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KEITH J. HOLYOAK
***THE HUMAN EDGE: ANALOGY AND THE ROOTS
OF CREATIVE INTELLIGENCE***

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BOOK REVIEW

Keith J. Holyoak, a Distinguished Professor of Psychology at the University of California, is a prominent researcher in cognitive psychology and cognitive science with significant contributions to studying human thinking and reasoning. His current work focuses mainly on the role of analogy in human cognition. He is also a poet and translator of classical Chinese poetry. Besides his poetry books, he has published many articles and books in the field of cognitive science. Holyoak's notable publications include *The Analogical Mind* (2001), *The Spider's Thread* (2019), and the recent book under review, *The Human Edge: Analogy and the Roots of the Creative Intelligence*.

The topic of this book is analogical thinking, which, according to the author, is a crucial component of human intelligence and creativity and is also an important part of the learning process. The notional first part of the book (chapters 1–8) lays the groundwork by defining analogy, exploring its cognitive mechanisms, and neuroscientific foundations. Holyoak presents the development of analogical thinking and, through various studies, compares the analogical thinking of animals, children, adults, and machine learning models. He discusses the function of analogy in language, science, the learning process, and especially in problem-solving. In the second notional part of the book (chapters 9–14), he shifts focus to computational models that attempt to achieve analogical thinking comparable to human thinking while also contemplating the intricate relationship between analogy and creativity.

Holyoak articulates his aim in the book as an effort to “*synthesize what has been learned about the cognitive and neural basis of human analogy*” (p. xii), targeting readers with a keen interest in the subject of analogy. The author organizes the book around 14 key questions, with each chapter dedicated to addressing one.

As the book title suggests, the author considers analogy to be a complex process, and understanding it is key to comprehending human creative intelligence. Holyoak states, “*Human analogy involves an overall assessment of important similarities and differences between a source and target perceived to be distinct from one another, where the comparison at least in*

part depends on explicit relations between entities.”(p. 5). He argues that the core of analogical thinking lies in the ability to recognize and represent relationships between objects or situations, which transform isolated objects into a richer concept. The ability to solve analogies also requires the use of attention and memory and is, therefore, closely linked to intelligence.

The author further reflects on what makes an analogy convincing and valuable (chapter 3). Drawing on Mary Hesse’s theory, he highlights the importance of evidential analogy, which relies on the similarity between source and target and, most importantly, on similarities and differences in the causal structure that connects individual elements within the analogy and gives meaning to the whole. Subsequently (chapter 4), Holyoak establishes and analyzes four key steps in using an analogy for problem-solving, which are: retrieval from memory, mapping, application to new situations, and formation of an abstract schema. He demonstrates that using analogy is not just about detecting similarity but about understanding the essential structure of a problem and transferring that structure to another context.

Chapter 5 details the neuroscience of analogical thinking, showing it involves a network of brain regions, including the prefrontal cortex and frontoparietal network, rather than a single center. Holyoak presents evidence that analogy uses broader cognitive functions like planning and integration of information and that abstract relational reasoning shares brain mechanisms with spatial thinking. Brain development enhances this network’s specialization, and training can improve its connectivity in adults. In Chapter 6, he then discusses the “analogy gap” between humans and animals, arguing that humans have a unique “Late system” for higher-level relational thinking, emerging around age three, which underpins our uniquely human capacity for knowledge representation. Holyoak argues that primate research lacks evidence that nonhuman primates use abstract relations for analogy.

The author perceives the importance of storytelling and communication as a means for transferring relational thinking (chapter 7). He cites studies demonstrating that knowledge and level of language proficiency, especially in terms of mental state vocabulary („think“, „believe“), are crucial for understanding mental states. He further suggests that language facilitates the comprehension of relations to the point where they become internalized through language and no longer require active analogical thinking.

The effort to understand how analogies work has led not only to research in neurosciences but also to the creation of computational models of analogy. Holyoak provides a concise overview of basic models that attempt to capture human cognitive mechanisms in creating analogies (chapter 9). He traces their evolution from a symbolic paradigm through so-called structure mapping to the combination with the connectionist paradigm, which better corresponds to human reasoning. At the end of this chapter, he introduces the LISA model, of which Holyoak is a co-author. This model distinguishes itself by separately representing individual roles of relations, enabling more flexible mapping between attributes and roles in analogies; it uses microstructures of word and relational meanings and can thus combine word embeddings, relational vectors, and probabilistic mapping (chapter 10).

Chapters 12 and 13 are devoted to a comparison of human and machine thinking and creativity. Holyoak holds the view that the foundation of human cognition is rooted in the biological process of learning and evolution, making it challenging for AI systems to replicate the breadth of human analogical abilities. In current language models and their potential integration with visual and

robotic technologies, he sees new possibilities that bring new challenges and insights. Still, he also cautions about the associated dangers and risks. Holyoak emphasizes the role of “mind-wandering” and “aha” moments in human creativity, facilitated by the ability to draw analogies from one domain to another. He raises concerns about the potential impact of social media on our capacity for mind-wandering and, consequently, on creativity. However, Holyoak suggests that we can support creativity through interdisciplinary collaboration and by focusing on personal experiences because creative ideas often stem from deeply personal experiences and symbols. These symbols function as evocative analogies to individual experiences and are thus triggers for creativity. He concludes that although current AI models demonstrate remarkable results and generate new and useful outputs, they lack crucial aspects of human creativity, including autonomy, intrinsic motivation, and emotional depth. He refers to AI models as mere Imitation Machines, and the use of AI in this regard represents an Age of Inauthenticity.

Holyoak’s book successfully delivers on its stated objective and provides a compelling summary of knowledge about analogical thinking, drawing on research from neuroscience, cognitive science, linguistics, computer science, and the author’s personal experience and research. The text is effectively punctuated by diverse examples of analogies drawn from everyday contexts, science, or literature, which not only illustrates the wide use of analogies but also makes the text readable and the content understandable.

However, it must be acknowledged that the book presumes at least a partially informed reader. Due to the complexity of the topic, the text would be indigestible for a complete layperson despite the clear and accessible writing style. This is particularly salient in the chapters addressing neuroscience and computational models of analogy, which demand a certain level of sophistication from the reader.

Furthermore, the very definition of analogy is not a simple task, and the definition used by Holyoak, although supported by argument and interpretation, is one of several possible variants. Given the breadth of the subject and the relatively concise format of the book, certain areas may seem superficial. In particular, I expected that since creative intelligence and creativity are in the book’s title, they would be analyzed in more detail and depth.



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