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From Noise to Music: Reframing the Role of Context in Clinical Reasoning

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INTRODUCTION

Traditional perspectives on clinical reasoning (CR) have framed it as a content-specific process in which differences in the information stored in a clinician's mind account for differences in CR performance.[1–3] The finding that individual clinicians perform differently on cases with the same clinical content but varying situational features or contextual factors suggested that context plays an important role in CR.[4–13] These studies advanced the idea of CR as not only "content-specific," but also "context-specific." Studies on diagnostic errors have identified how contextual factors can disrupt clinicians' reasoning, and subsequent work has primarily focused on contextual factors that may compromise accurate CR.[1,6–8,10,13]

Context-specificity argues that effective CR relies on both how information is stored in a clinician's mind *and* their ability to perceive (e.g., recognize the problem at hand), retrieve, and apply that information in practice. Individuals experience problems with applying what they learned in one setting (e.g., an inpatient ward) to another context (e.g., primary care clinic).[14–19] This so-called transfer problem may, in part, be due to the fact knowledge use in a specific situation relies on retrieval cues, many of which are likely to be connected to the context.[20] Because of context's integral role in CR, attending to clinicians' familiarity and dexterity with the contexts in which they reason offers the potential to advance their abilities beyond what is possible by developing content knowledge alone.

Despite their potential to improve CR, to date, empiric research and application of theory has viewed contextual factors (e.g., emotion, cognitive load, and biases), as noise that interferes with perception, retrieval, and application of knowledge.[4–10] Rooted in the information-processing (IP) paradigm, this perspective centers an individual's stored knowledge (i.e., "the world in the mind") and places less emphasis on the dynamic interactions between individuals and the environment (i.e., "the mind in the world").[3,15,21] Positioning contextual factors solely as detractors from cognition makes it difficult to move beyond viewing context as a burden to be mitigated in CR. In this paper, we aim to reframe contextual factors as not solely challenges to be mitigated but also opportunities to be leveraged in CR.

COGNITION AND CONTEXT IN CLINICAL REASONING

Because of the centrality of IP theory, context has been viewed as noise in CR—information that does not directly relate to establishing a diagnosis.[1–5,9,16] IP theory's central tenet is that effective CR entails building organized knowledge (i.e., interconnected information stored in memory) of diseases (e.g., illness scripts). From this perspective, becoming an expert physician entails focusing on the content that leads to establishing a diagnosis.[1–3,15] Contextual factors were not part of the IP model and thus considered to be largely noise.

Subsequent work, however, identified context-specificity in CR—that while holding the information needed to establish the diagnosis as (nearly) identical but changing contextual factors (e.g., a patient suggesting an incorrect diagnosis or having difficulty speaking the native language; creating glitches in the Electronic Medical Record (EMR)), the same physician would come to two different diagnostic decisions.[6–8,10,13] Exploring context-specificity required going beyond information within the physician's mind, approaching this phenomenon from a different paradigm, and redefining context as comprising the participants, their environment, and the interactions therein.[15,22] From this perspective, intentional engagement with and reflection on context can support the development of situation awareness, which plays an important role in recognizing, monitoring, predicting, and adapting to the dynamic unfolding of clinical cases.[23,24]

While these studies illuminated the presence of context-specificity and offered a potential hypothesis for why it occurs (e.g., causing distraction and negatively impacting working memory), they only explored how context might inhibit a physician's reasoning. Exploring how contextual factors may aide CR is a natural next step for investigation.

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Situated cognition (SitCog) and ecological psychology (EcoPsych) are two theoretical perspectives that can support this exploration of context as a potential enabler of CR.

Situated Cognition

SitCog argues that cognitive processes, such as CR, emerge from the dynamic interplay between individuals, the environment, and the interactions that unfold between them (Fig. 1).[15,25–27] This interdependence between cognition and context creates a bidirectional relationship: context shapes the content of a case and cognition, which goes on to further shape the context, which then influences the subsequent content and cognition.

Consider the case example and application of SitCog in Table 1. The historically dominant lens of IP theory would seek to minimize the role of context and center the physician's

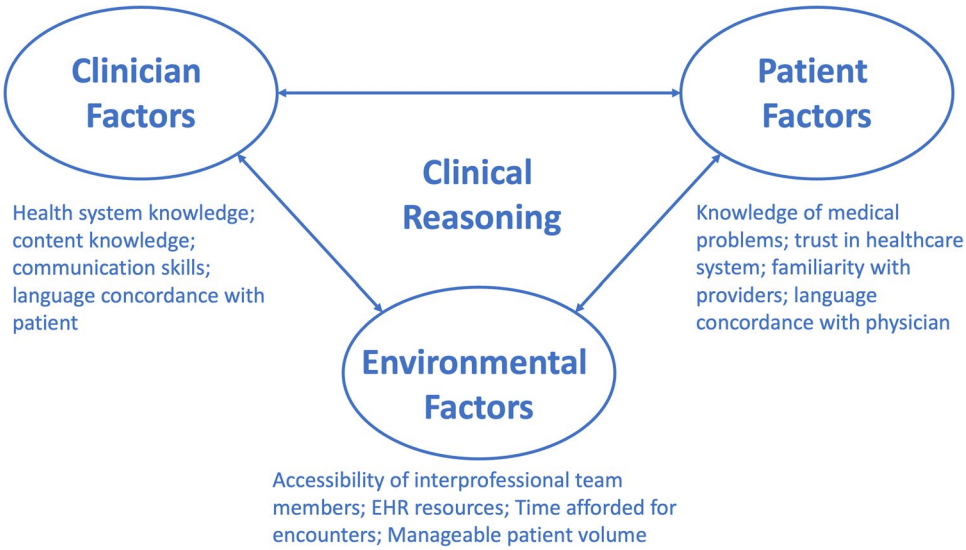

Figure 1 CR through the lens of SitCog.

Table 1 Application of SitCog and EcoPsych to a Clinical Case

A sample case for analysis using SitCog and EcoPsych

A hospitalist is called by a bedside nurse to evaluate a patient recently admitted for pyelonephritis who develops new palpitations and dyspnea. The hospitalist asks the patient how long he has had these symptoms, to which he replies, "about *[deep breath]* 4 hours *[deep breath],* but *[deep breath]* it's getting worse." Recognizing his labored breathing, she experiences a sense of worry. At the same time, as the bedside nurse is preparing to obtain an ECG, the two providers notice the bedside vitals machine, which shows the patient's pulse rate is 172 beats per minute.

"Do you want blood cultures? Could he have worsening sepsis? I just saw a similar case." the bedside nurse asks.

"He definitely could. Let's sit him up in bed to help his breathing and get him on telemetry. I'm concerned about his tachycardia," the hospitalist replies.

Recognizing the need for more support, the hospitalist activates the rapid response team. She and the nurse reposition the patient, who mentions, "this feels like my heart attack." The nurse asks if she wants a troponin, too. "Eventually, but let's prioritize getting him hooked up to the monitor," she responds.

The rapid response team arrives and helps attach the patient to a telemetry monitor, which reveals a regular, narrow complex tachycardia. Anticipating an upcoming management decision, she asks a colleague to draw up two doses of 6mg of IV adenosine. Upon verifying the patient has a stable blood pressure, she proceeds with administering adenosine, which converts the patient back into normal sinus rhythm.

Application of SitCog

- The physician's reasoning emerges from interactions with her internal state (e.g., her sense of worry), her content knowledge (e.g., tachycardia and dyspnea), the patient (e.g., hearing and observing his labored breathing), her colleagues (e.g., working with the bedside nurse), and the environment (e.g., activating the rapid response team).
- Her ability to enact and apply content knowledge (e.g., diagnosis and management of a narrow complex tachycardia) relied on these dynamic interactions and her management of their influence on her own cognition.
- For example, she integrates, but does not anchor to, the nurse's reflexive suggestion of sepsis based on a recent case (a possible example of availability bias[1]), demonstrating how others' cognitive biases can be a contextual factor to manage.
- Had these situational elements changed (e.g., she did not have support from a rapid response team), her CR would have had to adapt to different contextual factors.

Application of EcoPsych

- EcoPsych highlights the hospitalist's *effectivities* (e.g., her capacity to recognize the patient's labored breathing, collaborate with an interprofessional team, and diagnose and treat a supraventricular tachycardia).
- Enacting these *effectivities* is possible because of her perception of certain *affordances* (e.g., a telemetry monitor, interprofessional team members, and necessary medications.)
- With different *effectivities* or *affordances*, her CR would have changed.
- In addition to the effectivity-affordance dyad, this case also highlights another important interdependence in EcoPsych—*intention* and *attention*.
- *Intention* reflects one's goals and objectives (e.g., diagnose and treat the patient's dyspnea and palpitations), and *attention* refers to one's ability to perceive a certain affordance (e.g., identifying the availability of a telemetry monitor).[15]
- Intention drives attention and, in turn, shapes the affordances one perceives and thus the effectivities they enact.

stored knowledge (e.g., diagnosis and management of a narrow complex tachycardia).[1,3,15] In doing so, it filters out core contextual elements, such as the interactions between interprofessional team members, patients, and the physical environment. SitCog, however, centers these dynamic and emergent interactions, providing a way to diagnose how they impede or enhance CR.[25–28] Table 2 provides supplemental examples of how contextual factors can augment CR.

Ecological Psychology

EcoPsych offers another perspective for examining how an individual can identify and engage with contextual factors that enable wise action.[15,29–32] These contextual elements, which EcoPsych calls *affordances*, include anything that may support an individual's ability to act.[32] One way to conceptualize an affordance is the "-able" quality of an item; a chest x-ray is "interpretable," and a pocket of ascites may be "tappable." However, not all chest x-rays will be accurately read and not all pockets of ascites will be successfully tapped. For this to happen, an individual must also possess the ability to act on the affordance (e.g., interpret the chest x-ray or perform a paracentesis), which EcoPsych terms an *effectivity*.[33,34] Effectivities represent one's ability to perform a certain action in a certain context. Thus, there is an interdependence between affordances and effectivities—certain affordances are only available to individuals with specific effectivities, and certain effectivities are only relevant in environments with the necessary affordances. From the perspective of EcoPsych, successful CR emerges not only from the information stored in a clinician's mind, but also from the alignment between their effectivities and the environment's affordances.

Examine the case in Table 1 through the lens of EcoPsych. Unlike IP's conceptualization of CR as stored and static, EcoPsych allows us to re-envision it as emergent and intertwined with the environment. Thus, CR ability stems from not just the information an individual stores in their mind, but also the ways they perceive, engage with, and respond to the environment's affordances. By cultivating effectivities (e.g., training clinicians to effectively lead a rapid response scenario), altering the affordances a clinical context provides (e.g., embedding point-of-care references in the EMR), and refining the ways clinicians direct their *intention* and *attention* (Table 1) (e.g., by providing them with opportunities for feedback, debriefing, and reflection), context can transform from confounder to enabler of expert performance (see Table 2 for further case examples). We will now provide examples of how these theories translate to clinical teaching and practice.

Applications to Teaching

Clinical teachers can apply SitCog and EcoPsych by turning their and learners' attention to content *and* context when teaching CR. For example, in addition to probing learners on the causes of volume overload, they can also explore with learners how patient communication may support or impede their CR (e.g., What communication strategies allowed them to identify triggers for the patient's heart failure exacerbation? What elements of their patient interactions supported or hindered their reasoning? How might they overcome challenges in the future?). EcoPsych can help clinical teachers determine whether learners notice relevant affordances (e.g., the availability of a clinical pharmacist to review with a patient their discharge medication regimen) or possess key effectivities (e.g., the ability to use medical interpreting services with patients with whom they have language discordance). These teaching strategies, which can be applied in both authentic or simulated clinical encounters (e.g., with standardized patients or in simulation centers) can help teachers support learners' situational awareness (e.g., they learn to recognize and select the right tools in a given context) and shift the role of contextual factors, such as patient conversations, from noise to integral elements of CR.

SitCog and EcoPsych also make interactions with interprofessional team members and the clinical environment rich opportunities for CR instruction. Consider a learner who struggles to communicate a consult question or use the EMR. These interactions with clinicians and technology in the clinical environment help shape one's reasoning (Fig. 1). SitCog and EcoPsych can thus expand educators' repertoire of CR teaching tools to help learners leverage these interactions and cultivate new effectivities (e.g., how to best share information with consultants or use the EMR in a given context). In other words, teachers can help trainees learn to make "music" from what was previously "noise." Integrating content (e.g., criteria for diagnosing and treating spontaneous bacterial peritonitis) *with* context (e.g., how to best engage the patient and their caregivers in deciding which medication dosing regimen will work best on discharge) can advance CR education by incorporating how to enact and adapt knowledge structures in various contexts of practice.

Applications to Practice

Viewing context as a potential enabler of CR also offers opportunities to enhance practice. Consider the potential impact of reducing the often-hectic pace of practice. Social psychology has demonstrated how time pressures alter an individual's perception and behavior; those who are in a rush are less likely to recognize and help a distressed person.[35] Time pressures narrow one's cognitive map, limiting their perception of opportunities to help (i.e., affordances) and restricting their enactment of helping behaviors (i.e., effectivities).[35,36] Increasing the time available to clinicians brings the potential to augment CR by expanding the affordances they recognize and the effectivities they go on to demonstrate, particularly those that time pressures interfere

Table 2 Case Examples of How Contextual Factors Can Support CR. Concepts from *EcoPsych* (*italics*) are Highlighted Throughout the Clinical Scenario

Clinical scenario	How contextual factors enhance CR
A patient presents to primary care clinic at 4:30pm on a Friday with unilateral leg swelling and erythema. The patient shares they noticed the swelling yesterday and initially thought little of it, but decided to book a same-day visit after reading that their symptoms could be from a deep vein thrombosis (DVT). The clinician recognizes the exam findings as compatible with a lower extremity DVT (*affordance*) and orders a lower extremity ultrasound (*effectivity*). Noticing the time of day, they worry that ultrasound may close soon and pause the visit to get the phone number for ultrasound (*affordance*). The clinician calls the ultrasound tech and radiologist (*effectivity*), who agree to stay to complete the study. The ultrasound reveals a new lower extremity DVT. The patient returns to clinic to discuss the diagnosis with their physician and review side effects and precautions related to initiating anti-coagulation.	Patient factors: The patient's recognition of their symptoms and decision to seek more information after initially dismissing them both served to instigate the clinic visit. Their willingness to return to clinic after the ultrasound to discuss results and medication changes supported the initiation of anti-coagulation. Clinician factors: The physician perceives and acts on several affordances that support them making a diagnosis of a DVT. For example, recognizing of the time of day as a potential barrier to obtaining diagnostic tests prompts them to pause the visit and immediately contact ultrasound. Their health system knowledge and decision to re-structure their typical clinic visit alters the interactions between the clinician, patient, and environment and helps facilitate timely diagnostic testing. Environmental factors: While the time of day provides a potential barrier CR by creating constraints on what tests may be available, the health system environment provides several affordances that allow the clinician to overcome this barrier. For example, the presence of a directory that allows the clinician to directly call ultrasound and confirm their availability, and the willingness of the ultrasound tech and radiologist to stay and complete the study on short notice facilitate effective CR.
An overnight resident is admitting a patient with decompensated cirrhosis presenting with fever and abdominal pain. The resident notices abdominal distension on exam (*affordance*) and performs a point-of-care ultrasound (*effectivity*), which reveals ascites (*affordance*), prompting them to pursue a diagnostic paracentesis (*effectivity*). The resident struggles to identify an adequately sized pocket of ascitic fluid. The patient points to the area where prior paracenteses have been successful (*redirection of resident's attention*), which reveals a somewhat larger pocket. The resident recognizes their discomfort performing the procedure alone and reaches out to an in-house attending for supervision (*effectivity*). The attending has experience troubleshooting procedures and engages the bedside RN to help with repositioning the patient to further augment the size of the ascitic fluid pocket. They supervise the resident through the paracentesis, which confirms a diagnosis of spontaneous bacterial peritonitis.	Patient factors: The patient's prior experiences with paracenteses allows them to support the CR process by suggesting a location to look for a sizeable pocket of fluid, which helps the resident identify an area that is likely to yield a successful paracentesis. These patient-clinician interactions enable the collection of important diagnostic data for identifying spontaneous bacterial peritonitis. Clinician factors: In addition to possessing knowledge related to complications of decompensated cirrhosis (i.e., spontaneous bacterial peritonitis), the resident also recognizes important contextual factors (i.e., *affordances*) that support their CR, including the presence of exam findings suggestive of ascites and the availability of a point-of-care ultrasound to confirm its presence. Their capability (i.e., *effectivity*) to perform physical exam maneuvers, use the point-of-care ultrasound, and recognize and enact the need for more supervision play an important role in the reasoning process. Without these factors, the interactions between the resident, patient, and environment could have unfolded differently, delaying or precluding performing the paracentesis and making the ultimate diagnosis. Environmental factors: The clinical environment provides affordances that support the CR process, including the availability of point-of-care diagnostic tools (e.g., an ultrasound), the on-site presence of an attending to provide overnight supervision, and the availability and engagement of the bedside RN in providing procedural support for an effective paracentesis. Each of these environmental factors interacts with the resident and patient to influence the context in which CR occurs. As a result, they alter and enable the information available to the resident for enacting diagnostic and therapeutic plans.
A patient with recurrent urinary tract infections presents to urgent care clinic with dysuria and suprapubic abdominal pain. The physician seeing them obtains a urinalysis (*affordance*), which reveals pyuria, + nitrites, and + leukocyte esterase, prompting them to diagnose cystitis (*effectivity*). When discussing the need for antibiotics, the patient recounts a prior conversation with a pharmacist, who encouraged the patient to share with their providers that they have previously had antibiotic-resistant organisms cultured from their urine. This prompts the physician to review the patient's prior urine culture results (*affordance & effectivity*), which show several, flagged urine cultures that grew drug-resistant gram-negative bacilli. In need of support with antibiotic selection, the physician pages the on-call infectious diseases consultant, who reviews the patient's data and provides both an antibiotic recommendation and brief teaching on antibiotic selection for drug-resistant organisms.	Patient factors: The patient's knowledge of their prior urinary tract infections, prior interactions with a pharmacist, and decision to share this information with their physician play an integral role in prompting the physician's review of urine culture results before making an antibiotic selection. These past and current patient-clinician-health-system interactions support the CR process and facilitate potentially better outcomes than what the physician's stored knowledge and independent cognition alone may have offered. Clinician factors: The physician's receptivity to the information the patient shared, their ability to effectively use the EHR to review prior microbiologic data, and their recognition of the need for input from an infectious diseases consultant represent important interactions with contextual factors that support the reasoning process. Furthermore, beyond the decision to seek consultant input, their knowledge of the health system allows them to engage with the infectious diseases consultant in real time, which enables both CR and learning. Environmental factors: The presence of flags for abnormal urine culture results in the EHR can facilitate effective and efficient data review by the clinician. In addition, the structure of the health system, which includes an available infectious diseases consultant for synchronous discussions, enables CR by providing opportunities for real-time interactions between clinicians when needed.

Table 2 (continued)

Clinical scenario	How contextual factors enhance CR
The inpatient team (medical student, intern, resident, and attending) caring for a patient who was admitted with a working diagnosis of community-acquired pneumonia (CAP) notice their patient is continuing to have fevers despite 5 days of empiric antibiotic therapy for CAP. They consider alternative diagnoses (*re-direct their attention and intention*) and ask their patient (*effectivity*) about any new symptoms. The patient expresses new pleuritic chest pain (*affordance*). They decide to obtain contrast-enhanced computed tomography of the chest to evaluate for uncontrolled infection or non-infectious etiologies of fever (*effectivity*). The radiologist reads the scan as a possible developing pulmonary abscess. The team decides to seek further input (*effectivity*) of both the pulmonary and infectious diseases teams for guidance on further diagnostic testing and therapeutic changes (*affordance*). Rather than soliciting their input separately, the intern asks that all teams meet with radiology together to discuss the patient and review the imaging results (*effectivity*). The multi-disciplinary discussion leads to increased confidence in the diagnosis of a developing pulmonary abscess, which results in pursuing bronchoscopy and making changes to the patient's antibiotic regimen.	Patient factors: The patient's persistent symptoms and their development and communication of their new pleurisy contribute to the team's decision to re-evaluate their working diagnosis of CAP and obtain more diagnostic tests. While the persistent fever alone may have prompted similar reasoning, the patient-clinician interactions are contextual factors that provide further data to support the need to reconsider the accuracy of the working diagnosis. Clinician factors: The intern's suggestion for all teams to meet together with radiology creates a context for a multi-disciplinary discussion in which each team shares their expertise and perspective on the case. For each participant, the contents of this conversation influence their individual reasoning, and thus the team-based reasoning that unfolds between them. In this case, the perspective sharing facilitates new cognition, such as a re-interpretation of imaging results and co-construction of a new diagnostic and therapeutic plan. Environmental factors: The fact that there is physical space, time availability, and individual willingness for the inter-disciplinary team to synchronously meet to discuss the case is influenced, at least in part, by the clinical environment and health system. For example, the presence of on-site radiology and workloads that make engaging in a discussion like this feasible for all parties reflects the design of various elements of the health system. In addition, a culture of collaboration further contributes to these moments of synchronous, multi-disciplinary, team-based CR.

with, such as engaging in patient-centered education,[37–39] coordinating with or equitably referring to specialists,[40,41] or ensuring that management decisions align with clinical practice guidelines.[42,43]

The system provides several other opportunities to enhance CR, including optimizing the EHR to improve patient education materials and creating opportunities for effective interprofessional communication in clinical teams. Through the lens of SitCog, empowering patients with high-quality educational approaches that go beyond the facts of their illness can change the interactions that take place between patients, clinicians, and the health system.[44,45] Educating patients, for example, about the path for upcoming diagnostic and therapeutic decisions or about the how their medical care may intersect with their broader lives can help them transition from "passengers" to "co-pilots" in the CR that influences their care, like in the many self-managed care projects.[46–48]

Similarly, attending to the interactions that occur between clinicians has the potential to support collaborative CR in interprofessional teams.[45,49–51] The expansion of electronic consultations services (e-consults) across healthcare systems has demonstrated how changes in provider communication can facilitate or detract from CR.[52–55] Examining these forms of communication through IP theories may provide confusing evidence regarding their utility. However, exploring them through the lens of SitCog can help us identify specific patient, clinician, and environmental factors that may render each form of communication more or less helpful in CR. Furthermore, EcoPsych allows us to frame these various opportunities for communication as affordances and the ways a clinician engages in them as effectivities. As a result, opportunities emerge to examine how the two interact to enable effective CR. We encourage health systems to use interprofessional communication to advance CR by providing guidance on the optimal circumstances for different formats (e.g., e-consults, in-person consultations, multi-disciplinary conferences) and by offering strategies to cultivate clinicians' effectivities in each (e.g., communication skills, what information to include).

CONCLUSION

We have used two theories of cognition—SitCog and EcoPsych—to demonstrate contextual factors' potential to elevate CR education and practice. Together, these two perspectives help us see how CR is directly intertwined with the context in which it occurs. Interactions between patients, providers, and the health system; the presence or absence of certain opportunities and resources in the clinical environment (i.e., affordances); and the ways an individual can act on those opportunities (i.e., effectivities) all influence CR. When applied to CR practice and education, optimizing the context in which reasoning occurs and cultivating new ways for trainees and practitioners to engage with that context hold the potential to help clinicians transform noise into music.

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Declarations:

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