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Widening the lens on teaching and assessing clinical reasoning: from “in the head” to “out in the world”

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Abstract: Traditional teaching and assessment of clinical reasoning has focused on the individual clinician because of the preeminence of the information processing (IP) theory perspective. The clinician’s mind has been viewed as the main source of effective or ineffective reasoning, and other participants, the environment and their interactions have been largely ignored. A social cognitive theoretical lens could enhance our understanding of how reasoning and error and the environment are linked. Therefore, a new approach in which the clinical reasoning process is situated and examined within the context may be required. The theories of embodied cognition, ecological psychology, situated cognition (SitCog) and distributed cognition (DCog) offer new insights to help the teacher and assessor enhance the quality of clinical reasoning instruction and assessment. We describe the teaching and assessment implications of clinical reasoning and error through the lens of this family of theories. Direct observation in different contexts focused on individual and team performance, simulation (with or without enhancement of technology), stimulated recall, think-aloud, and modeling are examples of teaching and assessment strategies grounded in this family of social cognitive theories. Educators may consider the instructional design of learning environments and educational tools that promote a situated educational approach to the teaching and assessment of clinical reasoning.

Keywords: assessment; clinical reasoning; distributed cognition; ecological psychology; embodied cognition; error; social cognitive theories; situated cognition; situativity; teaching.

Introduction

Traditional teaching and assessment of clinical reasoning has focused on the individual clinician because of the preeminence of the information processing (IP) theory perspective [1, 2]. The clinician’s mind has been viewed as the main source of effective or ineffective reasoning, and other participants, the environment and their interactions have been largely ignored. This educational focus on what is “in the head” rather than what is “out in the world” limits our teaching and assessment practices related to clinical reasoning and error.

Empirical evidence from other fields stresses the importance of both social and environmental factors in performance and learning [3, 4]. Competency-based education models [e.g. the Accreditation Council for Graduate Medical Education (ACGME) Outcome Project [5], the CanMeds framework] [6] and the diagnostic error movement [7] are highlighting the important role of teams and systems in clinical reasoning and error. Complex clinical contexts, characterized by a multitude of interactions among social, cultural and environmental factors [8, 9], where teams of clinicians face ill-structured problems in multi-faceted systems under time pressure, remain fertile grounds for error [10]. Focusing on IP as a means to enhance clinical reasoning and reduce error is not moving the patient safety needle enough. Further improvements may require a new approach to teaching and assessment,

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one that ensures clinical reasoning and error processes are situated and examined in context.

In light of these circumstances, the family of social cognitive theories described in the preceding article, sometimes collectively referred to as situativity theory [11], can provide valuable insights into clinical reasoning, error and the complexity of today's health care system. These theories include embodied cognition, ecological psychology, situated cognition (SitCog) and distributed cognition (DCog). Applied to medicine, this family of theories characterizes clinical reasoning and error as social and situational in nature, emphasizing the importance of interactions between individuals and the environment.

In this article, we focus on these theories' implications on teaching and assessing clinical reasoning. We encourage the reader to review the companion paper (paper XX special ed) to learn more about the tenets of these theories. We will use an evolving clinical case as the example throughout this paper to provide a better understanding of the theoretical tenets and educational applications described. The evolving clinical case does not imply that the theories described in this paper are occurring separately or independently from one another. Indeed, this is a family of related theories and we seek to facilitate the understanding of overlapping principles and applications. We also do not mean to imply that more traditional theories (e.g. dual process theory, script theory) [1, 2, 12, 13] are not relevant and helpful to our understanding of clinical reasoning and error. Rather, we propose this family of theories offers new insights to help the teacher and assessor enhance the quality of instruction, feedback and clinical care provided.

Scenario 1: Embodied cognition (sensory and motor inputs matter)

A 65-year-old patient is admitted to the hospital with chest pain. Anne, a third-year medical student, enters the room and begins to conduct a history and physical examination. During cardiac auscultation, she hears a diastolic murmur while the patient is lying down. She wonders whether this could be a murmur of aortic insufficiency and remembers how she examined a patient with known aortic insufficiency at the simulation center last year. She asks the patient to sit up and fully exhale while she listens again. The murmur seems to get louder, but she is not sure, because there is noise coming from outside the room, and the patient has difficulty staying in this position.

Case and theoretical considerations

Embodied cognition emphasizes the connection of the mind to the body's sensory and motor inputs. Reasoning is the result of dynamic interactions of the body, mind and environment, and it can be affected by states of the thinker's body as well as the environment [14].

Traditional "amodal" (non-sensory) theories of cognition view knowledge as disembodied, emotion-free information with internal representations of concepts that are abstract and unrelated to the environment. By contrast, embodied cognition views knowledge as shaped by sensory and motor inputs in the unique environment where reasoning occurs. Embodied cognition argues that perception, reasoning and action create a continuous, dynamic loop of the individual's sensory and motor inputs interacting with the environment [15].

In applying embodied cognition to understanding clinical reasoning and error, there are several salient features. Take for example data gathering, which typically includes visual inputs [e.g. reading an electronic medical record (EMR) or examining a rash], auditory inputs (e.g. auscultating a murmur or listening to a patient's interview), tactile inputs (e.g. palpation of an enlarged lymph node) and even olfactory inputs.

From an embodied cognition stance, learners may have different abilities related to their perception-action systems which may affect their reasoning and error. For example, in the setting of cardiac auscultation, one learner may be able to hear a low-pitched murmur in diastole, while another learner may not. The hearing of a sound may be affected by transient clinician factors such as an ear infection leading to an impaired sensory system, clinician motor skills such as placement of the stethoscope in the correct area or application of pressure to the bell.

Perceptually grounded experiences such as touch, sight and smell are important for learning from an embodied cognition stance and would argue against the traditional order of instruction with a didactic session in a lecture hall first, and later authentic clinical experiences. An instructional approach that evolves from embodied cognition would include early authentic, experiential learning.

Teaching and assessment

For teaching clinical reasoning, embodied cognition would argue for the use of physically grounded education techniques, such as visual cues with spatial relationships, and multimedia that incorporates multiple sensory inputs [16, 17]. On-line, low-fidelity, multimedia instructional materials that employ visual and/or auditory inputs (e.g. Annals [18], Sketchy [19], Aquifer [20], i-Human [21]) are increasingly employing these principles rather than just using text to teach clinical reasoning. Virtual reality simulations involve visual inputs and psychomotor outputs, but most lack the tactile sensory feedback of physical simulations [22].

High-fidelity simulations, such as cardiac auscultation, surgical simulators and partial task trainers, provide even more intense ways of engaging the perceptual abilities and psychomotor outputs in multimodal experiences [14]. Standardized patients (actors playing the role of patients) provide the opportunity to practice with actual human beings that can even be implemented in authentic clinical environments (e.g. unannounced standardized patients) [23]. However, they are often limited by the ability to authentically portray disease states with physical manifestations (e.g. a heart murmur or fluid in the lungs).

Despite these limitations, low- and high-fidelity simulations allow the enactment and reenactment of perceptual and motor states, with feedback linked to reasoning, during interaction with the environment. For early learners who can be overwhelmed with the wealth of inputs in the "unkind" world of clinical practice, simulations also allow the educator to progressively increase the complexity of clinical reasoning scenarios as developmentally appropriate and to control the range of diagnoses that a learner "encounters" during compressed learning episodes. Therefore, simulation can be a helpful teaching and assessment tool to practice an embodied cognition approach to clinical reasoning and errors by reproducing the dynamic system and multitude of interactions that affect reasoning and error [24].

Returning to the case, perception (auscultation and perceiving the murmur) and reasoning are linked to action (asking the patient to assume a different position). The case example illustrates the importance of integrating sensory-motor capacities to properly examine a patient with a heart murmur, and how those sensory-motor abilities are embedded in the environment (the noise of the nursing station) and highlights how embodied "learning" (i.e. the student's practice with positioning an actual patient with aortic insufficiency) may enhance a learner's ability. Ultimately, from an embodied cognition perspective, there is a series of continuous perception-action loops that occur throughout the clinical reasoning process.

Scenario 2: Ecological psychology (learner-environment interactions matter)

Ann finishes her exam and she leaves the room to go and check the EMR. She accesses the EMR and looks up the patient record. She looks for an echocardiogram that the patient may have had in the past because the murmur is diastolic and she wants to know if the murmur is new. An echocardiogram from 2 years ago reports no valvular abnormalities. She tries to access the note of a consultant, however, she does not know how to open specialist documents. While she is searching the EMR, the screen gives an error message, so Ann decides to go back and ask the patient whether he has had a more recent echocardiogram.

Case and theoretical considerations

Ecological psychology emphasizes what the environment and other participants provide to individuals (affordances) relative to their abilities (effectivities) [25, 26]. The interactions in a clinical situation are central to ecological psychology and it focuses on what environmental resources called artifacts (e.g. the EMR) afford individuals (Ann) and how these affordances affect their behavior and create opportunities for or hindrances to action. For example, the EMR provides the student an opportunity to obtain data about the patient (affordance) which can lead to an action (effectivity) – retrieval of a consultant note which provides data that impact patient management.

Implications of ecological psychology include the importance of incorporating the environment (e.g. recognizing affordances and effectivities) into instruction and assessment. This should be done as soon as the learner is ready, as knowledge is not seen as the acquisition of static information in the mind but rather as a tool that is shaped by what the environment and other participants offer (affordances and effectivities). All the components of the environment should be seen as potential affordances and effectivities and how they can affect performance and development. This includes the use of artifacts such as the stethoscope, point-of-care resources and the EMR's functionality that may be overlooked when viewed through script or dual process theory.

Teaching and assessment

Implications of ecological psychology include the incorporation of simulated or real clinical contexts into teaching and assessment, which are critical to provide feedback on learner abilities to recognize affordances and maximize their effectivities. Further, one should consider multiple observations in diverse situations to recognize if learners are able to transfer recognition of affordances and performance of effectivities from one environmental setting to another. Consideration should also be given to assessments by other professionals who will work with the learners and can provide important feedback on interprofessional interactions (e.g. affordances and effectivities). Finally, one should consider incorporating authentic artifacts (e.g. EMR) into teaching and assessment methods to account for their impact on clinical performance [27]. Given the multiple interactions between the clinician, team members and environment, it is likely that statistical methods that can account for the complex, non-linear learner-environment interactions may be required.

Returning to the case, Ann's performance was impacted by her inability to navigate the EMR. From an ecological psychology perspective, learning how to use the EMR would not simply involve a lecture or brief orientation but rather the opportunity to use the EMR in real time with a coach and/or feedback from the EMR itself to help sharpen her recognition of affordances and effectivities available with the EMR.

Scenario 3: Situated cognition (cognition emerges from the relation of the learner with a complex environment)

Ann goes back to the patient room. The resident on call, Mike, comes into the room and begins to ask questions to the patient. While Mike is gathering the history, the nurse comes in to take the patient's vital signs and then leaves the room. Ann notices that Mike does not restart his interview from the same point and moves on to the physical exam. Mike then proceeds to cardiac auscultation. While Mike is listening to the chest, the patient says, "I am pretty sure this is acid reflux because the pain starts in my belly". Then Mike asks the patient to sit up and listens again; however, there is a noise coming from the nursing station and he has difficulty hearing. He says to Ann "I think the patient has a diastolic murmur, but I can't hear very well". The patient says, "What is that?" Ann says to Mike, "I heard that too. It sounds like a diastolic murmur. I tried to get a recent echo report from the EMR but the system crashed on me." Mike closes the door in an attempt to eliminate some of the noise and repeats the cardiac exam, while the patient is getting anxious…

Case and theoretical considerations

SitCog provides a way to view the clinical reasoning of two individuals (Ann and Mike) interacting dynamically with the environment. From a SitCog perspective, all of these components are potentially interdependent and located in the environment and cannot meaningfully be understood in isolation [28]. The activities of people within that environment, as in our aforementioned example, such as the entering in the room of a nurse to check the vital signs or the noisy physical setting, can affect what participants perceive, think and do. Therefore, the student's clinical reasoning cannot be separated from the context.

"Mind and world are causally coupled" [29]. In situated cognition, cognitive processes are the results of a coupled, bidirectional relation between the individual(s) and environment in a situation. Concepts of embodied cognition (perception-action) and ecological psychology (affordances and effectivities) may be explicitly or implicitly incorporated into a SitCog approach. From this view, reasoning and error are located and shaped by the participants, environment and their interactions. Thus, SitCog shifts the focus from the individual participant, which is emphasized in traditional theories, to the social, physical and cultural activities manifest in the clinical encounter.

From the SitCog view, meaningful learning and assessment of clinical reasoning is connected to the situation and is a social activity. The focus of the educator and assessor should be on the entire situation and not only on the clinical reasoning of a single individual or on the role of one element of the environment. The focus should be on the multitude of interactions situated in the environment. Clinical reasoning and the environment cannot be divorced from each other. Attempts to do so will not fully capture the construct.

Teaching and assessment

Teaching and assessment implications may include modeling, direct observation in a clinical setting, technology-enhanced simulation with video analysis and chart-stimulated recall.

One of the SitCog's teaching approaches that can be used in both non-workplace and workplace settings is modeling the thinking process, possibly across different contexts [30, 31]. Modeling can be performed for learners at different stages of their development. The physician models clinical reasoning by verbalizing their thinking and sharing it with a student (e.g. while discussing a paper case patient with chest pain). The physician can provide explanations, illustrations and examples to create a mental representation of the environment in which one can identify and demonstrate not only the interaction between contextual factors and clinical reasoning but also provide verbal descriptions and explanations of how a diagnostic error may occur. Similarly, such modeling may be performed in an authentic setting (in an ambulatory setting), sharing the thinking process about the diagnostic approach to chest pain while fostering participation and inquiry on the part of the learner. Modeling thinking throughout different environments may provide the educator with a better opportunity to highlight the impact of contextual factors on the clinical reasoning process. At the same time, the physician can gain insight into the learner's reasoning by posing questions, while providing students with a lived experience of how reasoning and error can be situated and affected by the environment.

Direct observation may be coupled with asking questions at specific moments of the encounter to investigate the learner's thinking [32]. These assessment methods (such as a think-aloud or self-regulated learning microanalysis) [33] allow the examination of the learner's clinical reasoning while immersed in a complex environment. The observer can assess the interaction of the learner with the patient, and seek to understand the influence of physical, social and cultural factors on the learner's reasoning processes [34]. It also provides an opportunity to analyze and understand a number of interactions between a student and the environment. For example, a teacher may observe a student who is seeing a patient with chest pain in the emergency department. The teacher can observe the student obtaining a history and physical examination ask about a differential diagnosis, and evaluate how the student interacts with and situates their reasoning in the environment. The teacher would therefore be able to observe and assess the effect of physical, social and cultural factors on the student' clinical reasoning process.

Further, it is possible that seeing that same patient with chest pain in an ambulatory setting would lead the student to a different approach even if the patient is presenting with the same diagnosis. The student's reasoning is now situated in a different environment and may impact thinking and actions. A triangulation of data obtained from the observation of the learner's clinical reasoning in patients with the same complaint from three different contexts may provide a more robust assessment of the learner's clinical reasoning, particularly over time.

The teacher needs to be aware that a change in one of the components of such a complex environment can cause a change in the thinking needed to solve a patient problem (e.g. "the butterfly effect"). Therefore, the methods of instruction and assessment should be attuned to a thinking process that often occurs in a chaotic and complex system, while students should be encouraged to reflect and develop clinical reasoning being aware of the situatedness of their thinking.

Another opportunity to teach and assess clinical reasoning from a SitCog perspective is technology-enhanced simulation. This strategy may be implemented in several ways by integrating video review and observation with stimulated recall and written notes (refs). The teacher is able to gather information in a detailed manner about all the actions that take place between a learner, a simulated patient and the environment. The instructor may change the conditions of the environment, may observe the actions of the learners in relation to the environment multiple times, or ask the learner to reflect and recall one's thinking about that particular environment in order to gain an understanding of the learner's clinical reasoning located in a context. Technology-enhanced simulations allow for a better control of environmental factors and their impact on teaching and assessment [32]. Additionally, an analysis of a video [35] may be performed by asking the learner to recall their thinking and reflect on actions related to the role of different factors in the environment, analyzing the impact of how situational factors impact clinical reasoning and error.

It is evident from the scenario that the teaching and assessment of clinical reasoning in such an instance cannot be divorced from the environment. Therefore, the assessment of clinical reasoning by means of direct observation of this event should take into consideration the situated nature of clinical reasoning and error, helping the learner reflect and understand the impact that factors, like the nurse coming in, the patient suggesting a diagnosis or the noise during the physical exam, could have on reasoning and error. Whether instruction occurs in a real or simulated setting, Ann and Mike should learn how to adapt their clinical reasoning to deal with a context that can be dynamic, volatile, complex and constantly changing.

Thus, the teaching and assessment of their clinical reasoning optimally is longitudinal, progressive, and with multiple occasions for observation and feedback in order to enhance one's ability to cope with multiple situations. SitCog also emphasizes the need for a sense of anticipation to better respond to the occurrence of unexpected factors that may emerge from the participants and/or the environment.

Returning to the case, Ann, the resident, and the patient dynamically interact with each other. The interactions are multiple, complex and are unpredictable. The specifics of the situation impact Ann's and Mike's thinking, dictating some of their actions. The interruption of the history taking, because of the unexpected entering of the nurse, the noise impacting the listening to the patient's murmur and the patient mentioning the diagnosis of acid reflux, can influence student, resident and attending clinical reasoning, enhancing the likelihood of making an error and offering teaching and assessment opportunities.

Scenario 4: Distributed cognition (a way to connect large teams from a social cognitive perspective)

After Mike and Ann finish their examination, the team begins to round. The team consists of an attending physician, another medical student, an intern and a pharmacy student. Ann presents the patient and develops a prioritized differential diagnosis with a high suspicion for aortic dissection. However, Ann can't find an explanation for the presence of a diastolic murmur. After conducting her exam of the patient, the attending physician begins to discuss the patient problem at the bedside. The intern mentions that while he was entering the patient room earlier, he was approached by a family member who gave him records from another hospital that showed that the patient had an echo from 2 weeks ago where aortic insufficiency was found. Mike mentions that the patient has a history of elevated blood pressure and recently stopped taking his medication. At that point, the attending physician proposes a diagnosis of aortic dissection and shares the idea that the aortic insufficiency may be a consequence of the dissection. The team decides that the patient needs a chest CT. Mike explains to the patient the possible reason for the chest pain and what the team is suggesting to do next. The patient agrees to the procedure. Mike orders a CT scan through the EMR after talking with radiology. The nurse transports the patient to radiology where the radiology team conducts the study.

Case and theoretical considerations

DCog emphasizes the need for considering how larger groups impact reasoning (and error) and emphasizes the need for communication across individuals as well as the numerous interactions between individuals, artifacts and the environment.

This case highlights the numerous participants and interactions centered around the goal of properly diagnosing and treating this patient. The multiple teams can be seen as multiple systems. When a clinical reasoning situation involves a team that is larger than a couple of individuals and/or involves multiple teams, DCog may provide a useful lens for teaching and assessing clinical reasoning. It can be thought of as SitCog involving multiple teams or a very large team (that is difficult to describe from a SitCog perspective). Information is shared among individuals and groups (medical team and radiology team), organized in a way to facilitate the construction of a shared meaning that benefits the team in achieving a common goal (make a diagnosis for this patient) including access to tools and artifacts (EMR). Members of the team need to rely on and trust the information reported by each member, yet they must develop opportunities to confirm the accuracy of the information to avoid errors. In essence, members of medical team(s) can act independently yet in parallel. DCog, like SitCog, implicitly or explicitly can incorporate ecological psychology and also endorses embodied cognition tenets with perception action loops for the various participants in the encounter.

From a DCog perspective, competencies that guide the teaching and assessment of clinical reasoning should include individual, team and systems competencies [5]. However, most of our current clinical reasoning assessment methods still focus on individuals [32], and robust models for teaching and assessing clinical reasoning for team/system performance are at still lacking. DCog offers a lens for the development and gathering of validity evidence for such tools.

Teaching and assessment

DCog provides a lens for viewing teaching and assessment across multiple educational environments, including the classroom, simulation and the clinical workplace. Like SitCog, DCog endorses teaching techniques that emphasize collaborative reasoning in context. DCog also encourages assessments that go beyond individual performance (e.g. multiple-choice or extended matching) to activities that capture team performance in specific systems [36].

In the classroom, pedagogies such as team-based learning (TBL) or problem-based learning (PBL) can be used to lay a foundation for future collaborative reasoning in simulated and clinical settings. Students can also be introduced to important environmental artifacts (e.g. electronic databases, decision support tools and the EMR) and taught to appreciate how physical space (e.g. proximity to other providers) can support or detract from cognition.

Simulations are ideal for practicing team/system interactions to achieve shared cognition in controlled environments. Intra- and inter-professional team members can learn to appreciate each other's roles and begin to leverage their different skills to achieve the best patient outcomes. Specifically, simulations can help teach and assess shared mental model construction through activities such as team huddles, handoffs, checklists, time-outs and closed loop communication, which are critical for optimally functioning in distributed cognitive systems. Simulations can also allow for learning and assessment on situation awareness, including honing the ability to appreciate different team members' "horizons of observation", which entails knowing what is visible to you and other members of the team at any point in time [37].

Authentic settings (e.g. the workplace) are an excellent location for teaching and assessing clinical reasoning and error from a DCog perspective. Assessment implications include the consideration of 360 evaluations, the importance of direct observation and feedback from multiple members of the team, and the emphasis on both intra- and inter-professional interactions and the effective use of artifacts in the environment.

The teaching and assessment implications discussed in SitCog apply to DCog with the latter extending to larger teams and/or multiple teams. DCog is particularly useful for looking at multiple or larger team settings such as morning report, multi-disciplinary rounds, tumor boards, hand-offs and patient discharge.

Returning to the case, there are multiple individuals on the ward team and multiple teams involved. Understanding of the patient's diagnosis and management plans as well as the natural history of their condition cannot be fully understood from the perspective of a single individual.

There is interaction, communication and cooperation among individuals, and the ward team functions more like a community than an individual. The learning environment for teaching and assessment from a DCog approach is also complex. Such complexity entails a multitude of interactions and people as well as more than one team/system or a community of networks. As illustrated in the case, communication, sharing of expertise and reliance on multiple individuals and/or artifacts are key principles of distributed cognition.

Discussion

We have introduced the reader to the teaching and assessment implications of this family of social cognitive theories using a case that evolves and illustrates teaching and assessment opportunities for both clinical reasoning and error. While traditional theories have served as a useful lens and much progress has been made, there are still significant opportunities to reduce error and improve clinical reasoning. These theories can shed a different light on the teaching and assessing of clinical reasoning and error through the recognition that these constructs are social and involve multiple participants, the environment and their interactions. These theories can provide a useful perspective when teaching and assessing in complex and dynamic settings that are a hallmark of medicine. We should also not assume that what happens in one situation will necessarily generalize to another situation given these diverse interactions and multiple situational factors. We need to realize that teaching and assessing clinical reasoning and error is more than looking at an individual learner devoid of the situation and other individuals present that may help (or hinder) diagnosis and management.

There is significant overlap of these theories, which is why they are often referred to as a family of theories. Embodied cognition argues that our clinical reasoning and error is not solely the result of knowledge and its organization; it also involves incorporating and tuning sensory and motor inputs. Ecological psychology places particular prominence on interactions between individuals and between individuals and their environment and raises the importance of recognizing and capitalizing on affordances and effectivities that are present that can be overlooked through more traditional theoretical approaches. SitCog emphasizes the dynamic, bidirectional interactions between the individuals and the environment, with a focus on small teams and/or how an individual interacts with their environment. DCog focuses on reasoning being distributed across highly interactive and complex systems comprising multiple individuals and the environment, particularly where individuals (to multiple teams) interacting with artifacts are shared, communicated and coordinated to achieve a common goal. Both SitCog and DCog can incorporate embodied cognition and ecological psychology tenets either explicitly or implicitly. Taken together, this family of theories provides unique opportunities for teaching and assessing clinical reasoning and the mitigation of error that look beyond what is "in the head" to what is "out in the world". We have provided a table that synthesizes teaching and assessment implications of these theories (see Figure 1).

These theories can be incorporated into existing teaching and assessment activities, and we have illustrated this in each section. For example, what is considered important for teaching and assessment (e.g. it often goes beyond the individual's thinking), the need for authentic teaching and assessment, and the need for multiple assessments by multiple observers involving multiple situations that is optimally performed longitudinally to be confident about one's appraisal of performance. Consider how morning report or morbidity and mortality could look from a teaching and assessment standpoint if tenets of these theories were included.

These theories also raise the centrality of the learning environment and the impact of how rich (or poor) the environment is for facilitating clinical reasoning and error. We believe that teachers and assessors need theory-driven teaching and assessment approaches to better understand why and how errors occur and that this family of theories provides a different perspective from what has traditionally been discussed by the field. Therefore, educators may consider the instructional design of learning environments and educational tools that promote a situated educational approach to the teaching and assessment of clinical reasoning.

There are limitations to the use of this family of theories. First, these theories are macro theories [38] and thus while they are helpful for explaining what happens when a complex situation goes well or wrong (error), these theories do not readily provide specific interventions. Doing the latter often entails partnering with a micro theory such as traditional theories on cognition. Indeed, such a combination can be a powerful means to explore the impact of the larger social setting on the individual decision maker. Second, we acknowledge that this family of theories do not represent all social cognitive theories that could be considered for teaching and assessing clinical reasoning and error. Third, we would like to point out that for an early learner (e.g. a first-year medical student), a teaching and assessment approach solely grounded in these theories may overwhelm the learner [39]. However, incorporating these theories with other theoretical approaches, while carefully designing experiences with a slowly increasing level of authenticity, may be beneficial [40]. Finally, we would like to point out that one should choose their theoretical lens based on goals; there is no right or wrong theory and indeed using different theoretical perspectives on problems such as error can be a fruitful endeavor.

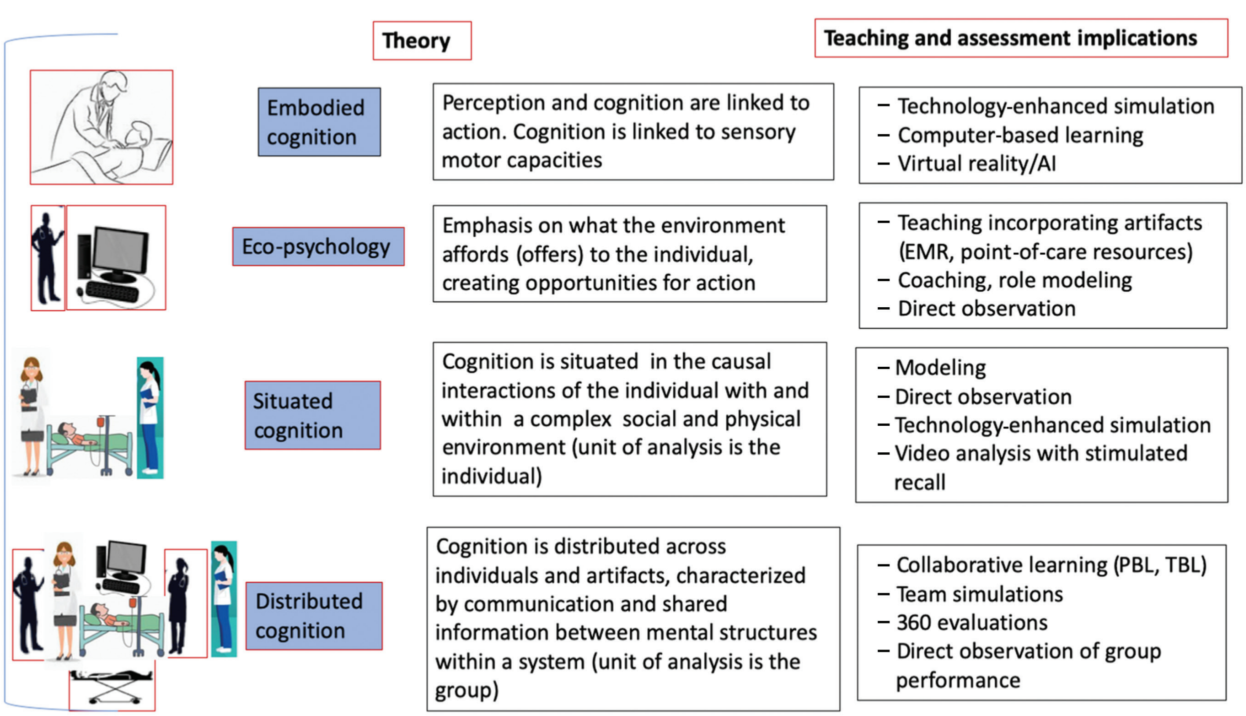

Figure 1: Social cognitive theories: teaching and assessment implications for clinical reasoning and error.

Future research should focus on investigating whether the implementation of teaching and assessment activities grounded in these theories leads to more effective teaching, assessment and clinical reasoning performance, with particular emphasis on error prevention.

Conclusions

We advocate for these theories to raise awareness among educators, enhance their understanding and promote the implementation of a more social cognitive grounded approach to teaching and assessing clinical reasoning. We contend that a description of this family of theories and some of their applications would shed some light into the situational aspects of reasoning and error, and lead to new learning strategies to improve reasoning and identify and prevent error.

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