Bias

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A cognitive bias refers to any systematic deviation from accuracy or "rationality" in judgment and decision-making. Some commonly examined biases include the following: *confirmation bias* (the tendency to interpret new evidence as confirming one's existing beliefs); *hindsight bias* (the tendency to overestimate one's ability of forecasting known outcomes); *base rate neglect* (the tendency to ignore general information and instead focus on specific information); and *sexual over-perception* – the tendency for men to over-perceive sexual interest in others. Simon (1955) first proposed that people use simple mental shortcuts (*heuristics*) for judgment and decision-making, leading to what appears to be biased decision-making. The "heuristics-and-biases program" achieved greater prominence as a result of the publication of Tversky and Kahneman's (1974) seminal *Science* paper. Tversky and Kahneman's work has largely focused on understanding heuristics and biases as *errors* in judgment and decision-making. That is, heuristics and biases were seen as violations of the standard utility-maximizing "rational" economic model of decision-making. However, this approach of understanding heuristics and biases as "errors" rather than products of adaptive decision-making processes has been widely criticized, especially by evolution-minded researchers.

A more contemporary, evolution-informed understanding suggests that cognitive biases may arise for three possible reasons. First, the use of mental shortcuts (*heuristics*, which reflect bounded rationality) may have systematic breakdowns, which lead to errors. Second, some errors in decision-making may have had (historical) asymmetries in their fitness cost, with the consequence that organisms evolved to favor errors that had the lowest net cost (manifesting in *error management biases*). Third, people may appear to make systematic errors because the laboratory tasks or evaluation standards used to measure such "errors" were unnatural and incompatible with the design of the human mind (manifesting in *artifacts*; reviewed in Haselton et al., 2009). In the following, we review each source of cognitive bias briefly.

Biases as a product of bounded rationality. Traditional economic utility-maximizing models of decision-making assume that actors have accurate and complete information, enough time to assess all decision alternatives, and enough cognitive capacity to go through a complete deductive process. The *bounded rationality* approach suggests that most decisions are products of simple heuristics that are cognitively efficient and robust to diverse environments (Gigerenzer & Selten, 2002). Moreover, research has demonstrated that heuristics often have high ecological validity. Some evidence suggests that heuristics operating on limited information are superior to decisions made with complete information (e.g., Gigerenzer & Goldstein, 1996; reviewed in Todd & Gigerenzer, 2007). However, while effective in a wide variety of circumstances, heuristics are prone to breakdown in systematic ways, leading to biases in judgments and decision-making (Tversky & Kahneman, 1974).

The hindsight bias, for example, has been demonstrated to be at least partly a product of bounded rationality. This bias has been hypothesized to be a product of a memory-updating heuristic when decision-makers do not have access to memory cues. Supporting this hypothesis, the hindsight bias is reduced when participants are given relevant memory cues (reviewed in Blank & Nestler, 2007). Some theorists argue that biases resulting from heuristics are due to the methodological neglect of decision environments. They argue that cognitive abilities were designed for specific environments and problems, and that these abilities cannot be properly understood or assessed when studied out of context (e.g., Gigerenzer, Todd, & the ABC Research Group, 1999). Expanding on the importance of ecological rationality, evolutionary theorists posit that ancestral environments should also be considered when investigating biases.

Error management biases. *Error management theory* (Haselton & Nettle, 2006) suggests that some biases reflect adapted preferences for errors with lower fitness costs. When inferring the presence or absence of a target in a stimulus, judgments can be falsely positive or falsely negative. However, false positives and false negatives cannot be simultaneously eliminated. Traditional signal detection theory (Tanner & Swets, 1954) posits that instruments should instead be biased towards the least costly error. Error management theory thus integrates evolutionary logic and signal detection theory.

Error management theory posits that biases are shaped by historical fitness costs. For example, the sexual over-perception bias can be explained by the potential costs of searching for a receptive mating partner (Haselton & Buss, 2000). Falsely perceiving sexual interest (false positive) costs an individual courtship effort, whereas failing to perceive sexual interest (false negative) costs a reproductive opportunity. Since men do not have to make the metabolic investment in gestation and lactation, a missed reproductive opportunity carries a far larger cost than a wasted courtship attempt (Haselton & Buss, 2000). Error management theory posits that certain biases exist because of environments and challenges that are proxies of fitness. However, biases can also arise when humans reason in environments that are unfamiliar to the evolved mind.

Biases as artifacts. Some evolutionary theorists argue that many documented instances of biases are actually artifacts of unnatural research designs. These theoriests argue that humans are functionally rational when reasoning about evolutionarily relevant information (e.g., Cosmides & Tooby, 1996). However, biases can occur when either the problem format or the problem content are incompatible with a mind shaped by natural selection.

Human bias is often inferred from inaccuracy when estimating probabilities or likelihoods (Tversky & Kahneman, 1974, 1983). Biases stemming from innumeracy, for example, might only occur because humans are not suited to reasoning with percentages and probabilities. Humans should be more proficient at estimating likelihoods when they are framed as discrete, naturally occurring events (Gigerenzer, 1997; Cosmides & Tooby, 1996). For instance, organisms must understand their probability of success when deciding whether to hunt a specific animal. However, organisms did not experience rates of success as percentage values or odds ratios. Instead, successes and failures were likely historically recalled as individual events. For example, consider someone projecting the success of a hunting attempt. It is likely that inference of the probability of success should be a product of the frequency of recent attempts (e.g., three of the last ten hunting attempts were successful), rather than a product of a percentage probability (e.g., 30% of hunting trips end in success). Consistent with this hypothesis, people are more accurate at making predictions when questions are framed as natural frequencies, rather than probabilities (reviewed in Gigerenzer & Hoffrage, 2007). The extant research suggests that many instances of bias might not necessarily be errors. Rather, such biases may be better understood as the consequence of the incompatibility between stimuli and mind.

The heuristics and biases program has demonstrated that human reasoning often deviates from utility-maximization and norms of rationality. Biases can impact outcomes in judicial, economic, and medical settings (e.g., Harley, 2007). It is thus important to understand the functional, evolutionary reasons for bias in order to develop effective interventions. Theories that only assume that biases are the result of flaws in the human mind are limited in their explanatory power. By contrast, ecological and evolutionary theories have produced many testable (and empirically supported) predictions about the nature of bias. In particular, cognitive mechanisms that manifest in biases reflect the importance of the historical (and contemporary) structure of decision environments, as well as the importance of problem formats and contents.

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