Why We Miss Things: The Science of Perception

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Medical errors are common and can affect overall patient care. Radiology is integral in many aspects of overall patient care, and radiologists play a critical role. As such, radiologists can affect patient morbidity and mortality as a consequence of diagnostic error. Radiologists must recognize common forms of bias and become familiar with methods (both internal and external) to minimize them.

Diagnostic errors account for a significant cause of patient morbidity and mortality and are an understandable source of anxiety for patients, clinicians, and radiologists alike. The contribution of cognitive bias to diagnostic errors within radiology is well described, with Garland [1] first discussing differences in interpretations of chest radiographs. Since then, research has delved into the potential causes of diagnostic error and provided insight and a framework for understanding the basis of these errors and potential avenues for mitigation [2].

Cognitive Processes

Kanehman's [3] Nobel prize-winning work first described critical concepts to understand cognition. In this framework, decision making can be divided into type 1 thinking (heuristics) and type 2 thinking (logic). Type 1 thinking is quick and involves mental shortcuts [4]; it is the muscle memory or gut reaction thinking necessary to accommodate the flood of millions of bits of sensory information processed by the brain at any given moment. Type 1 thinking allows one to make split-second decisions using limited available information, often based on experience, but it is also highly susceptible to cognitive bias. Type 2 thinking is slower and more deliberate. It is often used in completely novel situations. In radiology, an analogy would be the amount of time spent reviewing a head CT study for the first time by a 1st-year radiology resident. The student would spend a significantly longer time reviewing the study, looking slowly and intentionally for each structure (type 2 thinking), potentially with an inefficient search pattern. Compare this to the amount of type spent by an experienced attending radiologist reviewing the same head CT study. Search patterns in this practitioner have become automatic (type 1 thinking) with attention to high-yield areas for pathologic entities and common blind spots that is based on experience. This muscle memory interpretation is what allows speed and efficiency, but it may also open the door to cognitive errors in diagnosis. A further challenge is that type 1 thinking becomes more common as an individual gets older, as more and more processes become compartmentalized [4]. Although this shift allows greater efficiency, it also creates greater opportunity for cognitive error.

Errors can occur at any time in the process, from initial perception to final image interpretation. In addition to internal factors, systemic sources can also contribute to diagnostic errors in medicine [4, 5]. In this chapter, common errors along the path from initial perception to final interpretation will be reviewed and potential means for mitigating diagnostic errors will be discussed.

Perceptual Error

Errors in perception account for a large majority of interpretive errors in radiology. A number of factors contribute to errors in perception such as overall lesion conspicuity, including degree of contrast and border demarcation from adjacent soft tissue [5, 6].

Interpretive Error

More than 30 types of cognitive bias have been described [7]. The most commonly encountered forms of bias in diagnostic imaging include anchoring bias, confirmation bias, framing bias, availability bias, premature closure, inattentional blindness, and hindsight bias.

Anchoring Bias

Also known as focalism, anchoring bias refers to the common human tendency to place undue influence or anchor on an initial diagnostic impression, despite later information to the contrary [5, 8, 9]. A radiologist's initial gut reaction to a case, possibly made with limited initial information, can be difficult to deviate from and can potentially lead to useful information being disregarded.

Confirmation Bias

Conceptually related to anchoring bias is confirmation bias. In this case, data supporting an initially suspected diagnosis are sought, and contrary information is given less significance [8, 9]. As a result, diagnoses can be delayed, and potentially unnecessary procedures can be performed [10]. Further, this type of bias may also be encountered in the academic setting with attending

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radiologist review of preliminary reports by radiology trainees [11].

Framing Bias

In framing bias, different final diagnostic impressions can be made with the same information depending on the presentation of initial clinical information. In clinical context, different conclusions can be drawn from the same imaging study depending on the provided clinical history [10, 12]. Preliminary clinical history can be limited and potentially misleading [13, 14]. Further, the specialty of the referring physician may also be an influencing factor [10].

Availability Bias

In cases of availability bias, recent information is given undue influence in diagnostic decision making [15]. Recently missed diagnoses may linger in the mind of a radiologist and allow him or her to attribute a rare diagnosis in a case that they may otherwise have not. For example, a radiologist labels a case as "septic arthritis with osteomyelitis" on elbow MRI, only later to find that the case was acute lymphoblastic leukemia. This error might lead the radiologist to diagnose leukemia on more routine cases of osteomyelitis, even with confirmatory laboratory and clinical findings supporting that diagnosis [9]. On the opposite end of the spectrum is the concept of nonavailability bias; that is, diagnoses that are rarely encountered are rarely considered [9]. A variation of this bias is alliterative error, or satisfaction of report, commonly encountered in radiology as a repeat of a prior report's impression, even if this might not have been interpreted in the same way de novo. This error has been reported as the fifth most common cause of diagnostic errors by Kim and Mansfield [16].

Premature Closure

Premature closure, the interpretation of initial conclusions as being final, is the overall most common type of error within clinical medicine [12, 17]. This error includes the concept of satisfaction of search, in which an interpretive process is considered finished once an initial abnormality or finding is identified.

Inattentional Blindness

In the case of inattentional blindness, findings may be missed owing to their unexpected nature or their location at the periphery of the image. Corner shot findings on a radiograph or findings on the final images of a cine clip of an ultrasound are examples of potential causes of inattentional blindness [16, 18–20].

Hindsight Bias

Hindsight bias is described as the tendency to de-emphasize the difficulty in making an initial diagnosis after the fact. This bias can occur in group settings including tumor boards, clinical conferences, and medicolegal settings and can prevent realistic assessment of challenges faced with complex initial diagnoses [9, 21].

External Factors

Interruptions are a common occurrence in a busy practice with visiting clinicians, telephone interruptions, and technologist requests. In the face of these interruptions it is easy for radiologists to lose their trains of thought and potentially deviate unknowingly from their typical search patterns. These interruptions have been shown to lengthen interpretation times and reduce accuracy in abnormal cases [22, 23].

Methods of Mitigation

Metacognition

A potential means of partially addressing cognitive bias is the concept of metacognition; that is, an individual can evaluate one's own thought processes [22]. Metacognition involves introspection of one's thought processes and seeking outside perspectives.

Minimizing Interruptions

Although radiologists must balance providing high-level service to referring clinicians with efficient use of their time, methods for minimizing interruptions are critical [5, 16]. Employing reading room assistants to field and triage calls can provide a first line of screening for telephone calls to aid in reducing interruptions [24]. Further use of text messaging services can also allow radiologists to communicate findings efficiently and document exact conversations [25].

Structured Reporting

Structured reporting provides a checklist-style framework for reporting that allows reminders for interpreting radiologists to review all relevant anatomy. For trainees, this process also allows the development of desired interpretive search patterns [26].

Radiologic-Pathologic Review

Follow-up on challenging cases either through quality-control conferences, tumor boards, or personal review of cases is critical for improving and expanding radiologists' interpretive skills. Supportive and educationally oriented environments can allow meaningful discussion and review of diagnostically challenging cases.

Computer-Aided Diagnostics

Use of increasingly powerful means of computer-aided image interpretation provides another potential tool for radiologists to improve diagnostic accuracy and increase confidence. The current effectiveness of computer-aided detection within areas such as mammography has not been shown to be improved over interpretation without computer-aided detection [27]. However, there is growing potential for applications in multiple other areas with use of neural network–based approaches [28].

Conclusion

The impact of bias in radiologic interpretation can be substantial, with potential implications in patient outcomes. Better understanding the forms of bias, related to both internal and external pressures, can allow radiologists to implement methods for mitigating these biases.

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