refers to the number of elements that must be processed simultaneously in working memory and is dependent on both the complexity of the material and the individual's expertise. Extraneous load is additional cognitive load that is not related to the nature of the task but rather to inefficiencies in how the material is presented. Furthermore, according to cognitive load theory, working memory is very limited in terms of both capacity and duration, whereas the capacity of long-term memory is essentially limitless.

According to cognitive load theory, information held in long-term memory is organized and stored in the form of domain-specific knowledge structures known as schemas (or mental models). Schemas transcend organizing and storing information to free up working memory capacity in 2 important ways. First, schemas allow for the storage of large chunks of information (that is, chunking), thus limiting the number of possible combinations of information units that would otherwise have to be manipulated in working memory. Therefore, individuals with no prior knowledge or schema(s) for a task (for example, establishing a diagnosis), must consider all possible combinations of information units (for example, considering a broader differential diagnosis). Individuals with appropriate prior knowledge and schema(s) free up more working memory to accomplish other tasks (for example, the nuances of the proper treatment and its complications for the patient) that would have otherwise been used in creating combinations of information units. Although working memory can hold only a limited number of items at a time, the size and complexity of those items are unlimited.[8] Therefore, complex schemas consisting of huge arrays of interrelated elements can be held in working memory as a single entity.

The second important way that schemas free up limited working memory capacity is through automation. Automation occurs when, through continued practice, information stored in schemas is processed automatically and without conscious effort. Consequently, a person dealing with previously learned material that has been stored and automated in long-term memory is freed from the processing limitations of working memory. Thus, despite the decrements in working memory capacity that may occur with age, cognitive load theory suggests that schema construction and automation could actually liberate cognitive resources for other purposes.

It follows that despite the decreases in speed and capacity of working memory that appear to occur with aging,[8,24] older physicians may be able to compensate by using elaborate schemas stored in long-term memory. This compensation would not be expected to apply to new situations, but rather would apply to situations in which older physicians have had prior knowledge and experience. For example, chess studies[8] suggest the quality of first moves (or first diagnostic hypothesis) is better among older experts who appear to compensate for declines in search and retrieval speed (processing speed) with more refined knowledge-based processes (automation of schemas stored in long-term memory) to enable move selection.

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The situated cognition framework, when combined with cognitive load theory, would suggest that the physician factors of age and memory (both working and long term) would interact dynamically with patient and encounter factors (FIGURE 1). These patient, physician, and encounter factors each uniquely impact cognitive load and, potentially, overall physician performance. For example, even with elaborate schemas, working memory limits may be reached if the extraneous load is too large. Consider the potential impact on cognitive load that might occur when instituting a new electronic medical record system for a physician who has little familiarity with computers. Furthermore, although automation through practice (schema formation) reduces intrinsic load, automation does not mean that the limitations of working memory are never reached. Understanding of the effects of practice and patient factors on cognitive load among aging physicians is an area of inquiry that requires further exploration.

Aging and Deliberate Practice (Expertise)

Developing and maintaining expertise in any field requires extensive, sustained practice of the necessary skills. Multiple fields have shown a clear link between the extended engagement in domain-related activities (or deliberate practice) and the attainment of expert performance.[9,10] Furthermore, numerous studies have revealed that the most talented individuals in a domain require 10 or more years of experience to become an expert and achieve an international reputation in fields such as chess, sports, music, science, and the arts (the so-called "10-year rule"[10]). Deliberate practice[9,10] argues that expert performance is acquired gradually, that training tasks must be mastered sequentially, and that training strategies are initially designed by a teacher or coach. Deliberate practice requires effort, immediate and informative feedback about performance, and opportunities for repetition and correction of errors. From the situated cognition framework, deliberate practice involves a physician factor (expertise) with gradual increments of patient and/or practice factors, initially under the supervision of a teacher or coach. By focusing on specific components of an activity for practice, cognitive load is made more manageable.

Challenges to aging physicians in this model include declining peak cognitive performance over time (typically in the fifth decade) regardless of the field studied. Research has shown that more current deliberate practice is required in older adults to *maintain* cognitive performance than in younger adults within the same field.[8] Moreover, evidence suggests diminishing returns from deliberate practice in older adults and that older adults require more time in between deliberate practice sessions than their younger counterparts.[8] Importantly, studies of experts in other fields who maintain rigorous deliberate practice activities suggest that expertise can be maintained into the seventh and eighth decades.[8] This finding has important implications for continuing medical education (CME). For example, one should not assume that a 74-year-old physician is not competent, provided that this physician has demonstrated a complement of deliberate practice activities, satisfactory peer and patient ratings, and acceptable recertification exam scores. An additional challenge in medicine is to determine what *types* of deliberate practice activities should be implemented in a clinical environment that is complex and evolves over time (see FIGURE 1). The context of medicine is not so clear-cut as a chessboard, where the tasks to be performed and the system itself are more constrained.

Aging and Neurobiology

The prevalence of decrements in psychomotor ability with age and reduced speed and accuracy in most cognitive-motor tasks has motivated theories of broad intellectual decline with age, such as *general age-related slowing*.[29] For example, visual and hearing acuity decreases throughout adulthood with changes beginning in the second and third decades.[30] These decrements have important implications for the aging physician who relies on vision and hearing when conducting histories and physicals. As a general rule, negative age effects are more pronounced if the task requires more complex processing, like recall,[29] which is an important skill for the practice of medicine. For example, adults in their seventh decade typically need about 2 times as long to process the same tasks as adults in their twenties. Generally speaking, the evidence from research suggests that "normal" aging reduces the speed and efficiency of cognitive, perceptual, and psychomotor functions.[8] Proposed mechanisms for this decline include reduced working memory capacity, slowing of retrieval and storage to and from working memory (processing speed), deterioration of neural interconnectedness,[31] and the inability to ignore irrelevant information.[32] A similar concept within the field of medicine is "age associated cognitive decline," which is memory impairment in the elderly compared with normal young adults.[33]

Plasticity refers to the capacity of the brain to change cortical representations (neuroanatomy) as a function of experience. Plasticity is subject to the impact of age. That is, older adults tend to benefit less from performance-enhancing training programs, need more cognitive support during training, and ultimately attain lower performance after training when compared with younger adults. Further, studies show reductions in cognitive performance with loss of brain tissue from injury such as dementia, stroke, or trauma.[34] As these comorbidities are more prevalent in the aged, and individuals may not be aware of cognitive performance change, screening for these conditions in older physicians may be warranted.

From a situated cognition perspective, reductions in 1 or more of these physician factors (for example, hearing, vision, and speed of cognition) could be exacerbated (or even mitigated) by relevant patient and/or practice factors in terms of patient care. For example, reduced hearing and vision in an older cardiologist could be compensated for by a wealth of

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expertise (acquired through deliberate practice) in treating a patient with congestive heart failure (patient factor), provided that the patient presenting with heart failure has symptoms and/or findings that the older cardiologist recognizes with seeing hundreds, if not thousands, of patients presenting to him or her with this disease. Further, impairments in psychomotor abilities with aging could be compensated by less cognitive load through rich schemas. Studying the interactions between these factors is needed to understand the implications of age-related decline within an older physician's practice.

Aging and Self-Directed and Self-Regulated Learning

Self-directed learning is critical to continuous professional growth and the development of expertise; this seems especially true in a global economy where rapidly changing technology can quickly render knowledge and skills obsolete.[35] The health care field is no exception. So a vital component of many medical education curricula is helping students develop self-directed, lifelong learning skills.[36] Effectively directing one's own learning and cognitive performance requires more than just talent, interest, and good instruction; it also involves planning, motivation, and, especially, self-regulation.[37] In other words, effective self-directed learners must implement appropriate self-regulatory strategies when they realize, often based on input from teachers or peers, that they are missing certain knowledge and skills.[38] These strategies include an awareness of the knowledge and skills they do and do not possess, an ability to set goals and identify what they need to learn in order to solve the problem at hand, receptiveness to feedback, and a capacity for monitoring and evaluating implemented plans to determine if goals are being attained.[36] The complexity of the clinical encounter, as presented in the situated cognition framework (FIGURE 1), suggests that self-regulation in medicine may be even more difficult than in other fields, with aging likely exacerbating this complexity. This notion may partly explain discordant findings from the literature on self-assessment—an essential component of effective self-regulation.[39]

To date, few researchers have explored the extent to which self-regulation develops, is maintained, and how it may decline over a physician's lifetime. One might expect that cognitive changes in adulthood influence the quality and quantity of self-regulation in older physicians. In fact, several scholars have suggested that there may be important developmental differences in individuals' self-regulation and have encouraged researchers to explore the hypothesis that self-regulated learning might progress developmentally across the lifespan.[40] In 1 such study of graduate students' cognitive engagement in engineering and education-based programs, Richardson and Newby[41] found that younger students were more likely to use surface processing strategies (that is, limit cognitive engagement to the bare essentials and use rote memorization to learn) and surface motives (that is, meet requirements minimally), rather than more adaptive, deep processing strategies and motives. In the end, if developmental differences do exist, the question for medical educators becomes: How do we most effectively design CME programs that account for these differences in self-regulation such that CME effectively fosters the continued development of essential self-directed learning skills across the life span?

Implications and Future Research

Current cognitive theories, including situated cognition, are consistent with research that shows physician cognitive performance, on average, declines with age.[42] Situated cognition argues, however, that reductions in cognitive performance demonstrated in a controlled laboratory setting may not be seen in real-life practice. Instead, to understand the effects of age on cognitive performance truly, we must first explore the unique contributions and interactions of the physician, patient, and practice setting, because performance is tightly bound and fundamentally dependent upon the specific situation. Although cognitive performance, on average, may decline with age, the influence (both valence and magnitude) of patient and practice setting factors on cognitive performance are unknown. We believe this is an essential area for future research. We also know that traditional, passive approaches to CME are ineffective.[39] We believe that situated cognition is a useful framework for elucidating the potential impact of patient and practice factors on physician cognition[43] and provides a potential framework for future directions in continuous professional development and lifelong learning. The implications of this framework have been used, to a limited degree, in fields outside of medicine.[12,43]

Regarding *practice factors* (FIGURE 1), rapid changes in health care systems and environments require that physicians be highly adaptable. Older physicians may be more prone to errors and inefficiencies in a practice model that emphasizes throughput and 15–20-minute patient encounters. The patient-centered medical home, now being promoted by both physician groups and policy makers,[44] is a care model that could help ensure physicians have sufficient time to see complex cases and apply evidence-based practice at the point of care. Such models of care include support systems to help older physicians manage cognitive load as well as potentially avoid the overconfidence and premature closure traps that are suggested by findings from information processing theory and research. These models could become a part of more active CME approaches.

Another practice factor that has been neglected is the impact of peer support and mentoring. The majority of care in the United States is delivered in office practices of 5 or fewer physicians, with 20% of physicians working in solo practices.[44] Because of growing demands for productivity, many of these physicians spend little to no time at their local hospital participating in peer activities or other learning endeavors.[45] Ericsson and others have highlighted the importance of mentors and coaches for acquiring and maintaining expertise through deliberate practice, which is a

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physician factor. Physicians working alone are therefore at greater risk for declining expertise, particularly as they age when more deliberate practice is likely needed to maintain one's skills.[42,46] Indeed, some have argued that much of the observed decline in cognitive performance with aging can be attributed to reductions in deliberate practice.[47] Using the situated cognition approach would highlight the idea that physician factors (that is, aging and less deliberate practice) could combine with 1 or more practice factors (for example, limited to no learning activities for a practice), resulting in larger-than-expected declines in cognitive performance. Indeed, situated cognition theory would predict that such cognitive performance decrements in 2 or more factors would be much larger than those that would be expected when considering any 1 factor alone. Situated cognition theory—by addressing specific patient, physician, and practice factors, as well as their interactions—has important implications for individuals engaged in health care policy and planning. For instance, aging physicians' cognitive performance could be enhanced by strategies to reduce the burden of these factors, such as practice models that improve physician performance and productivity through technology, physician extenders, and access to point-of-care learning.

Educators should also be mindful that physician learning within practice (practice-based learning and improvement) is making an argument for situated cognition (and learning). Therefore, learning should be tailored to physicians' individual needs.[48]Situated cognition also supports the stance that continuing education guidelines should reflect the importance of performance, cognition, motivation, and context.[49] Furthermore, situated cognition (and learning) would argue that planners of continuing professional education must consider the dynamic interplay between personal and situational factors,[49] incorporate these factors into continuing education curricula, and allow physicians adequate time for reflection within this complex educational model.[50] Indeed, a key tenet of situated cognition (and learning) is the importance of the concept of practice-based learning and improvement, recently endorsed as an essential component of continuous professional development.[51]Ultimately, educators will need to identify novel teaching strategies and resources for assisting physicians with situated learning.[48]

The evolution of EMRs (a practice factor) will also require that we account for changes in cognition over time by providing more patient and practice-level data in real time and providing efficient point-of-care learning resources. As older adults are less familiar with new technologies, they are, in theory, more prone to performance decrements from the additional cognitive load induced by such technologies. However, if EMRs and other technologies for practice were designed with the aging physician in mind, performance could actually improve. To date, electronic tools to assist clinical reasoning have not been terribly useful.[52] Additionally, when physicians pursue structured educational activities (practice and physician factors), such as society meetings, it appears that they tend to gravitate toward courses and areas they are already comfortable with, instead of areas where they possess their largest deficits.[53] Therefore, more research is needed on how best to deliver knowledge and skills at the point of care and how to help aging physicians recognize and fill their own specific gaps (that is, how to support self-regulation—a physician factor). Although recognizing and addressing personal limitations through self-regulation is critically important, this adaptive habit is seemingly lacking in medical practice.

Might the modification of *patient factors* aid the aging physician? Groopman[54] proposed that patients, as well as physicians, should become more knowledgeable about medical decision making to avoid errors in care. Although this strategy has not yet proven to be effective, enhancing the quality of information for patients on the Internet through peer-reviewed sources, such as WebMD and other reputable educational tools, are steps that could theoretically create more informed consumers. Additionally, educating patients (patient factor) about emerging evidence-based and peer-reviewed treatment guidelines and benchmarks for diseases may improve interactions with physicians, thus improving the quality of care.

The *physician factor* of intelligence is an important consideration for the aging physician. Evidence supports the notion that different types of intelligence may evolve differently over the years. For instance, although mental efficiency (that is, fluid intelligence) may decline progressively after age 40, an individual's ability to apply contextually appropriate problem-solving methods (that is, crystallized intelligence or domain-specific, experience-based knowledge) can continue to grow throughout the life span. This continued growth is thought to occur because crystallized intelligence includes learned skills and accumulated knowledge.[55] Indeed, these competing processes—declining fluid intelligence versus increasing crystallized intelligence—and their interactions with emerging and increasingly complex systems of practice may be key issues that determine the successes of aging physicians.

Formal scrutiny of doctors' cognitive abilities may be in store for the future, as experts have called for age-related screening for cognitive impairment and rigorous neuropsychiatric evaluations after lapses in standard of care, regardless of age.[56] We believe that it would be superior to develop reliable and valid tests, so that capable aging physicians could continue to practice at high levels. Indeed, we found no studies testing objective physician cognitive performance and relating it to physician aging. We believe that aging physicians should be encouraged to attend to their physical health, because studies support that regular exercise and leisure activities decrease risk for dementia,[57] and improve longevity and independence,[58,59] with age. Additionally, exercise, diet, sleep, and mental health (physician factors) affect the multifactor, interacting framework of situated cognition. We also anticipate that attention to physical and emotional health will help mitigate the decrements in sensorimotor and processing-speed changes among aging physicians, thereby optimizing

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Lessons for Practice

- Given practice realities, older physicians will remain an essential part of the physician workforce.
- Aging, in and of itself, does not necessarily result in cognitive performance impairment.
- Situated cognition seeks to place an individual's thinking within the larger physical and social context of human interactions, and this theory provides insight into potential implications for older physicians.
- According to situated cognition theory, to understand the effects of age on performance, we must first explore the unique contributions and interactions of the physician, patient, and practice setting, because performance is tightly bound and fundamentally dependent upon the specific situation.
- Promoting research regarding how continuous professional development (CPD) should be implemented over the course of a physician's career is paramount.

the quality of patient care that is provided throughout a physician's professional life.

Now is the time to promote research regarding how continuous professional development (CPD) should be structured over the course of a physician's career. One program that would lend itself to such research is the maintenance of certification (MOC) program. The MOC is a professional, self-regulatory assessment process with the objectives of assuring the public that physicians are competent and helping physicians improve their cognitive performances.[60] Indeed, other research has shown that motivation, self-regulation and, ultimately, learning and cognitive performance can be enhanced through well-designed education and training programs that apply the tenets of contemporary learning theory.[61] Using situated cognition as a framework, the MOC program is a logical place to study new approaches to motivation, self-directed assessment, and learning activities built around principles of aging that can inform new directions in CPD. One example is a Web-based tool that includes practice-improvement modules that lead a physician through a guided assessment of their practice in specific conditions with explicit attention to the system where the physician provides care. Early evidence suggests this guided process helps physicians to uncover knowledge-performance gaps in care and facilitates changes in practice behavior.[62,63]

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