CHALK TALK

Thinking about Thinking: Medical Decision Making Under the Microscope

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Case: A 36-year-old African-American woman, healthy except for treated hypothyroidism, visits you in clinic complaining of six months of fatigue and progressive shortness of breath with exertion. You thoroughly interview and examine the patient. Physical examination reveals conjunctival pallor and dullness to percussion one third of the way up both lung fields. Something tells you to ask her about skin rashes, and you learn that she has had worsening sun sensitivity for the past year. A light bulb goes on in your mind. Along with routine labs and a TSH, you order an antinuclear antibody test and a chest X-ray. You find the hematocrit to be 25%, the TSH normal, and the ANA to be positive at 1:1024. The chest film shows large bilateral pleural effusions. You make the diagnosis of systemic lupus erythematosis.

Elementary, right? But how did you arrive at *this* diagnosis as opposed to another? Coming to an accurate diagnosis is based on pattern recognition, algorithmic thinking, and deductive reasoning—all enriched by experience. We rely on these tools to parse through all the information that is presented to us. Making accurate diagnoses with incomplete and often contradictory information in limited time is the playing field of the internist. However, the very processes that help us think are likely to incorrectly bias our thinking and cause diagnostic error. In essence, our minds are sometimes misled not only by the facts themselves but also by *how* we think. The often helpful but sometimes dangerous shortcuts that we take in thinking are called heuristics.[1]

To explore the concept of heuristics, please take the following quiz.

Question 1: Consider Neil, a 44-year-old man from Santa Monica, California. He is well educated and athletic—he graduated from college with a degree in physics and has completed several triathlons. Neil is a veteran of the US Navy, where he served as fleet naval aviator and landing signal officer. Is Neil more likely to be: a) a librarian or b) an astronaut?

Question 2: Jot down a list of English words that begin with the letter "r" (e.g. rooster). Next, jot down a list of words that have an r in the third position (e.g. forsake). Is the letter r more likely to occur at the start of words or in the third position?

Question 3a: In *no more than 10 seconds*, estimate the product 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 = n, and answer quickly whether n is closer to a) 1,000; b) 10,000; c) 20,000; or d) 50,000. Mark your answer and move immediately to the next question.

Question 3b: Now, wipe your mind's "slate" clean, and again *in no more than 10 seconds*, start in reverse order, and estimate the product 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1 = n. Answer *quickly* whether n is closer to a) 1,000; b) 10,000; c) 20,000; or d) 50,000. Resist the temptation to calculate the exact answer.

Question 4: As it happens, your friend Katrina (a former Russian child chess champion and math whiz) passes by the Starbucks lounge chair where you sit answering question 3. You like Katrina but sometimes tire of the way she drops hints about her intelligence and math prowess. (How, you wonder, did she manage to tell you that she scored 800 on the math SAT?) It bugs you that she always says that her undergraduate degree from Princeton was in "mathematics." (Why can't she just say "math" like a normal person?) And it is especially irritating that Katrina now glances at the multiplication you have just tried to estimate in less than 10 seconds and says "20,160" before moving breezily along with her coffee. Having Katrina's input, are you tempted to change your answer to questions 3a and 3b? Go ahead, admit it. Aren't you now more confident that the correct answer is that the product is closest to 20,000?

Question 5: You have known your medical school roommate Justice for four years. You trust him absolutely and have confided in him many times. Justice is always smartly dressed, and he loves to shop. You are at a mall shopping with Justice when you briefly notice him down another aisle putting what looks like a belt into his knapsack. (In truth you can't tell whether he was putting the belt into the knapsack or taking it out, and if pressed you couldn't be 100% certain that it was a belt. You think nothing of this.) A few minutes later you are shocked to find two security guards interrogating Justice, accusing him of stealing a belt. Justice insists that the belt was already in his bag. It seems odd that the belt still has the price tag on it, but you trust Justice, assume that he is telling the truth, and stand by him in his argument with the security guards. Thinking back, you wonder how Justice affords the expensive clothes that he wears, given his modest income. Later that month, despite your appearance as a character witness at his trial, Justice is convicted of shoplifting and ordered to pay a $500 fine and to perform 40 hours of community service.

Given this new and quite startling development, will you:

a) Believe Justice's denial of guilt (he is after all your good friend whom you trust) and carry on as if nothing had happened?;

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Step	running product of: 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8	running product of: 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1
1	2	56
2	6	336
3	24	1,680
4	120	6,720
5	720	20,160
6	5,040	40,320
7	40,320	40,320

b) Begin to reevaluate your relationship with Justice, perhaps thinking twice about confiding in him as you have?; or
c) Jettison your friendship with Justice?

Discussion of Quiz Questions

Question 1. The description of Neil was crafted to vaguely characterize an astronaut—an intelligent, athletic, motivated man with a background in aviation and physics. If you are like many smart people who have answered this question, you therefore chose astronaut and fell victim to what is referred to as the *representativeness* heuristic.[1] In short, you ignored prior probability. According to the American Library Association (www.ala.org), there are approximately 122,000 US libraries, employing 150,000 librarians. (This does not count 190,000 other paid staff who work in libraries.) According to NASA (www.jsc.nasa.gov/Bios), there are 62 active astronauts. This means that the prior probability that an individual employed adult is an astronaut is 2,400 times greater than the probability that he/she is an astronaut. You argue, "But Neil is an athletic physics major who flew jets in the Navy, and he doesn't sound at all like a librarian!" Even taking into account his demographics and background, given only those two choices, the odds are still greater that he is a librarian than that he is one of NASA's 62 elite astronauts.

Clinical examples of the danger of the representativeness heuristic abound, and we are in daily danger of falling prey to it. Indeed, we are sometimes encouraged to use representativeness by the following admonition: "If it looks like a duck, walks like a duck, and quacks like a duck, it's a duck." However, if a "duck" appears in a part of the world where this would be unlikely, such as the Sahara Desert, perhaps one should reconsider the label or rename the creature something more broad, like "a feathered animal with wings and a bill, resembling a bird." Awareness of the danger of representativeness has given rise to the clinical maxim "an uncommon presentation of a common disease is more common than a common presentation of a rare disease."

Question 2. We daresay that most people had a harder time, worse luck, and scratched their heads more coming up with words that have the letter r in the third position than words that begin with r—our minds are just wired that way—even though the harsh reality is that English words starting with r are certainly less common than those having r in position three.[1] This is an example of the *availability* heuristic.

In medicine, when constructing a differential diagnosis we naturally have an easier time thinking of diagnoses that we are more familiar with. The danger here is that we will not include on our differential some diagnoses that may be more common than ones we have thought of but are less familiar to us. For example, when asked to list causes of petichiae in hospitalized patients, many physicians will include vasculitis and endocarditis (both of these causes are drilled into us during medical training) but forget to include NSAID-induced platelet dysfunction, which is more common. A variant of the availability heuristic is called *last case bias*, in which your experience with a particularly memorable case causes you to overestimate the likelihood of the condition in subsequent differential diagnoses. For example, if you recently had a pancytopenic patient who turned out to have hairy cell leukemia, which is exceedingly rare, you might overestimate the likelihood that your next pancytopenic patient has hairy cell leukemia, bypassing other more common causes of pancytopenia.

Questions 3a and 3b. How did your estimate of the product 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 compare with the same product shown in reverse order as 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1? If you are like most people, your estimate was larger when the product was presented in descending order.[1] This is because when estimating a product expressed in descending order, you are starting with higher numbers at the beginning of your calculation and you naturally estimate higher (see table).

This effect is called the *anchoring* heuristic,[1] and it describes how we often estimate by choosing a starting value and then making an adjustment to it. The problem with this method is that while the starting value might be easy to imagine, we often do not make enough of an adjustment.

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A clinical example of anchoring might arise in the following situation. Imagine that you are a second-year internal medicine resident and that you are called for a preoperative cardiac risk assessment of a 92-year-old man who had a myocardial infarction six weeks ago and has diabetes (on insulin), chronic kidney disease (creatinine 2.1), congestive heart failure, atrial fibrillation and a history of ventricular ectopy, critical aortic stenosis, and a history of a prior stroke. The patient is scheduled for urgent exploratory laparotomy for suspected intestinal perforation. Although new to preoperative risk stratification, you are familiar with the Revised Cardiac Risk Index[2] (RCRI) and are aware that the probability of untoward cardiac events in the highest risk patients in the RCRI is about 10%. On reviewing the RCRI you decide that your patient has more comorbid illnesses and is older than the patients in the RCRI, so you decide to take the 10% figure and revise it upward to 20%. Although this might seem like a generous estimate, the actual cardiac risk in this patient is far higher than 20% (using the original Multifactorial Index of Cardiac Risk in Noncardiac Surgical Procedures,[3] the risk would be 78%), but because you started ("anchored") at a low number, your final estimate was too low.

Question 4. By now you have probably realized that Katrina the math whiz was wrong about the product in question 3, which is actually closest to 50,000, not 20,000. (It is 40,320.) If she did in fact influence you, it is because we gave her a semblance of authority in math (or in "mathematics") and perhaps led you to think that we agreed with her conclusion. If you took the bait, you fell victim to a heuristic referred to as *deference to authority*. Because of Katrina's ability and her breezy confidence, you might have allowed her to change your thinking.

An example of deference to authority in medicine is presented in the following story relayed to you by a friend and colleague who is still shaken by her experience. A 31-year-old woman who was on oral contraceptives and smoked cigarettes returned from a trip to Africa on a direct flight from Nairobi to Newark and over the next two days started feeling short of breath and right calf pain. On the third day she began to feel sharp pain near her right diaphragm each time she took a deep breath. Your friend saw her in the emergency department, where the patient had a heart rate of 105 beats per minute and a respiratory rate of 22 breaths per minute with obvious splinting on deep inspiration. There was pitting edema of the right calf and foot, and deep palpation of the right calf caused the patient to wince. She ordered a pregnancy test (negative) and a PA and lateral chest X-ray, which showed a small area of consolidation or atelectasis in the right lower lobe. Concerned about pulmonary embolism (PE), your colleague also ordered a D-dimer, which came back elevated (Don't they always?) and a PE-protocol CT-angiogram (CTA) of the chest, which was negative for PE. Relieved that the CTA was negative, your friend started antibiotics for community-acquired pneumonia and tried her best to convince the patient to give up smoking. While finishing up the discharge paperwork, your colleague was alerted that the patient was in respiratory distress. Indeed she was—the patient rapidly became grey-blue and lost consciousness—with an SaO_2 of 50%. A "code blue" was called. Luckily, the patient was kept alive by bag mask ventilation and a timely dose of intravenous tPA, which dissolved the pulmonary embolism and rescued her from the brink of certain death.

The experience was quite upsetting to your friend. To her great credit, she decided to learn from her error. With a little research, she found that the sensitivity for PE-protocol CTA for detecting PE in subsegmental vessels can be quite low.[4] She realized that she had relied too heavily on the "authority" of the CTA and had ignored the very high pretest probability of pulmonary embolism, which should have prompted her to start anticoagulation and to pursue the diagnosis of pulmonary embolism further. "Authorities" that we commonly defer to in medicine are experts, diagnostic tests, "UpToDate", textbooks, and medical literature—much of the time these authorities steer us in the right direction. The problem is that authorities are not always correct.

Question 5. There is of course no right answer to question 5. It is meant to illustrate *premature closure*—a term that describes sticking by a conclusion that we have made despite evidence that the conclusion is wrong. Initially, our tendency might have been to stick by Justice and to believe his version of the story, despite the fact that he was caught red handed shoplifting and that we saw him do it. Premature closure, a type of anchoring heuristic, deserves special mention because it has been cited as the single most common cause of diagnostic error in internal medicine.[5] In

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medicine, attachment to a diagnosis can lead us to ignore information that does not fit that diagnosis. We can prematurely conclude that we have the right answer, essentially forcing a round peg into a square hole.

So how do we avoid falling into the thinking pitfalls outlined above? At present, the best method seems to be *maintaining awareness that your mind may be playing tricks on you*. Here are six questions to ask yourself that may help you avoid falling prey to your own cognitive biases:

1. Is a singular previous clinical experience, either positive or negative, influencing my decision?
2. Am I emotionally vested in my diagnosis being correct?
3. Have I considered more than two to three alternative diagnoses?
4. Do I understand the sensitivity and specificity of the test results that have helped me establish this diagnosis?
5. Have I revisited my original diagnosis and weighted all of the subsequent information since that time? After doing so, do I still feel confident in my diagnosis?
6. When thinking about a diagnostic possibility, do I start by realistically assessing the prior probability of the disease or condition?

Thinking about how we think as physicians is an important component of enriching our mental models about disease processes. It is integral to becoming a better physician and is something to be revisited every time we choose one diagnosis over another. Ultimately it can be a fun and enriching exercise. Sharpen your senses, and get to work!

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