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4. Understanding the Role of Cognitive Processes in Decision Making: Implications in Practice

Prof. Nishit Singh

Humans alone do calculus, travel in machines with global positioning systems, search for life beyond our planet, and store information about how to do so in digital repositories accessible around the world. But none of these feats are hardwired in the human brain, nor were any of them invented de novo by a single enterprising individual.

Instead, all of these accomplishments depended on the accretion of thousands of years of incremental progress and a cognitive and cultural system that allowed (and motivated) individuals to acquire and transmit accumulated knowledge and skills (Tomasello M et al, 1993).

Organisms adopted cognitive biases rather than relying on conscious calculation.

The motives can be:

1. Speed- Cognitive Biases lead to rapid responses than the grinding demands of "expected utility calculations central to rational choice
2. Efficiency- Cognitive Biases are likely to have been biologically cheaper to produce, as well as more effective.
3. Evolvability- Cognitive Biases are likely to have been more readily available due to pre-existing cognitive machinery; and
4. Adaptive Landscape- Cognitive Biases may have been a small step up the slope of a local optimum in biological fitness (a "fitness peak," in the parlance of evolutionary biology), even if a better solution lay across a "valley" that natural selection could not cross.

According to Daniel Kahneman, "*We are prone to overestimate how much we understand about the world and to underestimate the role of chance in events.*"

The dual process model—our mind has two distinct operating systems, which he calls System 1 and System 2. System 1 represents fast, intuitive, and effortless choices, whereas System 2 represents deliberate, difficult ones. An example of System 1 interfering with System 2 is the Stroop effect.

Kahneman also asserted that "When System 1 runs into difficulty, it calls on System 2 to support more detailed and specific processing that may solve the problem of the moment." When it comes to the Stroop effect, System 1 (our automatic, fast thinking) seeks to find the quickest pattern available.

Kahneman believes by understanding how our brains make connections, we can overcome them to reach more logical conclusions by calling on System 2, our controlled thinking, quicker.

Introduction:

Cognition is a designed process of understanding using/relying on individual thinking processes, acquired knowledge, experience, and enabling senses as it stands out to carve and create as one of the vital aspects of human existence.

Since the earliest moments of human evolution to the complexities of modern-day society, cognition has been the cornerstone of the human ability to perceive, reason, explore, and solve problems and issues, and develop tools that enable need fulfilment, future growth, and survival (Sweller, 2003, 2020, 2022; Sweller and Sweller, 2006; Sweller et al., 2011; Paas and Sweller, 2022).

The evolution of cognition, and its applications in human learning, development, and evolutionary processes bring far-reaching impacts and have not only shaped individual lives but societies and civilizations too.

Evolution of Cognition: The journey of cognition can be traced to the earliest period of humanity when our ancestors grappled with the challenges of survival in a raw, harsh, and unpredictable environment (Pringle, 1951; Campbell, 1960; Popper, 1979; Mesoudi et al., 2004; Reisman, 2013; Kouvaris et al., 2017) . Over the millennia, the human brain evolved, becoming increasingly sophisticated in its capacity to process information, solve problems, and adapt to changing circumstances. The basic/primal cognitive abilities of early hominids to the currently sophisticated intricate neural networks of modern humans, cognition has undergone a huge evolutionary journey, reflecting the relentless drive of our species to understand and conquer the world.

Application in Human Processes: Cognition precedes and permeates most aspects of human action and activity, shaping how we perceive, learn, remember, and interact with the world. It provides undertones for our linguistics ability (Carpenter M et al, 1998) , (Brooks R et al, 2005) , creativity, decision-making, and social behavior. Through cognition, we make sense of our surroundings, solve complex problems, and innovate solutions to challenges before us.

In the field of education, cognition helps choose teaching methods and learning strategies, while in healthcare, it influences diagnoses, treatments, and interventions. In the realm of technology, cognitive science drives advancements in artificial intelligence and human-computer interaction, blurring the lines between human and machine cognition.

The Impacts of Cognition- Exploring Consequences for Teams and Societies:

The effect and impact of cognition on teams and societies is also of great significance as it serves as the bedrock upon which societies have been built over the period and has been well embedded in the societal processes and team functions. The effect, impact, and manifestations of the consequences of shaded/imprecise cognitive processes, whether at the level of a team or within an entire society, can be profound and far-reaching. In this exploration, *we delve into the impacts and fallout experienced by teams with deficient cognitive processes and societies characterized by low cognitive abilities.*

Civilizations, societies, and Teams rely on collective cognitive abilities to solve problems, innovate, and achieve common goals. When cognitive processes within a team are impaired or dysfunctional or the team needs to delve into the shaded unchartered domain(s), the implications and repercussions can manifest in various ways. Ineffective decision-making diminished problem-solving capabilities, and communication breakdowns became prevalent, hindering the team's productivity and performance. The barriers and incapacity to understand and leverage diverse perspectives, coupled with cognitive biases and limitations, can lead to conflict, stagnation, and missed opportunities. In the context of businesses and organizations, teams grappling with poor cognitive processes may struggle to adapt to changing environments, innovate in competitive markets, or respond effectively to challenges, ultimately jeopardizing their success and viability.

Zooming out to the societal level, the consequences of sub-level cognitive abilities are equally profound. Societies characterized by widespread cognitive deficits may face myriad challenges across multiple domains (Frith CD et al, 2012).

In education, low cognitive abilities among students impede learning outcomes, exacerbating disparities in academic achievement and perpetuating cycles of inequality. The workforce is saddled with diminished cognitive capacities, and limited productivity, innovation, and economic growth, undermining competitiveness and prosperity. In the area/field of governance and policymaking, the prevalence of cognitive biases and misinformation can erode trust in institutions, polarize societies, and impede collective decision-making, impeding progress and ultimately fostering social unrest.

The fallout of poor cognitive processes in teams and societies may also extend beyond inefficiency or underperformance. It may also undermine human potential and societal well-being. Addressing these challenges requires a multi-faceted approach that encompasses education, training, social support systems, and policy interventions. Working and investing in cognitive development, promoting critical thinking skills, and fostering environments conducive to collaboration and learning, can mitigate the impacts of cognitive deficits and empower individuals and communities to thrive in an increasingly complex and interconnected world.

Understanding Cognition: Evolution, Application, and Impact on Human Processes:

Cognition play a vital role in diverse fields such as learning science, cognitive neuroscience (Johnson, M.H., 2008), (McClelland, J.L., 2001), cognitive linguistics, cognitive behavioral therapy, and teamwork. Investigating the cognitive processes underlying human behavior and performance, the researchers and practitioners in the above-mentioned fields aim to advance knowledge, develop interventions, and improve outcomes across various domains of human endeavor.

Cognitive Neuroscience: Cognitive neuroscience seeks to uncover the neural mechanisms underlying cognitive processes and behavior. Cognitive neuroscientists investigate how different brain regions and networks support cognitive functions such as perception, memory, language, and decision-making deploying techniques such as neuroimaging, electrophysiology, and neuropsychological studies. Elucidating the neural basis of cognition, cognitive neuroscience informs our understanding of brain-behavior relationships, neurological disorders, and the effects of interventions on cognitive functioning. Insights from cognitive neuroscience have implications for fields such as education, healthcare, and artificial intelligence.

Cognitive neuroscience also investigates the emergence of cognitive function from the physical and chemical activity of neurons in the brain. Cognitive neuroscience helps unravel the mechanisms of the mind e.g.How the chemical and electrical signals produced by neurons in the brain give rise to cognitive processes, such as perception, memory, understanding, insight, and reasoning.

Cognitive Linguistics: Cognitive linguistics explores the relationship between language and cognition, emphasizing how cognitive processes shape language use and understanding. This interdisciplinary field investigates phenomena such as conceptual metaphor, mental imagery, language acquisition, and linguistic relativity. Cognitive linguists examine how cognitive structures and processes influence linguistic expressions, grammar, and semantics across languages and cultures. By integrating insights from psychology, linguistics, and neuroscience, cognitive linguistics offers a rich framework for studying the cognitive foundations of language and communication.

Cognitive linguistics also deals with the linguistic structuring of basic conceptual categories such as space and time, scenes and events, entities and processes, motion and location, and force and causation. It adds basic categories of cognition such as attention and perspective, volition and intention, and expectation and affect. It addresses the interrelationships of conceptual structures, such as those in metaphoric mapping, those within a semantic frame, those between text and context, and those in the grouping of conceptual categories into large structuring systems (Talmy. L, 2006).

Cognitive Behavioral Therapy (CBT): Cognitive behavioral therapy (CBT) is a combination of two therapeutic approaches, cognitive therapy and behavioral therapy. The exact treatment approaches depend on the illness or problem to be treated and the idea behind the therapy is that what we think, how we behave, and how other people make us feel are all closely related – and they all affect our wellbeing.

CBT is a widely used psychotherapeutic approach that targets maladaptive thoughts, emotions, and behaviors to promote psychological well-being. Central to CBT is the recognition of cognitive processes, including cognitive distortions, schemas, and automatic thoughts, as key determinants of emotional and behavioral responses. By identifying and challenging dysfunctional cognitive patterns, individuals can develop more adaptive coping strategies and change negative behaviors. CBT techniques, such as cognitive restructuring, behavioral experiments, and exposure therapy, are grounded in cognitive principles and have been applied effectively across various mental health conditions, including anxiety disorders, depression, and PTSD.

Learning Science: Learning science focuses on understanding how people learn and retain information effectively. Cognition plays a central role in learning processes, as it encompasses the mental activities involved in acquiring, processing, storing, and retrieving knowledge. In learning science, cognitive theories and models provide frameworks for understanding the mechanisms underlying learning, memory, attention, and problem-solving. By studying cognition, researchers in learning science aim to develop evidence-based instructional strategies, curriculum designs, and educational technologies that optimize learning outcomes across diverse learners and contexts.

Teamwork and High-Performance Teams: Effective teamwork relies on coordinated cognitive processes among team members to achieve shared goals and tasks. Cognition influences team dynamics, communication, decision-making, and problem-solving within high-performance teams. Shared mental models, mutual understanding, and distributed cognition are essential for promoting collaboration and synergy among team members. Cognitive factors such as team composition, leadership styles, and task complexity shape team performance and outcomes. Understanding the cognitive underpinnings of teamwork is crucial for optimizing team effectiveness, fostering innovation, and enhancing organizational performance in diverse domains, including business, healthcare, and sports.

Cognitive biases affect clinicians by allowing a practitioner to create their own subjective reality, which may alter their own perception of a data point. This "systematic pattern of deviation from an established norm or rationality in judgment" may lead to alteration in one's practices, affecting one's behavior (Landucci F et al, 2021). It is important to note that psychological deviation as a result of cognitive bias affects all humans—not just medical professional—and can cause errors in personalized medical care on an individual basis, or in public health policies, affecting whole populations (Lechanoine F et al, 2020).

The effects of cognitive bias on errors in medicine have long been understood to affect patient safety (Croskerry P, 2003), (Saposnik G, 2016). Cognitive bias can have significant impacts on decision-making for clinicians, including anesthesia professionals, potentially affecting the lives of patients (Beldhuis IE et al, 2021), (Saposnik G et al, 2016). By first understanding cognitive biases and how they affect our practice, we may mitigate their effect and improve patient safety.

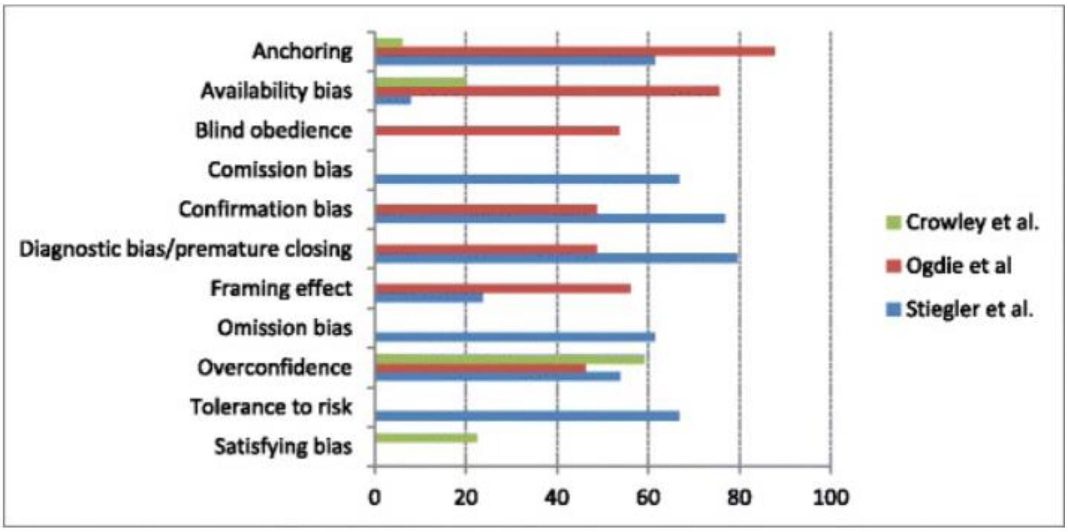
All studies found at least one cognitive bias or personality trait to affect physicians. Overconfidence, lower tolerance to risk, the anchoring effect, and information and availability biases were associated with diagnostic inaccuracies in 36.5 to 77 % of case scenarios. Five out of seven (71.4 %) studies showed an association between cognitive biases and therapeutic or management errors.

Most studies (60 %) targeted cognitive biases in diagnostic tasks, and fewer focused on treatment or management (35 %) and on prognosis (10 %). Literature gaps include potentially relevant biases (e.g. aggregate bias, feedback sanction, hindsight bias) not investigated in the included studies. Moreover, only five (25 %) studies used clinical guidelines as the framework to determine diagnostic or treatment errors. Most studies (n = 12, 60 %) were classified as low quality.

Decision Making and Its Cognitive Processes in Anesthesiology: The quality and safety of health care are under increasing scrutiny. Studies have suggested that health care is plagued with errors (Kohn et al, 2000), unexplained practice variability (Brook RH et al, 2000), (Reid RO et al, 2010), (Schuster MA et al, 1998), and guideline noncompliance (McGlynn EA et al, 2003), (Driskell OJ et al, 2012). These observations have led to increased interest in understanding decision-making cognitive processes and improving educational strategies for teaching decision-making skills (Berner ES et al, 2008), (Morrow DG et al, 2011). Most anesthesiology journals have not systematically described decision-making processes, and we understand little about how decisions may be improved or harmed by cognitive factors. The incidence of diagnostic error varies across physician specialties, with rates ranging from 2 to 12% in diagnostic radiology and pathology, 12 to 15% in emergency medicine, and up to 50% concerning diagnosing the cause of death (Podbregar M et al, 2001). Although the incidence of erroneous decision-making in anesthesiology is not known, reports from the American Society of Anesthesiologists closed claims registry suggest that more than half of diagnosis-related adverse events in obstetric anesthesia were related to a delay in diagnosis or treatment (Davies JM et al, 2009). Most decision researchers believe that specialties characterized by a high degree of time pressure, data uncertainty, stress, and distractors may have an even greater incidence of errors (Graber ML et al, 2012). In some estimates, more than two-thirds of missed or delayed diagnoses are caused in part by cognitive errors in decision-making (Graber ML et al, 2005). In principle, medical decision-making should be relatively straightforward. A constellation of clinical findings should generate a limited differential of known clinical conditions, ordered by their probability of occurrence. Diagnostic tests or responses to empiric therapy would then refine the list until only a few candidates exist with (usually) a clear favorite. Abundant evidence, however, suggests that real-world medical decision-making is beset with variability and complexity. Physicians often fail to agree on the interpretation of diagnostic test results (Van Den Einden LC et al, 2013), (Gobezie R et al, 2008), (Lim et al, 2013), are inconsistent in their approach to management (Aldrink JH et al, 2012), (Buchan CA et al, 2012), (Frank SM et al, 2012), and arrive at different diagnoses in the presence of identical information (Graber ML et al, 2005). Even for clinical conditions with a widely accepted theoretical framework and established diagnostic and therapeutic strategies, a startling amount of unexplained practice variability exists (Chong PC et al, 2009). Noncompliance with evidence-based guidelines developed by expert panels is high (McGlynn EA et al, 2003), further highlighting the need to understand physician decision-making. Noncompliance observed in simulated preoperative evaluation by anesthesiology trainees and experts shows the need to assess decision behavior in addition to medical knowledge(Vigoda MM et al, 2011), (Vigoda MM et al, 2012).

Studies evaluating more than two cognitive biases, found that 50 to 100 % of physicians were affected by at least one (Ogdie AR et al, 2012), (Stiegler MP et al, 2012), (Crowley RS et al, 2013). Only three manuscripts evaluated more than 5 cognitive biases in the same study, in-line with the narrow scope of most studies (Ogdie AR et al, 2012), (Stiegler MP et al, 2012), (Crowley RS et al, 2013).

The most commonly studied personality trait was tolerance to risk or ambiguity, whereas the framing effects and overconfidence were the most common cognitive biases. The framing effect, overconfidence, and tolerance to risk/ambiguity were the most commonly studied cognitive biases. However, methodological limitations make it difficult to provide an accurate estimation of the true prevalence.



Decision Making: Decision-making is a process that chooses a preferred option or a course of action from among a set of alternatives based on given criteria or strategies (Wang, Wang, Patel, & Patel, 2004; Wilson & Keil, 2001). Decision-making is one of the 37 fundamental cognitive processes modeled in the layered reference model of the brain (LRMB) (Wang et al., 2004; Wang, 2007b).

The study of decision-making is interested in multiple disciplines such as cognitive informatics, cognitive science, computer science, psychology, management science, decision science, economics, sociology, political science, and statistics (Berger, 1990; Edwards & Fasolo, 2001; Hastie, 2001; Matlin, 1998; Payne & Wenger, 1998; Pinel, 1997; Wald, 1950; Wang et al., 2004; Wilson et al., 2001).

Each of those disciplines has emphasized a special aspect of decision-making. It is recognized that there is a need to seek an axiomatic and rigorous model of the cognitive decision-making process in the brain, which may serve as the foundation of various decision-making theories.

Four Essential Cognitive Skills for the Future of Work:

1. **Attention:** The paramount cognitive skill for professional advancement. Strong cognitive abilities enable individuals to resist distractions and maintain focus on critical elements and/or tasks. Attention can be categorized into three sub-skills: sustained attention (long-term focus on a single task), selective attention (maintaining focus amidst distractions like emails or conversations), and divided attention (managing multiple tasks simultaneously without losing track of progress).
2. **Adaptability:** In the evolving landscape of work, adaptability stands out as a cornerstone cognitive skill. Adaptability has become a standard requirement in many workplaces. Consequently, decision-makers need to continually develop and demonstrate adaptability will be highly valued in the emerging tech-driven professional workspace.
3. **Agile Thinking:** Complementing adaptability, agile thinking is another indispensable cognitive skill. According to McKinsey, people capable of swiftly acquiring competencies beyond their expertise will distinguish themselves. In contemporary workplaces, agile thinking entails lateral problem-solving, maintaining contingency plans, and embracing a growth mindset by learning from past errors to foster personal development.
4. **Prioritization:** While strong time-management and prioritization skills have long been recognized as crucial, their significance has only grown in the context of today's rapidly evolving work environment. With adaptability and agility emerging as key attributes, the capacity to effectively balance and prioritize numerous data points – the available and missing information, often within tight timeframes, is poised to become even more essential for success in the execution and outcome of the process/work.

Conclusion:

In conclusion, this work sheds light on the intricate interplay between cognition and decision-making processes, with implications for various fields, including anesthesiology and patient safety. By examining the evolutionary origins, applications in human processes, and impacts on teams and societies, we gain a deeper understanding of how cognition shapes individual behaviors and collective outcomes.

It also underscores the critical role of cognitive processes in medical decision-making, highlighting the need for improved strategies to mitigate errors and enhance patient care. Insights from cognitive neuroscience, cognitive linguistics, and cognitive behavioral therapy offer valuable perspectives for optimizing decision-making skills and fostering better outcomes in healthcare settings.

Moreover, the exploration of decision-making across disciplines such as cognitive informatics, psychology, and management science underscores the interdisciplinary nature of this research area. By integrating diverse perspectives and methodologies, we can develop more comprehensive models of decision-making that capture the complexities of real-world scenarios.

Ultimately, this research not only advances our theoretical understanding of cognition and decision-making but also has practical implications for enhancing educational strategies, improving patient safety, and promoting better outcomes in healthcare and beyond. By recognizing the importance of cognitive processes and investing in their development, we can pave the way for a future where decisions are made more effectively, resulting in improved individual well-being and societal progress.

Book Chapter Student Support:

Ms. Sanjana K.,

Ms. Sapna C,

Mr. Manav J,

Mr. Nishant K

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