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Book Review

Kampourakis, K., & McCain, K. (2020). *Uncertainty—How It Makes Science Advance*. Oxford, UK: Oxford University Press. 264 pp. £19.99 (hardback), ISBN 978–0–19–087166–6.

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When casually browsing new titles on Amazon, students of visual science and art are greeted by a somewhat familiar-looking image on the cover of Kampourakis and McCain's recent book "Uncertainty - How it makes science advance". The picture resembles standard stimuli of illusory contours and the Venetian Blinds illusion experiments as well as MC Escher's famous prints such as "Lizards" and "Day and Night". Both research on illusions and Escher's work focus on the mysterious way how our brain resolves ambiguities in the visual sensory input to achieve a lasting singular impression. So it is just adequate to allude to these eye-catching examples when discussing the ubiquitousness and paramount importance of handling uncertainty in our life.

Uncertainty is not an unfamiliar concept for the readership of Perception. As the scope of "perception" has been steadily expanding over the years to include not only spatial vision but also higher-level complex visual routines, handling uncertainties emerged as a prominent issue in the field treated under the label of Bayesian Perception. Moreover, as the sharp boundaries between perception and higher-level cognition including decision making and social cognition got blurred in this process, the Bayesian approach grew beyond just being a good formalism for treating uncertainties rigorously. Uncertainty-based probabilistic computation became an intriguing alternative to characterise what our brain does during perception and, by extrapolation, during cognition. This disposition to interpret our basic perception by using uncertainty in the input provides a perfect reason for a researcher in perception to be intrigued by texts about how handling uncertainty becomes relevant in wider contexts such as higher cognitive behaviour and even in cultural constructs such as science itself.

The book approaches its main topic, uncertainty, from the specific perspective of investigating its relationship to scientific research. Kampourakis and McCain's main tenet is that while science, by definition, is uncertain to the level that scientific statements can never achieve full certainty, it is wrong to conclude that science is worthless, that it does not make progress, or even that uncertainty is a bad thing in science. Quite to the contrary, despite its inherent uncertainty, science provides very precise and solid insights, it builds cumulative knowledge and, importantly, without uncertainty, science would simply not exist.

To build their case, in the first part of the book, the authors briefly orient the reader about basic philosophical definitions relevant to the topic such as truth, knowledge, belief and the

distinction between epistemic and psychological certainty. Next, using the topics of visual illusion and fallacies due to incorrect probabilistic reasoning and cognitive biases, the authors demonstrate how mistakes of false certainty emerge even in the most trusted domains of human cognition, sensory perception and reasoning. The authors argue that reducing such failures calls for some efficient treatment of uncertainty, which argument is supported by the observation that across history, humans have constantly attempted to gain subjective certainty through various means (religion, ideology), and that science can be viewed as one of these attempts. However, the authors also point out that since science itself never provides fully certain claims, it apparently violates the main goal of eliminating uncertainty.

In the second part of the book, the authors visit five currently hot scientific topics, which demonstrate aspects of this apparent discrepancy between uncertainty and science: global climate-change, vaccination, human evolution, genetics and forensic science. While these chapters are quite useful and concise summaries of the given debates for the general public, they are relatively loosely linked to the main argument of the book about how uncertainty and science are related beyond the fact that research on each of these problems wrestles with various forms of uncertainty. Clarifying how despite the apparent diversity, each type of identified uncertainty in these case studies can be mapped onto one of the few canonical uncertainties defined with the help of a hypothetical generic scientific problem could help the reader reinforcing the message the authors wished to convey.

Part three contains the book's main arguments aptly summarised in the headers of its subsections. It covers why uncertainty is inherent in science, how explanations and predictions differ and what the main uncertainties are in each of those, what the difference is between understanding vs. being certain, and why uncertainty is indispensable for science to advance. The authors integrate ideas from scientists working in a variety of disciplines including physics, cognitive science, philosophy, mathematics and present them in a lucid manner that makes it easy for the lay reader to grasp the essence of their messages. The reader could achieve an even higher degree of enlightenment by combining these messages with ideas from two areas of related research not covered in the book. The first is formal modelling in the machine learning branch of computer science and statistics, which is concerned with how uncertainty could be treated optimally, the second is model-building in cognitive science, which investigates directly how ideas of treating uncertainty in machine learning and cognition can be integrated.

Despite of those minor omissions, Kampourakis and McCain succeeded in writing a notable book on multiple counts. First, uncertainty as a fundamental concept in our scientific and everyday thinking is on the rise and this book appropriately directs focus on the concept at the right time. Second, while uncertainty can be discussed in multiple contexts, one of its most explicit role is defined undeniably in the domain of science. One could make the case that building a proper understanding/model of uncertainty is a valid scientific goal, which must be preceded by a clarification of what the role of uncertainty is in any scientific model building. Certainly (pun intended), the so called "Bayesian movement" in perceptual sciences can gain more awareness by realising how deeply every cognitive phenomenon integrates uncertainty. Third, more than ever, in the public eyes, science is an uncontrolled and suspicious phenomenon, which is cultivated by a few yet provides benefits for many. Any account lifting the veil on the nature of doing science and its consequences, even if only a little, brings science closer to the non-scientists audience. This book is a worthwhile reading succeeding on all three counts.

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