CLINICAL REASONING

Grounding judgement in context: A conceptual learning model of clinical reasoning

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Abstract

Context: Contemporary research on clinical reasoning focuses on cognitive problem-solving processes. However, the decisive role that clinical context plays in clinical reasoning is often overlooked. We explored how novice learners make sense of the patient encounter in the clinical situation. In particular, we examined medical students' own judgements concerning diagnostic and management decisions and how the clinical context impacts on this. We aimed to produce a conceptual model of how students learn clinical reasoning in the clinical environment.

Method: We used grounded theory methodology to develop a conceptual learning model. A total of 23 medical students in their third academic year were recruited. Qualitative data were gathered from semi-structured interviews, participant observations and field interviews, during clinical clerkships.

Results: Learners participating in the clinical environment experienced tensions, called 'Disjunctions.' These disjunctions emerged in the context of the student–patient encounter and in particular in situations where an element from the interaction with the patient was perceived as being inconsistent with existing frames of reference. We categorised the sources of disjunctions into four subcategories: (a) observing the manifestations of clinical signs in reality; (b) fitting the symptoms to a diagnosis; (c) considering management decisions, and (d) communicating a medical decision to the patient. Disjunctions involved an affective component and were associated with feelings of uncertainty. These tensions provoked reactions from the learners, leading them to reassess and modify held assumptions in order to accommodate the encountered inconsistent elements. This facilitated changes in judgement. When making a judgement, participants learned to take into consideration situational elements.

Conclusions: Students experience disjunctions in the clinical environment as they encounter situations that challenge their frames of reference. These disjunctions carry significant learning potential. This study can contribute to knowledge concerning the role of the patient encounter in advancing clinical reasoning by transforming problematic habits of the mind.

1 | INTRODUCTION

Clinical reasoning is central to the practice of medicine.[1,2] Two theoretical frameworks are currently dominant. The first, process paradigm, distinguishes two distinct cognitive processes involved in judgement: one rapid, intuitive and effortless, called System 1, and one slow, conscious and analytical, System 2.[3-6] The alternative framework (structure paradigm) is primarily concerned with how knowledge is stored, categorised and recalled from memory (prototypes, exemplars and illness scripts).[7-9] It is certainly true that experimental research in cognitive psychology has offered invaluable insights into the thinking strategies involved in clinical reasoning. However, although context specificity has been shown to be an integral aspect of clinical reasoning,[10,11] the role of clinical context is often overlooked. Context is often addressed by reducing it to various measurable factors studied in isolation (ie, case difficulty or patient characteristics) or de-emphasised and discounted as 'noise,' with focus on internal and unobservable mental processes such as heuristics and biases. Croskerry et al remark that 'the major difficulty with such reductionist approaches to clinical decision making is that, in separating out independent variables, one is removing the very environment that characterises the process being studied.'[5 (p.199)]

Calls to address context in reasoning research are increasing,[4,5,11-15] along with a heightened awareness of the need for qualitative methods to explore the role of context.[16,17] Cook et al suggest that 'management reasoning involves a dynamic interplay among people, systems, settings and competing priorities, and is thus inherently complex and contextually situated.'[17] This view is also shared by the naturalistic decision-making literature.[18,19] Recent research has applied situated cognition to demonstrate the contextually dependent nature of clinical reasoning.[14,16,20,21] There is, however, a paucity of studies using well-established learning theories to explore how medical students actually learn to reason in the clinical environment.[21]

We believe that putting the clinical context into perspective and examining the interactions between the student and the environment, could not only provide a better understanding of how these interactions influence clinical reasoning but also unravel the learning processes involved.[5,12,13] We share the view of Durning et al[22] of clinical context as the interactions between the individual participants (patients, supervisors, medical students, etc.) and the setting (clinical environment).

This study aims to initiate the development of a conceptual learning model of how medical students learn clinical reasoning in the clinical setting. We explored how novice learners make sense of the patient encounter in a clinical situation. In particular, we examined medical students' judgements of diagnostic and management decisions concerning patients they had encountered in the clinical environment, as well as how these encounters influenced these judgements.

2 | METHODS

Grounded theory was chosen as an applicable methodology for the development of a conceptual learning model of clinical reasoning, based on empirical qualitative data from the interactions between the participants and the clinical environment. Qualitative methodology and in particular grounded theory strongly contrast with the experimental methods used in cognitive sciences and may naturally raise questions on the suitability of using interviews or observations in clinical reasoning research. Cognitive researchers have indeed argued that although individuals may have valid introspective access to the results of their thoughts, they lack awareness of the mental processes that generated these thoughts.[23,24] Although we agree with this statement, we regard grounded theory as a valuable and promising methodology for the study of clinical reasoning. Grounded theory allows analysis of rich, empirical qualitative data to construct theory that unravels the results of these thoughts and addresses the context of the clinical environment in which these thoughts are embedded.

We based our analysis on Charmaz's version of grounded theory, which takes a constructivist perspective.[25] Nevertheless, Glaser and Strauss' initial publication on grounded theory was consulted on the constant-comparative method.[26] Coding was based on techniques proposed by Charmaz and Saldaña.[25,27]

2.1 | Context

Study participants were students enrolled in the medical programme of a large Swedish university. The university offers a problem-based learning (PBL) medical curriculum. Teaching of basic science and clinical subjects is integrated. From the first academic year, students attend PBL sessions and primary health care centres monthly, where they observe patient-doctor encounters. In the third year (fifth semester) they attend clinical clerkships on the hospital wards (emergency medicine, pulmonology, cardiovascular medicine and geriatrics) at the university hospital or at regional county hospitals. Clerkships consist of 2- and 4-week placements where students observe and participate in supervised daily ward activities.

2.2 | Participants

A total of 23 medical students enrolled in the fifth academic semester were recruited (Table 1). The rationale behind choosing students in their early curricular years was that they were novice learners with limited previous clinical experience, in a transition phase from the pre-clinical to the clinical years, which would offer ample opportunities for learning.

Data were collected from the pulmonary and geriatrics ward of a regional county hospital and the emergency department of the university hospital. All students registered to attend the clinical placements where data collection was taking place, were asked on site to participate. Informed consent was obtained and the study was approved by the regional ethical review board in Stockholm (No. 2016/1397-31/5).

TABLE 1 Study participants and data collection process

Clinical Placement Year 3	No. of participants	Sex	Age range, years	Data collection first phase	Data collection second phase
Pulmonary medicine	9	7 males 2 females	22-28	7 semi-structured interviews	2 semi-structured interviews
Geriatrics	5	3 males 2 females	22-25	3 semi-structured interviews	2 semi-structured interviews
Emergency medicine	9	5 males 4 females	21-30		9 direct observations 9 field interviews 5 semi-structured interviews (within 1 week after observations)
Total	**23**	**15 males 8 females**	**21-30**	**10 transcripts**	**27 transcripts**

2.3 | Data collection and analysis

We conducted semi-structured interviews, observations and field interviews to obtain rich accounts of the students' subjective interpretations of the experience of real patient encounters on the clinical ward. Data gathering and analysis proceeded in two main phases (Table 1).

2.3.1 | First phase

During this phase, 10 participants were recruited during their geriatrics and pulmonary medicine ward placements and participated in individual, exploratory, semi-structured interviews. Interviews lasted up to 1 hour each and were audiorecorded. The interview guide (Appendix S1) was designed to encourage participants to discuss particularly challenging patients they had encountered during their ongoing placement, with attention on potential difficulties in understanding diagnostic and treatment decisions concerning these patients.

The material from these initial interviews was coded in two cycles: initial, and focused. During initial coding, data were coded sentence by sentence. Coding was descriptive, corresponding closely to the empirical data, and care was taken to remain open to different theoretical directions.[25] During focused coding, codes were revisited and reassessed. Similar codes were clustered together in preliminary categories. Different incidents coded under the same category were compared with each other. This constant comparative method[26] facilitated the emergence of new categories, the refinement, renaming or merging of existing categories as well as the establishment of relations between them. Memo writing during the analytical process facilitated the identification of points of uncertainty that demanded further investigation.

2.3.2 | Second phase

To further develop the properties of the initial categories and integrate their relations into a meaningful model, additional data were gathered from semi-structured interviews but also from participant observations and field interviews (theoretical sampling). In light of the results of the initial analysis, we revised the interview guide and developed an observation protocol (Appendix S2 and S3) to collect data to saturate the developing categories. Observations provided access to the verbal interactions of student-patient-supervisor encounters that was used to guide interviewing and facilitate the interpretation of the participants' responses in the follow-up field interviews.

Participants were observed during their emergency-medicine placement. The rationale was that we wanted to compare data, codes and categories from the first phase semi-structured interviews with data from field interviews and observations in a clinical environment different from the internal medicine wards. Moreover, students at the emergency department assumed a more active role when meeting patients than on the 'regular' wards, potentially providing the researchers with rich data on the student-patient encounter.

All observations took place in the emergency department of the university hospital. Before attending a patient assigned by their supervisor, the student was briefed by the supervisor on the patient's presenting complaints. Then the student would meet the patient, taking a history and completing a physical examination, before reporting the findings back to the supervisor. The student was observed during the whole procedure, with the observer taking an active part during the clinical encounter (observer as participant).[28] A brief individual field interview in a separate room on the ward was conducted with each participant directly after the patient encounter and before reporting back to the supervisor.

During this second phase of data collection, a total of 13 additional participants were recruited (Table 1). Four participants took part exclusively in individual semi-structured interviews during their geriatrics or pulmonary medicine placements. The remaining nine were individually observed for a total of 18 hours and participated in follow-up field interviews during their placement in the emergency department. Five of these observed participants also underwent semi-structured interviews within 1 week after the observations.

The initial five observations were recorded on paper. In order to increase the efficiency of gathering data, a decision was made to

audiorecord the remaining four observations, so that the observer would be able to concentrate on the observation process and prepare himself better for the subsequent field interview. A complementary ethical permit was granted to audiorecord the remaining observations (No. 2018/1182-32/5).

Data collected in this second phase were focused-coded. Previously coded data from the first phase were revised and re-coded when necessary by comparing new incidents in the new data with each other as well as with incidents, codes and categories from the previous data. This facilitated the raising of the categories developed in the first phase to a more conceptual level. The final conceptual categories were considered to be saturated with regard to their properties and further data from subsequent collection were not regarded to yield new theoretical insights. These conceptual categories and their relationships formed the backbone of the learning model.

Data collection, coding and analysis were mainly conducted by one of the researchers (CK), who is a physician employed at one of the study hospitals. Audiorecorded data from the total 37 sources were transcribed verbatim by a trained medical secretary. The transcribed material was checked for accuracy to ensure the quality of the transcription process. Another researcher (CS) read selected interviews to ensure the quality of the interview process and followed closely the analytical process. All data were recorded in Swedish and translated to English. The research team consisted of two specialist physicians with postgraduate training in medical education (CK and MW), two qualitative researchers in medical education with a nursing background (CS and KM), and one quantitative researcher in medical education with a background in psychology (JN). All members (CK, KM, JN, MW and CS) met at frequent intervals to discuss progress and contribute ideas and comments. CK drafted the manuscript, which was subsequently reviewed and edited by the rest of the authors (KM, JN, MW and CS). NVivo Version 12 (QSR International Pty Ltd., Doncaster, Australia) qualitative data analysis software was used for data management, coding and memo writing.

3 | RESULTS

We examined medical students' judgements of diagnostic and management decisions concerning patients they had encountered in the clinical environment, as well as how these encounters influenced these judgements. A conceptual learning model emerged from our analysis consisting of two main and inter-related conceptual categories: 'Disjunctions' and 'Grounding judgement in the clinical context.' We suggest that students experienced tensions that disrupted their understanding and challenged their assumptions concerning aspects of diagnosing and management. These tensions occured in the clinical situation and, in particular, in the context of the student-patient encounter. These tensions, which we called 'Disjunctions,' constituted the first conceptual category of the model. We identified and analysed the clinical situations where such disjunctions emerged and

grouped them into four subcategories, each representing a potential source of disjunctions.

- Observing the manifestations of clinical signs in reality.
- Fitting the symptoms to a diagnosis.
- Considering management decisions.
- Communicating a medical decision to the patient.

Disjunctions included an inherent affective component inasmuch as they were experienced with feelings of uncertainty. This composed a distinct subcategory, 'Emotions provoked by disjunctions,' signified by different characteristics compared to the other subcategories.

Tension restrained learners from making sense of the situation and this provoked a reaction to resolve the tension. The outcome of this reaction constituted the second main conceptual category of our model, which we called 'Grounding judgement in the clinical context.' Specifically, participants revised their assumptions to accommodate the inconsistencies that gave rise to the disjunction. The outcome of this was a change in judgement. Participants learned to take into consideration situational elements when making a judgement.

3.1 | Disjunctions

At the core of the proposed model lies the concept of disjunctions. Disjunctions signified the tensions experienced by the learners in a clinical situation when perceived elements in the situation appeared inconsistent with previous experience, unexpected, self-contradictory or unfamiliar. These tensions had a disruptive character. They challenged conscious and implicit assumptions or hindered understanding. Disjunctions arose from the interaction with the patient, signifying that they were contextually dependent.

3.1.1 | Observing the manifestations of clinical signs in reality

> *When you read a case and read the text, then you just suggest a treatment and that's it; you never get to know the patient properly. When I go in and meet a patient I am thinking "this is a human being"; I am thinking how they look, how old they are, what have they had before, how do they cough, how do they move when they breathe, how well they talk, how do they feel*
>
> (P7:1)

(Indicated in parentheses is the identification number of each participant [P] and the data collection phase [1 or 2]).

Given their limited previous experience with real patients, participants were naturally concerned with the physical manifestations of diseases they had been taught about during the previous

years and appearance of symptoms and signs. One issue leading to inconsistencies was the perception of normality. Learners were not only concerned about recognising pathological features but also acknowledging normality and its wide range of variations. Disjunctions emerged when there was an inconsistency between, which clinical signs should be regarded as normal and, which as pathological. A student observing a neurologist examining his patient remarks that:

> [...] have you never seen a reflex before then it is difficult to judge [if its normal or not]; but if you are aware that appearances may vary then you know that this one [reflex] could be normal.
>
> (P13:2)

An important source of disjunctions was the lack of correspondence between an expected and an observed manifestation of a measurable parameter or laboratory value (ie, blood pressure or haemoglobin levels):

> We take carbon dioxide for example, [which normally is] 4.5-6.0. And it was up at 11! Quite a lot, even for a COPD [chronic obstructive pulmonary disease] patient! So much indeed that, like, I'd written on the exam, he had, like, he is dead.
>
> (P16:2)

3.1.2 | Fitting the symptoms to a diagnosis

Students often faced difficulties in establishing meaningful links amongst a complex constellation of patient narratives, physical parameters and laboratory tests, and one or more possible diseases that could explain the patient's complaints. Disjunctions frequently emerged in this background:

> I did not think that her [the patient's] description of the problem ... agrees with any diagnosis that exists; it's this that's probably what's a bit frustrating. She is not text-book perfect. I did not come up with anything concrete.
>
> (P11:2)

A common misconception was that diseases manifested in the same way in different patients. The realisation that not all patients suffering from a particular disease presented with identical features created tension. Patients lacking typical features was something unexpected. The following description is illustrative:

> She had like no cough, no mucus. I thought that a COPD patient with COPD exacerbation will have lots of such symptoms, almost like pneumonia symptoms.
>
> (P3:1)

Another issue that was inconsistent with participants' held beliefs was how certain clinical features can contradict each other. Participants acknowledged the stark contrast with problem-based learning (PBL) cases, where patients were presented as having 'clear-cut symptomatology where all the parameters point in the same direction ... without paradoxes as it may happen in reality' (P19:2). Cases were perceived as having straightforward solutions and this was often clearly implied by the case narrative:

> ... they are usually presented as clear-cut for us to understand the typical symptoms or the typical sounds or findings in the physical exam, but the truth is usually different.
>
> (P9:1)

Tensions were triggered when encountering patients where the outcome of the diagnostic evaluation was uncertain. As one participant remarked, 'If you do not find anything how do you then proceed?' (P8:1), when he realised that a convincing diagnosis could not be made.

Patients suffering from multiple medical conditions simultaneously was another unexpected realisation:

> ... just because there is an infection does not mean that you can exclude cancer and this is important because in the lectures we've had it was more divided; if it is infection it looks like this, if it is cancer it looks like that, but it can be a mix of everything, so it's important to keep this mind.
>
> (P9:1)

Beliefs that symptoms are invariably explained by somatic diseases were challenged when meeting patients with psychological disorders:

> I just think we have not been taught so much about just stress; ... we rather learn that there should be an explanation at all times, but then out in the clinic you do not always have that explanation. On the contrary, it can be psychosomatic.
>
> (P19:2)

3.1.3 | Considering management decisions

The management of patients also exposed misconceptions. Participants often encountered management situations where they were unsure how to proceed. The belief that specific symptoms are invariably treated with specific medications was challenged. Students observed that indicated treatments were being withheld in certain situations where they caused unfavourable side-effects on other organ systems, actually worsening the condition of the patient. Prioritising one treatment strategy over the other or knowing when the conditions are favourable for administering a certain treatment became an important issue. The following quote is characteristic:

… she had many many, many symptoms. What should you focus on, what symptoms should you prioritise? … Some treatments may worsen treatments for other symptoms, etc, this was also interesting to keep in mind.

(P1:1)

Likewise, administering palliative care and withholding active treatment challenged previously held assumptions about patient management:

… you focus more on just relieving his symptoms rather than curing what he has. There was no outlook of him recovering but rather trying to keep him alive and feeling ok … despite all the medication you can give, the patient won't survive in the long run. I thought it was difficult; what to do in palliative care.

(P2:1)

Even treatment expectations were challenged. Administering medicines was anticipated to yield a predictable and invariable effect indiscriminately:

You start with antibiotics CRP[C-reactive protein] will fall. A new infection may well come, but not that it can't really go away. Do you get what I mean? Because in the textbook - in school - that's how it is. We start the patient on antibiotics, and the infection disappears; that's it!

(P4:1)

Observing that treatment is a dynamic process requiring continuous adjustments depending on effects and side-effects was inconsistent with views regarding it as a rather static phenomenon:

When we study theory, we see – you have a problem and you work up some solutions to this problem and then you apply a solution; or when you start with some medicine or treatment then it should get better. But now you see that it doesn't always get better; that you get to test different things, you get to combine different drugs together; you have to make many adjustments as well. It takes many adjustments to get the optimal treatment if you say so.

(P6:1)

3.1.4 | Communicating a medical decision to the patient

Participants experienced unexpected tensions when communicating treatment decisions to patients. Language, as well as power issues, gave rise to disjunctions. Tacit beliefs regarding the patient as a passive recipient of information were challenged. Participants experienced situations where a management plan was communicated to a patient in a way that was unconvincing or

incomprehensible to a 'layman.' The need to offer comprehensible medical explanations was regarded as a way of justifying a medical decision to the patient:

How to explain to a patient who is not familiar medically with carbon dioxide retention.

(P2:1)

But what can you say, as a doctor, that will get the patient feel more involved or what can you say that makes the patient feel good about this, about how it is managed, because she wants to go home but wasn't able to go yet because she needs more home health care [to be arranged]. What can you say in order for her to accept it.

(P1:1)

Securing the patient's acceptance of the decision became highly relevant. Patients were indeed expected to comply with medical recommendations. When patients refused to comply, disjunctions emerged:

She has become so comfortable in the hospital. That she is like - she does not look forward to coming home sometime soon. Because I ask her every week how about going home? It feels like it's soon time to send you home. She is always hesitant about it.

(P6:1)

Patients who posed difficulties in conforming to a treatment plan were labelled as 'difficult' or 'challenging patients.' These situations were in sharp contrast with incidents where the patient's acceptance was established seamlessly. Such patients were understood as being compliant and were described as 'cooperative,' 'easy,' 'being grateful' and 'satisfied with their doctor as long as they feel seen and understood':

She was a very grateful patient. She was very happy that we took care of her and ordered these medical tests – in that sense she was a pretty easy patient to have because she did not decline any tests.

(P8:1)

3.1.5 | Emotions provoked by disjunctions

Disjunctions were inherently connected with emotions. The students experienced a state of turmoil, which involved emotional reactions characterised mainly by uncertainty and uneasiness. Students often felt *'frustrated'* (P11:2) when manifested symptoms could not be assigned to a particular diagnosis, *'powerless'* (P17:2) when the test results failed to reveal a specific cause, *'alarmed'* (P8:1) when it was not clear how to proceed with the investigation, *'insecure'*

(P4:1) when the given treatment did not yield the expected results or 'unsafe' (P18:2) when the patient behaved in an unfamiliar way. Some disjunctions were associated with feelings of concern for the patient. Participants felt 'moved' (P1:1) when active treatment for a terminal patient was withheld. Others expressed their 'anticipation' (P7:1) when awaiting the next step when the treatment had failed to give results or when the patient posed challenging diagnostic difficulties:

> I am thinking it is exciting but very difficult to solve and this is also the reason why this patient is more interesting to me. Still easier with a heart failure patient, where the patient swells up and then you give diuretics - I am making it sound very easy - but often in these cases you are able to adjust the list of medicines, give diuretics so that the swelling goes down, makes sure they get the right drugs when they get home, discharge them home and that's it.
>
> (P5:1)

3.2 | Grounding judgement in the clinical context

While disjunctions constituted one conceptual category in this model, the outcome of students' learning through disjunctions constituted the other related conceptual category 'Grounding judgement in the clinical context.'

Disjunctions were productive inasmuch as they provoked a reaction from the learner. Participants attempted to make sense of these inconsistencies between their assumptions and the particular elements in the clinical encounter that elicited the disjunction. They sought to resolve the tensions inconsistencies aroused. Making sense of disjunctions involved reassessing beliefs, views and convictions in order to accommodate the inconsistent elements encountered. This need to modify these assumptions was brought into awareness by disjunctions themselves. Assumptions were adapted in light of disjunctions and the emerging outcome was a change in judgement.

This change in judgement involved an increased capability to integrate situational factors from the patient encounter. When making a judgement, participants learned to take into consideration situational elements. In other words, judgement became more grounded in the clinical context. The following example is from a participant reflecting on a terminally ill patient:

> ... along with the diagnosis, there is another dimension, life expectancy, something like mortality in the short term. So, this complicated the whole process a little ... it was interesting to see how exactly this with life expectancy had such an impact ... had it not been this life expectancy, then the discussion on whether it is worth it or not would have looked completely different. It was almost more decisive than what the actual disease itself

was with its symptoms, but instead the important thing was almost like, what is best for the patient and what will help her?

> (P1:1)

The participant recognised that the treatment strategy was closely determined by elements inherent in the particular situation, namely the worsening condition and limited life expectancy of the patient. The understanding that situation-specific factors weighed more than the actual disease regarding the treatment decision illustrates this change in judgement.

In another example, one participant remarked on his frustration that despite extensive evaluation, the search for a cause that could account for the patient's symptoms ended up fruitless. The patient, however, was soon discharged home as her symptoms had markedly improved:

> Sometimes you have to accept it, but basically, if you send the patient home, it shouldn't be dangerous for the patient.
>
> (P8:1)

This decision was made in relation to what was safe for the patient by taking into consideration how dramatically her condition had improved. We notice again how situation-specific factors infiltrated the reasoning process. This is also illustrated in a quote from another participant:

> You enter as a new student and you believe you can cure everyone; everyone will be 100% healthy. You think so from the beginning but then you notice that in many of the patients actually, the treatment goal is not that they should fully recover but instead that their quality of life should improve. They should be able to manage by themselves but they will never be completely healthy.
>
> (P7:1)

4 | DISCUSSION

Our findings demonstrate that students experienced productive tensions, that we named 'Disjunctions', in situations where an element from the interaction with the patient is perceived as being inconsistent with existing frames of reference. Disjunctions arise in the context of the patient encounter and concern diagnostic and management decisions. These inconsistencies restrain the student from making sense of the situation and signify tensions that trigger emotions of uncertainty. Disjunctions provoke reactions from the learners. Reactions involved revising beliefs, views and convictions in order to accommodate the encountered inconsistent elements. Assumptions are adapted in light of disjunctions and the outcome involves a change in judgement. This change involves an increased capability to integrate situational factors from the patient encounter.

Judgement becomes grounded in the clinical context. Disjunctions thus carry significant learning potential.

Disjunctions should not be confused with gaps in knowledge of diagnostic and treatment algorithms. They likewise bear no conceptual relation to failing to establish the correct diagnosis (diagnostic accuracy) or falling short of suggesting an appropriate drug treatment, which are used often as proxies for underlying cognitive processes in clinical reasoning research.[29,30] Disjunctions represent tensions operating on a deeper, subjective level when convictions are challenged regarding the manifestation, diagnosis and management of patients because they appear inconsistent with elements perceived from the encounter with an actual patient.

We have categorised the sources of potential disjunctions into four subcategories: (a) observing the manifestations of clinical signs in reality; (b) fitting the symptoms to a diagnosis; (c) considering management decisions, and (d) communicating a medical decision to the patient. Beliefs of diseases manifesting uniformly and indiscriminately in every patient, symptoms being invariably explained by a single ailment, treatments yielding consistently desired effects, as well as patients passively conforming to medical recommendations, exemplify these subcategories. Disjunctions have also an affective component. Feelings of frustration, uncertainty and powerlessness are experienced, highlighting the inherent relation between emotions and judgement in line with previous research.[31,32]

Disjunctions have the potential to change the individual's problematic frames of reference by provoking reaction. The need to reassess and modify problematic assumptions is brought into awareness by disjunctions. The realisation that real patients are not 'textbook perfect' represents a clear departure from the context-stripped classroom world. A view of linearity and predictability exemplified by patients described at PBL cases with clear-cut, generalisable 'one-size-fits-all' solutions to their problems, gradually gives way and is replaced by a more nuanced understanding, grounded in the context of the patient encounter. Learners understand such encounters often contain unpredictable, contradictory elements and yield unexpected outcomes. When making a judgement, participants learn to take into consideration situational elements. Judgement becomes more relativistic and situational. The following excerpt illustrates this vividly:

> I thought I learned something about this clinical insight - you get to hear so much about it ... that you have to see the patient as a whole. So, you look at the whole and not just individual values. To see how she feels, both mentally and how she appears to be ... sometimes you don't have to or sometimes you can't go all the way and fix things directly.
>
> (P17:2)

Disjunctions thus drive learning and this emphasises the significant learning potential of the clinical placements. Although the value of the clinical experience in learning is undisputed, clerkships have been compared to a black box, as learning is often tacit, unpredicted and contextualised.[33-35] A growing body of research has applied sociocultural theories of learning to explore workplace learning.[33,35-38] Our study proposes an alternative framework for understanding the complex processes involved in learning clinical reasoning in the opportunistic clinical environment. It provides also insights into how clinical reasoning develops during the transition from pre-clinical to clinical years. Research on transitions has shown that they are stressful events but also offer valuable opportunities for learning.[39]

Our findings share similarities with cognitive dissonance theory (CDT), which postulates that the perception of inconsistency between two cognitive elements leads to an aversive state of dissonance that, in turn, necessitates a resolution by the individual experiencing it in order to return to a state of cognitive consonance.[40,41] Cognitive elements include beliefs, attitudes and behaviours and dissonance occurs when, for example, new knowledge contradicts such perceptions, leading to a state of discomfort and heightened arousal. Individuals employ different strategies to reinstate consonance (rejecting or reducing the importance of the new knowledge, seeking more evidence to support held beliefs, etc.). One possible strategy that is particularly relevant to our results is that individuals can revise their held beliefs so that they can accommodate the new knowledge. The disjunctional state shares also notable similarities with the liminal phase when a learner encounters a threshold concept,[42-44] where liminality is defined as 'a transformative state in the process of learning in which there is a reformulation of the learner's meaning frame.'[42(p.201)] As Fredholm et al remark, 'the old view is thus so challenged that it creates a disjunction that cannot be ignored by the learner.'[43(p.3)]

Our findings show that learners experience such states of imbalance, which are emotionally charged and necessitate a resolution, which may bring about a change in beliefs. What we have observed, however, is that reassessing previously held assumptions involves a transformation at a deeper level. The learner is not just revising her 'point-of-view'[45] but changing what Mezirow calls 'the habits of the mind.'[45] The learner transforms her habitual way of thinking by learning to take into consideration the clinical context in which the patient encounter takes place. Again similar to our findings, Mezirow identifies sources of conflict, which he calls 'disorienting dilemmas,'[46] that have the potential to elicit such potent transformations. Disjunctions as described in our conceptual model represent learning experiences with transformative potential.[47] They stimulate transformative learning by changing problematic frames of reference or habitual ways of thinking through critical reflection.[45] Dewey regarded reflection as a need to solve perplexity arising from doubt or uncertainty.[48]

Cognitive dissonance, disorienting dilemmas, threshold concepts and disjunctions may appear to describe similar phenomena; tensions driving learning. This study, however, contributes new knowledge at different levels. First, we have identified the phenomenon at the early stages of medical education. Second, we have recognised the different situations in which these disjunctions arise in relation to the patient encounter. Third, we have suggested that disjunctions not only play a central role in the clinical reasoning process but also

contribute to learning of the clinical reasoning ability by maturing judgement. Finally, we have provided further evidence supporting the role of context in clinical reasoning.[13,14,16,20,21] Clinical reasoning has indeed been defined as taking wise action justified in the particular context[49] and understanding context is regarded as a sign of adaptive expertise.[50-52] We therefore support the notion that clinical reasoning is a situated activity.[53]

Our findings stress the need for supervisors to provide to their students ample opportunities for transformative learning, as highlighted in a recent literature review,[47] by encouraging patient contact in the clinical environment. Supervisors need to acknowledge the powerful learning potential that disjunctions carry, as a means to support learning in the clinical environment. Experiencing disjunctions can be challenging for the learners, who may feel reluctant to communicate their uncertainty, so supervisors should remain vigilant. Learning from these tensions often remains implicit and tacit, which places added responsibility on the supervisors to facilitate students to articulate and discuss these tensions, stressing the value of support and dialogue in line with previous research.[34,35]

4.1 | Limitations

Hierarchical and power issues between the students and the researcher who collected the data could have potentially influenced our analysis. The researcher (CK) who collected them was a senior physician employed at one of the two hospitals where data collection took place. However, care was taken to ensure the trustworthiness of the results. It should be noted that the researcher (CK) had no professional or academic relationship with the participants. There was also a gender imbalance in the participants but this is attributed to randomness in the actual recruitment strategy, because all students who were enrolled in clinical placements at the corresponding sites were asked to participate. It should also be noted that the proposed conceptual model applies to medical students during their early stage of the curriculum. The transferability of findings to students in later curricular phases remains to be seen in future research.

5 | CONCLUSIONS

We used grounded theory to initiate the development of a conceptual learning model of clinical reasoning, highlighting the role of disjunctions. We suggest novel conceptual links with knowledge areas outside the traditional realms of clinical reasoning research, such as cognitive dissonance theory and transformative learning, to broaden the scholarly dialogue around this topic. This study places the learning aspect of clinical reasoning and the clinical context into perspective and can contribute knowledge concerning the role that the patient encounter plays in advancing clinical reasoning by transforming problematic habits of the mind. The conceptual model needs to be developed further, particularly on how it relates to students in later stages of the curriculum.

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REFERENCES

1. Croskerry P. A universal model of diagnostic reasoning. *Acad Med*. 2009;84(8):1022-1028.
2. Norman G. Research in clinical reasoning: past history and current trends. *Med Educ*. 2005;39(4):418-427.
3. Monteiro SM, Norman G. Diagnostic reasoning: where we've been, where we're going. *Teach Learn Med*. 2013;25(Suppl 1):S26-S32.
4. Eva KW. What every teacher needs to know about clinical reasoning. *Med Educ*. 2005;39(1):98-106.
5. Croskerry P, Petrie DA, Reilly JB, et al. Deciding about fast and slow decisions. *Acad Med*. 2014;89(2):197-200.
6. Evans JSBT. Dual-process theories of reasoning: contemporary issues and developmental applications. *Dev Rev*. 2011;31(2–3): 86-102.
7. Charlin B, Boshuizen HPA, Custers EJ, et al. Scripts and clinical reasoning. *Med Educ*. 2007;41(12):1178-1184.
8. Schmidt HG, Rikers RM. How expertise develops in medicine: knowledge encapsulation and illness script formation. *Med Educ*. 2007;41(12):1133-1139.
9. Bordage G. Prototypes and semantic qualifiers: from past to present. *Med Educ*. 2007;41(12):1117-1121.
10. Eva KW. On the generality of specificity. *Med Educ*. 2003;37(7): 587-588.
11. Van der Vleuten CPM. When I say … context specificity. *Med Educ*. 2014;48(3):234-235.

12. Mylopoulos M, Regehr G. Cognitive metaphors of expertise and knowledge: prospects and limitations for medical education. *Med Educ*. 2007;41(12):1159-1165.

13. Cristancho S, Bidinosti S, Lingard L, et al. Seeing in different ways: introducing 'rich pictures' in the study of expert judgment. *Qual Health Res*. 2015;25(5):713-725.

14. Durning S, Artino AR, Pangaro L, et al. Context and clinical reasoning: understanding the perspective of the expert's voice. *Med Educ*. 2011;45(9):927-938.

15. Pelaccia T, Tardif J, Triby E, et al. How and when do expert emergency physicians generate and evaluate diagnostic hypotheses? A qualitative study using head-mounted video cued-recall interviews. *Ann Emerg Med*. 2014;64(6):575-585.

16. McBee E, Ratcliffe T, Schuwirth L, et al. Context and clinical reasoning. *Perspect Med Educ*. 2018;7(4):256-263.

17. Cook DA, Sherbino J, Durning SJ. Management reasoning beyond the diagnosis. *JAMA J Am Med Assoc*. 2018;319(22):2267-2268.

18. Kahneman D, Klein G. Conditions for intuitive expertise: a failure to disagree. *Am Psychol*. 2009;64(6):515-526.

19. Klein G. Naturalistic decision making. *Human Fact*. 2008;50(3):456-460.

20. McBee E, Ratcliffe T, Picho K, et al. Consequences of contextual factors on clinical reasoning in resident physicians. *Adv Health Sci Educ*. 2015;20(5):1225-1236.

21. Durning SJ, Artino AR, Boulet JR, et al. The impact of selected contextual factors on experts' clinical reasoning performance (does context impact clinical reasoning performance in experts?). *Adv Health Sci Educ*. 2012;17(1):65-79.

22. Durning SJ, Artino AR, Pangaro LN, et al. Perspective: redefining context in the clinical encounter: implications for research and training in medical education. *Acad Med*. 2010;85(5):894-901.

23. Nisbett RE, Wilson TD. Telling more than we can know: verbal reports on mental processes. *Psychol Rev*. 1977;84(3):231-259.

24. Greenwald AG, Banaji MR. The implicit revolution: reconceiving the relation between conscious and unconscious. *Am Psychol*. 2017;72(9):861-871.

25. Charmaz K. *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*. London, UK: SAGE Publications Ltd.; 2006:1-417

26. Glaser GB, Strauss LA. *The Discovery of Grounded Theory: Strategies for Qualitative Research*. New Brunswick: Aldine Transaction; 1967:1-284

27. Saldaña J. *The Coding Manual for Qualitative Researchers*. Thousand Oaks, CA: SAGE Publications Ltd.; 2015:1-369

28. Hammersley M, Atkinson P. *Ethnography: Principles in practice*. London, UK: Routledge; 2007.

29. Mamede S, van Gog T, Moura AS, et al. Reflection as a strategy to foster medical students' acquisition of diagnostic competence. *Med Educ*. 2012;46(5):464-472.

30. Sherbino J, Dore KL, Wood TJ, et al. The relationship between response time and diagnostic accuracy. *Acad Med*. 2012;87(6):785-791.

31. LeBlanc VR, McConnell MM, Monteiro SD. Predictable chaos: a review of the effects of emotions on attention, memory and decision making. *Adv Health Sci Educ*. 2015;20(1):265-282.

32. McNaughton N. Discourse(s) of emotion within medical education: the ever-present absence. *Med Educ*. 2013;47(1):71-79.

33. Dornan T, Tan N, Boshuizen H, et al. How and what do medical students learn in clerkships? Experience based learning (ExBL). *Adv Health Sci Educ*. 2014;19(5):721-749.

34. Barrett J, Trumble SC, McColl G. Novice students navigating the clinical environment in an early medical clerkship. *Med Educ*. 2017;51(10):1014-1024.

35. Steven K, Wenger E, Boshuizen H, et al. How clerkship students learn from real patients in practice settings. *Acad Med*. 2014;89(3):469-476.

36. Dornan T, Boshuizen H, King N, et al. Experience-based learning: a model linking the processes and outcomes of medical students' workplace learning. *Med Educ*. 2007;41(1):84-91.

37. Yardley S, Teunissen PW, Dornan T. Experiential learning: AMEE Guide No. 63. *Med Teach*. 2012;34(2):e102-e115.

38. Van der Zwet J, Zwietering PJ, Teunissen PW, et al. Workplace learning from a socio-cultural perspective: creating developmental space during the general practice clerkship. *Adv Health Sci Educ Theory Pract*. 2011;16(3):359-373.

39. Teunissen PW, Westerman M. Opportunity or threat: the ambiguity of the consequences of transitions in medical education. *Med Educ*. 2011;45(1):51-59.

40. Gawronski B. Back to the future of dissonance theory: cognitive consistency as a core motive. *Soc Cognit*. 2012;30(6):652-668.

41. Harmon-Jones E, Mills J. An introduction to cognitive dissonance theory and an overview of current perspectives on the theory. In: Harmon-Jones E, Mills J, eds. *Cognitive Dissonance: Progress on a Pivotal Theory in Social Psychology*. Washington, DC: Amer Psychological Association; 1999:3-21.

42. Land R, Rattray J, Vivian P. Learning in the liminal space: a semiotic approach to threshold concepts. *High Educ*. 2014;67(2):199-217.

43. Fredholm A, Henningsohn L, Savin-Baden M, Silén C. The practice of thresholds: autonomy in clinical education explored through variation theory and the threshold concepts framework. *Teach High Educ*. 2019;25(3):305-320.

44. Meyer JH, Land R, Baillie C. *Threshold Concepts and Transformational Learning*. Rotterdam: Sense Publishers; 2010.

45. Mezirow J. Transformative learning: theory to practice. *New Dir Adult Cont Educ*. 1997;74:5-12.

46. Mezirow J. *An Overview on Transformative Learning, in Lifelong Learning: Concepts and Contexts*. New York, NY: Routledge; 2008:40-54.

47. Van Schalkwyk SC, Hafler J, Brewer TF, et al. Transformative learning as pedagogy for the health professions: a scoping review. *Med Educ*. 2019;53(6):547-558.

48. Dewey J. *How We Think*. New York, NY: Barnes & Noble; 2005.

49. Higgs J, Jones MA, Loftus S, Christensen N. *Clinical Reasoning in the Health Professions E-Book*. Philadelphia, PA: Elsevier Health Sciences; 2008:1-520.

50. Moulton C-A, Regehr G, Mylopoulos M, et al. Slowing down when you should: a new model of expert judgment. *Acad Med*. 2007;82(Suppl 10):S109-S116.

51. Mylopoulos M, Woods NN. Having our cake and eating it too: seeking the best of both worlds in expertise research. *Med Educ*. 2009;43(5):406-413.

52. Woods NN, Mylopoulos M. On clinical reasoning research and applications: redefining expertise. *Med Educ*. 2015;49(5):543.

53. Mylopoulos M, Woods NN. When I say ... adaptive expertise. *Med Educ*. 2017;51(7):685-686.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.