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The Linguistic Effects of Context Specificity: Exploring Affect, Cognitive Processing, and Agency in Physicians' Think-Aloud Reflections

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Abstract

Background: The literature suggests that affect, higher-level cognitive processes (e.g. decision-making), and agency (the capacity to produce an effect) are important for reasoning; however, we do not know how these factors respond to context. Using situated cognition theory as a framework, and linguistic tools as a method, we explored the effects of context specificity [a physician seeing two patients with identical presentations (symptoms and findings), but coming to two different diagnoses], hypothesizing more linguistic markers of cognitive load in the presence of contextual factors (e.g. incorrect diagnostic suggestion).

Methods: In this comparative and exploratory study, 64 physicians each completed one case with contextual factors and one without. Transcribed think-aloud reflections were coded by Linguistic Inquiry and Word Count (LIWC) software for markers of affect, cognitive processes, and first-person pronouns. A repeated-measures multivariate analysis of variance was used to inferentially compare these LIWC categories between cases with and without contextual factors. This was followed by exploratory descriptive analysis of subcategories.

Results: As hypothesized, participants used more affective and cognitive process markers in cases with contextual factors and more *I/me* pronouns in cases without. These differences were statistically significant for cognitive processing words but not affective and pronominal words. Exploratory analysis revealed more negative emotions, cognitive processes of insight, and third-person pronouns in cases with contextual factors.

Conclusions: This study exposes linguistic differences arising from context specificity. These results demonstrate the value of a situated cognition view of patient encounters and reveal the utility of linguistic tools for examining clinical reasoning.

Keywords: agency; clinical reasoning; context specificity; emotion; linguistics.

Introduction

Diagnostic error is a national – if not international – crisis and is frequently cited as a leading cause of death in the United States [1, 2]. One important source of error relates to context specificity, a phenomenon whereby a physician sees two patients with identical presentations (symptoms and findings) and yet comes to two different diagnostic decisions [3, 4]. Situated cognition theory, which argues that knowing cannot be separated from context, activity, or language [5], provides a useful framework for exploring context specificity. In the case of clinical reasoning, one way to explore context specificity is to account for *contextual factors*: elements in the specific situation that pertain to the physician (e.g. burnout, sleepiness), patient (e.g. spoken language proficiency, challenging physician credentials), and environment (e.g. time for appointment, availability of ancillary staff), but that are not pieces of information traditionally viewed as needed to establish the diagnosis or management and often are unique to the situation. These contextual factors interact as the encounter unfolds and, from the situated cognition perspective, clinical reasoning emerges. Therefore, situated cognition provides a useful

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theoretical lens for exploring errors and other variation in physician performance that result from context specificity.

The literature suggests that affect, higher-level cognitive processes (e.g. problem-solving and decision-making [6]), and an individual's agency (the capacity to produce an effect [7, 8]) are important for reasoning [8–17]; however, we do not know how these factors interact and respond in different contexts (i.e. situations). Moreover, only affect has been explored in the context of *clinical* reasoning [9–11]. Linguistics provides a mechanism for understanding how different contexts may impact affect, cognitive processes, and agency, providing a potential means for better supporting physician performance in the presence of contextual factors as well as helping to unravel the vexing phenomenon of context specificity. Therefore, the purpose of this study is to use situated cognition theory and linguistic analysis to determine whether contextual factors lead to differences in affect, cognitive processes, and individual agency, and, if so, to describe these differences.

Affect, cognitive processes, and agency in clinical reasoning

While much of the clinical reasoning literature focuses on the logical aspects of cognition, emotion (an affective state characterized by arousal that results from a specific stimulus in the environment [9]) is also an integral part of the reasoning process [9, 10, 18, 19]. The greater the magnitude (increase in level of arousal) of the emotion, the greater the possible effect on the clinical reasoning process [11]. But some emotional arousal is present in *all* reasoning [19], particularly in the high-stakes context of patient care, where anxiety and stress often exist [9]. Negative emotions like anxiety can cause a narrowing of attention and risk aversion (along with potentially resultant narrowing of cognitive capacity and increasing cognitive load), which, in turn, can increase the chance of medical error in the form of missed or delayed diagnoses [11, 20–22]. Positive emotions can often support reasoning, but they can also lead to overconfidence which can, in turn, result in less information gathering during a patient encounter [11, 20, 23]. Recent research has also linked emotions to contextual factors, with study participants voicing primarily negative emotional reactions to various contextual factors such as low English proficiency of the patient [24, 25]. One potential solution proposed by those interested in ameliorating diagnostic error is to increase *explicit awareness* of these emotions, taking them seriously and exploring how different contextual factors may trigger different emotional states [10, 11]. Linguistic analysis is one such path to increased awareness of emotions [12, 26], offering a novel way of exploring how various emotions are triggered by contextual factors.

While the major *outcomes* of clinical reasoning may be diagnostic and management plans, clinical reasoning itself is also a complex *process* of meaning making that scholars are only now beginning to fully understand [25, 27–29]. Contained under the umbrella of the clinical reasoning process are narrower cognitive processes like problem representation, hypothesis generation, hypothesis testing, and metacognition (which involves, among other things, being aware of, controlling, and managing one's cognition in pursuit of a task [30–32]). Sometimes these cognitive processes are conscious and sometimes they are unconscious [32], and they appear to be inhibited by certain contextual factors, such as interruption and diagnostic suggestion [24, 28, 33]. The presence of these inhibiting contextual factors can increase cognitive load, defined as perceived mental effort [33, 34]. When the cognitive load is too high for a clinician, their reasoning can be negatively affected, leading to diagnostic error [33, 35]. In order to study cognitive processes in clinical reasoning and how they may be related to cognitive load, we can explore the patterns of distinct linguistic markers like *think, know*, or *consider* [36]. This allows us to examine whether and how expression of cognitive processes shifts under the influence of context specificity. Following Khawaja and colleagues, we predicted that higher cognitive load would be associated with more cognitive process markers as individuals worked to actively understand their situation [36].

While situated and context-dependent, the process of clinical reasoning is largely *directed* by the physician. It is the physician who marshals the necessary resources – some of which may involve other people (e.g. specialty consultation) and diagnostic artifacts (e.g. diagnostic imaging, laboratories) – to eventually reason to a decision. Yet, as discussed earlier, physicians may feel uncertain or anxious in the presence of contextual factors, letting their emotions guide their reasoning [20, 21, 24]. We approach this through the lens of *agency* (broadly defined as the capacity to produce an effect [7, 8]), exploring whether contextual factors affect how physicians talk about themselves as agents (or not) of the reasoning process. In particular, we examined the frequency of the first-person singular pronoun *I*, as it has been argued in prior work to be indicative of a feeling of individual, intentional causation, particularly in comparison to other pronouns like generic *you* [8, 15, 37]. Moreover, the first-person singular pronoun has been associated with greater

depth of reflection in medical student essays [38] in one study and decreased cognitive load in team problem-solving in another [36]. These studies along with the broader cognitive load literature suggest additional reasons why we might expect to see decreased *I* usage in the presence of contextual factors.

In order to examine and describe potential effects of context specificity on affect, cognitive processes, and individual agency so that we can better support clinicians, we pose the following research questions:

1. Does the presence of contextual factors in cases lead to differences in linguistic measures of affect, cognitive processes, or individual agency?
2. If so, what are the patterns of different subtypes of affect, cognitive processes, and agency in cases with and without contextual factors?

Based on the literature reviewed earlier, we hypothesized that increased cognitive load in the condition with contextual factors would lead to a greater frequency of affect and cognitive process markers and a lower frequency of first-person singular pronouns.

Materials and methods

This study is a comparative and exploratory linguistic analysis of think-aloud reflections drawn from a larger investigation [28, 39] of context specificity and clinical reasoning at Uniformed Services University of the Health Sciences, Walter Reed National Military Medical Center, and Naval Medical Center San Diego. The study was approved by the institutional review boards at all three sites. Physicians in internal medicine, family medicine, and surgery were quasi-randomly assigned (study dates and times were scheduled randomly and then physicians were placed according to their schedule availability) to a video or live scenario condition. While video cases were shorter (4–6 min) than live scenario cases (11–18 min), content between the two cases was controlled. Participants in the video condition viewed one patient encounter with contextual factors (e.g. low English proficiency, diagnostic suggestion) and one without and there were no racial or ethnic differences in standardized participants across cases. After viewing each case and determining the diagnosis and management plan (see Durning et al. for the format used [40]), participants were asked to immediately rewatch the video and "think aloud" about how they came to their diagnosis. Participants in the live scenario condition experienced the same cases, also one with contextual factors and one without, but participated in the case as a physician with a simulated participant as the patient rather than viewing a video. After giving a diagnosis and management plan in the same format as the video condition participants, they watched the encounter they had just participated in and immediately conducted a think-aloud procedure. Participants in both conditions worked with cases that had typical presentations of common diseases: diabetes mellitus and unstable angina. The case content was controlled (i.e. identical presenting symptoms, language and gestures to represent those symptoms, and physical findings); thus, the only differences between the cases with and without contextual factors were the contextual factors themselves.

Think-aloud procedure

For the think-aloud procedure, participants were asked to speak their thoughts out loud, without making judgments or offering insights, as they engaged with the task (e.g. a video of an event [41]). Past work has indicated that think-aloud transcripts represent a reasonable measure of thinking [41–43], as well as an effective way to assess clinical reasoning [44–46]. In this study, participants were given brief instructions and a warm-up exercise in the think-aloud method prior to engaging in the cases. Then, after either viewing the video case or participating in the live scenario and determining the diagnosis and management, they were prompted to think aloud about their thoughts leading to diagnosis and treatment. Participants were given up to 30 min to complete this and were allowed to stop or rewind the video.

Data analysis

To understand how the process of clinical reasoning is affected by context specificity, we used Linguistic Inquiry and Word Count (LIWC) software. LIWC is a transparent (i.e. coded words and phrases are accessible to researchers) text analysis program that codes for affect, cognitive processes, and agency, among other psychological processes [12]. We coded all transcripts with LIWC for the broad categories of affect and cognitive processes and the subcategory of first-person singular pronouns (i.e. *I* and *me*). To control for the potential effect of varying word counts, LIWC calculates a percentage of coded categories per 100 words (e.g. if there were 10 affect-related words in a 200-word transcript, LIWC assigns that transcript a value of 5% for affect). We then conducted a repeated-measures multivariate analysis of variance (MANOVA) and follow-up univariate analyses with affect, cognitive process, and first-person pronouns as the dependent variables, comparing participants' language in the cases with and without contextual factors.

To explore patterns in affect, cognition, and agency, we examined descriptive statistics of the subcategories making up affect [positive emotions (for which LIWC has no subcategories) and negative emotions (for which LIWC denotes the subcategories of anxiety, anger, and sadness)] and cognitive processes (insight, causal processes, certainty, tentativeness, discrepancy, and difference – described in greater detail in the Results section). We also examined descriptive statistics of other personal pronouns (*we*, *you*, *he/she*, and *they*) to better understand how individual actions interacted with the actions of others in these data.

Results

Participants were 64 internal medicine, family medicine, and surgery physicians; 22 were women and 41 were men

Table 1: Demographic variables arranged by study condition.

	Video condition		Live scenario condition	
	Mean (SD)	Range	Mean (SD)	Range
Age in years	35 (8.8)	26–67	37 (10.3)	26–61
Years of experience	7 (8.6)	0–39	8 (10.7)	0–35

SD, standard deviation.

(See Table 1 for demographic details). Think-aloud transcripts of cases without contextual factors (n = 64) were between 198 and 1903 words (m = 458) and those with contextual factors (n = 64) were between 256 and 2293 (m = 513). Across all transcripts, affective markers represented between 1.4% and 10.4% of the words, cognitive processing words between 9.9% and 25.5%, and first-person singular pronouns between 0.2% and 9.6%.

The effects of context specificity: affect, cognitive processing, and individual agency

Repeated-measures MANOVA results revealed significant differences in cases with and without contextual factors [Pillai's trace = 0.22, $F = 5.6$, $df = (3, 61)$, $p < 0.01$]. Follow-up univariate analyses indicated that participant language contained statistically significantly more cognitive process markers in think alouds of cases with contextual factors. There were also more affective markers in cases with contextual factors, but this difference was not statistically significant. Additionally, in think alouds without contextual factors, participants used more first-person singular *I/me* pronouns, suggesting perhaps a greater expression of individual agency, although this difference was not statistically significant (see Table 2).

Table 2: Univariate tests of LIWC affect, cognitive process, and individual agency markers in cases with and without contextual factors.

	No contextual factors, mean (SD)	Contextual factors, mean (SD)	*F*-test, significance
Affect	4.1% (1.68)	4.5% (1.27)	$F = 4.8$, $p = 0.06$
Cognitive processes	16.7% (3.57)	17.5% (2.67)	$F = 4.1$, $p < 0.05$
First-person singular *I/me* pronouns	3.8% (2.26)	3.5% (2)	$F = 3.9$, $p = 0.05$

SD, standard deviation.

In order to better understand the differences in affect in cases with and without contextual factors, we explored LIWC's affect subcategories: positive emotions, negative emotions, and the three subcategories of negative emotions, anxiety, anger, and sadness (see Table 3). The difference between conditions resulted from more negative emotions in cases with contextual factors, where participants thought aloud about the standardized patient's emotions (stress, anxiety) and their own thought processes (e.g. thinking "that's ridiculous" about a potential diagnosis of a coal worker's lung). LIWC also identified some medical terms (e.g. *stress* test, head *trauma*, *resolves* with rest), but these uses appear in both conditions (with and without contextual factors).

Next, LIWC's cognitive process category derives from six subcategories: insight, causal processes, certainty, tentativeness, discrepancy, and difference (see Table 4). The greatest contrast appears to be in terms of insight (terms associated with learning or understanding like *think, explain, evaluate*, or *consider* [12, 47]): participants talked more about their learning or understanding when contextual factors were present, more often explicitly reflecting on their *thinking* or *considering*. While the other differences were not as great, it is notable that, in the presence of contextual factors, participants seemed to use fewer markers of certainty (terms indicating a certain level of conviction like *clear, sure, certainly*, or *namely* [12]) and more markers of tentativeness (terms indicating a hedging or uncertain stance like *kind of, may, if*, or *anything* [12]). Similarly, participants made more discrepancies (terms indicating a difference between an actual and possible state like *should, would, could*, and *need* [12]) in the presence of contextual factors, often conveying a speculation about what could or would be the case, given some condition (e.g. "Her HCTZ [dose] **could** be improved….[so] her lifestyle **could** improve."). Finally, markers of causal process (terms implying that one thing gives rise to another like *how, based, because*, or *why* [12]) and difference (terms of distinction, including negation, like *but, really, not*, or *other* [12]) appeared to be similar across conditions.

Finally, examining agency beyond first-person pronouns (discussed earlier), participants appeared to use third-person pronouns in the presence of contextual factors to focus on the actions of *others*, often the patient or, in the video cases, the doctor depicted in the video (Table 5). In fact, thinking aloud about the actions of third-person singular others was the most common pronominal use across conditions (between 4.8% and 5.5% of the word count), but these exploratory analyses

Table 3: Results of exploratory analyses of LIWC affect category markers in cases with and without contextual factors.

	No contextual factors		Contextual factors		Example
	Mean (SD)	Range	Mean (SD)	Range	
Positive emotions	2.3% (1)	0.7%–6.8%	2.4% (1.27)	0.5%–8%	It [blood pressure] looks **pretty good**.
Negative emotions	1.7% (0.84)	0.3%–4.4%	2.1% (0.83)	0.6%–4.2%	This [doctor-patient exchange] is very **awkward**.
Anxiety[a]	0.5% (0.41)	0–1.7%	0.7% (0.4)	0–1.8%	[Patient works] **stressful** long hours. He could have **anxiety**.
Anger[a]	0.1% (0.1)	0–0.4%	0.2% (0.2)	0–1%	[Patient] stopped because this [the pain] was **bothering** him.
Sadness[a]	0.5% (0.4)	0–1.8%	0.3% (0.3)	0–1.1%	I had **low** reasonable suspicion for something like a PAD in the legs.

SD, standard deviation. [a]These are sub-categories of negative emotions.

Table 4: Results of exploratory analyses of LIWC cognitive process category markers in cases with and without contextual factors.

	No contextual factors		Contextual factors		Example
	Mean (SD)	Range	Mean (SD)	Range	
Insight	3.2% (1.44)	0.3%–8.2%	3.6% (1.06)	1.3%–6.2%	**Realized** I'd forgotten to ask about smoking.
Causal processes	1.7% (0.81)	0–3.8%	1.7% (0.65)	0.3%–3%	That is probably not unstable [angina] **because** it's not worsening.
Certainty	1.2% (.056)	0–3.2%	1.1% (0.57)	0–2.6%	I make **sure** I'm not missing anything.
Tentativeness	5.8% (1.66)	2.6%–10.6%	6.1% (1.68)	2.9%–10.5%	The patient **seems** uncomfortable.
Discrepancy	2.4% (1.25)	0.4%–6.9%	2.6% (0.94)	0.9%–4.4%	An infection like the flu **could** be a trigger.
Difference	4.9% (1.17)	1.3%–7.5%	5% (1.37)	2.3%–9.3%	She has a slightly elevated pulse, but **not** tachycardic.

SD, standard deviation.

Table 5: Results of exploratory analyses of LIWC personal pronoun markers in cases with and without contextual factors.

	No contextual factors		Contextual factors		Example
	Mean (SD)	Range	Mean (SD)	Range	
First-person singular (*I/me*)	3.8% (2.26)	0.3%–9.6%	3.5% (2)	0.2%–8.3%	**I'**d want more information from the lungs.
First-person plural (*we*)	0.3% (0.29)	0–1.1%	0.3% (0.3)	0–1.6%	**We'**re seeing that the polydipsia and fatigue has been progressive.
Second person or generic (*you*)	0.8% (0.78)	0–3.4%	0.8% (0.8)	0–3.5%	Not sure why **you'**re asking about alcohol. [reference to doctor in video]. **You** do see maybe a little flattening of the diaphragms. [reference to physicians generally].
Third-person singular (*he/she/him/her*)	4.8% (1.97)	0.9%–8.5%	5.5% (2.16)	0.6%–10.8%	**He** mentioned that **he** felt like it was GERD.
Third-person plural (*they)*	0.2% (0.32)	0–1.8%	0.2% (0.26)	0–1.2%	I'm really curious what **they** [patient generally] think and what **they'**re worried about.

SD, standard deviation.

suggest that *he/she/him/her* usage goes up in the presence of contextual factors as *I/me* goes down. Despite the increase in cognitive processing words (which often have *I* subjects) in the presence of contextual factors, the overall focus on the self's actions yielded to thinking aloud about the patient and video doctor, often with reference to a contextual factor. For example, here a participant reflects on the case with a patient who is not a native speaker of English: "**She** [patient] asks **him** [doctor] about speaking Spanish and **he** says **he** only speaks English". This participant only referred to herself eight times (0.9% of words) in this case, while

she referred to herself 45 times (4.3% of words) in the non-contextual factors case.

Discussion

This study demonstrates how linguistic tools can offer insight into the situated nature of the clinical reasoning process: when contextual factors are present, participants verbalize their cognitive processes more as they work to make sense of the situation and the case. Also, while not statistically significant, the trends in the hypothesized direction suggested that participants voice more emotions and fewer of their own thoughts and actions (as measured by first-person pronouns) in the presence of contextual factors. These trends, while they need to be tested on a larger data set, are in line with the predictions that emerge from situated cognition and cognitive load theory; specifically, that contextual factors would engender higher cognitive load and, thus, more cognitive processes and emotion and less focus on the self (versus the contextual factors themselves). It is important to note that while there are also effects due to case *content* (we compared these same LIWC variables across diabetes and angina cases and found more affective markers in the angina case and more cognitive process markers in the diabetes case), the context has independent effects on performance.

Moreover, descriptive findings from this study offer further insight into how participants react to context specificity. First, the major difference in affect markers was in negative emotions. While positive emotions can also affect reasoning [11, 20], negative emotions are more frequently associated with error, which is what we see in the presence of contextual factors. As with prior studies of emotion and clinical reasoning [9, 18], anxiety was common, even with physicians solving typical cases for their field. This suggests the need to be more mindful of the effects of contextual factors, including helping physicians identify and mitigate stress and anxiety during clinical encounters.

Second, the cognitive process marker that was most strongly associated with context specificity was LIWC's "insight" category, which is language associated with understanding. The presence of a contextual factor, then, appears to focus participants' verbalizations on to what they *think, know*, or *remember*, among other insight processes. Future work might explore how to co-opt this verbalization of insight to support deeper metacognitive practices in the presence of contextual factors, perhaps giving physicians transcripts of their think alouds with cognitive processes highlighted to point out areas where they are and are *not* thinking about their thinking [48].

Third, our exploration of pronouns beyond *I* indicated that the decrease in *I* pronouns was accompanied by an increase in third-person singular *he/she/it* pronouns. This suggests that the introduction of the contextual factor may be acting on clinical reasoning in part by distracting the participant away from her own reasoning actions and toward the actions of others (patient and, in the video condition, doctor). This finding further explains earlier work that found frequent mentions of contextual factors in think alouds [24, 25]: the shift in focus to a contextual factor that is patient related entails a shift in focus to the patient rather than the diagnostic process *about* the patient.

Our study has several important limitations. First, think alouds are not a direct measure of cognition. Instead, they are an assessment method for understanding what individuals think based on what they say. Nonetheless, think alouds provide a useful way to explore clinical reasoning and linguistic markers [3, 23, 44, 49]. Second, LIWC is not sensitive to linguistic context, and so it sometimes miscodes certain words (e.g. "*stress* test" as affective). This linguistic "noise", however, appears to be present across both conditions, thereby allowing LIWC to detect meaningful differences. Nonetheless, future work could benefit from refinements in the linguistic software and increased sample size to offer the necessary statistical power to account for some of this inevitable noise. Finally, we examined think alouds across video and live scenario modalities. While using our full sample (gathered for a project comparing video and live scenario modalities) offers the statistical power to discern differences, these differences between face-to-face and video interaction may impact the clinical reasoning process and arguably are different contexts.

Our research has important implications for practice. As observed in the present study, context affects the clinical reasoning process, as predicted by situated cognition theory. Taken together with the research on errors in reasoning outcomes [2–4], these findings argue for education around these contextual factors, perhaps through training in metacognition and awareness [50]. Moreover, the richness of these process-based measures of clinical reasoning lend themselves to a more nuanced conceptualization of "performance". These linguistic measures could be added to the growing assessment toolbox in medical education to improve early education and remediation of struggling learners. As voice recognition technology improves, automating transcription of learner reflections, LIWC could eventually be used as a formative assessment tool to alert instructors to when learners are being distracted by contextual factors and need support.

From a research perspective, these findings support the value of empirical work using situated cognition to explore context; reasoning differs in the presence of inhibiting contextual factors. Furthermore, while scholars are beginning to examine the cognitive processes and emotions inherent in physicians' clinical reasoning [9, 11, 20, 21, 51], to the best of our knowledge, agency has not yet been addressed. Future research could investigate, for example, whether experiences of agency shift between clinic and inpatient contexts or between patients of different cultural backgrounds, and, if so, whether this affects clinical reasoning.

Finally, these findings demonstrate the value of linguistic analysis generally and LIWC in particular. Such tools could be applied beyond the application of exploring context specificity, examining, for instance, errors present in electronic health records, assessment of diagnostic competencies, or patient-doctor communications. If we listen carefully to what physicians say about and during the diagnostic process, we may be able to better support them across shifting and even confusing contexts.

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References

1. Donaldson MS, Corrigan JM, Kohn LT. To err is human: building a safer health system. Vol 6. Washington, DC, USA: National Academies Press, 2000.
2. Singh H, Graber ML. Improving diagnosis in health care – the next imperative for patient safety. N Engl J Med 2015;373:2493.
3. Durning SJ, Artino AR, Boulet JR, Dorrance K, van der Vleuten C, Schuwirth L. The impact of selected contextual factors on experts' clinical reasoning performance (does context impact clinical reasoning performance in experts?). Adv Heal Sci Educ 2012;17:65–79.
4. Eva KW. What every teacher needs to know about clinical reasoning. Med Educ 2005;39:98–106.
5. Brown JS, Collins A, Duguid P. Situated cognition and the culture of learning. Educ Res 1989;18:32–42.
6. King A. Structuring peer interaction to promote high-level cognitive processing. Theory Pract 2002;41:33–9.
7. Kaptelinin V, Nardi BA. Acting with technology: activity theory and interaction design. Cambridge, MA: MIT Press, 2006.
8. Konopasky AW, Sheridan KM. Towards a diagnostic toolkit for the language of agency. Mind, Cult Act 2016;23:108–23.
9. Kozlowski D, Hutchinson M, Hurley J, Rowley J, Sutherland J. The role of emotion in clinical decision making: an integrative literature review. BMC Med Educ 2017;17:255.
10. Stolper E, Van de Wiel M, Van Royen P, Van Bokhoven M, Van der Weijden T, Dinant GJ. Gut feelings as a third track in general practitioners' diagnostic reasoning. J Gen Intern Med 2011;26:197–203.
11. Resnick ML. The effect of affect: decision making in the emotional context of health care. In: 2012 Symposium on Human Factors and Ergonomics in Health Care, 2012:39–44.
12. Tausczik YR, Pennebaker JW. The psychological meaning of words: LIWC and computerized text analysis methods. J Lang Soc Psychol 2010;29:24–54.
13. Pennebaker JW. The secret life of pronouns: what our words say about us. NY: Bloomsbury, 2011.
14. Pennebaker JW, Graybeal A. Patterns of natural language use: disclosure, personality, and social integration. Curr Dir Psychol Sci 2001;10:90–3.
15. Konopasky A, Ramani D, Ohmer M, Durning SJ, Artino Jr AR, Battista A. Why health professions education needs functional linguistics: the power of 'stealth words'. Med Educ 2019;53:1187–95.
16. Bandura A. Toward a psychology of human agency. Perspect Psychol Sci 2006;1:164–80.
17. Weiner B. An attributional theory of achievement motivation and emotion. Psychol Rev 1985;92:548–73.
18. Simpkin AL, Murphy Z, Armstrong KA. A randomized experimental study to assess the effect of language on medical students' anxiety due to uncertainty. Diagnosis 2019;6:269–76.
19. Damasio AR. Descartes' error. London, UK: Random House, 2006.
20. Heyhoe J, Birks Y, Harrison R, O'Hara JK, Cracknell A, Lawton R. The role of emotion in patient safety: are we brave enough to scratch beneath the surface? J R Soc Med 2016;109:52–8.
21. Surry LT, Torre D, Trowbridge RL, Durning SJ. A mixed-methods exploration of cognitive dispositions to respond and clinical reasoning errors with multiple choice questions. BMC Med Educ 2018;18:277.
22. Mamede S, Van Gog T, Schuit SC, Van den Berge K, Van Daele PL, Bueving H, et al. Why patients' disruptive behaviours impair diagnostic reasoning: a randomised experiment. BMJ Qual Saf 2017;26:13–8.
23. Estrada CA, Isen AM, Young MJ. Positive affect facilitates integration of information and decreases anchoring in reasoning among physicians. Organ Behav Hum Decis Process 1997;72:117–35.

24. McBee E, Ratcliffe T, Picho K, Artino AR, Schuwirth L, Kelly W, et al. Consequences of contextual factors on clinical reasoning in resident physicians. Adv Heal Sci Educ 2015;20:1225–36.
25. Durning S, Artino Jr AR, Pangaro L, van der Vleuten CP, Schuwirth L. Context and clinical reasoning: understanding the perspective of the expert's voice. Med Educ 2011;45:927–38.
26. Kahn JH, Tobin RM, Massey AE, Anderson JA. Measuring emotional expression with the Linguistic Inquiry and Word Count. Am J Psychol 2007:263–86.
27. Ilgen JS, Eva KW, Regehr G. What's in a label? Is diagnosis the start or the end of clinical reasoning? J Gen Intern Med 2016;31:435–7.
28. Konopasky AW, Ramani D, Ohmer M, Battista A, Artino AR, McBee E, et al. It totally possibly could be: how a group of military physicians reflect on their clinical reasoning in the presence of contextual factors. Mil Med 2020;185(Suppl 1):575–82.
29. McBee E, Ratcliffe T, Picho K, Schuwirth L, Artino AR, Yepes-Rios AM, et al. Contextual factors and clinical reasoning: differences in diagnostic and therapeutic reasoning in board certified versus resident physicians. BMC Med Educ 2017;17:211.
30. Cleary TJ, Durning S, Gruppen L, Hemmer P, Artino A. Self-regulated learning in medical education. Oxford Textb Med Educ 2013:465–77.
31. Patel V, Arocha J, Zhang J. Thinking and reasoning in medicine. In: Holyoak K, Morrison R, editors. The Cambridge Handbook of Thinking and Reasoning. Cambridge, UK: Cambridge University Press, 2005:727–50.
32. Ten Cate O, Durning SJ. Understanding clinical reasoning from multiple perspectives: a conceptual and theoretical overview 2018:35–46.
33. Ratcliffe TA, McBee E, Schuwirth L, Picho K, Van der Vleuten C, Artino A, et al. Exploring implications of context specificity and cognitive load in residents. MedEdPublish 2017;6. Available at: https://doi.org/10.15694/mep.2017.000048 [Epub ahead of print].
34. Paas F, Tuovinen JE, Tabbers H, Van Gerven PW. Cognitive load measurement as a means to advance cognitive load theory. Educ Psychol 2003;38:63–71.
35. Fraser K, Ma I, Teteris E, Baxter H, Wright B, McLaughlin K. Emotion, cognitive load and learning outcomes during simulation training. Med Educ 2012;46:1055–62.
36. Khawaja MA, Chen F, Marcus N. Measuring cognitive load using linguistic features: implications for usability evaluation and adaptive interaction design. Int J Hum Comput Interact 2014;30:343–68.
37. Arnold J, Clarke DJ. What is 'agency'? Perspectives in science education research. Int J Sci Educ 2014;36:735–54.
38. Howe A, Barrett A, Leinster S. How medical students demonstrate their professionalism when reflecting on experience. Med Educ 2009;43:942–51.
39. Battista A, Konopasky A, Ramani D, Ohmer M, Mikita J, Howle A, et al. Clinical reasoning in the primary care setting: two scenario-based simulations for residents and attendings. MedEdPORTAL 2018;14. DOI: 10.15766/mep_2374-8265.10773 [Epub ahead of print].
40. Durning SJ, Artino A, Boulet J, La Rochelle J, Van Der Vleuten C, Arze B, et al. The feasibility, reliability, and validity of a post-encounter form for evaluating clinical reasoning. Med Teach 2012;34:30–7.
41. Ericsson KA, Simon HA. How to study thinking in everyday life: contrasting think-aloud protocols with descriptions and explanations of thinking. Mind, Cult Act 1998;5:178–86.
42. Durning SJ, Artino AR, Beckman TJ, Graner J, Van Der Vleuten C, Holmboe E, et al. Does the think-aloud protocol reflect thinking? Exploring functional neuroimaging differences with thinking (answering multiple choice questions) versus thinking aloud. Med Teach 2013;35:720–26.
43. Fox MC, Ericsson KA, Best R. Do procedures for verbal reporting of thinking have to be reactive? A meta-analysis and recommendations for best reporting methods. Psychol Bull 2011;137:316.
44. Burbach B, Barnason S, Thompson SA. Using "think aloud" to capture clinical reasoning during patient simulation. Int J Nurs Educ Scholarsh 2015;12:1–7.
45. Durning SJ, Graner J, Artino Jr AR, Pangaro LN, Beckman T, Holmboe E, et al. Using functional neuroimaging combined with a think-aloud protocol to explore clinical reasoning expertise in internal medicine. Mil Med 2012;177(suppl_9):72–8.
46. Funkesson KH, Anbäcken E-M, Ek A-C. Nurses' reasoning process during care planning taking pressure ulcer prevention as an example. A think-aloud study. Int J Nurs Stud 2007;44:1109–19.
47. Shaw BR, Hawkins R, McTavish F, Pingree S, Gustafson DH. Effects of insightful disclosure within computer mediated support groups on women with breast cancer. Health Commun 2006;19:133–42.
48. Croskerry P. From mindless to mindful practice – cognitive bias and clinical decision making. N Engl J Med 2013;368:2445–8.
49. Oliver EJ, Markland D, Hardy J, Petherick CM. The effects of autonomy-supportive versus controlling environments on self-talk. Motiv Emot 2008;32:200–12.
50. Trowbridge RL, Dhaliwal G, Cosby KS. Educational agenda for diagnostic error reduction. BMJ Qual Saf 2013;22(Suppl 2):ii28–32.
51. McBee E, Ratcliffe T, Goldszmidt M, Schuwirth L, Picho K, Artino AR, et al. Clinical reasoning tasks and resident physicians: what do they reason about? Acad Med 2016;91:1022–8.