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Abstract

Background and Purpose. Clinical reasoning is a complex, non-linear problem solving process that is influenced by models of practice. The development of physical therapists' clinical reasoning abilities is a crucial yet under-researched aspect of entry-level physical therapist education. **Objectives.** The purpose of this qualitative study was to examine the types of clinical reasoning strategies physical therapist students engage in during a patient encounter. **Methods.** A qualitative descriptive case study design involving within and across case analysis was used. Eight, second-year, entry-level physical therapist students from two different programs completed an evaluation and initial intervention for a standardized patient followed by a retrospective think aloud interview to explicate their reasoning processes. Participants' clinical reasoning strategies were examined using a two-stage qualitative analysis of thematic analysis. **Results.** Participants demonstrated consistent signs of development of physical therapy specific reasoning processes, yet varied in their approach to the case and use of reflection. Participants who gave greater attention to patient education and empowerment also demonstrated greater use of reflection-in action during the patient encounter. One negative case illustrates the variability in the rate at which students may develop these abilities. **Conclusions.** Participants demonstrated development towards physical therapist specific clinical reasoning yet demonstrated qualitatively different approaches to the patient encounter. Multiple factors including the use of reflection-in-action may enable students to develop greater flexibility in their reasoning processes.

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Introduction

Clinical reasoning is a complex problem-framing, problem-solving, and decision-making process necessary for effective healthcare practice. This highly context-dependent process requires interaction with the patient, caregivers, and other healthcare team members and is influenced by models of practice.[1] The process of clinical reasoning encompasses how a healthcare practitioner's knowledge is translated into patient care, [2] yet many factors, including beliefs and models of practice, influence what resources a practitioner uses during rapid decision making. [3] Additionally, the iterative process of clinical reasoning requires clinicians to make decisions and continually re-assess actions taken in the face of uncertainty.[1,2]

Importance of Clinical Reasoning Specific to Physical Therapy

While studies have addressed the issue of diagnostic reasoning in medical students,[4-6] three key differences in physical therapy practice suggest the need to examine teaching strategies and the development of clinical reasoning in students specific to physical therapy. Studies of medical reasoning have focused on diagnostic reasoning to identify active pathology (medical diagnosis).[4-9] Within physical therapy practice diagnostic reasoning must not only identify the active pathology but also identify the reason for the problem and the consequences of illness/disease process.[10-13] Second, physical therapists' (PTs') clinical reasoning includes an emphasis on the analysis of movement[10,13] that is central to experienced PTs' clinical reasoning processes[14] across varied PT practice settings.[15-18] Third, due to the ongoing and interactive nature of therapeutic work, physical therapists work collaboratively with the patient to determine ways to engage and motivate the patient in the treatment process.[19,20] The interactive process of clinical reasoning includes gaining an understanding of the patient's context and perspective on

the illness or injury.[12,21] As PT students progress through their education, they should develop these physical therapy specific characteristics in their reasoning processes.

The process of hypothesis formation and evaluation is central to clinical reasoning.[22] During the diagnostic process, health care practitioners develop hypotheses that guide data collected during examination[12] and the development of treatment.[23] A hypothesis is any diagnostic idea,[2] that may identify pathology, an impairment, functional deficit, or causes of and factors influencing the patient's disability.[9,10,23] These hypotheses represent the way practice specific knowledge is organized.[24] A critical component of clinical reasoning in orthopedic physical therapy is the generation of comprehensive hypotheses that address factors related to the patient, the therapist, and the specific context.[25] The hypotheses a clinician develops during the patient examination and assessment represent his/her unfolding diagnostic process.

Patient cases are ambiguous by nature; thus clinical reasoning requires practitioners to develop a reasoning framework when not all the facts are known.[2] The lack of explicit structure in patient cases requires the clinician to determine what to focus on prior to solving the problems presented.[26] The approaches PTs take to interacting with, examining, and assessing patients are shaped by the way the therapists frame the patient's problems[27] and are observable reasoning strategies. The types of reasoning strategies used represent the nature and scope of the specific healthcare practice.[28] The reasoning strategies physical therapists engage in, alongside the hypotheses they form represent the scope and shape the clinical decisions they make. Analyses of the reasoning strategies PT students draw on and the hypotheses they form can provide insight into their approaches to framing clinical problems.

Expert physical therapists demonstrate not only efficient forward-reasoning processes, but also a balance of analytical problem solving with narrative reasoning focused on the patient

as an individual.[28,29] Expert PTs demonstrate ongoing collaborative reasoning with the patient while drawing on diverse knowledge sources through a seamless flow of social interaction integrated with assessment and treatment.[14,30] Further, expert PTs give more attention to empowering, engaging, and educating the patient than to their own skills and techniques.[31,32] These prior studies of clinical reasoning and expert practice in physical therapy have provided a framework for describing practice, yet have provided minimal insight into how students develop these capacities.

To date, there has been little work addressing how to bridge what is known about expertise and expert practice with entry-level educational practices for instruction and assessment of clinical reasoning.[33,34] Entry-level physical therapist educators lack consensus on what constitutes clinical reasoning and describe great variation in approaches to teaching it.[35] To effectively prepare entry-level physical therapist students for autonomous practice,[36,37] entry-level educational programs must support students in developing their clinical reasoning skills. One important step towards elucidating PT students' development of clinical reasoning is to examine how they engage in clinical reasoning. Building on the existing frameworks of clinical reasoning in experienced physical therapists, this study examined the patterns of reasoning strategies and assessments second year physical therapist students demonstrated during a patient encounter. The primary research question for this study was: During an encounter with a patient, what clinical decisions do PT students make, and what clinical reasoning strategies underlie their decisions?

Methods

This qualitative, descriptive multiple case study design involving within and across case analyses[38] allowed analysis of the individual students' reasoning, patterns within the two Doctor

of Physical Therapy (DPT) programs, and patterns across all students.[39,40] The participants' clinical decisions and reasoning strategies were analyzed using the qualitative method of thematic analysis.[41]

Participants and Contexts

Students were recruited from two entry-level physical therapist educational programs. These educational programs were selected based on differences in their overall program structure. Both programs use traditional curricula[42] but differ in the sequencing of their courses, the types of pre-clinical experiences included, and the scheduling of students' full time clinical experiences. University A uses primarily terminal clinical experiences, while University B uses integrated clinical experiences. At the time of this study, students from University A had participated in 6 weeks of full-time off campus clinical affiliations and one semester part-time at an onsite clinic, while students at University B had participated in 16-20 weeks full-time, off-site clinical experiences. Table 1A summarizes the preliminary differences and Table 1B presents the entire curriculum at each program, highlighting the different timing of clinical experiences.

Participant Selection

To best identify differences due to the influences of program structure rather than clinical experiences, students were selected from the final term of their second year in the three-year doctoral programs. A random sample of four student volunteers representative of gender distribution within each program was selected from each program to participate in this study.

Participants

The participants at both programs had similar demographics. No participant had prior experience as a PTA or athletic trainer. All participants had prior experiences as PT aides and/or volunteers. Most also had personal experience as a patient in physical therapy or with a family

member as a patient. Average age at University A (mean age 27 years) was slightly higher than University B (mean age 25.25 years). Participants expressed interest in a variety of physical therapy practice settings, but the spectrum of practice areas was evident across both programs.[39,40] Table 2 summarizes the demographic information of the participants.

Data Collection

Participants completed the standardized patient (the patient) encounter[43] that entailed a physical therapy examination, assessment and intervention. Prior to meeting the patient, each participant was presented with instructions and given the patient's referral information (see Appendix 1). If the participant had not completed the assessment in 35 minutes, he/she was instructed to proceed to the treatment phase. Participant-patient interaction during the encounter were video and audio recorded. The primary researcher took notes on the participant's actions during the patient encounter to guide the post-encounter interview. The duration of the patient encounters ranged from 20 to 40 minutes with an average time of 28 minutes, similar to initial assessments in many clinics.[44] The standardized patient did not provide any feedback to the participant.

Immediately following the patient encounter, the primary researcher interviewed the participant regarding his/her reasoning processes during the patient encounter (see Appendix 2 for interview guide and guide development). Review of the patient session video was used to prompt discussion of participants' thought process underlying actions taken during the encounter. All interviews were audio recorded and transcribed verbatim.

Analyses

Transcripts from the patient encounter were annotated to indicate the participant's and the patient's actions alongside the verbal exchange. The first stage of coding used structural coding[45]

to identify the participant's actions during the patient encounter, hypotheses formed, and interventions selected based on the elements of physical therapy examination.[46] Each participant's statements of diagnostic ideas, contributing factors, and judgments were coded as hypotheses.[2,24] Each statement coded as a hypothesis could be coded in two categories, for example, a statement identifying muscular weakness as a cause of the patient's injury could be coded as both an impairment and a contributing factor. Hypotheses represent the clinician's synthesis and interpretation of clinical data.[24] Hypotheses and clinical reasoning strategies represent the clinician's knowledge structure and organization during the patient encounter.[24] PT clinicians generate hypotheses related to physical therapist diagnosis and management.[47] The categorization of the hypotheses generated using the coding scheme described by Jones et al[24] can be used to relate the particular clinical reasoning and decision making to the broader International Classification of Functioning (ICF) framework. Coding categories for the hypotheses were derived from Jones et al.'s[24] hypothesis categories, with additional codes emergent from the data (See Table 3 for definitions of Hypothesis codes). Participant's selected treatment interventions were categorized based on the physical therapy interventions described in the APTA *Guide to Physical Therapist Practice* [46] and the dimensions of the ICF.[48]

All stages of analysis, including the preliminary coding frames, were informed by the existing literature in the field.[49] Within each coding category, additional emergent codes were added using an iterative process during the initial data coding. As this work was part of a doctoral dissertation, the original and revised coding frames were reviewed by the primary researcher's dissertation committee prior to final coding of the data. Further, subsets of the transcripts were coded by secondary coders (trained research assistants) to establish the reliability of the coding.[50] Finally, the final coding of the data was reviewed by the committee to

establish consensus on the application of the codes. The primary researcher maintained a log of the coding and analysis process (including initial impressions from the data collection sessions) to document the evolution of the final analysis.

To enhance the credibility and consistency of these findings, a random sub-sample of the data were coded by a second coder trained on the coding system. The primary investigator and the second coder achieved 97% agreement (kappa .964) for coding of clinical actions and 72% agreement (kappa 0.69) for coding of hypotheses. Discrepancies between coders when coding hypotheses occurred due to the use of co-occurrences of the codes. Almost all of the discrepancies arose when one coder had applied only one code (usually a "contributing factors" code) and the other coder had applied two (the "contributing factors" and the type of factor such as "impairment"). Following discussion between coders, consensus on the use of multiple codes was achieved. The higher level of agreement on the reasoning strategies (see below) that built on the identification of the hypotheses demonstrates the overall level of agreement in the analysis. Further, each participant confirmed his/her actions during the post-encounter interview.

The second stage of coding examined the relationship of the hypotheses participants formed, examination data collected, and actions taken to identify their reasoning strategies. Reasoning strategies represent the range of clinical decisions and actions physical therapists make across practice fields.[28] The participants' reasoning strategies were coded based on the strategies defined by Edwards et al.[28] (See Table 4 for strategy code definitions) Again, a random sample of the data was coded by the primary researcher and second coder trained on the coding system, achieving 90% agreement (kappa 0.88). During the retrospective think-aloud each participant's explanations were analyzed for instances of reflection in- and on-action.[51,52] Also, any reasoning errors the participant made were classified based on the nature of erroneous

conclusions drawn.[53] In this second stage, the relationship between the treatment interventions to examination data collected and participant's stated overall goals for the patient was also analyzed.

Results

The following section describes the students' clinical actions and reasoning processes during the patient encounter. The section begins by describing their actions during the examination process and the types of hypotheses they generated. The relationships between the students' examination processes and hypotheses generated are presented in terms of their reasoning strategies, reasoning patterns, and reasoning errors. The section continues with explanation of the relationship between the students' reasoning processes and the goals and interventions they selected for the patient. Finally, this section presents evidence of the participants' use of reflection in- and on-action during their work with the standardized patient.

Examination Process

During the standardized patient encounter, students demonstrated many similarities across programs. Consistent with elements of the physical therapist examination process,[46] all students began the patient encounter with an interview and transitioned to examination/tests/measures aimed at identifying the patient's pathology and biomechanical or structural links to the pathology. These biomechanically focused examination tests included assessing posture and active range of motion (AROM) of the spine, palpating the painful region, and conducting special tests aimed at identifying affected tissues.. All participants sought information about the patient's description of chief complaint, goals for therapy, and details of the patient's pain. Most (three of four at each program) participants elicited information about the patient's employment and recreational interests, and past and current medical history.

The students from the two programs differed in how they responded to the patient's disclosure of her Type II Diabetes. At University A, participants inquired if she took medication and then asked no further questions when they learned that she did not. At University B, upon learning that the patient did not take medication for the diabetes, the participants asked further follow up questions regarding her management of the diabetes.

Hypotheses

Students formed hypotheses about the patient's condition throughout their examination process. The hypotheses the participants formed focused primarily on identifying the patient's affected body structure. Figure 1 displays the hypotheses participants named most frequently and Table 5 provides example quotations. For example, Hannah (from University B) hypothesized about the relationship of the patient's tight hamstrings to her back pain: "She was really tight… For somebody that tight anytime you bend would be strenuous if you don't have that give through your hips" Three students demonstrated a pattern of generating hypotheses focused on understanding the patient's behavioral characteristics in addition to identifying the pathology. For example, Lisa (from University B) hypothesized about the patient's willingness to move following observation of a forward bend: "So I wanted to see how willing she was to move for one thing… Very cautious with bending forward." The pattern of identifying behavioral characteristics was unique to these students (from University B) and not present universally in the participants. Participants, however, rarely discussed the impact of the pathology on the patient's life (participation) or the patient's perspective on her condition.

Statements coded as hypotheses could be coded in two categories (code co-occurrences) if the statement was representative of two categories. The hypothesis code co-occurrences further illustrate the elements of physical therapy diagnosis in the students' problem solving processes.

Table 6 summarizes the most common co-occurrences. Each count in table 6 indicates an occurrence of a statement that was coded in both identified categories. Following from their focus on identifying the affected structure, the most common co-occurrence involved ruling out a structure that had previously been identified. For example, following negative findings on neurological testing, Kelly stated "Probably can rule out nerve at that point that's causing her pain." This statement was coded as "ruling out" and "structure." For example, Hannah explained her testing of the patient's hamstring length: "She had a lot of tightness in her hamstring. She couldn't do (forward flexion) with her knees straight, so I'm thinking okay well, you're supposed to be moving your hips but you're getting a lot of from your back so that could be contributing to some of your pain." Hannah's statement was dual coded as "impairment" and "contributing factor." Students also frequently linked a structure (such as a specific muscle) to a pathological process (such as a strain). This pattern of linking an anatomical structure to a pathological process (for example identifying a paraspinal muscle strain) was also evident in the students' final assessments of the patient.

Reasoning Strategies

The students' reasoning strategies were identified based on the relationships between their examination data collection and hypothesis generation. The most common reasoning strategy[28] was Diagnostic Reasoning, demonstrating a focus on diagnosis of the primary pathology as well as movement patterns that contribute to and are affected by the pathology. Students also frequently exhibited diagnosis of movement impairments, reasoning about procedures (identifying possible interventions and strategies for implementing the interventions), and diagnosis of causal factors (see Figure 2 and Table 7 for examples) Two participants (Lisa from University B and Bethany from University A) demonstrated greater reasoning focused on

identifying the patient's personal needs and impact of the pathology. Bethany explained her reasoning for asking the patient about her goals for therapy: "Just to know where she is heading to and make sure we're on the same page. Obviously I want her to get better, I want to not have pain. I want her to know there are a million things we want patients to do, but we can only prioritize so much."

Overall Reasoning Patterns

The organization of the students reasoning strategies determined their overall reasoning patterns. Four primary patterns of reasoning emerged including: following protocol, the hypothetico-deductive process, reasoning about pain, and analysis of patient behavioral patterns. Figure 3 presents the overall distribution of reasoning patterns.

Protocol. Six of the eight participants initiated their patient encounter by creating an examination form based off their memory of forms they had used in classes or clinical experiences. Mason (from University A) explained the notes he had written prior to meeting the patient:

> I was jotting things down because those little notes, they make sense to me, and that's what I would use to go back to write my initial evaluation to document I can go back and sort of like when we were taught to go through a typical evaluation exam an eval and we needed to hit these points, so I'm just kind of making a written note as to what the points are for documentation purposes, but also if I go back, say I do my exam, and I realized that I forgot to ask her something, I could look over there to see if I wrote it down or if I did forget to ask, I can ask it next time.

A seventh participant, Sophia (from University B), did not create a form, but during the interview she referred to information and structure from prior examination forms as part of what guided her examination process. Drawing on the structure of these examination forms helped participants organize their examination process and make sure they addressed the information they had learned was important during a patient evaluation. Most participants expressed that they

were afraid they might forget to elicit important information from the patient if they did not write themselves the examination sheet as a reminder.

Hypothetico-Deductive Process. All but one participant demonstrated use of the established reasoning pattern, the hypothetico-deductive process, through their identification of multiple primary hypotheses with follow up testing to rule in or out selected hypotheses [5,7] The students used this process not only to identify the patient's primary pathology (medical diagnosis) but also in a physical therapy specific pattern of identifying the impairments that contributed to the patients pathology.

Reasoning About Pain. Participants demonstrated two distinct patterns of reasoning about pain that have been identified in the literature. First, all participants demonstrated a biomedical approach to reasoning about pain.[54] This process included using the location and description of the patient's pain to develop hypotheses about the primary pathology. Hannah (from University B) demonstrated the biomedical approach to reasoning about pain as she explained her use of the patient's pain description in guiding her thinking.

> Because different structures causes different types of pain and I would like to know which structure is most likely caused her pain and her describing what it feels like can help differentiate…. Achy, I thought it could be muscle or joint but then the sharp made me think okay, there might be some involvement with the joint. Maybe a fracture or even just nerve involvement if it's like any other symptoms associated with it so I wanted to ask more about that.

Further, six participants used the patient's ratings of her pain to determine the level of severity of the injury. Finally, five participants also used the patient's ratings of her pain to set goals for treatment. Mason (from University A) explained that the patient's pain ratings could help him determine if his treatment had been effective

> I kind of have to have a range of a pain scale and pain is something I can document over time, like patients, if I see that her pain is going down over time, that is another objective

> measure I could use to be like alright the treatment seems to be working, so a couple different reasons.

Three of the participants from University B demonstrated a behavioral approach to reasoning about pain in addition to the biomedical approach. These three students formed assessments about the patient's behavioral responses to the pain and the patient's perspective on the pain, in addition to their biomedical analysis of the location and description of her pain. Lisa (from University B) interpreted the patient's ratings of the pain as an indication of how the patient reacts and perceives her injury.

> So the visual-analog scale obviously is very subjective, it's hard to compare one person to another but really for me it just gives me a good idea of how this person reacts to pain. What their idea of pain is. So at rest she gave it a 1 out of 10 and at best a 1 out of 10. That means it is bothering her all the time, which is good to know which is still kind of in that inflammatory phase, but it's a pretty low level, not too bad and then it's getting to a 7 or 8 out of 10 at the end of the day and that's a big jump and I am a little bit more inclined to believe her.

These different approaches to reasoning about pain demonstrate that even though all the participants collected similar data from the patient, their reasons for collecting that data and their interpretations differ.

Behavioral Analysis. Two of the three participants (from University B) who demonstrated a behavioral analysis approach to reasoning about pain also reasoned about the patient's overall behavioral responses. Their analysis of patient's immediate and current management of back pain and management of diabetes demonstrated a focus on the patient's overall behavioral patterns that was not present in the other participants' work with the patient. For example, Lisa explained that the patient's current approach to managing her back pain provided insight into the patient's behavioral profile and how she would respond to a treatment program. Sophia similarly explained how she interpreted the patient's use of diet and exercise to

manage her diabetes as evidence that she would be likely to follow through on a home exercise program.

> So that made me want to, especially ask, what type of exercise is she doing. But that, she's going to make those kinds of changes in her life that probably, her compliance is going to be a little bit better than someone who is not mindful of exercise or their diet.

Reasoning Errors

The participants in this study demonstrated two primary patterns of reasoning errors during their encounter with the patient: failing to generate a key hypothesis and hanging on to a hypothesis in the face of conflicting findings. Six participants demonstrated a failure to generate key ideas or hypotheses in their evaluation of both the patient's primary pathology and co-morbidities due to jumping prematurely to one idea and never generating alternative hypotheses. This pattern is consistent with Croskerry's[55] description of Confirmation Bias and Premature Closure. As a result, these participants failed to appropriately assess the patient's current condition and impact of her comorbidities. Four participants (three from University B and one from University A) maintained a hypothesis of muscle strain despite gathering data that suggested other reasons for the patient's pain. Finally, participants demonstrated different understandings of the process of making a diagnosis of sacroiliac joint dysfunction. Participants from the two programs differed in which factors they gave the most weight to during their assessment: provocation tests or pelvic alignment. The participants discussion of their decision making process following the patient encounter indicated that these differences represent a difference in their learning of the necessary and sufficient conditions for ruling-in an sacroiliac joint dysfunction.

Negative Case Example

One participant demonstrated reasoning patterns that diverged from the consistent use of protocol and hypothetico-deductive processes evident in the other students' work. As a negative case example,[38] Bethany (from University A) relied on trial and error throughout her interactions with the patient. When she conducted a test that elicited the patient's pain, Bethany was unable to form any assessment from that test, as she didn't feel that she had been able to conduct the test as she had learned in class. She also was unable to determine follow-up tests to clarify the results of the test. Bethany further carried out numerous manual muscle tests for the purpose of "documentation." She stopped three-quarters of the way through the examination and asked if a clinical instructor was available to assist her.

Goals, Interventions and Relations to Reasoning Processes

The relationship between participants' interventions, goals and examination data revealed both strengths and limitations of the reasoning processes across participants. The PT Clinical Performance Instrument (CPI)[56] (item 12 for Plan of Care) and the literature in clinical decision-making indicate that the interventions a physical therapist selects should be guided by the examination data and evaluations.[57] Differences were seen in what the students from the two programs prioritized in their treatment plans. Three of the four participants from University A placed the highest priority on pain management. Bethany described her reasoning for prioritizing pain management in her treatment program.

> Decrease pain because pain is so limiting. Pain limits her from doing anything. So she says sitting is better, which is good but she works so much and for her to return to work like say 8 hours, I think pain management is a big part. Her active movement and everything, I think she can get by – I think pain is the culprit, and I want her to rest too, but if she's not able to then... I would really love to see if the e-stim helps her.

The students from University B, on the other hand, prioritized patient education and self-management. Sophia explained her reasoning for prioritizing patient education.

> Definitely her patient education. So that she has follow through when doing the activities. Telling her why this is beneficial. And then also, as well with what patient education goes, continuing to move instead of stopping altogether. I've seen patients who hurt their back and then they stop moving and it's five months down the road and they can barely move anymore. That's the worst thing you could have done for yourself.

Sophia's attention to patient education paralleled her attention to the patient's behavioral responses throughout the encounter.

Six of the eight participants developed goals that followed from examination data collected and hypotheses formed, and selected interventions based on the goals and examination data selected. Two participants, however, demonstrated disconnections between their examination process and intervention selection. Kelly (from University A), for example, focused her examination on identifying the primary pathology and did not include any functional movement or strength assessments. Her goals, however, addressed participation, and she described interventions focused on strengthening and functional activities. The most common disconnection between examination data and goals/interventions was the inclusion of functional activity goals and interventions without an assessment of those movements. Four participants had the patient perform an active forward flexion range of motion (a measure of impairment) and indicated that constituted their functional movement assessment.

Reflection

Students' responses during the post-encounter interview indicated their use of both reflection in-action and reflection on-action[52] during the patient encounter. This use of reflection shaped their clinical decisions through their assessment of their in-the-moment decision-making as well as their ability to draw on prior experiences to inform their decisions. Figure 4 depicts students' overall use of reflection in- and on-action.

Reflection in-action. Students demonstrated reflection in action through their assessment and questioning of their findings and decisions during the patient session. Some used reflection to re-evaluate conclusions they had drawn from prior tests or to consider tests they needed to re-visit. Hannah (from University B) explained:

> I wanted to see if maybe I missed something at the beginning. And based on the way that she was bending, I wanted to see if she had any anterior tilt because before I was just kind of looking at if things are even between the sides but now I wanted to see if okay if something is contributing to the way she's moving that's limiting it.

Other participants actively debated the merits of following clinical wisdom over what they had read in research as they made decisions during their work with the patient. Lisa (from University B) explained:

> The fall, I especially wanted to see, sometimes with a fall onto one side or the other you can cause a little bit of a jarring with that SI and her pain the way she was pointing to her pain I wanted to see if there was any mal alignment there. I know that the research is all over the place with SI stuff but I've seen enough patients feel better after you do a mobilization or an MET (muscle energy technique) and I think it's worth looking at in terms of pain relief.

The participants who demonstrated reflection in action demonstrated a greater ability to adapt their examination and evaluation process to the unfolding findings. Peter (from University B) and Mason and Kelly (from University A) demonstrated the least reflection in action and also demonstrated the most "linear" rule-driven approach to reasoning that is typically evident in novices.[31,58]

Reflection on-action. Students demonstrated reflection on action as they re-assessed their immediate actions during the patient assessment and drew on prior experiences with patients from classes or clinical affiliations. These patterns parallel Wainwright et al.'s[51] findings of Reflection on Specific Action and Reflection on Professional Experience in novice and experienced clinicians. The students demonstrated reflection on specific action as they re-

evaluated decisions they had made during the immediate patient session. The students from University B who had more clinical experience demonstrated greater use of reflection on professional experience as they drew on specific prior examples of patient experiences to guide their decision-making throughout the interview and examination and to inform their selection of interventions.

Overall, students' use of reflection enabled them to draw on prior patient experiences and adapt their examination process to the specific current patient. Students' use of reflection on action demonstrated their learning from prior experiences (reflection on professional experiences) and their potential to learn from their experiences with the current patient (reflection on specific action).

Discussion

This study has described students' clinical decisions and reasoning processes during their encounter with a standardized patient. These analyses contribute to our understanding of the developmental patterns in PT students' clinical reasoning. The hypotheses the students developed represent their organization of knowledge specific to their practice.[24] The types of reasoning strategies the students engaged further represent their development of a physical therapists' specific scope of practice.[28] The analysis of the students' hypotheses, reasoning strategies, and reasoning patterns has provided insights into their foci during a patient encounter. All of the students were at the same stage of their professional education, yet they demonstrated qualitatively different foci in their clinical reasoning and decision-making. The following section discusses the relationship of the students' hypothesis generation and reasoning processes to their development of physical therapist specific reasoning. First, the students' reasoning processes suggest their progress towards physical therapist specific reasoning as well as limitations in their

development. Second, the students' demonstrated qualitatively different approaches to identifying and addressing the patient's problems suggesting different approaches to framing the clinical problems.[27]

Development of Physical Therapy Specific Reasoning

All of the students demonstrated two of three key characteristics of established diagnostic patterns in physical therapy: a focus on movement and the integration of a biomechanical analyses of factors contributing to injury.[24] The students demonstrated less explicit attention, however, to the impact of the patient's injury on her level of participation and quality of life, elements of the evaluation process highlighted in the PT CPI (Item 10).[56]

Seven participants demonstrated a focus on movement analysis through their examination process, hypotheses, reasoning strategies, and interventions. The students' attention to movement is likely influenced by the coursework in biomechanics, exercise science, and motor control in both programs (see Table 1B). The students' attention to movement parallels the focus on movement in the reasoning of expert and novice physical therapists.[15,18] The students, however, demonstrated two different approaches to their reasoning about movement suggesting that some participants held different foci for their assessment processes. Four students focused exclusively on movement at the impairment level, such as identifying limitations in a forward bend or hip abduction strength. The students' focus on impairments over functional assessments, however, suggests gaps in their understanding of the importance of functional movement in physical therapy assessment and intervention.[59,60] Three students, however, demonstrated greater attention to the patient's movement patterns and behaviors. These three students' attention to movement patterns suggests progress towards the development of movement scripts identified in expert therapists.[15] The variability in the students' perspective on movement (biomechanical or

behavioral) within and across programs suggests factors beyond the explicit curriculum may contribute to their approaches to reasoning about movement. The absence of an organized reasoning process in the negative case exemplar illustrates the variability in development of clinical reasoning process evident in professional education.

The participant's focus on developing hypotheses identifying affected anatomical structures and movement impairments contributing to the patient's current condition (as demonstrated in the hypothesis counts in Figure 1) indicates development towards a physical therapy specific diagnostic process of identifying movement factors that contribute to the injury.[11,61-64] First-year DPT students in a prior study developed hypotheses almost exclusively focused on identifying anatomical structures, influenced by their recent basic sciences courses.[53] The trend of identifying both anatomical structures and movement impairments in the second-year students in the current study demonstrates progress towards PT specific clinical reasoning.[24] The students' continued attention to identifying anatomical structures may be influenced by their academic coursework or their clinical instructors' approaches to clinical reasoning. Further, the participant's identification of movement impairments as contributing factors (as demonstrated by the co-occurrences of impairments and contributing factors noted in Table 6) enabled them to develop interventions based on the hypotheses they had formed.[61]

The students reasoning strategies and reasoning patterns further demonstrate their progression towards physical therapist specific reasoning. Two of the most common reasoning strategies employed were the diagnosis of movement impairments and causal factors (see Figure 2); key elements of the physical therapist's responsibility to address movement patterns (pathokinesiology) that contribute to a patient's health condition.[64] The student quotations in Table 7 provide examples of the students' movement specific analysis of the patient's

impairments and causal factors. The most common patterns in the students' overall reasoning (use of protocols and the hypothetico-deductive process as illustrated in Figure 3) are also consistent with the work of novice physical therapists.[30,31] A higher reliance on protocols was noted in first-year DPT students in a prior study.[53] The students in this current study used protocols to organize their initial reasoning but demonstrated flexibility to diverge from the protocol as the case unfolded. The students' use of protocols may help the students in developing the routines necessary for well organized clinical reasoning process.[2] The two patterns of reasoning about pain (biomedical and behavioral) demonstrated by the students in this study are also consistent with patterns of reasoning about pain by musculoskeletal physical therapists.[54] The limited number of students who demonstrated a consistent pattern of reasoning about the patient's behavioral responses and psychosocial experiences (as noted in Figure 3) points to a limitation in the students' development of attention to the patient's experience of the process.[65,66]

The participants demonstrated less attention to the impact of the patient's injury on her life function. Physical therapists must address the consequences of the patient's disease process in addition to the pathology itself,[11] and this process includes understanding how the effects on physical function impact a patient's ability to carry out his/her life roles. Only three students, however, developed multiple hypotheses about the impact of the pathology on the patient's life and the impact of the patient's personal characteristics on her function and prognosis (demonstrated by the low percentage of hypotheses developed about Patient Characteristics in Figure 1). Further, as demonstrated in Figure 3, only two students engaged in patterns of reasoning concerning the patient's behavioral presentation. The remaining students focused their examination, assessment and treatment on identifying the patient's health condition (pathology) and biomechanical problems. This biomedical focus of the encounter is evident in the most

common reasoning strategies (Diagnosis of Primary Pathology and Diagnosis of Movement Impairments in Figure 2) as well as five of the students' use of Biomedical Reasoning about Pain (Figure 3). For example, Mason explained that measured increases in range of motion would be his primary indication that he had been effective in treatment. "Did she get better post-test? So, if I'm doing an intervention whether it's to gain range of motion, … so post-assessment would be my best gauge." The students' attention to movement and impairments as contributing factors suggests that the students' are developing the analytical or technical aspects of the physical therapy diagnostic process, yet giving limited attention to the psychosocial components of the process. This limited attention suggests these students may have only a limited understanding of patient-centered care. Further research should investigate the relationships between students' understandings of patient-centered care and their approaches to the patient encounter.

Different Approaches to the Patient Encounter

The differences observed in students approaches to the patient encounter illustrate Schon's theory that real world problem solving involves first framing the problem, then solving it.[52] The two primary approaches to the patient encounter were the biomedical approach and the behavioral approach. Students demonstrating the biomedical approach focused their examination and hypothesis development around identifying the patient's primary pathology and treatment plans focused on the biomechanical and impairment levels. Three students (from University B) demonstrated a greater focus on identifying patient behavioral characteristics that impact movement and treatment, and included patient education and activity modification in their treatment plans in addition to a biomedical analysis. These students' educational approach to patient treatment suggests they may be developing some of the characteristics of more expert practitioners, even at this early stage of their education.[31,32] Programmatic differences may

contribute to the differences observed in how they learned to interpret and act on the data they collected, yet further study is necessary to draw definitive conclusions.

Although all participants collected similar data during their examinations, their interpretation and use of that data suggests different approaches to framing the clinical problem. For example, all students asked the patient to rate her levels of pain. Six students used this information as an indication of the severity of the patient's injury and a measure for progress. Two students, on the other hand, used the pain ratings to gain insight into the patient's perceptions of and behavioral responses to the injury as demonstrated through their reasoning patterns concerning pain (demonstrated in Figure 3). The students' variations in approach to the patient problem suggest that they may be operating from different models of practice (most from a biomedical model and two from a biopsychosocial model).[27] Further research should investigate students' conceptualizations of practice in relation to their clinical reasoning and decision-making.

Managing Uncertainty with Reflection. Reflection in- and on-action influenced the students' processes through the evaluation process. Each participant demonstrated use of reflection on-action at least once during the patient encounter as demonstrated in Figure 4. This use of reflection on-action has been noted in prior studies of students and novices.[51,67] The use of reflection-in-action was observed more frequently in some participants than previously reported in the literature.[51,67] Six of the students demonstrated at least one occurrence of reflection in-action. Overall, students' reflection in-action took two primary forms. Four students used reflection to re-assess their actions, re-evaluate (or re-examined) certain tests or examinations and shift course during the examination. These students demonstrated greater flexibility in their progress through the case and were able to adapt their tests and measures to the unfolding

situation.[51,52] One student who demonstrated the least knowledge regarding the case, reflected on her own limitations and indicated desire for external guidance from a clinical instructor during the examination and the interview. This use of reflection in-action to question one's confidence during clinical reasoning has also been noted in the nursing education literature.[67] While these comments indicate limitations in this student's own capacities for clinical reasoning, they also indicate her awareness of her limitations. Fostering a deep approach to learning may support students' development of reflective capacities as a deep approach to learning requires ongoing self-evaluation to achieve a true understanding of the matieral.[68] This deep approach to learning is necessary overall for clinical reasoning, as surface approaches to learning are not compatible with the skills needed for clinical reasoning.[69]

Limitations and Future Directions

This study has contributed to our understanding of PT students' development of clinical reasoning skills by examining the varieties of patterns of clinical reasoning in students from two different entry-level educational programs. This study has several limitations that should be addressed in future research. First, program level factors that influence the students' reasoning processes could be better examined in studies repeating the methods of this study that include more participants and more programs. The data from this current study suggest that students from University B (with greater clinical experience at the time of the study) engaged in more reflection in action and patient education; however, more in-depth analysis of the programs curricula, culture, and andragogy are necessary to draw any definitive conclusions about program level factors. Future studies should include greater breadth of program related data sources such as a review of course syllabi, observation of classes, and interviews with faculty and administration.

Second, this study did not relate the students' clinical reasoning processes to their broader academic or cognitive abilities. Future studies could increase our understanding of the relationship between students' academic and cognitive abilities and dispositions through further analysis of the relationships between students' patterns of clinical reasoning and their academic and clinical performance within their program. Further analysis alongside established measures such as the Health Sciences Reasoning Test[70] of Study Processes Questionnaire[71] (assessing deep versus superficial approaches to learning) could enhance our understanding of the cognitive and dispositional factors that underlie students' development of clinical reasoning.[72]

Finally, the qualitatively different approaches to clinical reasoning demonstrated by the students in this study suggest that individual level factors may also underlie these differences.[73] Further examination of the individual students' backgrounds (prior educational, personal and professional experiences) and their perspectives on physical therapy practice may shed more light on individual level factors that influence students' engagement in reflection and patient-centered care. The exploration of students' different approaches to clinical reasoning could also be expanded by replication of this study but using multiple standardized patient encounters representing different patient cases within and across physical therapy disciplines. The use of a multiple patient cases could provide greater confirmation of student specific patterns of reasoning versus context specificity in response to the patient case. As with any qualitative research, there are inherent limitations in the interpretive nature of qualitative coding.[74] Considering the limitations of the coding process, multiple methods to ensure trustworthiness were employed in this study including use of established methods and coding frames,[49,50] triangulation,[38,75,76] and reliability coding.[50]

Conclusion

This study has begun the process of describing the variations in development of clinical reasoning in physical therapist students. The findings from this study indicate that students are engaging in qualitatively different approaches to clinical problem-framing and problem solving through the types of hypotheses they develop and reasoning strategies they engage. Differences were evident both within and between programs. While the findings from this study are only preliminary, they suggest that both individual and program level factors may contribute to differences in the development of physical therapist's reasoning. This preliminary examination of students' clinical reasoning provides an initial step in linking the theories of clinical reasoning in experienced physical therapists to the developmental needs of entry-level students. Further studies should investigate the impact of programmatic factors (such as timing of clinical experiences) on students' development of clinical reasoning abilities.

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Table 1A: Preliminary program differences

	University A	University B
Course Sequencing	First term includes course on professional interactions	First term is entirely foundational science
	Separate clinical courses for examination and intervention (in separate terms)	Clinical courses address examination and intervention in same course
Timing of Clinical Experiences	Pre-clinical experiences are in integrated onsite clinic Readings on expert practice included	Pre-clinical experiences are two week experiences off site
	Clinical experiences concentrated during third year (Terminal experiences)	Clinical experiences interspersed over second and third years (Integrated experiences)
	Students have had 6 weeks of clinical experience	Students have had 2 2-week pre-clinical experiences and 12-16 weeks of clinical experience

Table 1B:Program Structure Differences

Data Collection for this study occurred during Term 6 in each program

	Term	Program A Courses	Program B Courses
First Year	1	Anatomy Tissue Mechanics Neuroanatomy Professional Interactions	Anatomy Developmental Anatomy Biomechanics Pathophysiology Research Methods Current Issues in Healthcare
	2	Biomechanics Physiology Anatomy Motor Control/Learning Professional Practice Issues	Kinesiology Neuroanatomy Orthopedic Pathology Physical Therapy Examination Processes Acute Care Principles Research Methods
	3	Exercise Science Pathology Gait Musculoskeletal Examination Neurological Examination Acute Care Principles	Neuroanatomy Neurophysiology Neurological Pathology Musculoskeletal Practice (lower quarter) Physical Agents (Modalities) **2 Week Clinical Practicum**
Second Year	4	Imaging Orthopedic Practice Management Integration Research Methods Critical Thinking **6 Week Clinical Practicum**	Musculoskeletal Practice (upper quarter) Neurological Practice Motor Control/Learning Psychology and Cultural Diversity Research Methods **2 Week Clinical Practicum**
	5	Musculoskeletal Interventions Neurological Interventions Cardiopulmonary Practice ENMG I Pharmacology Research Project **On Campus Clinical Practicum (ICE)**	**12-16 Week Clinical Practicum**
	6	Advanced Musculoskeletal Pediatric Practice Neurological Practice Prosthetics and Orthotics ENMG II Current Trends in Healthcare Research Project **On Campus Clinical Practicum (ICE)**	Anatomy II Rehabilitation Practice Cardiopulmonary Practice Pediatric Practice Diagnostic Imaging Physical Therapy Ethics Research Project
Third Year	7	Neurological Interventions II Differential Diagnosis Current Trends in Healthcare II **6 Week Clinical Practicum**	**12-16 Week Clinical Practicum**
	8	Advanced Neuromuscular Practice Geriatric Practice Pathophysiology Advanced Cardiopulmonary Practice Orthopedic Practice II Research Project	Advanced Clinical Practice Wellness and Complementary Medicine Geriatric Practice Leadership and Administration Applied Administration Pharmacology Research Project
	9	**12 Week Clinical Practicum** **12 Week Clinical Practicum**	**16 Week Clinical Practicum**

Table 2: Participant demographic information

	Pseudonym	Age/ Gender	Clinical Experience	Pre-PT Clinical Experience	Other Work Experience
University A	**Bethany**	27 Female	• Integrated neurological clinic • Outpatient orthopedics (6 wks)	• Hospital/rehab volunteer • MDA camp volunteer • Outpatient orthopedics aide (1 yr)	• Restaurant service • Research assistant • Peer advisor
	Mason	27 Male	• Integrated neurological clinic • Outpatient orthopedics (6 wks)	• Outpatient orthopedics aide (6 years, 2 clinics)	• Food service • Retail
	Kelly	25 Female	• Integrated neurological clinic • Outpatient orthopedics (6 wks)	• Outpatient orthopedics volunteer • Volunteer at Rehab Hospital	• Water polo coach
	Chloe	29 Female	• Integrated neurological clinic • Inpatient hospital (6 wks)	• Outpatient orthopedics aide (4.5 years)	• Interior design • Gym coordinator • Organic orchard
University B	**Peter**	27 Male	• Outpatient orthopedics & neurology (12 wks) • Stroke boot camp (2 wks) • Outpatient orthopedics (2 wks)	• Outpatient orthopedics aide (2 yrs, 2 clinics)	• Customer service • Food service • Basketball coach
	Lisa	26 Female	• VA outpatient orthopedics (8 wks) • Outpatient orthopedics (private clinic) (8 wks) • Inpatient rehabilitation (2 wks) • Pediatrics (2wks)	• Observation: orthopedics and pediatrics • Volunteer at inpatient hospital	• Corporate sales • Nanny/babysitting • Gym front desk • Event hostessing
	Sophia	24 Female	• VA outpatient orthopedics (8 wks) • Private outpatient orthopedics (8 wks) • Outpatient orthopedics (2 wks) • Outpatient orthopedics & vestibular (2 wks)	• Hospital volunteer: inpatient rehabilitation and skilled nursing • Acute care volunteer • Outpatient orthopedics aide	• Dorm residence Assistant (RA) • Food service • Event hostessing
	Hannah	24 Female	• Hospital based outpatient orthopedics (12 weeks) • Pediatrics (2 wks) • Outpatient orthopedics (2wks)	• Outpatient orthopedics (private clinic) • Hospital based outpatient orthopedics	• Kitchen work • Server/hostess in food service • Hair and make-up work

Table 3: Hypotheses [24]

Code	Description and Subcodes
Impairment (body function)	Physiological or biomechanical function (i.e.: ROM, Strength, Sensation, Pain)
	Subcode: Pain Irritability Level (Assessing how irritable the pain level is, Factors that affect the pain)
Pathology/ Medical Diagnosis	Tissue healing processes, pain mechanisms (inflammation etc.), using medical terminology (i.e.: tendonitis, muscle strain, arthritis, joint sprain etc.)
	Subcode: Phase of Healing (acute, chronic)
Participation ability/restriction	Abilities or limitations in involvement with life situations/activities
Examination Planning*	Generating an idea for further examination
Precautions Contraindications to PT	Activities, tests or interventions to avoid or proceed with caution
Contributing Factors	Identifying factors that contribute to the development and continuation of the problem
Prognosis	Making a prediction about expected functional outcomes or expected response to treatment
Unsure*	Participant indicates he/she is unsure about what is going on for the patient, or may make a hypothesis but indicates uncertainty about that idea
Patient Perspective/ Impact of Pathology	Hypothesizing about how the pathology is affecting the patient's life experience, Commenting on impacts on patient activities (i.e.: comment on pain interfering with occupation, or impairments limiting ability to play with kids etc.), also any comment about how the patient might feel/think about the situation
Structure	Body structure or tissue source, anatomical structure
PT Success*	PT states findings confirm what he/she was thinking, or PT is please with self that he/she is making progress in the dx
Patient Characteristics*	Assessment of the patient's interactive style/ personality, assessing patient's likelihood of compliance/follow through
	Subcode: Movement Characteristics (patient movement behaviors or patterns)
Management and Treatment	Developing ideas for management
Activity ability/ restriction	Abilities or difficulties in executing activities (ICF)
Ruling Out*	Determining the structure, pathology or activity is not the problem
Measure of Progress*	Data is used to assess progress or change

* Not part of Jones' et al. original list

Table 4: Reasoning strategies [28]

Code	Description and Subcodes
Ethical Reasoning	Considering dilemmas that impinge on treatment and assessing the best action
Interactive Reasoning	Establishing and maintaining the patient-practitioner relationship
Reasoning about Teaching	Determining content and approach to patient education and assessing outcomes of education, rationale for teaching/explaining to patient
Reasoning about Patient Personal Needs*	Considering what the specific patient may want/ need
Reasoning about Procedures	Determining and carrying out the appropriate interventions
Reasoning about Goal Setting*	Developing ideas for treatment goals
Organizing/ Planning Examination*	Organizing thoughts for the next set of tests to conduct
Managing Uncertainty*	Trying to make sense of unclear findings
Predictive Reasoning	Envisioning and evaluating future scenarios and the role of patient and PT choices
Collaborative Reasoning	Building a consensual approach towards goal setting and treatment planning
Protocol*	Attempting to follow instructions from class or evaluation sheets from clinic
Narrative Reasoning	Seeking to understand the patient's understanding of his/her condition
Diagnostic Reasoning	Determining the active pathology, impairments, functional limitations, and contributing factors
	Subcodes: Diagnosis of Causal Factors, Diagnosis of Precautions/ Contraindications, Diagnosis of Movement Impairments, Diagnosis of Primary Pathology, Diagnosis of Functional/ Activity Impacts, Diagnosis of Severity

* Not part of Edwards original list

Table 5: Examples of hypotheses

Code	Examples Quotations
Structure	Just furthering if I'm really in or out of SI and so she did have aggravation with compression and alleviation with distraction so that's leading me a little bit more towards SI. (Sophia) It supported my hypothesis that it was, the pain was coming from her muscle because the fact that she was tender and she said that was the pain that she was complaining of. (Peter) I was thinking maybe SIJ or maybe facet. (Chloe)
Impairment (body function)	So that's sort of a modified Thomas test that I picked up in the clinic and it's not going to give you a number, but it's going to give you an idea if there is some tightness. And she was tight through the front of her hip. At least on that left side, and was getting a little bit of pain, and it was really easy to feel that if I got to that end, she was immediately going into some lumbar extension. So it was pretty quickly pushing her in, causing that kind of excessive lordosis. That psoas and rectus, both of them. (Lisa)
	Pain: "Just to have a, like I said from a 0% to a 100%. 0% would be a 1/10 and a 100% pain would be an 8/10 and so if she gets into a 4, that's already halfway through her tolerance. Just to see her tolerance and to see it's irritability." (Bethany)
Contributing Factors	"She was really tight. She was very tight uhm, I had, for somebody that tight anytime you bend would be strenuous if you don't have that give through your hips" (Hannah)
Pathology/ Medical Diagnosis	"The mechanism of injury, the trauma, it was a fall, it was two weeks ago, there were no x-rays, I have to rule out fracture if and I think I put that on my hypothesis list if there was a fracture or a possibly a small fracture to the pelvis." (Mason)
	Phase of Healing: "It's probably – it's furthering my idea that this is an inflammatory response so that's where a lot of this pain was coming from." (Sophia)
Ruling Out*	"Well, achiness didn't really, it drove me away from thinking nerve because a nerve I would think that would be more described as a numbness or tingling or radiating" (Peter)
Patient Characteristics*	"See where she is at with that, sometimes they're not taking medications because they are in denial that there's an issue or maybe she's not taking medication because it's not as severe as you know, if she did need to take medication. It seemed like I didn't get the sense she was in denial of it. It felt more of it wasn't as severe as it needed to be." (Sophia)
	Movement characteristics: "So I wanted to see how willing she was to move for one thing. Not very willing to move. Very cautious with bending forward, which is always an interesting thing with somebody who says they are crouching things to pick up pots and pans from underneath." (Lisa)

Table 6: Code co-occurrences of hypothesis codes

	Ruling Out	Contributing Factors	Activity ability/ restriction	Impairment (body function)	Pathology/ Medical Diagnosis	Structure
Ruling Out		3	1	10	9	22
Contributing Factors	3		9	18	6	8
Activity ability/ restriction	1	9				1
Impairment (body function)	10	18			6	7
Pathology/ Medical Diagnosis	9	6		6		16
Structure	22	8	1	7	16	

Table 7: Reasoning strategies examples (Most commonly employed strategies)

Strategy	**Example**
Diagnosis of Primary Pathology	That can kind of tell if there is facet issue versus quadrant. So facet versus maybe nerve. Just to kind of rule that out. And she had a lot of pain with it but teamed with flexion and the pain with extension it's still probably not, I mean the location of pain might be facet but it's like she has mixed everything (Kelly)
Diagnosis of Movement Impairments	So I was looking at Thomas test a little bit just sort of hip flexor length. So that's sort of a modified Thomas test that I picked up in the clinic and it's not going to give you a number, but it's going to give you an idea if there is some tightness. And she was tight through the front of her hip. At least on that left side, and was getting a little bit of pain, and it was really easy to feel that if I got to that end, she was immediately going into some lumbar extension. So it was pretty quickly pushing her in, causing that kind of excessive lordosis. (Lisa)
Reasoning about Procedures	You gotta know the aggs (aggravating factors) and eases you gotta know what makes it worse, what makes it better, if you don't then I kind of feel like the therapist is just blindly sort of guiding, that's how I guide my interventions, if I know that backward bending and forward bending make it worse, I wanna try to limit that as much as possible and if side bending and rotation don't really bring it on, I'll be a little less concerned about those positions or movements, or whatever it may be. (Mason)
Diagnosis of Causal Factors	Because posture can affect low back pain, again, those mechanics, bad posture could put strain on certain areas. (Peter)
Reasoning about Patient Personal Needs	Just to know where she is heading to and make sure we're on the same page. Obviously I want her to get better, I want to not have pain. I want her to know there are a million things we want patients to do, but we can only prioritize so much. I know she wants to get back to work without pain and then go back to hiking. Just no pain, able to go hiking, and increase productivity since her back pain, her work productivity decreased, so just three goals. (Bethany)

Figure 1: Most common hypotheses generated by participants

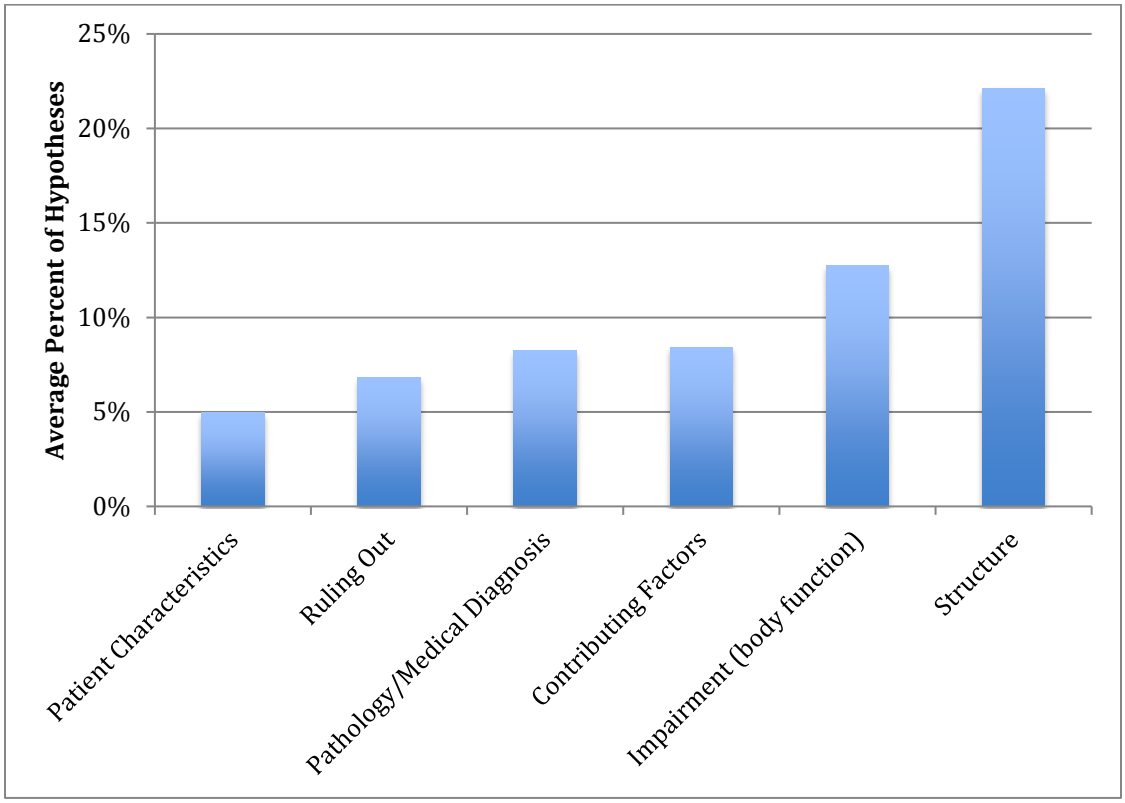


Figure 2: Reasoning strategies employed

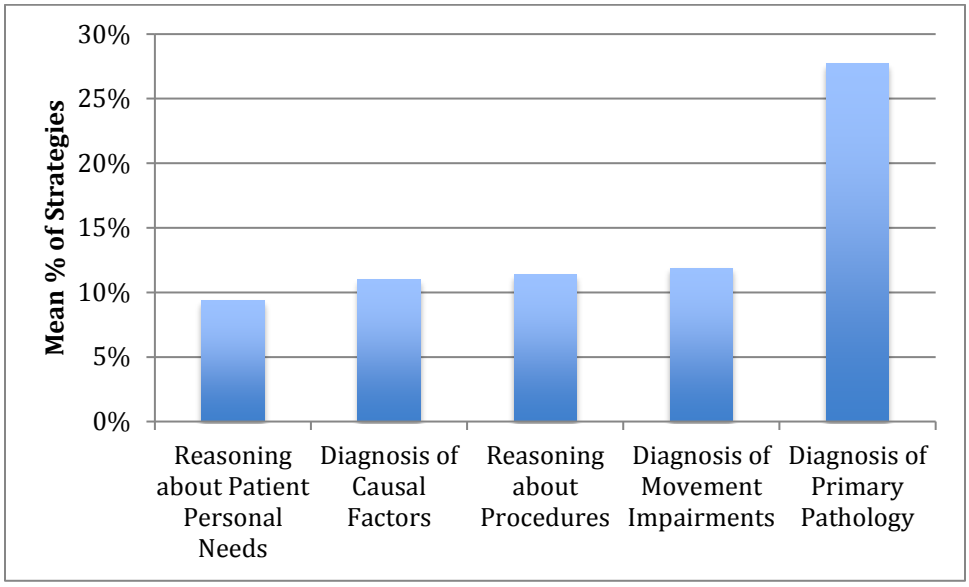


Figure 3: Reasoning patterns

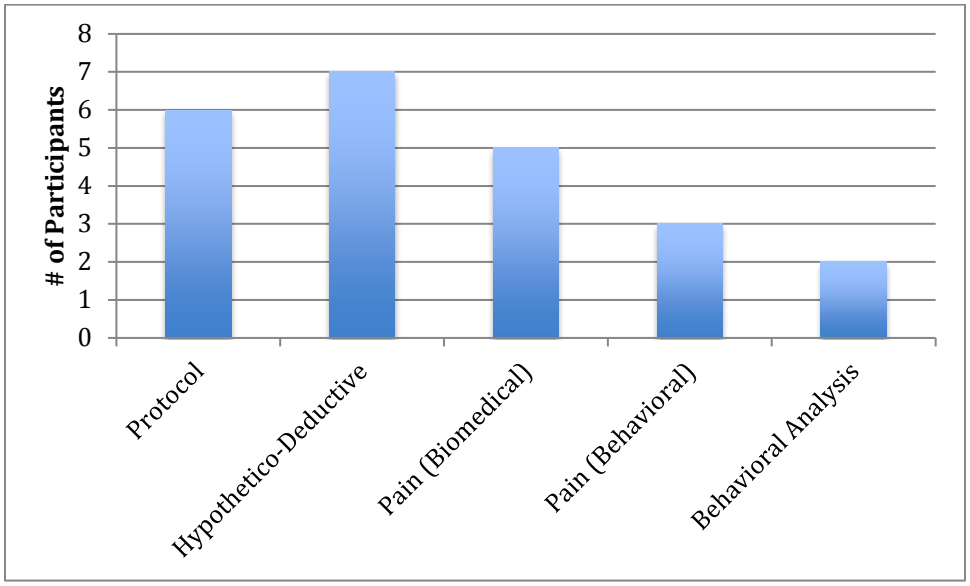
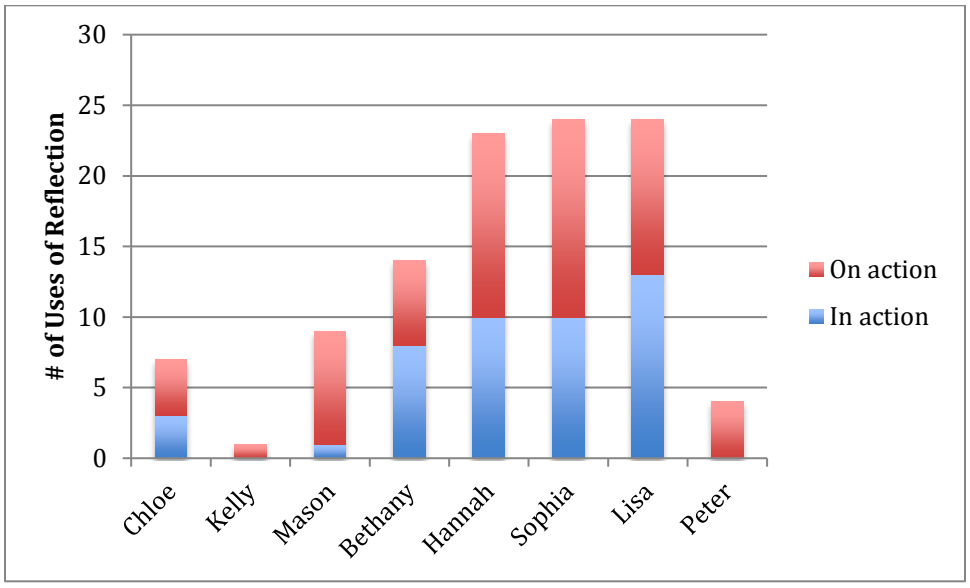


Figure 4: Participants' use of reflection



Appendix 1: Standardized Patient Encounter Instructions to Participant

1. The Patient Encounter
    a. You will receive the referral information for your new patient. You may have up to 5 minutes to plan your examination. You may write yourself notes as you want.
    b. You will conduct your physical therapy interview and examination as if you were conducting your initial evaluation of the patient in the clinic. Throughout the process, you may write any notes that you need to, as you would in the clinic.
    c. When you have completed the examination and assessment, you should move into the first treatment intervention, just as you would in the clinic.
    d. After you begin the treatment, the researcher will instruct you to proceed to the conclusion of the session.
    e. Use the final 5 minutes to wrap up the session as you would in the clinic.
    f. If you have not initiated treatment 35 minutes into the session, the researcher will instruct you to conclude your examination and proceed to treatment.
    g. Throughout the process you should speak to the patient as you would in the clinic. Do not address the camera or researcher.

2. Interview
    a. After you have completed the patient session, the researcher will interview you about your work with the patient.
    b. Part of the interview will focus on explaining your thought process during the patient encounter.

3. Referral information (provided to participant prior to encounter)
    a. MD referral: Low Back Pain, evaluate and treat
    b. Vitals (taken by PTA): BP: 135/85, HR: 75
    c. Insurance information: approved for 10 visits.
        i. Copay for initial visit is $75
        ii. Copay for follow up visits is $60 each

Appendix 2: Interview Questions for Post Encounter Interview

Interview Guide Development: A key aim of this study was to extend the work of Jensen et al[31] and Wainwright et al[51] to examine the clinical reasoning and use of reflection in PT students, thus the interview process probed for similar elements of their clinical reasoning processes. Jensen's work[30,31] set the stage and laid the foundation for the study of expertise and clinical reasoning in physical therapy. Wainwright et al further built our understanding of how PT clinicians think by bringing greater attention to the role of reflection. Thus the interview methods used in these studies provides a foundation for the study of clinical reasoning in PT students. The work of Sandholtz[77] brings attention to an additional factor in professional development regarding what the student views as effective and ineffective practice.

1. Prior to patient encounter: What is your goal for this patient session? What do you hope to accomplish? (prompting: what would be an ideal outcome?)

2. Prior to video review: What were your first thoughts when you first started to work with the patient?

3. Session/Video Review: Prompted by researcher's notes from patient encounter and review of the video:
    a. What are you thinking here?
    b. Why did you ask __ (or why did you do ____) here?
    c. What did you make of the response/finding?
    d. How did this information help you?

4. How did you arrive at your assessment [31]?

5. Describe your approach to treatment for this patient?[31]

    a. What is the highest priority?

    b. Explain what all you would have done during this first session with the patient.

    c. Explain what you would do on ensuing sessions.

    d. What do you think will be most challenging?

6. How would you know if you have been effective in your treatment?[31]

7. What experiences most influenced your work with this patient?[51]

a. Probing: what experience in PT school? What experiences with PT prior to PT school? What clinical experiences in PT school? What other life experiences? What types of mentoring?

8. If you could do this encounter over again:[77]
    a. What would you do the same?

    b. What would you do differently?

9. Basic Demographic Questions
    a. What practice areas of physical therapy are you most interested in?
    b. What clinical experiences (if any) do you have in physical therapy?
        i. Volunteer experiences?
        ii. Aide experiences?
        iii. Short term clinical experiences? (integrated? If so, what format)
        iv. Long term clinical experiences?
    c. What work experience do you have besides physical therapy (if any)?
    d. What is your age?