

“Our Hands Will Know”: The Development of Tactile Diagnostic Skill—Teaching, Learning, and Situated Cognition in a Physical Therapy Program

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Relying on observational and interview data from a clinical practice class in a graduate physical therapy program, I examine, within a situated cognition framework, the teaching and learning of a concept in biomechanics, the manual techniques and tactile discrimination skills that accompany it, and the diagnostic frame of mind that informs concept, technique, and skill. In examining this complex set of practices, I hope to add to and qualify the literature on working knowledge, participation and competence, and situated learning and pedagogy.

Jody and Martina were naturals for a program like this. Excellent students, they also had rich experience with physical performance and biomedicine. Martina was a volleyball player in college, majored in athletic training, and volunteered for over five years in a hospital acute care unit, assisting in physical therapy, helping patients become ambulatory, and the like. Jody majored in biology, was athletic, and volunteered for three years in a physical therapy clinic where she performed a number of tasks, administering ultrasound, doing “a little soft-tissue work,” and so on. Their backgrounds were fairly typical of the 40 students enrolled in the graduate physical therapy program at Mount Saint Mary’s College on the west side of Los Angeles, a rigorous 28-month mix of course work and clinical experience leading to a master’s degree in physical therapy.¹ Jody and Martina were in their second semester of a curriculum that spans seven terms and includes courses in anatomy and physiology (gross anatomy, orthopedics, neurology, cardiopulmonary function, etc.), classes in the procedures and practice of physical therapy (these range from introductions to the field and its modes of treatment, to interpersonal and professional communication, to research methods, to ethics and the law), clinical courses in which students put biomedical knowledge into practice (e.g., orthopedic management, assessment of neurologic dysfunction, etc.), and a number of directed research practice and supervised clinical internships. Generally, these courses are sequenced by level of difficulty, and there is a cumulative thrust to them. So, for example, biomechanical concepts learned early on are revisited and elaborated in later courses, with the expectation that students will be able to reason about etiology and treatment in ever more complex ways.

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And this ability to reason clinically is a central, informing goal of the program.

The workload—seven or more courses of varied unit weight per semester—is, everyone agreed, daunting. But most agreed, as well, that the concerns students had about achievement were not equally distributed across this curriculum. Jody, Martina, and their peers had long histories of academic success; they knew how to “do school.” So even the anatomy and physiology courses, which are about as information-heavy as those one would find in medical school, though certainly taxing, were familiar in their cognitive demands. Of particular interest to me are the courses that were less familiar, the clinical courses. It is primarily from time spent as an observer in one of these courses, Orthopedic Management II, that I write the present article, developing it from field notes, interviews, and course and program textual materials. It is courses like Ortho II, for reasons that will become clear as I proceed, that present some of the program’s most challenging demands. But first I will provide some background on this project.

For about a year and a half now, I have tried to gain a better understanding of the cognitive processes involved in skilled work, the array of conceptualizing, problem-solving, troubleshooting activities involved in carpentry, auto mechanics, electrical wiring, plumbing. To help me frame this research, I have observed high school students as they learned the fundamentals of this work, and I have interviewed their teachers and other experts in these trades. To provide bases for comparison, I have also spent some time observing and interviewing people involved in learning a “low-tech” skill, such as flower arranging, and people involved in several service industries, like waitressing and bartending, work that is not considered among the skilled trades but is known for the memory demands and other abilities it requires—planning on the fly, interpersonal adroitness—at least when it is done well. And, finally, these considerations have led me to examine work in several professions that, like all the above, require skills people tend to label “physical” or “tactile” as well as “conceptual” (I hope this article complicates the ease of that distinction), where problem formulation and problem solving occur in complex ways both “within” the individual and “out there” in the world—or, as one current school of thought would have it, in systems of activity (see, e.g., Wertsch 1995). Surgery is one such kind of pursuit, and physical therapy is another. This article will be developed, primarily, from my physical therapy data, though insights gained from my other research, and an occasional reference to it, will appear as well.

These pilot studies, and the fuller research that is emerging from them, touch on a number of issues currently in the burgeoning literature that is helping us reconsider cognition, learning, and teaching from a social and cultural perspective: situated cognition (e.g., Greeno 1998), apprenticeship (e.g., Brown et al. 1988), legitimate peripheral participation (e.g., Lave and Wenger 1991), and various articulations of cultural psychology (e.g., Cole 1996) and activity theory (e.g., Engeström 1993; Wertsch 1995). This literature informs my studies, and I hope that the present article contributes to

it. The article analyzes an activity that, unlike those at the center of many recent studies, is, for all its sophistication, fairly low-tech in its practice. (I worry that the direction in a good deal of newer research toward managerial-industrial, military, and technology-intensive settings—though certainly legitimate settings to study—will skew our understanding of thought and action.) Also, by its nature and the way it is taught, physical therapy makes learning particularly open to observation, with some interesting implications for the way we articulate our social-cultural theories of learning and the pedagogies that issue from them.

As is the case with so many research projects, this one has a personal dimension to it. During the time I was commencing the pilot studies on skilled work, some old back trouble was stirring up, so I began seeing a physical therapist at an orthopedic rehabilitation unit attached to the University of California at Los Angeles Medical Center. His approach to therapy involved a good deal of musculoskeletal manipulation, observation of me performing various tasks, a fair amount of discussion of what I was feeling at any given point in movement, and an ongoing exercise routine. I started feeling better quickly, and I was struck by how much the guy knew about the body—*anatomy but, more so, biomechanics*—and how skillful he seemed to be at picking things up through touch, observation, and talk. I cannot recall exactly when, though it was not too long into treatment, it hit me that physical therapy provided interesting parallels with the knowledge and practice of the skilled work I was beginning to study. I started asking the therapist about his work and, through him, began meeting and informally observing several other therapists in the clinic. The clinic includes a small gym, and once my treatment was completed, I joined it and over the year continued my casual observation, striking up friendships with several of the therapists, having long talks about their work. My therapist assists in the master's program at the institution where he studied, nearby Mount Saint Mary's College, and, as my interests developed beyond curiosity, he arranged for me to observe a class.

Orthopedic Management II is a 14-week course—with an additional two-week field placement—that meets two days per week, three hours per meeting. It comprises lectures, demonstrations, and a good deal of hands-on practice by the students, who sit in pairs at padded tables, from which they take notes, observe demonstrations, and practice the techniques under discussion, usually on each other. It is taught by Nicole Christensen, a faculty member and orthopedic curriculum coordinator at the college who received her graduate education in a distinguished Australian program, and two physical therapists who assist Nicole: my therapist, Tim Gilleran, and Sydney Risser, who, along with Tim, works at the UCLA Rehab Center. Occasionally, a fourth physical therapist will visit to assist in giving students feedback on their practice. Nicole is responsible for the curriculum and the overall organization of the class and carries the primary weight of instruction. Tim and Sydney deliver lessons on particular topics and, along with Nicole, provide a

great deal of individual assistance to the students, as all three move about the class during those considerable stretches of time—at least one-half of each class period—when students practice techniques.

The course covers a number of topics and considers them in reference to each of the major human musculoskeletal structures. So, for example, the topic of the “range of motion” of a structure, the play of its movement, is considered for the spinal vertebrae, the pelvic girdle, the knee, and so on. This topic and its application call up a significant amount of lecture and reading material from other course work in anatomy, biomechanics, and orthopedic pathology which must now be put into practice via techniques of manipulation—for example, palpating the spinal vertebrae, moving a patient’s leg—and this practice must be proficient enough to avoid hurting the patient and to yield information to the therapist about a patient’s condition, what might be causing it, and what might be done to treat it. Throughout this information gathering and after, the therapist must be able to engage in “clinical reasoning,” that is, diagnose the cause of a patient’s problem and formulate a treatment plan in a systematic manner. In this article, I select one of the many key topics that emerged during my observation, the concept of resistance, and its application to the spine, hip, and knee. I begin my discussion by defining *resistance* and explaining its importance in manual physical therapy—though for present purposes I will simplify course content a bit and not rely on technical terminology. Then I will discuss the use of the novice physical therapist’s body—the development of proper technique—in order to gain information about range of motion and resistance. From there I will cover, in two subsections, one of the key abilities—the ability to make fine tactile discriminations—that the novice must develop in order to gauge resistance accurately. Then I will discuss the overarching practice of clinical reasoning, which gives meaning to the work just listed. These topics are interrelated, and I break them out for convenience of discussion. Woven throughout will be descriptions of the various pedagogical techniques the instructors use to help students develop these skills and abilities. I will conclude with some thoughts on the theoretical significance of the above and on its implications for the way scholars talk about teaching and practice within the current reconsideration of cognition and learning.

I will make one more point before proceeding. Though physical therapy generally is built on the study of human movement and is directed at assessing, treating, and preventing movement dysfunction, it is a broad and complex field, composed of many areas of specialization and foci of treatment—orthopedics, neurology, cardiopulmonary, pediatrics, and so on—each of which contains further approaches and schools of thought, with attendant variation in belief about the specific causes of dysfunction and in favored techniques and routines. The class I observed reflects the manual or manipulative therapy approach to orthopedics, particularly as it has been developed in Australia. Australian manual therapy places strong emphasis on the systematic manipulation of musculoskeletal structures

through an array of hands-on techniques that are used strategically as the therapist, through careful observation, questioning, and listening, develops a hypothesis about the source(s) of a patient's problems; tests, rejects, or refines the hypothesis; and formulates a treatment plan. Undergirding and guiding this approach are particular conceptualizations of the body and assumptions about our ability to be subjectively aware of it and to articulate that awareness in language—what one of manual therapy's key figures calls "the body's capacity to inform" (Maitland 1997:27). As well, there are beliefs, based on a history of clinical experience and empirical study, about the efficacy and interconnection of the techniques, routines, diagnostic frameworks, and modes of rationality that constitute manual physical therapy. All this forms the assumptive base and ideology of this approach and is thus central to its tradition of practice. In this article, therefore, these assumptions will be accepted as integral to this tradition, though other approaches to physical therapy, not to mention other critical disciplines outside of biomedicine, might take issue with one or more basic tenants.

Resistance

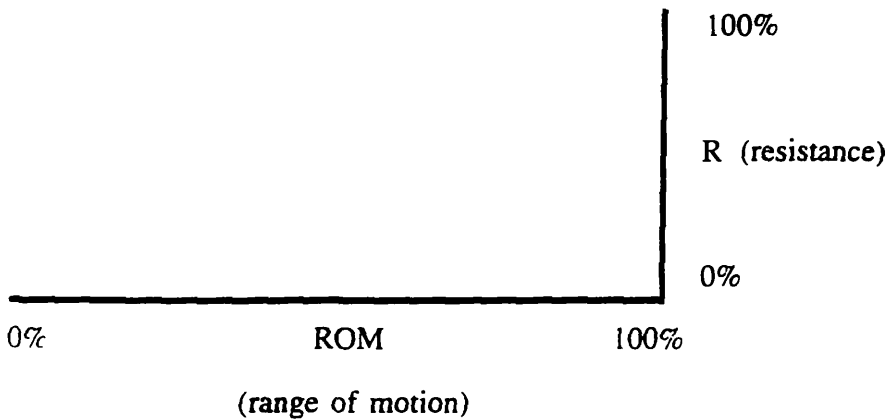
Put simply, *resistance* refers to the stiffness of a musculoskeletal structure—the degree of flexibility or fluidity of movement of a knee or vertebrae—and a physical therapist tests resistance by manipulating the structure by hand (i.e., the patient does not perform the movement) through its potential range of motion. As a vertebra is being palpated or a leg lifted, the therapist tries to determine two particular points of resistance: r_1 is that point at which the therapist first feels any stiffness in motion—and this, for novices especially, can be subtle—and r_2 , which is an end point, is the place where the structure can move no further without some other compensating movement. For example, in one of the tests for hip problems, the patient lies on her or his back, and the therapist, holding the leg straight, raises it—the therapist would exceed r_2 if the patient began to lift her or his pelvis or turn her or his torso. And, of course, resistance can be related to pain, which brings with it further medical, social-psychological, and ethical issues.

Resistance is a concept of key diagnostic importance, for it provides a way to conceptualize how severely a patient's mobility is restricted and provides information that contributes to diagnosis of cause and possible treatment. The concept is threaded throughout Orthopedic Management II as students continually try to refine their ability to assess r_1 and r_2 . The instructors talk of "respecting a patient's resistance," underscoring the centrality of the concept in the professional relationship established with clients.

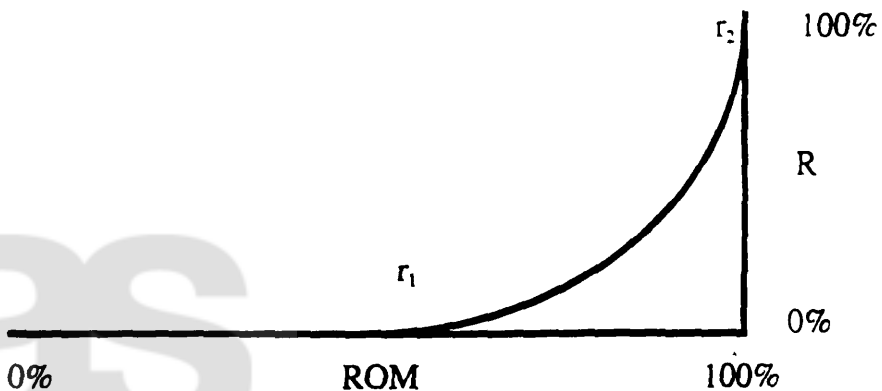
In the classes I observed, the instructors used a number of methods to help students comprehend, tactilely as well as conceptually, the notion of resistance. They assigned reading on resistance and defined and discussed the concept in lecture format before the whole class, and, during lecture, they referred to material the students learned in other classes, locating that more technical material in this context of practice. They related stories from their own clinical experience and, not infrequently,

commented on each other's stories. They performed clinical demonstrations of techniques and talked out loud as they assessed r_1 and r_2 . They alerted students to visual clues that indicate r_2 has been reached, for example, the aforementioned rotation of the pelvis during a leg raise. "Use your eyes," Sydney, the assistant instructor, said one day. "Use your eyes until your hands get more sensitive."

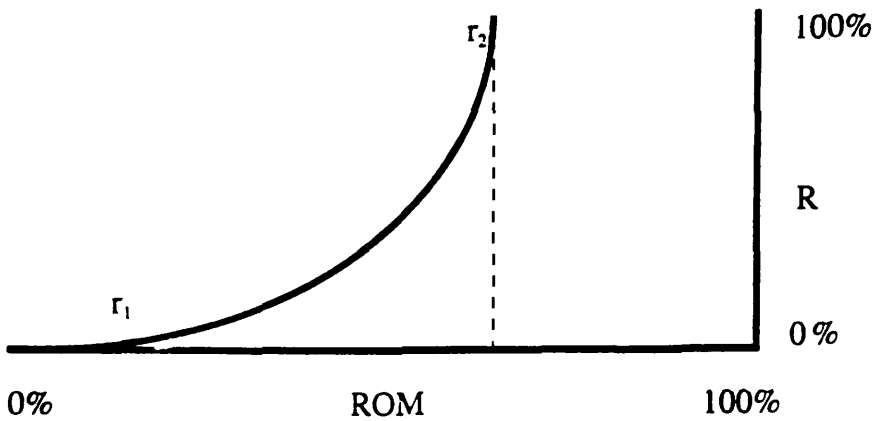
They also used graphic representations, drawn on the chalkboard, to formally depict resistance. A common one was some variation of the following, called a "movement diagram":



The horizontal axis represents the range of motion of the musculoskeletal structure, from no motion whatsoever (0%) to full motion (100%). The vertical axis represents the intensity of resistance as the therapist moves the structure through its range of motion. The instructors, after initially explaining the diagram, frequently asked students to graphically depict a manipulation they had conducted or a case the instructors had presented verbally. For example, a graph for a person whose leg moves easily through its range of motion, encountering a first point of resistance (r_1) fairly well along and an end point (r_2) when the leg is extended, would look like this:



Whereas the graph for a patient with significantly limited mobility, whose r_2 comes pretty quickly, would look like this:



The instructors shifted back and forth from the tactile, to the verbal, to the graphic. So Nicole might draw a diagram and ask, "What would this feel like? Describe it in words." Or, once students had executed a technique, an instructor might ask what that execution would look like graphically. "I want you to think about what you just felt," Nicole would say, "and how you would draw a picture of it to show or explain it to someone."

There is more to say about resistance, but it would be helpful, first, to cover several other topics: the novice physical therapists' development of their bodies as diagnostic instruments and the refined tactile discriminations they learn to make. Before moving on, though, it is worth noting again how many conceptual, visual, and tactile pedagogical modes and techniques the instructors used in combination to help students come to understand the notion of resistance. As Nicole put it one day in lecture, "Sometimes it helps to see something three different ways."

The Body as Instrument

The body becomes the physical therapist's instrument in several metaphoric senses of the word.² It is, first of all, the means by which physical therapists perform a technique, whether for diagnostic or for treatment purposes: it is with their palms and fingers that they palpate spinal vertebrae, and it is by stabilizing and lifting the leg that they check for problems with the hip or related structures. Therefore, to take the example of vertebral palpation, novice therapists have to learn how to position their bodies in order to perform the technique most effectively—that is, their shoulders up and over the patient's spinal column, so that the "lines of force" of palpation are precisely on target, producing optimal, controlled movement of the target vertebra. There is another reason for this care in the positioning of the body: to protect oneself from fatigue or injury. So there was a fair amount of talk in Ortho II about being in this "for the long haul" and the "efficiency" of one's motions—knowledge

of biomechanics here applied to the protective use of one's own body. And bodies, of course, vary. So one concern that emerged throughout Ortho II was how an individual student learns to use *her* or *his* body, given height and weight, injuries or musculoskeletal limitations, and so on. During the period when the class was learning to use the fleshy part of their palms (with the other hand interlocked over the top) and their thumbs to palpate the spinal vertebrae, Sydney gave a brief impromptu lecture about variation in the flexibility of the thumb. She stood in the middle of the room, held her right hand high, and, with her left, bent her right thumb quite far back toward her wrist. Her thumbs, she said, were "wobbly." She called on Nicole, who was standing close by, to do the same with her thumb, which had much less bend to it. They talked informally and laughed for a minute or so about the difference, and, around the room, students did the same, bending their thumbs, talking, comparing. Sydney then offered several ways to compensate for a "wobbly" thumb. She placed the thumb of her one hand over the other, stabilizing the first thumb—and students did this too. Then she slipped what looked like a piece of jewelry off her middle finger—a thin, gold spiral—and put it on her thumb as a "thumb splint," a device to reinforce the body. The effective and efficient (two words I heard frequently in Ortho II) use of one's body, then, was a central goal in this class, and it involved a degree of bodily self-awareness that, for many, even for this quite physical group, was unusual. As Martina explained to me, "I'm more aware of myself in space, where my hands are, or is my elbow in the line of force, am I hurting myself?"

There is a second sense in which the body is the physical therapists' instrument: it is the primary means by which they get "good information" about a patient's condition—through feeling and seeing and listening to a patient's response to what happens when they perform a particular technique. Performing a technique effectively and efficiently, then, is important not only to protect the patient and oneself from injury (and eventually to provide good manual therapy) but also to gain tactile data—the therapist's body becomes both tool and gauge.

These various uses of the body are, of course, intimately related. Sydney was demonstrating the hip exam on one of the students, holding the prone student's leg lightly, bending it at the knee, moving the leg gently back and forth toward the torso. Sydney spoke throughout the demonstration, noting the way she positioned the student's body close to the edge of the examining table for ease of access and calling the class's attention to the movement of her own body, the way she rocked her body back and forth to move the leg, not using her arms a lot, thus not tiring herself: "stay in a stride stance," "keep your spine in neutral," "keep a nice, clean plane." And during this discussion of her own stance and movement, she talked about the information her efficient motion enabled her to gain. For example, "Move gentle, move slow, but get in

close. The patient will let you get more information if you can get in close and move the leg."

As has been pointed out, the instructors used a range of pedagogical methods in Ortho II, and, accordingly, they helped students learn to use their bodies effectively and efficiently in a number of ways that include methods I have discussed: lecture and demonstration, the relating of personal anecdotes, and so on. In addition, during lecture and demonstration, they used visual metaphors. In describing and demonstrating to students the way to position themselves over a patient to perform the palpation of the spinal vertebrae, Nicole said, "You want to make a triangle from your shoulders to your hands." Another, related method is to connect a particular position and movement to the familiar. Sydney, working with a group of students, said, "Get your sternum over the spine. Think CPR."

There are further pedagogical strategies. Following a lecture demonstration and the attendant practice of a technique by the students, it was common for the instructors to check in with the entire class. After the students practiced the palpation of the vertebrae, Nicole asked, "Okay, how many of you feel you're using your wrist extensors a lot?" She waited for a response, then said, "You should not be activating your wrist extensors." Then, after more practice, she again checked in: "If your hands are sore, you're pushing too hard." During demonstrations, the instructors would sometimes use one of several plastic skeletons to pinpoint a particular structure, calling up work done in anatomy and biomechanics and connecting that knowledge to the particular manipulation techniques being learned at the moment. To help students get a better sense of where to place their thumbs when palpating the facets of the spinal vertebrae (those flat pieces of bone lying to either side of the raised central ridge of the vertebrae), Nicole had a student lie face down on a table and placed over his back a partial skeleton of the spine and rib cage. "Okay," she said to the class, "now you have X-ray vision," and she positioned herself over the spinal column, showing the students how to move their thumbs off of the (easily locatable) elevated ridges of the vertebrae and onto the less accessible facets.

As the instructors moved about the class to provide individual and small group assistance, they often intervened quite directly in the way students were using their bodies, placing their hands on shoulders, hips, forearms, and hands to adjust the students' positions. Nicole was having a student demonstrate on another student one element of the exam of the sacroiliac joint of the pelvis, a difficult exam. After he performed the technique, she placed her hand over his, which was on the other student's left pelvic bone, and turned his palm outward about ten degrees. As she did this, she explained to him and the class how this made "the lines of force more vertical." She and the student then talked for a few moments—he knew he was "coming in at an [ineffective] angle"—and he tried the technique again but still not exactly right. Nicole adjusted

his hand again, explaining, at one point taking over and modeling the position, having him try again, staying with him until he got it. "Once you do it right," she said to the class, "you'll have a feeling for what it feels like done correctly. Then you need to do it on a lot of people."

And students practiced on each other, on some days for nearly an entire class. The following example comes from an introduction to the neurological examination, which, though not dealing with resistance directly, is necessary to establish a baseline of performance and to rule out neuropathology. Kim and Elizabeth were learning to test the reflex of the Achilles tendon with a reflex hammer (that little hammer with a triangular rubber head). Kim was the patient and was lying on her stomach, feet just over the edge of the table; Elizabeth was holding Kim's right foot, and, as Tim had demonstrated to the class earlier, had flexed Kim's foot and had the ball set lightly against her thigh. Elizabeth tapped Kim's tendon but got no response. She did it again—no response. Sydney came by, observed, and, asking for the hammer, demonstrated, tapping the tendon a little higher—and got the reflex response. Elizabeth tried it, and it worked. Sydney moved on to the next table. Elizabeth then began explaining to Kim where one has to hit the tendon, did it again, and, again, got a good response. "Whoa. Feel that?" she said. Then she talked to Kim about swinging the hammer with a light touch and the need to "try to stay consistent" in that movement. They switched places; Elizabeth was now the patient, Kim the therapist. Kim had a little trouble initially assuming the right position—"I can't quite get it," she said—so Elizabeth, propping up on one elbow, guided her. Then Kim tapped Elizabeth's tendon. "Does that feel like I'm hitting in the middle?" she asked. "No," Elizabeth told her, "you can go a little higher up." Then after several more attempts, Elizabeth observed, "You're a little bit better on the medial than on the lateral side," referring to the direction from which Kim was approaching the tendon. This kind of exchange in its precision and collaborative helpfulness was quite common and was, perhaps, the essential activity in helping students refine their technique. As Tim observed to the class, "You've got to try these [techniques] on each other. It doesn't make sense unless you try to feel it." One further element of this collaborative practice involved having one of the instructors perform the technique in question on one's own body—as we saw Sydney do with Kim in the above episode—so that, as Nicole put it, "You'll know what it feels like. Then you can give better feedback to your partner."

Reading the above vignette, Tim noted how hard it was to create the conditions for this kind of collaboration to occur. Students have to struggle publicly to express sensations and movements that are hard to express—an issue I return to later—and they must come to trust each other, admit uncertainty, venture being wrong—not an easy thing for such academically competitive folk. Establishing training space for these

kinds of risks takes explicit curricular and pedagogical effort, both across the program and within Ortho II.

Tactile Information

As is evident above, novice physical therapists work hard at mastering technique in order to get "good data" from their patients. As Tim explained one day, "No matter how smart you are, if you have bad information, you'll make a bad decision." It may sound a little odd initially—I know it struck me when I first heard it—to think of the tactile as data, but it is central to the manual physical therapist's profession to work with the information about the musculoskeletal structure that is yielded by the performance of effective and efficient technique. "Go slow," Nicole advised when students were first learning how to palpate the spinal vertebrae; "you get better information with your hands when you go slow." And one day, later in the month, Tim said to the class, "You need to get to where your technique is good and consistent, and then you go through your routine and get good information." Getting tactile information is central to the routines, protocols, and general habits of mind that the program refers to as clinical reasoning (which I will discuss shortly); "no matter how smart [one is]," no matter how much textbook anatomy one knows or how quickly one can list off the steps in the neurological exam, without good information, one will hypothesize and diagnose poorly and generate inadequate treatment plans: "You'll make a bad decision."

What is required, therefore, to return to the notion of the physical therapists' bodies as their instruments, is to, over time, continue to improve one's skill at executing manual techniques, refining one's sense of touch and motion in order to acquire increasing sensitivity to the feel of musculoskeletal processes and tissues. Efficient, just-right movement on the therapist's part is critical. Tim explained, "If there's too much of the therapist's movement in the system [i.e., the physical system of the therapist's and patient's interrelated bodies], then you're not going to get the clean movement" of the particular musculoskeletal structure being tested. The language is almost cybernetic here: the body cannot be an efficient instrument if one's movement is not fluid, is too pronounced, irregular, or exaggerated, because noise enters the system. Observing a student execute one of the techniques for the hip exam, whereby the therapist stabilizes the patient's leg and raises it, Tim offered a corrective metaphor as he assisted her: "You've got too many links in the chain. Picture yourself as one circular piece of steel, rocking. Otherwise, there's too much movement to confuse you."

Over time, one begins to discern a developmental trajectory in the use of the body as an information-collecting device. As Sydney explained to me, "When an experienced therapist works, you're thinking results, clinical pathways. When you begin, you're thinking techniques—did I do the test right? These students are having to think [about properly

executing techniques] so much." (A student independently told me the same thing: "When you start, you're concentrating on getting your technique right.") This concerns the automatization of processes that comes with expertise (Bracewell and Witte 1997; Hutchins 1986). There are two interrelated issues here: The more one's attention can shift from executing a technique properly to what one is feeling, the more focused one can be on the information the technique is yielding. And the more efficient one is at executing technique, the less interfering "noise" there is in the information one acquires.

Refining Discrimination

For a good while during my time in Ortho II, students would, in their words, "blow right past r_1 " (the first indication of musculoskeletal resistance). Sydney observed one day, "Some of you guys go right to the end range" (that is, r_2). As Jody put it, "I'm not used to feeling for little changes." A different, though related, problem, one touched on at the end of the last section, was succinctly expressed by one of the students: "I focus too much on r_2 and miss other things." If students miss the "little changes," they may also concentrate so intently on a particular technique or diagnostic moment (like r_2) that they miss the broader band of information a more experienced therapist might register. At heart, I am talking here about the development of an increasingly refined perceptual ability: the ability to make discrete distinctions in the feel of musculoskeletal structures. It is "finesse," Nicole told the class one day: "You'll start to feel more finely." A bit later in the class a student laughed and said, "Feeling is believing."

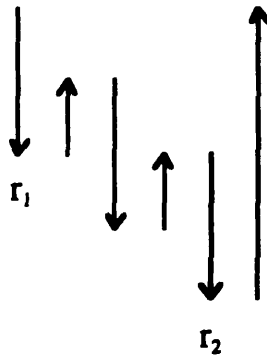
One of the things that makes the development of this refined tactile discrimination difficult, of course, is that the physical therapist works with a number of quite different musculoskeletal structures, each with its own range of motion—from the limited movement of spinal vertebrae to the wide swing of the shoulder—and each has its own tactile indicators of r_1 and r_2 . But what seems to make the development of this refined tactile skill even more difficult is the fact that, as Sydney put it one day, "Every single person is going to have their own r_1 and r_2 , though there's a normal range." Within a normal range, there is significant variation—and for each of the musculoskeletal structures. When the class was in its first few days of learning the technique for palpating the spinal vertebrae, one student said in frustration, "I can't get it. I do it on different people, and they're all different. I can't get it." He hit on one of the key challenges in the development of this keen discriminating ability: the need to establish a sense of a normal range, a kind of broad-banded "average" of mobility. As Sydney explained later in that same class meeting, "You need to try other people to get a feel for all the feels. Then you'll form an idea. You need to get an idea of the normal spine and get a sense of r_1 and

r_2 . You need to get a sense in your hand. You need to train your hand to feel." This knowledge in the hand, then, is not reducible to the finding of a correspondence for or the mapping of a particular feel onto a specific process or condition but, rather, seems to involve the development of a sense of a bounded range of sensations, a tactile concept, a kinesthetic "idea" of the feel of the normal spine, or hip, or knee. It is a complex business and yields in this setting a language of the tactile and abstract intertwined: Sydney's idea that develops through the hand.

How did the instructors create the conditions for their students to master these subtle discriminations? Much of what we have already seen was involved: from calling up textually derived knowledge of anatomy and biomechanics, to instructor modeling and explanation, to hands-on practice with peers. The development of keen discrimination emerges primarily from a manual pedagogy, but it is worth dwelling for a moment on the ways it also involves the visual, the graphic, and, especially, the verbal.

In the discussion of resistance, I quote Sydney calling a student's attention to the compensating movement of the hip after that student had raised a patient's leg past the end point of resistance, r_2 . "Use your eyes," she said, "until your hands get more sensitive." At another time, one of the students showed me something an instructor had just shown him: how, when one has gone past r_2 on the third lumbar vertebra, the vertebrae above it descend slightly into the back—a visual tip that one has missed r_2 . Jody speculated that because people tend to be more visual than tactile, it helps to use visual clues until, as Sydney said, they get better at feeling things. The visual becomes a kind of perceptual scaffold assisting the refinement of the tactile. And, it seems, though further study would be needed to explore this, that some students rely on mental visualization as they develop their tactile skill. Jody explained, "At this point, I just have to visualize [the r_1 and r_2 of vertebrae] before I can do it and believe eventually we'll move past having to visualize and just be able to go in there and know—our hands will know."

The graphic representations play in here as well. Tim told the class several times, and mentioned it to me more than once, that when he was a student, he and his peers drew movement diagrams a lot as a way to help them understand the different patterns of resistance and communicate what they were feeling to each other. As the instructors introduced the charts and other graphic conventions to the class, students began to use them. During the session when students were learning to palpate the spinal vertebrae, Nicole drew arrows on the board to illustrate an effective rhythm of palpation (its "oscillation"): pressing down on the vertebrae with the palm of the hand, then coming up, then "in a little deeper," then up again, "but don't come all the way out," then in until the end point, r_2 , is hit. She drew the following:



Toward the end of that class—after everyone had practiced the palpation and had an instructor model it, assist them, or, in some cases, do it on them—one of the students asked Tim about the differences she felt when he performed the technique on her versus what she believed was the way she performed it on her partner. It was a hard thing to express—a reminder of how difficult it is to find a tactilely apt language—and Tim did not quite get what she was asking. So she took him up to the chalkboard and explained, as she drew arrows, that she seemed to need to come farther back up in her oscillation than Tim did—the length of Tim’s arrows was shorter, hers longer—in order to gauge r_1 and r_2 . Her oscillation seemed gross and slow to her, and she used these graphics to try to convey to Tim a fairly discrete difference in oscillation. She had quickly appropriated this representational device to aid her attempt at articulation. Perhaps the graphics function as another scaffolding device in the refinement of technical skill and discrimination. What we see here is, I think, a particularly nice example of a phenomenon discussed by cultural-historical psychologists (e.g., Cole 1996): the acquisition of a culturally transmitted mediating device (variations of these graphic representations of movement are part of the conceptual and communicative tradition of Australian manual therapy) by a new member of the community, in a new context, to solve an emerging problem.

And there may be a developmental pattern to the use of the movement diagrams. Tim explained to me that though he no longer had need (or was required clinically) to draw movement diagrams, except in teaching, the process “now goes on in my head.” And one day Nicole said to the class, “Will you be drawing these diagrams when you’re out working on people? No. But you’ll go through the process in your head.” Exactly how the diagrams and the processes they embody get internalized and represented is hard to say—and some social scientists now suggest that graphics (or “inscriptions”) can better be understood as a social rather than a cognitive/mental phenomenon (Roth and McGinn 1998)—but Tim and Nicole’s comments suggest that, for some therapists, the diagrams function as an aid to the development of discriminating competence and the way they are used goes through some sort of transformation over time.

During the class when Nicole was introducing the movement diagrams, she drew a diagram with a line that had a slowly ascending trajectory. "What would this feel like?" she asked, "Describe it in words." There was a good deal of talk attached to the use of the graphics, and, in general, instructors were continually encouraging students to describe what they felt as they performed techniques and to give precise feedback on what a partner's technique felt like when it was performed on them. Following Nicole around the classroom as she observed students working on each other, I heard her asking continually, "Feel what that feels like. Can you feel the difference [between r_1 and r_2]? Try to put it in words." And she had students direct their answers to each other. These were attempts to articulate the kinesthetic, and language, then, became another mediating device in the attempt to refine the ability to make fine tactile discriminations. Cindy Moore, the chair of the program, had an interesting take on the use of language here. She suggested that this vocalizing of the sensual, difficult though it may be, acts to not only assist discrimination but to confirm it: "It's a way of validating that they're feeling what they're feeling. What they feel feels intuitive; it doesn't feel 'real.' To talk about it is a way of assuring that what you feel is not made up."

Finally, and not unrelated to the above, the instructors encouraged students to reflect on their own thinking and sensation—metacognition. Sometimes the encouragement was indirect as instructors modeled what might go on in their heads as they work on a patient. Talking about r_2 to the class, Nicole paused and, as though pondering, asked, "What's a normal 'end-feel'? So I'm thinking in my head, What's normal?" More often, the encouragement toward metacognition was direct. During the time when students were just learning how to palpate the spinal vertebrae and had just finished executing the technique on padded tables, Nicole asked everyone to take a moment and "think about what you just felt." And it was not uncommon for students to be encouraged to think out loud, making cognition public. "Take me through your thought process," Tim told a student, "so I can make sure I'm following you." As students articulated differences in sensation and their thoughts about them, the interior became open to the assessment of and feedback from peers and the instructors, whose responses could further socialize students into a clinical tradition, assisting them in making a particular kind of sense out of what they feel, one more mechanism by which their hands come to know.

Clinical Reasoning

The orientation to manual physical therapy found in Orthopedic Management II is often referred to as the Australian approach, and a key figure in formulating that approach is Australian physiotherapist Geoffrey Maitland. Reading his core textbook, *Vertebral Manipulation* (1997, originally published in 1964), one encounters, within the first few pages,

the following caveat about the manipulative techniques the students in Ortho II spent so much time trying to master: "When people talk about manipulative treatment, it seems impossible to avoid the problem of their putting inordinate emphasis on the techniques. . . . This is most unfortunate to say the least, because it prevents their seeing the *whole picture*" (1997:4, emphasis in original). The "whole picture" of manual therapy for Maitland is framed by what he calls "analytical assessment" and what Nicole referred to as "clinical reasoning," which she explains thus in a handout that students in Ortho II receive early on:

Clinical reasoning can be defined as the cognitive processes, or thinking, used in the evaluation and management of patients (Jones, 1992). . . . The goal of clinical reasoning is "wise action"—i.e., making the best judgment in a specific context (Dutton, 1995). Clinical reasoning requires situational thinking, done "in the moment" as well as retrospectively.

The students were not yet at the place in their training where, even with supervision, they could do a comprehensive evaluation on a patient, though they already had been taught the rationale for and stages of assessment, as proposed in the Australian approach. The full protocol is somewhat elaborate, but, in essence, the therapist attempts to gather a patient's history; a precise understanding of the presenting problem from the patient's perspective; and, through the strategic use of procedures and techniques—like those we have seen—information on the physical factors that may be related to the problem. From all this, the therapist formulates a hypothesis about causality and a related treatment plan, but what is particularly important in the Australian approach is that each subsequent treatment becomes the occasion for further assessment. The initial hypothesis must be open to revision or refutation, "for even treatment is viewed as a form of hypothesis testing. Results of treatment serve to modify or reform hypotheses, contributing further to the therapist's evolving concept of the patient's problem" (Jones et al. 1994:94). Maitland's concerns about an overemphasis on his manipulative techniques becomes clear: technique has to be executed effectively and efficiently to yield good data, but data will be useless unless the therapist operates with a critical, reflective mind.

It is no surprise, then, that throughout Orthopedic Management II, students heard from Nicole and from Sydney and Tim about the importance of thinking things through, of using whatever academic and clinical knowledge one has combined with all a patient reveals to analyze and reanalyze possible causes of malady. When Nicole was introducing the pelvic girdle exam, she discussed a tendency a decade or so ago to rush to judgment and overdiagnose sacroiliac problems. Then, stressing the importance of a careful and thoughtful examination, she said, "We want you to be able to figure out when sacroiliac treatment is appropriate and when it isn't." A bit later, discussing the many variations and anomalies in the pelvic bones, she cautioned, "It is an error in your

reasoning if you find a bony anomaly or odd alignment and assume it's related to mobility problems." Even a finding that seems clear-cut needs to be carefully considered and analyzed, for so many orthopedic problems are complex and nuanced. Sydney explained one day how X rays and more sophisticated computer-assisted imaging techniques (e.g., the MRI) that show a deformity or pathology—for example, a slightly herniated disc—may not reveal the cause producing a patient's symptoms, and, during that same class, she explained how local pain may have its source in other regions of the body. "Never assume," she said cryptically, "that a knee is a knee." So, though a central goal of Orthopedic Management II is the mastery of techniques and procedures that, given their precision and continued practice, could be seen as being "mechanical," the manner and purpose of their deployment is anything but mechanical. There is an ethos in Ortho II, a culture, if you will, of reflective thought, problem solving, troubleshooting—talk about clinical reasoning surrounds technique.

Central to this analytic habit of mind is the precise use of language and the fostering of effective communication between therapist and patient. Maitland's *Vertebral Manipulation* has an entire chapter on communication, and throughout the book he stresses "detail," "specificity," and "precision" in language and underscores the importance of careful listening and questioning, "believing that the body can inform the patient about aspects of her disorder that cannot be found by examination" (1997:9). The course of study at Mount Saint Mary's College is unusual, including four half-unit courses on "personal and professional communication," and throughout Ortho II the instructors, as we have seen, create the conditions for students to articulate what they are doing, their reasons for doing it, and what they are experiencing as someone works on them. It was telling that when I asked Jody what it was that characterized the expertise of the therapist who supervised her first clinical field placement, she quickly said that the therapist "really fosters good communication with her patients. She listens to them, explains things to them, includes them in the treatment." So every time an instructor asks a student to explain what he or she is thinking or experiencing and every time students tell each other what they are doing or feeling, this difficult push toward articulation of the tactile anticipates the give and take of language in professional practice.

There are powerful assumptions in the foregoing about subjectivity, cognition, language, communication, and hypothetico-deductive reasoning that, as I noted at the beginning of this article, could themselves be open to analysis—just the relation of language to thought has occupied a major place in 20th-century philosophy—but one can see the coherence of the assumptions and their relation to practice. And, for my purposes, it is important to understand that comprehending resistance, mastering techniques, developing the use of one's body, and refining one's tactile discrimination are all integrated and given meaning within

an orientation to human movement, cognition, and language which defines and directs the tradition of practice that informs the work students do in Orthopedic Management II.

Discussion

This article is an attempt to examine a classroom setting in which beginning physical therapy students develop the ability to use their bodies to make increasingly fine tactile discriminations about the resistance of musculoskeletal structures, an ability that is made sense of and deployed in the context of reasoning clinically about the possible causes of and treatments for a patient's problems with movement. The study is built from field notes, textual materials from the class and about the program, interviews (both during practice and post hoc) with instructors and selected students, interviews with the chair of the program, histories of manual physical therapy and books and articles from the field's professional literature, and informal observations and interviews with physical therapists not connected with the instruction of Ortho II.

As a number of researchers working within the frameworks of sociocultural psychology, activity theory, practice theory, and situated cognition have been recommending over the past decade (see, for example, Cobb and Yackel 1996; Cole 1996; Engeström 1993; Lave and Wenger 1991; Rogoff 1995), I have tried to consider these data along several inter-related analytic layers/domains (Hull and Rose 1989; Hull et al. 1991) or "planes of focus" (Rogoff 1995). The concepts, techniques, uses of language and other signs, and habits of mind we have seen have complex histories of development, and these technical, discursive, and cognitive practices can be understood as the "tools of the trade," transmitted by professional culture, that constitute the practice of the Australian approach to manual physical therapy. Each cohort of students that passes through Ortho II acquires these tools through guided and sustained practice; the students' learning is "situated," then, both in a tradition and, more immediately, in the conditions created by the instructors which enable them to develop competence. At times, the analysis has been at the level of the student, or a pair of students, or a student and instructor, focusing on the acquisition of particular techniques, procedures, or linguistic or cognitive skills and abilities. This analysis could have a fairly tight temporal focus—for example, Kim and Elizabeth learning the reflex exam for the Achilles tendon—or could be more developmental, considering a process over time. At other points in the article, analysis shifts to the classroom as a complex unit of activity: for example, when considering the ways the instructors created the conditions—through language, graphics, actions, and objects—for this cohort of students to participate in and acquire some of the practices of manual physical therapy. And the analysis, at times, considers the tradition of Australian manual physical therapy—a tradition comprising techniques, routines, guiding assumptions—and the way that tradition affects

particular practices in Ortho II—for example, the role of communication and hypothetico-deductive reasoning in the development of technique and the refinement of tactile discrimination. Though provisionally isolable for purposes of analysis, all these domains or planes converge in the day-to-day activity of Orthopedic Management II. I will now consider in more detail several topics from within this activity.

A Pedagogy of Multiple Methods and Symbol Systems

"Sometimes," Nicole has said, "it helps to see something three different ways." The instructors in Ortho II utilized and interwove a wide range of instructional approaches to help students acquire tactile discrimination skills related to resistance. As we have seen, the instructors lectured, demonstrated, modeled, told stories from clinical practice, incorporated readings assigned for their class and others, used aids such as the skeleton, organized dyads for collaborative learning and practice, physically adjusted students' bodies and guided motion, surrounded activity with talk that focused attention, elaborated, connected, and evaluated, used metaphor, used graphics, encouraged articulation, strategically shifted—and encouraged students to shift—among senses and symbol systems (touch, sight, speech, nonlinguistic graphics, expressive motion), creating what Rogers Hall (1990) calls an ecology of representations. (Interestingly, about the only methods absent were those related to electronic technology—except for an old overhead projector used a few times—which reminds us that quite complex learning and instruction can occur in quite low-tech settings.) What is the pedagogical purpose for this range?

One reason is simply that some of these methods and orientations are part of the educational tradition of Australian manual physical therapy, developed and modified over time and place, used to help Nicole learn in Australia and, after her, Tim, who trained in this program three years before. The methods and their purposive interplay provide one way to assist the transmission of the manual techniques, their connection to concepts, and the philosophy of their use in service of clinical reasoning. Another reason for the variety was suggested to me by Tim during one of our interviews: People learn different things in different ways, so the more ways instructors have of coming at material, the more possibilities there are that one or more methods will click with all of the people in the room, who, for all their similarities—high achievers, physically oriented—are, of course, a diverse lot, as any population of 40 would be. This addresses the long-standing concern of educational psychology with individual differences.

And there is a third reason, I think, for the variety, not unrelated to the previous two: In their study of blacksmithing, Keller and Keller note that the "development of a coherent conceptual structure requires the ability to construct and move among diverse informational structures [and] the ability to translate some information from one representational mode

into another" (1996:179). So to gain a rich understanding of resistance, a student may be encouraged to visualize musculoskeletal structures, verbally describe what he or she is feeling, and so on, in addition to using touch and movement. To integrate resistance, tactile discrimination, and clinical reasoning into fluid practice requires a complex and, for most of us, unfamiliar integration of sensory and epistemological domains that in our culture are usually segmented. To blur that segmentation, in fact to challenge it instructionally, seems to require, at least in this setting, a convergence of methods and a fluid play of symbol systems. One could even consider the rhetorical devices the instructors sometimes use—metaphor, synesthesia (ideas emerging from the hand), paradox (a knee is not a knee)—as contributing to this movement among ways of knowing.

The Abstract and the Concrete

For a complex host of reasons ranging from our Western philosophic tradition to the sociology and organization of work, we tend to make quick and quite consequential distinctions between mental activity that we define as abstract, theoretical, or conceptual and physical activity that we define as material, concrete, or applied. To be sure, there is some legitimacy to the distinction: In fundamental ways having to do with semiotic systems, cultural antecedents, routines of practice, and so forth, calculating a Poisson distribution is different from filling out a form at the Department of Motor Vehicles, which, in turn, is different from shaping a table leg on a lathe. Still, the ease and assurance of the distinction have led to a number of problems in the way we conceptualize intelligence, our understanding of work, and our educational practice—not to mention the invidious ways the distinction feeds into social stratification.

Sylvia Scribner, along with others who study manual work within a sociocultural tradition, emphasizes the "continual interplay between internal representations and operations and external reality throughout the course of the problem-solving process" (1986:23), thus challenging the abstract-concrete distinction. Spending time in Ortho II helps us push on it even further, for the curriculum sits astride the "academic" and the "applied." There is a body of knowledge the students learn that is essential to practice—for example, gross anatomy and biomechanical concepts like resistance—but knowing the definition of *resistance* is not very useful unless it is integrated or blended (one struggles for words here) with manual techniques. And the techniques, in turn, gain meaning as novice therapists develop the ability to derive information from them—"average feels" of different musculoskeletal structures and the data from a particular patient's structures—and form hypotheses through that information. There is an ongoing, interactive play between hand and mind that would be very hard to compartmentalize; it is hard to know, at times, how one would label the activity one observes. As noted a moment ago, this blending is evident in the language the

instructors use. Take, for example, Tim's metaphors about the student therapist and her "patient" being a physical system, "links in a chain," "one circular piece of steel, rocking." Tim used language, a system of abstractions (but embodied here in Tim, his gestures, and the teacher-student relationship), to create a comparison, which is an abstraction, via metaphors that use physical objects (chain links, a band of steel). The complexity continues, for the metaphors are in the service here of the abstraction "information"—gathered, however, via the physical embodiment (therapist and patient) of the abstract notion of a system. Where does one make the abstract-concrete demarcation?

Brown, Collins, and Duguid call for a fundamental reconsideration of the "profoundly misleading theoretical separation between *knowing* and *doing*" (1988:1, emphasis in original). And activity theorists suggest that, rather than relying on the dichotomy between mind and body, we begin from the proposition that the conceptual and the physical "are not absolutely exclusive categories, but are unified by their common source in activity" (Bakhurst 1991:217). But, it seems, we need to continue to revise our theories and craft fresh vocabularies to render this "marriage of the hand and the mind" (Harper 1987:118),³ particularly for those educators who must, finally, create the conditions for people to acquire complex kinesthetic-conceptual skills and abilities, assess when acquisition is going awry, and effectively intervene.

Authentic Activity, Apprenticeship, and Communities of Practice

I want to be clear at the outset: I think that the last decade's worth of reformulations of cognition and learning, grouped together by Greeno (1998) as "situativity," has been very valuable in both theory building and educational practice. The situational framework has pushed us to think hard about the ways learning is narrowly conceptualized and measured. And this framework has been very helpful in thinking through the present research. But what we have seen also yields caveats about the way the situated learning literature has been advanced and interpreted in terms of educational practice. I am particularly interested here in the arguments for authentic activity (Brown et al. 1988) and the claims about communities of practice and legitimate peripheral participation (Lave 1996; Lave and Wenger 1991).

In an attempt to counter classroom instruction that is unengaging, acontextual, or detached from real-world practice, there has been a call to create educational settings that are built around practices drawn from the activity of real readers, mathematicians, scientists, city planners, and so on. Orthopedic Management II seems to be such a setting: Students are learning the very procedures and routines they will use as physical therapists, and they do so in situations that, in some ways, offer a one-to-one correspondence to actual practice. Yet it is worth considering just how much instructional intervention is involved in Ortho II—just as there is, if thought about from the perspective of a teacher, in many of

the successful instructional programs that have been developed out of the situated learning perspective. To be sure, the situated learning literature notes an instructional sequence to authentic learning—whereby, as Brown, Collins, and Duguid nicely put it, there is “modeling, coaching, and fading” (1988:25)—but I am talking about much more instructional artifice than that. In the activity we have witnessed, tasks are frequently not presented in authentic wholeness but broken down and analyzed (e.g., the parts of the hand used in palpation, the steps in the palpation process); students are guided physically—held, positioned—repeatedly over time until some level of competence is attained; students are encouraged to articulate what they are doing and why and what they feel as others work on them (think of how odd this would be in most real-world settings); students appropriate mediating devices (like the movement diagrams) to assist them in acquiring techniques and concepts, devices they will not use (at least as actual graphics) as professional therapists; and so on. All this, in some ways, makes the activities the students engage in different from—though still related to—those found in authentic practice. There is a great deal of strategic instructional alteration and mediation of tasks in *Ortho II*; if this were not the case, the practices of physical therapy would be overwhelming and, to a degree, be kept opaque, even secret.

Let me consider, in this regard, the notion of legitimate peripheral participation, “the process by which newcomers become part of a community of practice” (Lave and Wenger 1991:29). I will begin with an anecdote drawn from my studies of skilled work. An automotive class I observed was in some ways set up as a community of practice, with kids and the instructor hanging around cars that the students themselves, family, or friends would bring in for repair. The social structure pretty well matched the description of “legitimate peripheral participation”: students who were more skillful participated more fully in tuning and repairing the cars on the floor; others hung back, observing, occasionally assisting in less demanding ways; and some, over time, moved from periphery to center. But some did not. They hung out, looked on but looked around, occasionally did a few things, marked time. It was not a case of access to participation being blocked, a possibility Lave and Wenger illustrate (1991:76–79), but of there being no systematic and explicit pedagogical mechanisms to encourage, guide, and sustain involvement. To move into authentic practice does not rule out along the way a host of traditional teacherly devices, from the pep talk, to direct instruction, to the quick quiz. In fact, for some, full participation may require it; otherwise one gets a shadow involvement never leading to true participation and competence. Lave and Wenger (1991) astutely discuss the need, in a community of practice, for artifacts and activities to be “transparent” to newcomers—that is, open to inspection; I would simply suggest that pedagogic strategies not normally found in work sites

and social groups could facilitate transparency and access—and without compromising the conceptual power of practice theory.

To be sure, there is within the sociocultural and situated learning literature discussion of tutor or teacher guidance and assistance (e.g., Griffin and Cole 1984; Rogoff 1995; Stone and Gutierrez 1998). How could work emerging from a Vygotskian tradition not honor the role of the more knowledgeable other? But something happens rhetorically in some of this literature that has a narrowing effect on our understanding of teaching and learning. There is a sometimes implied, sometimes explicit critique of mass education and any procedures commonly associated with it—for example, lecturing, testing, direct instruction, structured curriculum—and, in line with a long progressive education tradition, there is a contrasting validation of social process, self-direction, exploration. God knows, the progressive critique of schooling, and its newer variations, bears much truth. But the critique tends to be quickly executed, a single-hued portrait of mainstream classrooms that has the unintended effect of stripping instruction from its setting. One of the significant contributions of sociocultural and situated approaches is that they acknowledge the role of historical and cultural forces in learning, yet they sometimes fail to consider historical, political-economic, or social-psychological contexts in which particular teaching methods have merit (cf. Cazden 1992: ch. 8; Delpit 1995; Walker 1996), thus obscuring the artfulness, strategy, and variability of what good teachers do in real-world settings (Rose 1995).

In an attempt to create a synthesis of current perspectives on learning, Greeno (1998) suggests that we incorporate into the situative perspective the behaviorist focus on the instructional steps necessary to foster skill acquisition with the cognitive focus on the informational processes involved in learning. Attempts at synthesis usually leave strong proponents of particular positions unsatisfied, but I think Greeno is on to something critical here: the necessity of specific study and articulation of the way learning transpires, the way change in performance occurs, explicitly, up close, in specific domains. For even if learning is justifiably defined as participation in authentic practice, even if it is entirely describable as a social phenomenon, we still need ways to articulate in detail the processes of such participation, what goes awry when participation does not occur or occurs in inadequate ways (cf. Erickson 1996; Gutierrez et al. 1995), how a teacher can intervene, yes, to change the social organization of the classroom, but intervene on the individual level as well—for so many variables are involved in the phenomenon of participation. It seems to me that if we are to assert the rich and nuanced character of activity and of real-world practice that belies, at every turn, attempts to easily categorize it, and if we are to honor the diversity of actors, the wide variability in the histories of participants, then how can we advocate a single conceptualization of how people become proficient? Nicole was right. Sometimes it does help to see things three different

ways, and some of those ways are not, at times, given their due in the sociocultural and situated learning literature.

Competence and Identity

As can be inferred by some of the vignettes in the body of this article, most students in Orthopedic Management II were developing, to varying degrees, an embodied understanding of the concept of resistance and a concomitant facility with the manual techniques to access it. They were getting a bit more adept at articulating the tactile; were applying, elaborating, focusing, and refining their "book knowledge" about anatomy and biomechanics through practice; were beginning to grasp diagnostic patterns across regions of the body; and were beginning to know with their hands. Jody and Martina, the two students who opened this article, whom I interviewed again toward the end of Ortho II, were on the path toward competence. To borrow Lave and Wenger's (1991) metaphor, they were no longer on the periphery—they were in some ways more central to the practice of physical therapy (though still with supervision and limits, experiential and legal) as they continued to develop an expertise that complicates mind and body.

There is significant literature on expertise—most of which emerges from a cognitive psychology paradigm—and, within this, a smaller literature on medical expertise (e.g., Patel and Groen 1991) which includes a handful of studies of expertise in physical therapy (e.g., Jones et al. 1994). This literature, in various ways, addresses the skills and understandings sketched in the previous paragraph. But in thinking about the students in Ortho II, I got a sense of other things going on, rarely discussed in the cognitively oriented literature on expertise but nicely captured in work of a more situated nature. As Miller and Goodnow put it, "The concept of *practice* recognizes that the acquisition of knowledge or skill is part of the construction of an identity or a person" (1995:9, emphasis in original). As expertise develops, it brings with it a socialization into the traditions and values of a community of practice, beliefs about the self, an orientation toward the world, a sense of possibility (Lave and Wenger 1991), and a motivating desire to "pursue increasing mastery of the skills, knowledge, and emotions associated with a particular social practice" (Eisenhart 1995:4).

Jody and Martina talked about noticing—outside of school—how people move, their posture, their gait. Though pressured by the rigors of their program, they spoke with excitement about pursuing orthopedics, or pediatrics, or athletic training—things seemed "wide open." They commented admiringly on the qualities and abilities displayed by Nicole, Tim, and Sydney and by the therapist who supervised their field placement, and they tentatively, hopefully, began to think that, as Martina put it, "from more experience, from hearing more people's stories—of what has happened to them and what they're going through—and . . . from hearing from other, more experienced therapists,"

from all this, they could project their own future competence. There was, amid the crush and frustration of their studies, desire and a sense of the future. Jody and Martina were beginning to imagine themselves as competent practitioners.⁴

I would think, and this is speculation, that before a course like Ortho II, it would be difficult to imagine expertise vividly, in detail. Before entering the graduate program, Jody, as mentioned, volunteered for three years in a physical therapy clinic, administering ultrasound, doing occasional light massage, and the like. Reflecting back on that experience, she said,

If I had this image [of the work], it was very rough. . . . I could maybe see the big picture, but I couldn't get very detailed about it. . . . Now, I mean, I find myself [thinking,] "Oh, that person," you know, "they walk a little more this way." . . . I start noticing more things and try to cue in and try to get myself to notice the finer points.

This is a retrospective account, of course, but if Jody's characterization is even partly accurate, it suggests an outcome of Ortho II that would be missed in most evaluations and in many studies of the development of competence. Through all the pedagogical mechanisms that we saw—from direct instruction, to the mixing of symbol systems, to cooperative practice, to a field placement—students begin to develop a proficiency that particularizes imagination, with consequences for motivation and goal setting. Jody's image of competence seems to orient her toward achievement. If we tend to segment mind from body, we also miss the possible connection between the precision of technique and the driving force of imagination, though, as Eisenhart's quotation suggests, technique, knowledge, planning and goal setting, identity, and fantasy might mutually reinforce each other as people develop skill in and understanding of a complex practice like physical therapy.

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Notes

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1. I use with permission the actual names of the school and the physical therapists. However, because the students still face multiple phases of testing and accreditation, I use pseudonyms for them.

2. A full treatment of the way images and understandings of the body are involved in the learning and practice of physical therapy is beyond the scope of this article. It is worth noting, though, that the cognitive-epistemological challenges facing students in regard to conceptualizing the body are formidable. They have to modify and enhance their commonsense notions of both the body and their own bodies as they use their bodies in new ways and act on other peoples' bodies and learn to interpret them. In addition, the different disciplines comprising their course of study—orthopedics, neurology, and so on—each has its own traditions and conceptual frameworks for understanding the body. (One could read the history of biomedicine as a history of the varied ways the body has been understood and represented.) All this, at the least, calls for significant elaboration of students' initial conceptions of the human body—theirs and others'.

3. A wonderful guide to this thinking through is the festschrift for Sylvia Scribner edited by Martin, Nelson, and Tobach (1995).

4. One of the anonymous reviewers of this article referred me to Hazel Markus and Paula Nurius's 1986 article "Possible Selves." "Possible selves," write the authors, "represent individuals' ideas of what they might become . . . and thus provide a conceptual link between cognition and motivation" (1986:954). Markus and Nurius's treatment of the role of imagined selves in behavior is as comprehensive and elaborated as mine is thin; all I would add is that particular instructional and training experiences might contribute a consequential particularity to people's conceptions of what they might become.

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