

## Biases in Radiologic Reasoning

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*The most difficult subjects can be explained to the most slow-witted man if he has not formed any idea of them already; but the simplest thing cannot be made clear to the most intelligent man if he is firmly persuaded that he knows already, without a shadow of a doubt, what is laid before him.*

Leo Tolstoy [1]

**OBJECTIVE.** The purpose of this article is to outline common biases in medical reasoning that contribute to avoidable errors in diagnostic and therapeutic decision making.

**CONCLUSION.** By recognizing and understanding common biases in medical reasoning, we can more effectively counteract them.

**M**edical reasoning is prone to a number of biases. These biases contribute to avoidable errors in diagnostic and therapeutic decision making, with potentially adverse consequences for patients. Some of these errors represent classic logical fallacies that have been acknowledged by philosophers for centuries [2]. Others have been recognized only recently and are receiving considerable attention from other medical disciplines [3]. Studying biases in medical reasoning provides important insight into how physicians think [4]. It also offers practical advantages. Because radiologists make so many diagnostic decisions every day, these biases deserve special attention in radiology education. If we as radiologists deepen our understanding of such biases, we can do a better job of recognizing and compensating for them, helping to reduce future errors. This article reviews eight important types of bias: attribution bias, availability bias, commission/omission bias, confirmation bias, framing bias, hindsight bias, regret bias, and satisfaction of search bias. The first step in counteracting each is to recognize it and understand its effects.

### Attribution Bias

Attribution bias occurs when we ascribe characteristics to a person or thing simply because it belongs to a certain class [5]. Consider, for example, the potential impact of

misleading information on radiologic decision making. A requisition that misrepresents a patient's race, ethnicity, and even sex may lead a physician to underestimate or overestimate the probability of a particular diagnosis [6]. For example, sickle cell anemia may be overlooked as a diagnostic possibility if a radiologist does not know that the patient is African American. Another example is the clinical indication for an examination. If radiologists think they are interpreting the cervical spine radiographs of a patient with chronic neck pain, they may overlook subtle evidence of acute neck trauma.

Reasonable inferences can be made based on groups to which patients, examinations, and clinical scenarios belong. Yet clinical information is often imperfect, and the radiologist needs to inspect images on their own terms, in addition to viewing them in the light of clinical information. Stepping outside the network of assumptions that informs the referring health care team's perspective may enable the radiologist to make a diagnosis that no one else had considered. By recognizing our innate and learned tendencies to respond to people and things on the basis of classes to which we unconsciously assign them, we can make an extra effort to deal with each case on its own merits.

### Availability Bias

Availability bias, also known as heuristic bias, operates when we allow easily recalled

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experiences to exert undue influence on our diagnostic thinking, relying excessively on what we know best, even if it does not apply well to a particular case [7]. An old adage says, "When your only tool is a hammer, everything looks like a nail." Availability bias is well known in medical practice. For example, suppose the most recent pediatric patient with abdominal pain seen in the emergency department turned out to have ileocolic intussusception. For at least the next few days, intussusception is likely to figure more prominently in the emergency physicians' differential diagnoses when new patients present similarly. Availability bias is also at work when a physician accords undue weight to a colleague's prior diagnostic impressions.

Radiologists are subject to availability bias in three principal respects. First, as for all physicians, recent cases occupy a more prominent place in our memory and tend to exert greater influence in our diagnostic reasoning. This effect can be particularly striking in the case of a recent error, when the desire to avoid a similar mistake can prove especially strong. Second, radiologists can fall victim to availability bias because we tend to think of the diagnostic process strictly in terms of imaging. When a referring physician asks for diagnostic advice, the correct answer is not always a radiologic examination. In some cases, some other form of diagnostic evaluation, such as physical examination, serum chemistry assays, or biopsy, may be a more appropriate choice. Third, reading the report of a prior radiologic examination may lead a radiologist to overestimate the probability of a colleague's impression, a pitfall described by Leonard Berlin as "alliterative error" [8]. One way to compensate for this would be to examine the images first without looking at the report, formulate a diagnostic hypothesis, and only then look at a colleague's impression.

### Commission/Omission Bias

Commission bias operates when we feel the need to do something instead of nothing, even when there is no objective support for doing so [9]. This can occur in many contexts. For example, radiologists asked by referring physicians to recommend a radiologic examination for a patient may feel subtle pressure to suggest something, even if they know that imaging is unlikely to be helpful, as in performing a lower extremity sonography examination to rule out deep venous thrombosis in a patient with bilateral leg swelling.

Something similar may occur when radiologists are presented with a clinical question that lies outside their domain of expertise. Rather than admit they do not know, they may find it easier to make a poorly informed recommendation. Of course, the determining factor in medical decision making should be the best interests of the patient, not the reputation of the physician, and radiologists in such situations have an ethical obligation to admit their own limitations.

Omission bias is similar but inclines in the opposite direction. When errors occur, we tend to judge them more harshly when they have resulted from doing the wrong thing rather than failing to do the right thing, even though the consequences for the patient may be equally harmful. This is grounded in part in the Hippocratic maxim, "First do no harm," which tends to reinforce an attitude of conservatism. However, doing nothing is not preferable to doing something if there is good reason to think that something needs to be done. Physicians are not held to a standard of perfection; they need simply act reasonably on the basis of the information they have available.

A radiologist who is faced with equivocal imaging findings of a potentially life-threatening diagnosis such as an acute aortic dissection involving the ascending aorta may be reluctant to contact the referring physician directly for fear that doing so would result in immediate and potentially hazardous treatment for the patient. However, failing to make the call may be equally or even more dangerous. When urgent and potentially life-threatening diagnoses are in play, it is better for radiologists to share their concerns and be frank about their own uncertainty. Perhaps the referring physician has access to additional information that makes the diagnosis much more or much less likely than the radiologist can determine on the basis of imaging findings alone. When in doubt, it is probably better to err on the side of sharing information rather than withholding it.

### Confirmation Bias

Confirmation bias leads physicians to collect and interpret information in ways that confirm rather than refute their existing hypothesis [10]. Who does not prefer to have his or her judgment vindicated? Who does not wince at the prospect of being shown to be wrong? And yet, the truth of the patient's diagnosis must take precedence over the reputation of the physicians. Better to be

proven wrong and save the patient's life than to carry on protesting our unflinching accuracy right through the patient's funeral.

A radiologist who has stated that a vertical line overlying the lung on a chest radiograph represents a skin fold may not look for additional evidence that it represents a pneumothorax, or may interpret such evidence in a way that supports the skin fold hypothesis. This tendency can be dangerous, in part because first impressions are not always accurate. One means of counteracting this bias is to examine and then reexamine the evidence, including alternative hypotheses, before stating a conclusion that may be psychologically difficult to retract at a later time.

### Framing Bias

Perhaps the most important of all biases in medical reasoning is framing bias, which concerns the fact that we can often get opposing answers to the same problem, depending on how the problem is posed. One well-known example concerns how consequences are stated. If we say that a new medical tool will enable us to save 300 out of every 1,000 patients, we tend to adopt a "gain" frame of mind, in which risk aversion is relatively high. On the other hand, if we stress that without the new medical tool, 700 of every 1,000 patients will die, a "loss" frame of mind leads us to tolerate higher levels of risk [11]. In radiology, there is considerable evidence that clinical data affect diagnostic accuracy [12, 13].

How ideas are presented powerfully influences what we take them to mean. For example, the American Trial Lawyers Association recently sought to enhance its public reputation by changing its name to the American Association of Justice. There are similar instances in radiology's own history. The term "nuclear MR," which reminded many patients and health professionals of nuclear power and nuclear bombs, was replaced by "MRI." Changing the name had no effect on the radiation exposure of patients undergoing MRI, but it went a long way toward allaying nuclear anxiety.

One practical lesson of framing bias for radiologists is to resist the temptation to accept narrow cognitive frames. A particular symptom, sign, or imaging finding framed in the context of one anatomic-physiologic system may distract the radiologist from the possibility that another system is involved [14]. Just because a patient is referred by a gastroenterologist does not mean that the

patient's disorder lies in the gastrointestinal system [15]. Avoiding framing bias and also helping other health professionals to do so can be one of radiology's most important diagnostic contributions. In dealing with various specialists, radiologists can step outside narrow disciplinary boundaries and examine patients' cases from a truly interdisciplinary perspective.

### Hindsight Bias

Hindsight bias is ubiquitous in medicine. It refers to our tendency to overestimate the probability of a particular diagnosis when we already know, in retrospect, the correct diagnosis [16]. It might be called the "I knew it all along" bias [17]. For example, a radiologist who offers a differential diagnosis consisting of six or more possibilities on first reviewing a case may be inclined to shorten the list to two or three possibilities when discussing the case several weeks later in a case review conference. Some observers might respond, "In view of the fact that the diagnosis is already known, what is the harm in this?"

In fact, hindsight bias can lead to several difficulties. First, it can burden trainees with unrealistic expectations regarding their own level of certainty. Unaware of the role of hindsight bias when they hear cases discussed, they may feel inadequate because they cannot match the apparently spontaneous but in fact retrospective confidence of a more senior discussant. Second, it can create a misleading impression that some radiologists—namely, those who happen to be viewing cases through the "retrospectroscope"—are more astute than others—namely, those who initially consulted on the case. Finally, hindsight bias can take a toll on the character of those who fall victim to it, because in essence it is a form of self-deception that can foster a habit of mendacity.

Hindsight bias is strongly related to self-serving bias, which is the tendency to take more credit for successes than failures. When we get the answer right, we may talk as though all credit is due to us, but when we are wrong, we may be inclined to blame extraneous factors over which we have no direct control. This is hazardous conduct because over time colleagues may come to believe that we cannot view our own practice as objectively as we should, or even that we are deluding ourselves. This is one instance in which a dose of humility, even the ability to laugh at ourselves, can prove salutary.

### Regret Bias

Regret bias is directly related to a phenomenon commonly described as "defensive medicine" [18]. It occurs when physicians overestimate the probability of a serious or life-threatening diagnosis because of the remorse they would experience if the diagnosis were missed [19]. This attitude can result in unnecessary inconvenience, risk, and expense for patients and the entire health care system when physicians order questionable tests or perform questionable procedures out of a concern that they cannot afford to miss a particular diagnosis. For example, physicians may order head CT examinations in patients with severe headache even though they are nearly certain that subarachnoid hemorrhage is not responsible.

Radiologists need to understand regret bias for several reasons. First, it is again important to recall that physicians are not held to a standard of perfection. The consequences of missing a diagnosis are not so dire that the radiologist needs to recommend every available imaging examination "just in case" one might turn out to be positive. Second, radiologists need to be prepared to offer frank assessments of the appropriateness of different imaging examinations in particular clinical situations, and to support referring physicians who make a reasonable choice to forgo imaging. Third, radiologists need to continue to play an active role in developing evidence-based criteria for the appropriateness of different imaging examinations.

### Satisfaction of Search Bias

This bias is particularly well known in the field of radiology; it refers to the tendency to terminate the search for abnormalities once an abnormality has been found [20]. There is, of course, no guarantee that every patient has one and only one finding, and often the first finding the radiologist notes may be the lesser of two or more abnormalities. Even if a highly important abnormality is identified, it is important to proceed with a systematic inspection of each imaging examination to ensure that no additional abnormalities are missed. The radiologist's goal is not to find an abnormality, but to provide a complete diagnostic assessment.

One pitfall concerning satisfaction of search bias is the referring physician who brings the radiologist a study and asks for assessment of a single image, imaging finding, or diagnosis. Of course, it is important to respond to the specific clinical

question, but there is danger in doing nothing more. If the radiologist merely answers the referring physician's question, additional important findings may be overlooked if the radiologist does not inspect all the images. An effective response to this pitfall is to take the time to formulate a more comprehensive assessment. If this is not possible at the moment, the radiologist can always do so at a later time. Computer-aided diagnosis has important implications in this area [21].

### Conclusion

Our cognitive apparatus is prone to stereotypical biases. The appropriate response to the existence of such biases is not to pretend that they do not exist or that we can somehow operate on a plane above them. Instead, all radiologists need to own up to the fact that each of us is subject to biases and do our best both to recognize and to understand them, for only in understanding can we effectively compensate for them. As nineteenth century English artist Benjamin Haydon wrote, "Fortunately for serious minds, a bias recognized is a bias sterilized" [22]. The treatment for the affliction of bias is knowledge.

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