

Diagnostic Reasoning by Experienced Speech-Language Pathologists and Student Clinicians

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Clinical reasoning, or problem-solving, has been described as “the often intangible, rarely explicated thought processes that lead to the clinical decisions” that clinicians make

on a daily basis while caring for patients (McAllister & Rose, 2000, p. 205). In many health care-related disciplines, extensive research has been conducted in the area of clinical reasoning to determine how

ABSTRACT: Purpose: Clinical reasoning, or problem solving, has been described as “the often intangible, rarely explicated thought processes that lead to the clinical decisions” that clinicians make on a daily basis while caring for patients (McAllister & Rose, 2000, p. 205). In many health care-related disciplines, extensive research has been conducted in the area of clinical reasoning and how clinicians come to make the clinical decisions they do. In speech-language pathology, there has been extremely limited research in the area of clinical reasoning. The present study explored the diagnostic clinical reasoning used by experienced speech-language pathologists as well as by student clinicians for the purpose of understanding and comparing the patterns of each.

Method: This qualitative study made use of the “think-aloud” (TA) method of data collection to gain insights into the thought processes of 15 experienced clinicians with at least 5 years of clinical experience and 15 speech-language pathology graduate student clinicians. Each participant was given 2 abbreviated

fictional case studies—1 adult and 1 child. The TA responses were recorded and transcribed for later analysis.

Results: Results suggested that student clinicians and experienced clinicians shared many thinking processes; however, experienced clinicians were more likely than student clinicians to engage in planning specific assessment hierarchies, developing contingency plans for the assessment process, and making connections between the assessment process and treatment planning.

Conclusion: With greater understanding of how experienced clinicians approach diagnostic clinical reasoning, we are better prepared to develop evidence-based educational approaches to teaching graduate students how to develop effective and efficient diagnostic clinical reasoning skills.

KEY WORDS: diagnostic reasoning, clinical reasoning, evidence-based education, speech-language pathology, scholarship of teaching and learning

expert clinicians come to make the clinical decisions they do. For example, in the field of medicine, clinical reasoning has been a focus of research for the past 50 years (Norman, 2000, 2005; Van der Vleuten & Newble, 1995), whereas in the fields of physical therapy and occupational therapy, such research has been more recent, with many studies being published in the past 20 years (Edwards, Jones, Carr, Braunack-Mayer, & Jensen, 2004; Mattingly, 1991).

The value of understanding how clinicians make decisions related to patient care, including the diagnosis of disorders, is critical for both patients and educators. Clinical reasoning associated with patient assessment is important to patients in terms of their care and outcomes (Norman, 2005; Wainwright & McGinnis, 2009). Clinicians who are ineffective or incompetent in their completion of a clinical assessment put patients at risk for disorganized evaluations, misdiagnosis, and inappropriate treatment plans. Thus, effective and efficient patient care depends on effective and efficient assessment.

Insights into diagnostic clinical reasoning are also associated with the preparation of future clinicians (Dietz, Quach, Lund, & McKelvey, 2012; Hoben, Varley, & Cox, 2007; McAllister & Rose, 2000). Research regarding diagnostic clinical reasoning has been used in a variety of health professions to develop more effective pedagogy for preparing future clinicians (Ark, Brooks, & Eva, 2007; Banning, 2008b; Eva 2004). If we do not adequately understand the process by which master clinicians come to the diagnostic decision process, it would seem that we would be less likely to effectually teach students how to think about the assessment process appropriately, and thus we are adding unnecessary time and effort to the already steep learning curve that student clinicians in health care-related fields experience.

Clinical and Diagnostic Reasoning

It is generally agreed that the clinical reasoning of experienced clinicians is based on an interaction between an individual's domain-specific knowledge, experience that is often contextually based, and intuition (Banning, 2008a, 2008b; Forsberg, Ziegert, Hult, & Fors, 2014; Fowler, 1997; Simmons, Lanuza, Fonteyn, Hicks, & Holm, 2003). Specific domain knowledge is gained through a combination of formal education in the classroom, clinical experiences such as internships, and real-life experiences in a variety of work settings. Banning (2008a) defined intuition as knowing something by "hunch" or "gut feeling" or the immediate knowing of something without the conscious use of reason" (p. 180). The variety of contexts in which learning happens contributes to the overall experience

that experienced clinicians have and enriches their knowledge base. One specific form of clinical reasoning is *diagnostic reasoning*, which may be defined as "trying to identify the problem accurately" in a patient or client (Harjai & Tiwari, 2009, p. 305).

In the field of speech-language pathology, there has been very limited research in both the broad area of clinical reasoning and, specifically, in diagnostic reasoning. McAllister and Rose (2000) noted that when caring for patients with possible communication disorders, "the processes involved in clinical reasoning in our profession have been poorly researched and are little understood within the profession" (p. 205). A recent search of the PubMed and CINAHL databases yielded fewer than 12 studies in the intervening 15 years that examined the clinical reasoning of speech-language pathologists (SLPs) in general, and only one looked at the evaluation of patients from a broad perspective (Hoben et al., 2007).

Prototypes

Literature from the field of medicine, including literature about both nurses and physicians, can be instrumental in helping us understand the differences in the diagnostic reasoning between experienced clinicians and novices (Harjai & Tiwari, 2009). These studies have resulted in an information theory-based conceptualization of how experienced clinicians approach diagnostic reasoning (Simmons et al., 2003). The combination of domain-specific knowledge and experience, along with intuition and context, allows clinicians to develop a prototype database (Arocha & Patel, 1995; Banning, 2008a; Forsberg et al., 2014; Harjai & Tiwari, 2009; Patel, Glaser, & Arocha, 2000). A prototype, or a prototypical database, "is an abstract, central, mental model for a concept, a set of characteristics associated with the image of a particular concept in the mind of the owner" (Harjai & Tiwari, 2009, p. 306).

Experienced clinicians have prototypes that are based on extensive domain-specific knowledge as well as experience with real patients; therefore, their prototypes are typically complex (Arocha & Patel, 1995; Forsberg et al., 2014; Wainwright & McGinnis, 2009). This experience with actual patients enables clinicians to develop a holistic view of the patient and the setting in which they are assessing him or her (Harjai & Tiwari, 2009). Their prototypes may also represent the "messy" patient who was not straightforward and obvious in his or her diagnosis (Arocha & Patel, 1995). During the assessment process, experienced clinicians may rely on "professional memory" to connect the person they are trying to evaluate to those they have seen in the past (Arocha & Patel, 1995; Forsberg et

al., 2014, p. 4). The resulting knowledge bases are organized hierarchically and can quickly filter out irrelevant information (Patel et al., 2000).

Student clinicians, in contrast, have limited prototypes due to a lack of extensive domain-specific knowledge bases. Because their formal education may not yet be complete and they have seen relatively few real patients, their prototypes tend to be classic cases and resemble the textbook examples of conditions (Arocha & Patel, 1995; Patel et al., 2000). Because new or student clinicians have limited experiences in various clinical settings, their prototypes are also not fully realized relative to context. Thus, the prototype databases of student clinicians are generally limited in depth and applicability.

Schemas

Studies of nurses and physicians have demonstrated that strong prototypes can lead to the development of schemas or mental models for assessing patients. These models are flexible and allow clinicians to integrate new information into their understanding of the person they are assessing (Patel et al., 2000). Flexible and informed schemas allow clinicians to be focused in their evaluations, adapting to variations of patient presentations that they have seen before, such that they are able to conduct their evaluations in a well-organized, efficient manner (Forsberg et al., 2014; Patel et al., 2000). Because of their focus, clinicians are likely to be able to diagnose the person before them quickly and efficiently.

The schemas used by new clinicians tend to be less efficient. As a result of their limited prototypes, student clinicians are likely to conduct an assessment that is either too broad or too specific, which may result in diagnostic errors (Patel et al., 2000). Because they lack real-world clinical experience, student clinicians may have a limited understanding of the expected outcome of an evaluation and therefore are not strategic in their planning or consideration of the evaluation process (Hoben et al., 2007; Patel et al., 2000). Limited prototypes and underdeveloped schemas are likely to result in evaluations that do not discern between relevant and irrelevant information regarding the patient (Hoben et al., 2007). As a result of limited schemas, patients being assessed by student clinicians may have to endure lengthy, inefficient evaluations that may not result in an accurate diagnosis.

Heuristics

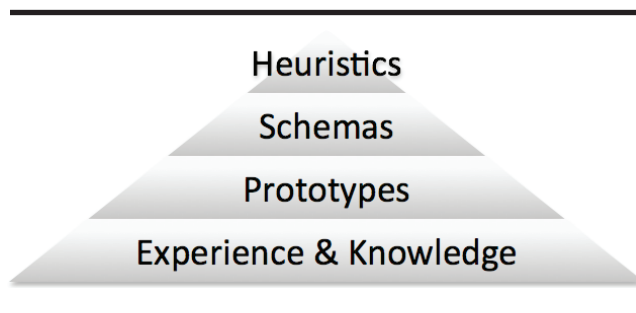
When completing an evaluation of a patient, based on their prototypes and ensuing schema, experienced clinicians are likely to use heuristics, or thinking

strategies, that will help them identify the difficulties that a patient presents with (Fisher & Fonteyn, 1995). Numerous studies of experienced nurses and physicians have resulted in a number of different lists of heuristics that clinicians might use during clinical reasoning tasks (Aitken, Marshall, Elliott, & McKinley, 2011; Fisher & Fonteyn, 1995; Fowler, 1997; Simmons et al., 2003). Which set of heuristics is most applicable depends on the task a clinician is being asked to conduct and in what context they are being asked to conduct it. Heuristics commonly noted in previous studies include recognizing patterns, seeking clarification or more information, and providing rationale (Aitken et al., 2011; Fowler, 1997; Simmons et al., 2003).

Experienced clinicians demonstrate heuristics that are clearly linked to their prototypes and schemas. Their knowledge base and experiences allow them to recognize patterns that they have seen before and to reason about the diagnosis of the current patient (Fisher & Fonteyn, 1995; Harjai & Tiwari, 2009). They form hypotheses quickly and anticipate the resulting outcomes of the evaluation (Forsberg et al., 2014; Patel et al., 2000; Wainwright & McGinnis, 2009). Studies have demonstrated that experienced clinicians often use several heuristics concomitantly such that the process of assessing and planning for treatment occurs synchronously (Banning, 2008b; Simmons et al., 2003). Figure 1 is a conceptual representation of the foundational development of experienced clinicians' model of hierarchy of thinking.

Although the studies discussed so far have examined the heuristics used by nurses and physicians who have been practicing for an extended period of time, few of them have examined the use of heuristics in novice or student clinicians. One study that did examine the thinking process of student clinicians was a study of speech-language pathology students by Hoben et al. (2007). This study examined pairs of undergraduate and graduate students who were conducting an assessment of a virtual patient within an electronic database. Data captured the students'

Figure 1. Experienced clinicians' hierarchy of thinking.



activities and comments in reviewing patient information on screen during the assessment process. Results suggested that students not only had a difficult time planning a diagnostic strategy, but they also had difficulty in organizing the information that they were using in their decision making. Although the study did include one pair of experienced clinicians in the data collection process, a comparison of student thinking to clinician thinking was limited. Furthermore, the study did not develop a specific list of heuristics that the students demonstrated, but rather noted the depth of their thinking (Hoben et al., 2007).

In order to develop an understanding of the best way to teach the diagnostic clinical reasoning process, we must learn more about how experienced and student clinicians in speech-language pathology differ in their approaches to diagnostic clinical reasoning. Although SLPs can learn from research in related health care disciplines, the clinical challenges of each field differ, and we are therefore left to extrapolate lessons learned from their research to be applied to our field.

Thus, the purpose of the present study was to explore the diagnostic reasoning used by experienced SLPs and the diagnostic reasoning used by student clinicians for the purpose of understanding the differences and similarities between the two groups. Learning how experienced clinicians problem-solve and then comparing that to how student clinicians approach the same task will allow us to develop insights into how to facilitate the development of student clinicians and provide more powerful pedagogical approaches to teaching patient assessment to our novice and student clinicians.

We asked the following research questions:

- What clinical reasoning thought processes do experienced SLPs use to determine the procedures by which they will plan an assessment of clients with possible communication disorders?
- What clinical reasoning thought processes do inexperienced students in speech-language pathology use to determine the procedures by which they will plan an assessment of clients with possible communication disorders?
- When the clinical reasoning of experienced clinicians is compared to that of students, what are the significant differences? Are there significant similarities?

METHOD

This qualitative study made use of the “think-aloud” (TA) method of data collection to gain insights into

the thought processes of experienced clinicians and student clinicians. These types of studies are often referred to as *expert–novice* studies because the thinking processes of a novice in a discipline are compared to the thinking processes of someone with a higher level of experience in the discipline (Bernstein, 2010). The TA method (Ericsson & Simon, 1993; Wineburg, 1991) is a validated method of learning about cognitive processes by having participants verbalize their thinking as a complex cognitive process, such as clinical problem-solving, is occurring.

TA studies were popularized for expert–novice process comparisons by Wineburg (1991), who examined the differences between how academic historians process information while reading historical texts and how students process information while reading historical texts. Since then, TA studies have been used to examine how the thinking of novice practitioners compares to that of experienced practitioners in a wide variety of disciplines, including the health sciences, mathematics, and political science (Banning, 2008a; Bernstein, 2010; Forsberg et al., 2014; Wainwright & McGinnis, 2009).

Data Collection

Graduate students enrolled in speech-language pathology programs at two Midwestern universities and experienced clinicians from three Midwestern states were offered an opportunity to participate in the study, which had been granted university human subjects’ review board approval. Student clinicians were graduate students who had completed no more than two semesters of on-campus, university clinical experience, and had not completed an externship. Student participants were offered the opportunity to take part in the study during classes or student meetings that were not conducted by the investigators.

Fifteen graduate students in speech-language pathology participated in the study. The students ranged in age from 22 to 37 years old and were all female. Experienced clinicians, all of whom had held their national certification in the form of a Certificate in Clinical Competence in Speech-Language Pathology (CCC-SLP; American Speech-Language-Hearing Association, 2013) for at least 5 years, were recruited via e-mail from local communities adjacent to three universities. The group of experienced clinicians consenting to participate in this study consisted of 15 clinicians (14 female, one male). They ranged in age from 29 to 57 years old and had between 5 and 35 years of clinical experience. The experienced clinicians in the study were balanced in their familiarity with pediatric and adult clients.

All of the participants in the study met separately with one investigator to collect data for the study. In their session with the investigator, each participant was given two abbreviated fictional case studies that were based on lengthier case study texts (Hale & Evans, 2011; Sands, 2011) (see the Appendix) The brief case studies described two individuals—one adult and one child—who were experiencing possible communication disorders. The participants were asked to read each brief case history and then to develop an assessment plan for each client. Half of the participants were presented with the adult case first, the other half with the child case first. Their TA responses were audio recorded and transcribed for later analysis. Each investigator participated in data collection, with ongoing analysis of data indicating that saturation had been achieved with the participation of 15 experienced clinicians and 15 graduate students (Bogden & Biklen, 2006; Thomson, 2011). Thus, a total of 30 participants were recruited for and completed this study.

As per the TA method, the investigator prompted the participants to articulate their assessment plan along with an associated rationale for each case study they were presented with. If a participant failed to articulate his or her thinking at any time during the one-on-one interaction, they were prompted by the investigator to provide additional details to explain their thinking (Bernstein, 2010; Fisher & Fonteyn, 1995; Hoffman, Aitken, & Duffield, 2009). In making requests for additional information, the investigator provided no additional information for the participants and only prompted them with neutral subprompts such as “tell me more” to gather greater detail about the participant’s thinking.

Data Analysis

All of the data were initially coded and analyzed by the first investigator. Data analysis moved forward to include the second and third authors using a protocol that is commonly associated with grounded theory research (Creswell, 2002; Denzin & Lincoln, 2012). In adhering to this protocol, the verbatim text of each transcript was read as a whole to determine initial emerging codes and overall impressions. Using an inductive approach to identify specific thought processes associated with the participants’ choices of assessment techniques, we developed a code book with specific codes, descriptions, and examples. The code book, along with randomly selected transcripts collected by all three authors, was then shared with the second author, who independently read the transcripts for analysis and coding. A consensus-building process was used to discuss corroborated coding and

verify validity. Differences between the authors were discussed until agreement was reached (Hoben et al., 2007). Following initial coding and author agreement, the first author reviewed all of the individual interviews to identify overall emerging themes in secondary, axial coding and development of themes. Emerging themes, comparisons of the two groups of participants, and comparisons of themes to those found in the literature were discussed and agreed on by all of the authors.

RESULTS

Analysis of content was coded for the type of thinking strategy (heuristic) used or the focus of the participants’ diagnostic reasoning. A total of 10 themes that reflected the strategies and orientation of diagnostic planning for the participants were developed. All of the themes were present to some extent for both the experienced clinicians and the student clinicians. These themes are presented and defined in Table 1.

Both experienced clinicians and student clinicians engaged in hypothesizing. By *hypothesizing*, participants shaped their planning by stating what they thought the behaviors or symptoms represented. Hypothesizing was occasionally combined with *summarizing*, such as noting that “it says that he has good phonetic awareness, so I’m going to look at motor for [his] speech” or “She is probably not going to be a functional communicator would be my guess.” Although hypothesizing suggested the participant’s best guess as to what was likely a diagnosis or problem area for the client, its use was relatively infrequent during the TA for both groups.

Rationalizing, the process of explaining why an action would be taken, was common to both groups of participants. The clinicians explained reasons that they would choose a particular test or why they would complete items in a particular sequence. The rationalizing addressed the reasoning behind the action, such as, “I would sit down and do a little play with him...see how comfortable he is talking to me.” A student clinician noted that she would perform a task in order to “just get a baseline of where she is with her verbal output.”

Seeking outside input was a strategy demonstrated by all of the participants. In both the adult and pediatric cases, comments made by the participants indicated that more input from family members and/or professionals would be helpful in understanding the concerns. One student clinician noted that for the adult case, it would be helpful to “ask family members what they notice about her understanding at home.” Additional input was often sought from

Table 1. Themes with definitions that reflect the strategies and orientation of diagnostic planning for the study participants.

<i>Theme</i>	<i>Definition</i>
Hypothesizing	Specifying thoughts as to what the symptoms likely indicate or what the diagnosis is.
Summarizing	Verbalizing a review and summation of information from the case study.
Rationalizing	Providing an explanation as to why they would conduct an assessment or take an action.
Seeking outside input	Indicating that they would seek further detail about history or symptoms or would consult other disciplines to get more information.
Differentiating	Describing possible interpretations of presentation or indicating differential diagnosis options.
Deferring	Commenting on a lack of knowledge or experience relative to the case study.
Comparing	Making a comparison of the client in the case to some other form of knowledge or experience (prototype).
Specific planning	Describing plans in specific detail, including prioritizing, sequencing, alternatives, and expected outcomes of assessment activities.
General planning	Verbalizing broad strokes of evaluation strategy without inclusion of specific details.
Treatment planning	Stating connections between the assessment and potential treatment options.

professionals in other disciplines, including teachers, audiologists, and physicians.

Both groups of clinicians engaged in frequent differentiating for both the child and adult case. *Differentiating* was represented by the process of indicating that they thought one diagnosis or deficit area was unlikely, but that they would test the skill to “rule out” that it was not an issue. Common examples of this were references to the probable articulation or phonological disorder for the child. However, many clinicians, both students and experienced, noted that they “always check on language as well” in order to

“cover all bases.” With the adult who had a history of dysphagia, many participants stated that although the dysphagia appeared to be resolved, they would conduct a screening “just to be sure that everything is good.”

Deferring commentary was heard from a number of participants in reference to their limited knowledge about a client. For experienced clinicians, these comments often referenced that they had not seen the type of client or the age group described in the case study for many years, such as declaring “I’m drawing a blank.... I am trying to think back to when I worked in rehab. That was 20 years ago.” For student clinicians, comments described limited clinical experience or a need to learn about the type of disorder depicted in the case study. When given the adult case study after the pediatric case, a student clinician indicated that “this one I am a lot more hesitant with because I am learning about this kind of stuff now, but have not completed course work.”

Student clinicians and experienced clinicians differed in their use of the themes of comparing, specific planning, general planning, and treatment planning. *Comparing* appeared more often in TA data from experienced clinicians than from student clinicians. Experienced clinicians typically made comparisons to large patient populations that they had worked with or to clinical settings that they had worked in. In planning the evaluation for the adult case, an experienced SLP noted that “for anyone that is here [in her work setting] with a history of a stroke, I would do a language evaluation.” As student clinicians did not have an extensive practice base to make comparisons, they made very limited comparisons in their TA processes. They occasionally attempted to compare the client in the case history to their limited experience with clients, saying “It sounds exactly like my case that I had from clinic.” In the absence of experience, one student clinician noted that she would “want to look at some of the research” to compare the patient’s difficulty with evidence-based treatment approaches in order to augment her knowledge.

There was a marked difference between the *specific planning* completed by the experienced clinicians and that completed by the student clinicians. Specific planning details that were outlined by experienced clinicians included items such as specific test names, informal assessment methodology, prioritizing tasks, and contingency planning in the event that the client was unable to complete the given assessment. The diagnostic plans articulated by this group were often highly detailed, even for the cases that the experienced clinicians made deferring comments for. The plans were focused in nature and were designed to differentially diagnosis the client’s communication

disorder efficiently. Experienced clinicians frequently prioritized as part of their specific planning, indicating what they would do first and what their biggest concerns were. One experienced clinician typified this type of detail for both implementation of a standardized test, informal measures, hierarchies, and contingency planning in his diagnostic plan. He commented on what he would do if the patient were unable to perform a test that he planned to administer to indicate his contingency planning.

So we would start with the Western Aphasia Battery, and if you truly want to know how I would give it, I would probably give it as complete as possible but yet not making her feel terrible that she is bombing it. If she is onto her comprehension and so forth, maybe the first half of the tasks she cannot complete well, I would say, "That's fine, that's fine enough. I understand." If she is doing really poorly, I would stop that part and try something else. I would try some verbal things of course.... I do a writing analysis to have them do the writing task for a little while, writing down letters and numbers, her name and address; see what they can do there, and then word dictation. If they do pretty well of that, then we go into a paragraph writing task where they write about the action picture. If they are bombing on their name, don't go much further than that.

Student data reflected that the student clinicians were much less likely to verbalize specific planning regarding either contingencies or hierarchies for their diagnostic approaches. They often defaulted to more *general planning*. Although the experienced clinician occasionally demonstrated general planning, the students were much more likely to describe general planning with little detail included. Here a student clinician articulated a general planning strategy, "an auditory comprehension assessment to see how the severity is on that...and since she has a problem with language, like syntax and using nouns and verbs, doing a language assessment too."

Specific planning by the student clinicians was typically limited to identifying specific test names and listing several informal assessment activities that they would ask the client to perform. Specific tests were often named, followed by a rationale that demonstrated limited exposure to standardized tests, reporting "so the Hodson Assessment of Phonological Patterns is the one that I have learned a lot about so, I would probably give that." Although the student clinicians' plans may have had some level of detail in terms of specific test and informal assessment, they were limited in their depth, being more broadly focused, as was demonstrated by a student clinician who was planning her assessment of the adult case, saying "so perhaps the Boston Diagnostic assessment for aphasia and I would do some non-standardized assessments, like a cognitive exam, looking at her attention, memory, visual-spatial."

The student clinicians were also less likely than the experienced clinicians to identify tasks within an assessment hierarchically. They might indicate that they would assess a number of aspects of speech, such as "diadochokinesis and vowel prolongation," but they would rarely identify varying levels of difficulty within one area of language to probe. Related to the inability to identify hierarchical assessment procedures, the students did not delineate a contingency plan for the client in the event that they were unable to complete the task because it was either too difficult or too easy.

There was a striking difference in how the experienced clinicians and the student clinicians incorporated *treatment planning* into their diagnostic approach. The experienced clinicians remarked on the value of an assessment in terms of helping them plan treatment. There was a direct link from a specific assessment task to its implication for treatment. In reference to the adult case, one clinician stated that "I would want to do some informal test to see if there is anything beneficial for her—repetition, does she need picture support, cues, and which ones benefit her the most—so that way I could help implement some kind of treatment for her." The student clinicians rarely commented on the connection between the assessment process and the treatment process that might follow.

DISCUSSION

This study compared the diagnostic planning and reasoning of experienced clinicians with those of student clinicians in speech-language pathology. The findings were consistent with much of the literature grounded in other health-related fields. Coding of verbal TA data resulted in the identification of 10 heuristics themes and focal areas for comment with both groups of clinicians (Simmons et al., 2003). The themes that arose from this data, including seeking outside input, rationalizing, hypothesizing, differentiating, summarizing, deferring, comparing, specific planning, general planning, and treatment planning, shared a great deal of overlap with heuristics suggested by studies of nursing clinical reasoning (Aitken et al., 2011; Fowler, 1997; Simmons et al., 2003). Despite the differences in the specific tasks and contexts that were set before the participants in the different studies, as well as the different clinical focus of nursing from speech-language pathology, the literature supports the credibility of these codes as indicative of clinical reasoning. Simmons et al.'s (2003) heuristics of "searching for information" in which additional information

is sought from families and professionals, “providing an explanation” in which rationalizing is shared, and “setting priorities” that were frequently seen as part of the participants’ specific planning are examples of the overlap between nursing findings and the findings presented here.

Prototype Findings

The literature suggests that the development of a mental prototype database aids experienced clinicians in assessing patients (Arocha & Patel, 1995; Banning, 2008a, 2008b; Forsberg et al., 2014; Harjai & Tiwari, 2009; Patel et al., 2000). Experienced clinicians in other studies relied on patient exemplars from their wide-ranging clinical experiences and contexts and not on a classic representation of a particular condition. The use of prototypes was demonstrated by our experienced clinicians, who often referred to their own database of prototypes and experiences that guided them in the process of planning an evaluation. Frequent references to work settings, to general patient populations, and to best practices suggest that experienced clinicians relied on a variety of experience-based prototypes to guide their clinical reasoning. In contrast, the student clinicians in these studies relied on the use of more classic exemplars, which were likely to match a textbook prototype. Probably due to a lack of experience and real-life patients, the student clinicians in our study did not verbalize accessing a prototype database because they have yet to form one. Instead, they made occasional references to knowledge grounded in textbooks or made comparisons to the one or two real patients that they had seen.

Schema Findings

The difference between experienced and student clinicians in the focus of the schema or planning an evaluation was also consistent with findings from medicine. Previous findings noted that experienced clinicians develop schemas that allow them to identify the less common conditions more efficiently and with greater focus because they possess a knowledge base that is interconnected and quickly accessible (Arocha & Patel, 1995; Fisher & Fonteyn, 1995; Forsberg et al., 2014; Patel et al., 2000). Experienced clinicians in this study demonstrated a more goal-oriented approach to their evaluation process by connecting assessment tasks with implications for treatment. As a result, they were able to develop a detailed plan for assessing a patient. Their approaches were focused on the purpose of the assessment, whether that was to determine a child’s ability to function in the classroom or an adult’s potential

to benefit from further treatment. Consistent with novice nurses and physicians, the student clinicians in this study were typically unable to move past broad general planning for the assessments that they would conduct. Their diagnostic plans were often all encompassing and called for generic assessments of receptive or expressive language without detail regarding particular tasks that patients would be asked to perform. The student clinicians did not draw connections between the evaluation process and subsequent treatment issues.

Heuristic Findings

Past literature is limited in the study of heuristics and novice or student clinicians compared to studies of experienced clinicians. Two studies of nurses and physicians developing the heuristic of hypothesizing found that there were differences between the experts and the novices (Arocha & Patel, 1995; Forsberg et al., 2014). These studies suggested that novices either form a hypothesis early without considering multiple options or generate a hypothesis and disregard any data that invalidate the hypothesis. Experts in those studies tended to wait until they moved beyond the initial phases of patient evaluations to start recognizing patterns in the patient that would allow them to generate several possible likely hypotheses.

In the present study, both groups of clinicians made relatively few hypotheses, possibly owing to the sparseness of the case study compared to real or virtual patients used in the studies from medicine. The heuristic of differentiating, which is related to hypothesizing, was used frequently by both groups in our study. Clinicians with and without experience often noted diagnoses that were more likely and less likely, indicating that they would test particular areas just to be confident that there were no hidden deficits that they failed to identify.

The experienced clinicians in the present study offered a great deal of specificity in their evaluation plans. Consistent with the literature, the experienced clinicians’ thinking demonstrated the use of specific planning of an evaluation for each case study, relying on pattern comparison and recognition (Harjai & Tiwari 2009; Patel et al., 2000). The experienced clinicians’ assessment plans held a greater level of detail than those of the student clinicians, including more hierarchical thinking (Patel et al., 2000) and more contingency planning. The experienced clinicians’ thinking processes demonstrated that assessment and treatment planning occurred concomitantly (Hoben et al., 2007; Simmons et al., 2003).

Experienced SLPs in this study often commented that information that they had learned as a result of a

particular assessment task would be useful in determining treatment approaches. Experienced clinicians planned evaluations that were specific and hierarchical (Patel et al., 2000). Rather than verbalizing that expressive language would be assessed, they listed the levels of assessment, such as noting that the probes for expressive language would include the word level, sentence level, and spontaneous speech. Contingency planning was revealed through scaffolding levels of difficulty in the tasks to make them easier or more difficult should the patient encounter difficulty in completing the activity or if it was too easy for them.

Student clinicians in this study engaged in less comparing than experienced clinicians, which was expected given their limited repertoire of prototypes. That they used more general planning than experienced clinicians and less specific planning should not be surprising, given both their limited clinical experience and their incomplete domain-specific knowledge. However, this study sheds light on the particular ways in which specific planning between the two groups differed. Although some student clinicians did engage in specific planning, such as identifying formal measures and specific aspects of speech or language to be assessed, few engaged in hierarchical thinking. More commonly, tasks were listed serially, demonstrating prioritization, indicating that they would first assess swallowing during a meal, followed by receptive language with yes/no questions, followed by expressive language assessment of a picture description. This is in contrast to experienced clinicians, who reported a plan that delineated hierarchies within one aspect of assessment. The student clinicians were not frequently observed to describe contingency plans in the event that a given evaluation tool was too easy or too difficult for the patient. Student clinicians were very unlikely to consider assessment tasks in light of the end goals for treatment, which is consistent with previous findings (Banning, 2008b; Hoben et al., 2007; Simmons et al., 2003). Comments regarding the implications of a patient's performance on how treatment would proceed were rare. For these student clinicians, the overall purpose of the evaluation, in large part to determine what to recommend regarding treatment for the patient, was not clearly connected to the evaluation process itself.

Implications for Teaching

Clinical and diagnostic reasoning processes need to be well understood in order for educators to tailor educational approaches to improve each discipline's process. Many educators in clinical fields, such as nursing, are relying on problem-based learning until

they develop a more evidence-based educational strategy (Fowler, 1997). We need to develop approaches to teaching that will foster the development of prototypes and schemas and the use of heuristics that are seen with experienced clinicians in speech-language pathology. Particular focus on classroom teaching on the implementation of hierarchies in the evaluation, along with contingency thinking for potential patient responses, may be very helpful in shaping novice thinking. Additionally, clear connections between what we learn about our patients during testing and the implications for treatment need to be highlighted for students.

One mechanism for improving diagnostic reasoning is to increase experience through the provision of clinical clock hours using in-house and community-based practica, as all programs in the country already do. However, there is undoubtedly more that we can be doing in the classroom to increase the development of clinical and diagnostic reasoning before students engage in clinic-based learning. In medicine, Patel et al. (2000) called for increased "authentic activity" such as "learning by doing," focus on procedural skills, more "apprenticeship learning" (guided with a mentor), collaborative learning, and case-based learning to increase exposure to a wider range of cases, contexts, and problems (p. 259).

Limitations

Our study is limited in that the data were collected based on a sparse case study presentation. This was done intentionally so as to replicate the incomplete amount of information that SLPs often receive in the process of having patients referred to us for evaluation in many settings. However, in order to make stronger comparisons to the work of our colleagues in health-related fields, it may be useful to extend this study to the use of virtual patients and real patients from a variety of settings. It would be of interest to see how student planning for an evaluation compares to the actual performance of an evaluation (Mavis, Lovell, & Ogle, 1998).

Conclusion

The results of this study provide us with evidence on which to base teaching and learning strategies for diagnostic reasoning in speech-language pathology. Although we can extrapolate learning about experienced and student clinicians from studies of nurses and physicians, it would be most beneficial if we could gain a greater understanding of the diagnostic reasoning process for SLPs in particular so as to be able to customize our pedagogy. Armed with a greater understanding of the difficulties that new clinicians face in

planning an assessment, we can focus our educational strategies more specifically to create opportunities for improving teaching and learning. It is our expectation that these results will inform our pedagogy and support an evidence-based approach to education (Ginsberg, Friberg, & Visconti, 2012). Adopting the methods of problem-based learning, increased reflection, and a focus on heuristics that include hierarchical thinking and treatment planning specifically for use in teaching diagnostic methods courses is evidence-based education that may increase our students' diagnostic efficacy.

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APPENDIX. CASE STUDIES

Pediatric Case Study: David (adapted from Hale & Evans, 2011)

David is a 6 year, 4 month old boy brought for a speech and language evaluation by his mother. Pregnancy and birth history for David are unremarkable. Medical history is significant for recurrent otitis media (middle-ear infection) three to four times per year, treated with antibiotics followed by placement of pressure equalization tubes at the age of 3. No further ear infections were noted following the tube placement. Developmental milestones were all met at expected ages. David has completed kindergarten and exceeded all academic standards, including phonetic awareness and conceptual knowledge of numbers and colors. He has a sight-word vocabulary of 50 words. His teacher reported that he was reticent in groups of peers and in volunteering to answer questions aloud in class. David’s mother reports that he has poor intelligibility, expressing specific concerns regarding the apparent discrepancy between his level of intelligence and his speech intelligibility. When asked why he thought he had been brought in for an evaluation, David indicated “Because my friends don’t understand me sometimes.”

Adult Case Study: Patricia (Sands, 2011)

Patricia is a 45-year-old woman referred by her physician for a speech and language evaluation. She is married with two children and has a high school education. Medical history is significant for smoking and high blood pressure. Two years ago, she developed some transient difficulties with her speech and a right facial droop; however, she did not seek medical attention at that time. An MRI has indicated a lesion in the left parietal area. Her speech and language has continued to deteriorate. She uses primarily automatic phrases with appropriate use of syntax and intonation, but without information words, mainly nouns and verbs, necessary to make her an effective communicator. In addition, she sometimes uses word substitutions that are either random or resemble the intended word. She is unable to understand verbal information unless given frequent visual cueing. She is able to understand some key words in the context of a conversation.