COURSE DIRECTOR: Alan Lesgold, Ph.D., Dr. h. c.
LOCATION: tba
TIMES: 1:00-3:00 PM
CREDITS: 2

Grading:
Letter Grades
Class Participation: 60%
Analyses of Instructional Cases: 40%

Text

Literature Resources (partial list)


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TOPIC I  
Wednesday, September 17  
Monday, September 22

Models of Medical Reasoning
- Rasmussen Skill-Rules-Knowledge Model
- Norman Seven Stages of Action

LEARNING OBJECTIVES:
- Understand the possible stages in responding to a situation with planned actions
- Understand the three kinds of competence that Rasmussen identified
- Be able to examine the performance of physicians during rounds and to classify their decisions and actions according to Rasmussen’s and Norman’s models

DESCRIPTION:
We introduce the basic idea that different kinds of cognitive activity are involved in medical decision making. Further, we explore two different views of the sequence of activity that can go on when a problem is confronted and addressed, such as the diagnosis and treatment of a patient.

ASSIGNMENT

NEEDED VIDEO EXAMPLES
We will need three examples of performance during clinical rounds. One will be a very straightforward situation in which the physician immediately recognizes a situation and takes a standard protocol-driven action. The second will be a situation in which a set of rules that trained physicians generally know is sufficient for reaching a diagnosis and an appropriate treatment. The third is a situation in which the standard diagnostic knowledge of physicians does not readily lead to a diagnosis and physicians must instead do extensive knowledge-driven problem solving.

ADDITIONAL INFORMATION

Rasmussen's SRK model
Rasmussen divides human performance into three levels, based on the information processes required by the task:
- Skill-based
- Rule-based
- Knowledge-based

According to Rasmussen, performance at the lowest level is skill-based. It is simple or automatic behavior following patterns that have been stored, in response to signals that have been learned. No interpretation work is involved. Above this level is the rule-based level for information processing. At this level, remembered knowledge must be used to correct mistakes according to established routines in a previously learned "if then" pattern. When more unusual problems arise, skills or rules are not sufficient. Information must be re-interpreted. Problem-solving skills are needed, since there are no established routines for correcting the mistake. Rasmussen calls this level the knowledge-based level, since it is marked by a flexible use of knowledge.
We can view the same model from a slightly different perspective, in which we consider all the ways that cognitive activity can proceed from one state to another:

**Norman’s Action Model**

Donald Norman put forth a model that is a bit different. It assumes that all levels are involved – to some extent – all the time. This is not all that unreasonable, and indeed many models assume a “horse race” between what would be lower and higher levels for Rasmussen.
Figure 1. Norman's seven stages of action (from Norman, 1968).
LEARNING OBJECTIVES

- Understand rule-driven processing
- Be able to write a set of rules for a particular set of diagnostic problems
- Be able to estimate the likely rules applied by a fellow in one or more examples presented via video

DESCRIPTION:
Cognitive activity can often be described as being driven by rules. Rules are IF-THEN relationships: IF a particular combination of goals and activated memories are present, THEN some combination occurs of new goals being set, new memories being activated, and actions being taken.

ASSIGNMENT
- Anderson, J. R. Cognitive Psychology and Its Implications, Chapter 8, 9.
- Follow up assignment will be to write the rule set that accounts for a particular video case. (will need a few cases short enough to write onto CR-ROMs for student use in completing this assignment).

NEEDED VIDEO EXAMPLES
Need a few relatively straightforward cases in which a small set of rules is applied to make a diagnosis and develop a treatment. Students will work to develop rule sets that match the behavior of the physicians in the example and will consider whether there are any “expert rules” that were not manifest or “buggy rules” that younger physicians sometimes apply.

ADDITIONAL INFORMATION

Rule-Based Performance (Anderson)
Anderson took the old psychological notion of the conditioned response and moved it to a cognitive level. So, he focuses on rules that are embedded in human cognitive capability in the form of IF → THEN relations, where the IF side of the relation is a cognitive state (i.e., information or a goal temporarily in mind or “activated in memory”) and the THEN side is a mental action (i.e., setting a new goal or bringing some new information to mind or making an inference or taking a physical action). Anderson then laid out a complete theoretical account, with substantial matching empirical validation, of how learning and thinking are driven by these automated cognitive rules and how new rules are acquired.

There are instructional approaches directly driven by the Anderson model. These will be discussed, along with the ways in which different kinds of learning activities might work given the Anderson view.

Schemas and scripts
Our culture provides us with scenarios for decision making, and these scenarios are major determinants of how we think and solve problems. We will explore the basics of the theory of such phenomena, called schema theory. The theory will be explained in the context of medical decision making.
TOPIC III
Wednesday, October 1
Wednesday, October 8
No class on October 6

The nature of automated sensorimotor responding

LEARNING OBJECTIVES
• Be able to recognize and analyze expertise needed to respond automatically to specific situations.
• Be able to develop a training plan to deal with a specific sensorimotor responding capability that physicians need to develop (likely a critical care emergent situation)

DESCRIPTION
We will explore sensorimotor responding, consider its strengths and weaknesses, and develop specific training regimens for some sensorimotor training that might be needed – or analyze some existing training approaches. Likely areas where sensorimotor capability is important include performing certain diagnostic procedures and responding to emergent situations.

ASSIGNMENT
Anderson, Chapter 4.

NEEDED VIDEO EXAMPLES
It might be useful to have a few video examples from initial critical care training that uses the simulation dummies, places where a situation must be recognized and responded to more or less instantly. Another possibility would be something like a difficult blood draw, where it would be possible to distinguish between immediate sensorimotor competence, say in finding a vein, and the need to move to a rule based level, perhaps to consider looking for another vein or using a different kind of needle. I’m open to possible alternative examples – perhaps involving auscultation or palpation of abdominal organs, but I’ll need help in figuring out what makes sense.

ADDITIONAL INFORMATION

The nature of automated sensorimotor responding
Quite a number of routine activities can be so automated as not to have a cognitive component. This is how we can do things faster than we can think, e.g., playing a fast piece on the piano or typing at high speed. We will explore some of the issues that arise in automated performance, and this will set the stage for further discussions under the topic of limitations on performance.

Automatic & effortful processes
• Automatic processes occur without conscious "thinking."
• Automatic processes don't interfere with each other or with effortful processes.
• Effortful processes occupy limited cognitive resources.
• Effortful processes require conscious "thinking."
• Effortful processes interfere with one another: doing more than one effortful process means doing all of them less well.
TOPIC IV
Monday, October 13
Wednesday, October, October 15

Knowledge based performance

LEARNING OBJECTIVES

- Become able to recognize situations in which knowledge-based processing is required.
- Become able both to design training that boosts needed knowledge for such situations and to teach fellows to monitor their performance and decide when knowledge driven performance is necessary, i.e., when does it become necessary to move from “Can I recall what to do here?” to “Can I figure out what to do here?”

DESCRIPTION

We will explore the most difficult kinds of diagnoses, situations in which the expert does not have a rule set “in stock” that will lead to a diagnosis. These are the kinds of cases that turn up in grand rounds, for example. They can arise when multiple causes are masking each other in ways that are not common, for example, when one disorder tends to decrease a particular indicator while another is occurring simultaneously that tends to increase that indicator.

ASSIGNMENT

NEEDED VIDEO EXAMPLES

We’ll need video from a few really hard grand rounds cases, along with enough information on what led to the final diagnosis so that the instructor can participate meaningfully in a class discussion of the case and how it got resolved. Cases from the New England Journal can be useful along with video of actual knowledge based problem solving.

ADDITIONAL INFORMATION

When there are not sufficient rules to handle a problem, one is forced to use overt, conscious inference processes and verbal knowledge to find a solution. Problems presented at grand rounds are often of this character. Earlier views of how to teach medical reasoning emphasized this knowledge level of processing. For example, students were urged to develop a differential diagnosis, considering in turn each of the possible diagnoses that might be consistent with the facts at hand. There is no question that every physician solves some diagnostic problems this way, but not all, and sometimes operating at the knowledge level interferes with performance, just as reciting all the chords and arpeggios might interfere with piano playing. Aspects of knowledge driven reasoning, especially case-based reasoning, will be considered under this topic.
LEARNING OBJECTIVES:

DESCRIPTION:
In this section, we will consider all of the ways in which human decision making is limited by structural and functional characteristics of human thought. We will return more substantially to the issue of medical errors later. In this part, we want to take up each of the areas of limited cognitive processing capacity.

ASSIGNMENT
Anderson, Chapter 10.


NEEDED VIDEO EXAMPLES
No video examples needed, but we do need about a half dozen examples of medical error cases. It may be possible to rely on the students to bring these up in class discussion – we should discuss that.

ADDITIONAL INFORMATION

Limitations on performance

Memory limitations
We have limited information processing capacity.

This is due to limitations in both the perceptual and response systems.

This limited capacity must be divided between simultaneous tasks.

Automatic (practiced) tasks require less attentional capacity.

There are multiple resources involved in attention.

Task interference is a function of overlap in resources, so depends on perceptual and response modality.

Context-specificity of knowledge
Knowledge acquired in one context may not be retrievable in different contexts. In the most extreme cases, changes of mood or moving from above water to under water (with Scuba gear) can result in lesser memory for newly learned information. As Whitehead put it, knowledge learned in one context may be inert in others.

Bounded rationality (Simon)
This matter can be seen both psychologically and economically. Simon was the first to realize that human reasoning is seldom thorough. People seldom put in the mental or material investment needed to make perfect decisions. For example, few people will spend hours on the web or visiting grocery stores to get the best price on oranges, yet all of us want to pay as little as possible for a given item of constant quality. Classical economic theory assumed that people act in their best interests. While this is true, it must be qualified by the now-well-established principle of bounded rationality. People do about as much optimizing of their decisions as they think is worthwhile. Coase received his Nobel prize in economics for demonstrating that the cost of optimization influences the extent to which optimizing occurs.
This concept is important to medicine more than in the past because it also can help us understand how much to invest in enhancing the reliability and accuracy of a diagnostic decision. Increasingly, learning how to make good diagnoses and achieve effective therapies for lowest cost is going to be a focus of medical learning and probably of medical teaching.

**Limits on understanding of probability (Kahneman)**
We will discuss the various fallacies commonly observed and best explained by Kahneman’s prospect theory. How to avoid being more upset about six out of 1000 patients dying than about a survival rate of .994.

**Non-monotone aspects of learning due to multiple levels of performance**
Because we can make decisions at different levels (remember Rasmussen) and using different knowledge bases for reasoning, it is possible to show temporary setbacks in performance. In little children, this happens when they temporarily substitute “goed” for “went,” (even when they had been using “Went” correctly for a while first) and in medical education, it happens when people move from purely probabilistic judgments to judgments driven by deeper medical knowledge and at least implicit consideration of possible alternatives that might be mistaken for the diagnosis that first comes to mind.
TOPIC VI
Monday, October 27
Wednesday, October 29

The value of learning by doing with reflection

LEARNING OBJECTIVES:

DESCRIPTION
In this section, we consider the basic model of training introduced by Lesgold and various others. The needed supports for effective learning by doing will be considered along with the opportunities for reflection after problem solving as an important component of learning.

ASSIGNMENT
Lesgold and Nahemow.

NEEDED VIDEO EXAMPLES
If examples are available of discussions among fellows after a diagnostic problem has been solved, these would be very helpful. Possibilities include summarizing of the decision process by a fellow, summarizing by a senior attending, discussions of diagnostic pitfalls encountered or avoided, and any other kinds of coaching that is driven by the opportunities presented by a just-completed piece of diagnostic work.
TOPIC VII
Wednesday, November 5
No class November 3

The role of practice

LEARNING OBJECTIVES

DESCRIPTION
We will consider what role practice plays in each kind of learning – skill, rules, knowledge – giving attention to what makes a practice session likely to be effective and also what instructional aids or techniques can facilitate each kind of practice.

ASSIGNMENT
Anderson, Chapter 3,6.

NEEDED VIDEO EXAMPLES
No examples needed
LEARNING OBJECTIVES:

DESCRIPTION
We will integrate the materials covered over the course by reviewing recent models of human error and relating them both to levels of problem solving activity and modes of learning and practice. We will return to Rasmussen’s and Norman’s theories and also consider Reason’s “Swiss cheese” model.

ASSIGNMENT

NEEDED VIDEO EXAMPLES
No examples needed.

ADDITIONAL INFORMATION
Norman’s taxonomy of errors

Norman (1983) divides all human errors into two major categories: mistakes and slips. Mistakes are errors of intention. Thus, in terms of the model of human action, mistakes occur at the level of inappropriate goals or intentions. Planning based on such goals or intentions cannot bring the system closer to the desired state except by chance. Slips are errors of execution. In terms of the model of human action, the goals, intentions, and plans are all correct (no mistake is in play), yet the executed action sequence deviates from the planned sequence. Mistakes occur as a result of errors in conscious processing, while slips occur as a result of automatic processing (Norman, 1990). This latter characterization of slips and mistakes, based on the distinction between automatic and effortful processes, is more coherent than is the distinction based on level in the model of action, because some slips do cause erroneous intentions. This will become apparent in the next section, which covers the subcategories of slips.

- **Mistakes—errors of intention & conscious processing**
  - Having the wrong goals
  - Having the wrong intention
  - Can't get closer to your real goal
  - Come from errors in effortful (conscious) processes

- **Slips—errors of execution & automatic processing**
  - Come from errors in automatic processes
  - slips in forming intentions
    - mode errors—forgetting what mode the system is in
    - description errors—insufficiently specifying an action
  - schemas
    - "scripts" that tell us what to do under different circumstances
    - activated by intention
triggered to control our actions when conditions are met

slips due to faulty activation or triggering of schemas (emphasized slips are most important for computer systems)

- unintentional activation
- capture errors—unintentionally doing a similar, but wrong, sequence
- data-driven activation
- associative activation—doing something related in meaning (a Freudian slip)
- loss of activation—forgetting what you were going to do in the midst of doing it
- forgetting an intention
- misordering steps in a sequence

Reason’s Swiss Cheese Model of Error
LEARNING OBJECTIVES

DESCRIPTION
We will review the literature on medical errors and consider, given what we have learned throughout the course, how different kinds of errors can best be prevented. In some cases, this will involve training, but in other cases, the best approach may be various safeguards that can be built into the care delivery system.

ASSIGNMENT


NEEDED VIDEO EXAMPLES
No video examples needed, but this section would benefit from the participation of one or two medical faculty.