Editorial

Mental Traps That Impact Diagnostic Imaging

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Daniel Kahneman reinforced and popularized the idea of two distinct modes of thinking.[1] System 1 relies on pattern recognition, detecting simple relationships, correlating stereotypes, and associating ideas in a search for coherence. It is fast, intuitive, automatic, and requires little or no effort or energy. It cannot be turned off and continuously monitors the environment, driven by a survival need rooted in our ancestral past. System 2, on the other hand, demands attention, compares objects based on various attributes, and makes deliberate choices among options. It evaluates scenarios using logical and statistical reasoning. Because it requires attention, its activity is interrupted when that attention is diverted. Therefore, tasks that require effort interfere with one another (for instance, making a turn while driving and performing a complex calculation simultaneously is impossible). However, System 2 is slow, deliberate, effortful, and orderly. The two systems are interconnected: System 1 effortlessly generates impressions and feelings that serve as the main source for the explicit beliefs and deliberate choices made by System 2. In daily life, we often make decisions based on heuristics—mental shortcuts closely linked to System 1—used to save time and energy. While extremely efficient, this faster way of thinking opens the door to cognitive biases, which are systematic tendencies that distort logical reasoning and lead to flawed decisions.

The causes of error in diagnostic medicine can be categorized into two main groups: perceptual errors and interpretive errors. Perceptual errors occur when an abnormality is present on the image but goes undetected. These may be related to image acquisition, post-processing, or equipment quality. Interpretive errors arise when the abnormality is seen but its significance is misunderstood. In such cases, cognitive biases may be involved and are estimated to account for up to 74% of diagnostic errors.[2-4] Approximately 30 types of cognitive biases have been described in literature.[5] In diagnostic imaging, the most relevant include anchoring, confirmation bias, availability bias, attribution bias, framing effect, and satisfaction of search.[2-4,6]

Anchoring refers to the disproportionate influence of initial impressions or salient information — typically presented at the beginning of a case — on subsequent analytical processes. This bias occurs when a clinician remains fixated on an initial hypothesis and fails to adequately incorporate new clinical or imaging data that emerge during the diagnostic investigation. It is a phenomenon linked to the so-called "anchoring effect," in which the first piece of information received tends to exert a significant impact on decision-making. A classic example involves numerical estimation: when a group is asked whether the Golden Gate Bridge is more or less than 2,500 meters long, and then prompted to estimate its actual length, the responses often cluster around the suggested figure — demonstrating anchoring to the initial reference. This bias becomes even more detrimental when combined with confirmation bias. In such cases, the reasoning process begins with a belief or preconceived notion, so that information supporting this initial hypothesis is readily accepted, while contradictory data are more easily dismissed.

Another important bias is availability bias, which refers to the tendency to judge the likelihood of an event based on how easily it comes to mind. The most readily available information is typically the most recent, frequent, or emotionally charged (especially if extreme, vivid, or negative), and therefore tends to be considered first in the diagnostic process. Attribution bias occurs when certain findings are interpreted based on patient characteristics or stereotypes — usually derived from clinical history. Factors such as ethnicity, geographic origin, or age group may influence diagnostic reasoning, as certain genetic or infectious diseases have higher prevalence in specific populations. A common example is the tendency to underestimate the likelihood of atherosclerotic coronary artery disease in young patients presenting with acute coronary syndrome.

One of the main strategies to mitigate the impact of these biases is to analyze imaging studies without clinical context initially, followed by a subsequent review in light of the clinical scenario. This approach is also useful in addressing the so-called "framing effect," in which different diagnostic conclusions may be drawn from the same information depending on how the case is presented. The way the clinician describes the case or formulates the imaging request can influence interpretation — sometimes in suboptimal ways. It is well established that appropriate clinical information tends to enhance diagnostic sensitivity without compromising specificity. However, imaging requests are often incomplete, inadequate, or, in some cases, incorrect.

Satisfaction of search is another cognitive bias frequently encountered in radiologic practice. It refers to the decrease

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in vigilance or attention to additional abnormalities after the first finding has been identified. Naturally, the likelihood of detecting a second or third abnormality diminishes once an initial anomaly has been recognized.

Several other biases may also be present, all of which have a direct impact on everyday medical practice. When these are understood as cognitive traps, a critical question arises: how can they be avoided? Metacognition[3] — defined as "thinking about one's own thinking" — is a multifaceted process that involves recognizing the limitations of memory, understanding the context and perspectives that influence decision-making, and cultivating self-awareness and critical reflection. These strategies aim to promote conscious questioning of the main sources of cognitive bias. However, evidence regarding their effectiveness in reducing diagnostic errors remains inconclusive.

Although artificial intelligence-based methods[7] hold promise in supporting diagnostic decision-making in imaging, with the potential to mitigate cognitive biases, studies have shown that these systems can internalize certain preexisting biases and introduce new ones inherent to the models themselves, ultimately compromising clinical outcomes.

For the foreseeable future, it will remain the human perspective — grounded in knowledge and experience — that serves as the primary driver of clinical decisions. When this central role is combined with a deeper understanding of our own cognitive processes and a humble acknowledgment that the capacity for error is as intrinsic as the ability to perform with expertise, a new pathway emerges. This path leads to a culture that embraces error recognition, fosters learning from mistakes, and, consequently, enhances strategies for bias mitigation.

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