Hagen and Yang's book offers a hands-on, practical as well as theoretical account of how we should treat eyewitness identifications in court. They do not go into the topic of how the eyewitness expert may be of assistance to the court in cases where manipulative interviewing techniques, therapeutic interventions, or group processes should be considered to have caused false memories in witnesses and victims. I know that this would be beyond the scope of this book, but it may still be interesting to read similar excerpts and analyses on this topic as well, perhaps in another book.

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REFERENCES

Jackson, J., Hough, M., Bradford, B., Pooler, T., Hohl, K., & Kuha, J. (2011). *Trust in justice: Topline results from round 5 of the European Social Survey*. Retrieved from http://www.europeansocialsurvey.org/

Loftus, E. F., & Greenspan, R. L. (2017). If I'm certain, is it true? Accuracy and confidence in eyewitness memory. *Psychological Science in the Public Interest, 18,* 1–2. doi:10.1177/1529100617699241

Magnussen, S., Melinder, A., Stridbeck, U., & Raja, A. Q. (2010). Beliefs about factors affecting the reliability of eyewitness testimony: A comparison of judges, jurors and the general public. *Applied Cognitive Psychology, 24,* 122–133. doi:10.1002/acp.1550

McAuliff, B. D., & Kovera, M. B. (2007). Estimating the effects of misleading information on witness accuracy: Can experts tell jurors something they don't already know? *Applied Cognitive Psychology, 21,* 849–870. doi:10.1002/acp.1301

Misra, P., Marconi, A., Peterson, M., & Kreiman, G. (2018). Minimal memory for details in real life events. *Scientific Reports, 8*(1), 16701. doi:10.1038/s41598–018–33792–2

National Research Council. (2014). *Identifying the culprit: Assessing eyewitness identification*. National Academies Press.

Open Science Collaboration. (2015). Psychology. Estimating the reproducibility of psychological science. *Science, 349*(6251), aac4716-aac4716. doi:10.1126/science.aac4716

Østby, H., & Østby, Y. (2018). *Adventures in memory. The science and secrets of remembering and forgetting*. Greystone Books.

Rachlew, A., Brøste, I. L., Melinder, A., & Magnussen, S. (2020). Recruiting eyewitness science in criminal investigations: The pocket man case. *Journal of Forensic Psychology Research and Practice*. doi:10.1080/24732850.2020.1714407

Saraiva, R. B., Hope, L., Horselenberg, R., Ost, J., Sauer, J. D., & van Koppen, P. J. (2020). Using metamemory measures and memory tests to estimate eyewitness free recall performance. *Memory, 28,* 94–106. doi:10.1080/09658211.2019.1688835

Schacter, D. L. (1999). The seven sins of memory. Insights from psychology and cognitive neuroscience. *American Psychologist, 54,* 182–203. doi:10.1037//0003-066x.54.3.182

Shaw, J. (2017). *The memory illusion. Remembering, forgetting, and the science of false memory*. Random House.

Simons, D. J., & Chabris, C. F. (2011). What people believe about how memory works: A representative survey of the U.S. population. *PLOS ONE, 6*(8). doi:10.1371/journal.pone.0022757

Strange, D., Dysart, J., & Loftus, E. F. (2014). Why errors in alibis are not necessarily evidence of guilt. *Zeitschrift für Psychologie, 222,* 82–89. doi:10.1027/2151–2604/a000169

Text of President Clinton's Testimony. (1998). Retrieved from https://archive.nytimes.com/www.nytimes.com/specials/starr/testimony/clinton_7.html

Transcript from U.S. District Court Southern District of California. (2016). Retrieved from https://www.documentcloud.org/documents/2895623-Declaration-of-Jason-Forge-With-Exhibits.html

Wixted, J. T., Mickes, L., & Fisher, R. P. (2018). Rethinking the reliability of eyewitness memory. *Perspectives on Psychological Science, 13,* 324–335. doi:10.1177/1745691617734878

Wixted, J. T., & Wells, G. L. (2017). The relationship between eyewitness confidence and identification accuracy: A new synthesis. *Psychological Science in the Public Interest, 18,* 10–65. doi:10.1177/1529100616686966

DO THE MATH

Innumeracy in the Wild: Misunderstanding and Misusing Numbers

By Ellen Peters. New York, NY: Oxford University Press, 2020. 302 pp. Hardcover, $39.95.

> ***Less depends upon the choice of words than upon this, that their introduction shall be justified by pregnant theorems.***
>
> ***—Carl Friedrich Gauss (1827) on the primacy of numeracy over literacy[1]***

With Roman letters and Arabic numerals being the two preponderant symbol systems in most parts of the world, it is natural for psychologists to track individual differences in the mastery of these codes and to study the consequences of low (vs. high) levels of ability and skill. Innumeracy has thus become the companion of illiteracy. As some people have trouble reading and writing well, so do many have trouble running the numbers. Just as illiteracy is associated with poverty and poor education, so is innumeracy. Just as illiteracy begets disadvantages and inhibits progress in life, so does innumeracy. In his bestselling book, John Allen Poulos (1988) popularized the term "innumeracy," characterizing it explicitly as "mathematical illiteracy" in the book's subtitle. Poulos, a highly literate mathematician, relied mainly on compelling anecdotes. He argued that innumeracy is both hilarious and dangerous. He sought to educate. Better to laugh a little less but be safe.

Ellen Peters, a distinguished professor of journalism and communication at the University of Oregon, provides an overview of the state of the art of innumeracy research in her *Innumeracy in the Wild: Misunderstanding and Misusing Numbers*. Peters builds on Poulos's legacy by situating innumeracy within the web of contemporary psychology of judgment and decision making. Peters has more than 20 years of pertinent research under her belt. Her collaboration with Paul Slovic and others on the affect heuristic has become highly influential (Slovic, Finucane, Peters, & MacGregor, 2002). She has published many research articles on (in)numeracy, and the numerate may count the references in her book. I settle for the qualitative term "many."

In 2012, Peters published an introduction to research on innumeracy in the *Current Directions in Psychological Science*. At the time, her five main points were the following. First, people low in numeracy (the innumerati, as it were) are more likely to fall prey to attribute framing effects (e.g., by falsely seeing a difference between a product said to contain 5% fat and one said to be 95% fat-free). Second, the innumerate are more likely to visualize scary but improbable events when these events are presented with the absolute frequencies with which they occur. Third, their judgments and decisions are more likely to be affected by incidental moods not relevant to the task. Fourth, they are more easily persuaded by information (true or false) that is presented in narrative instead of numerical form. Fifth, and not surprisingly, the innumerate have greater trouble computing, or even intuitively estimating, expected values.

The findings reported in 2012 still form the core of the story. The research base has become broader, though, and Peters now raises additional questions of theoretical importance. The structure of the book might have been more effective. With a little sorting, we can distill these five issues related to conceptualization, measurement, causality, anomalies, and advice. Let's consider these issues in sequence.

Conceptualization

Peters distinguishes between three constructs, one of which is numeracy proper. This is what she calls objective numeracy, and she defines it as "the ability to understand and use basic probability and mathematical concepts" (p. 5). Next, there is subjective numeracy, which is a person's own nonpsychometric assessment of their own numeracy, defined as "a person's confidence in her ability to understand numeric information and use mathematical concepts" (p. 9). It becomes clear that the latter cannot work as a proxy of the former. For an analog, see the interplay of confidence and ability in performance prediction (Krueger & Heck, 2021). The main implication of an imperfect correlation between objective and subjective numeracy is that the law of regression guarantees specific discrepancies (Fiedler & Krueger, 2012). People are most likely to overestimate their own numeracy when their objective numeracy is very low or when their subjective numeracy is very high. Finally, there is the intuitive number sense, arising from the approximate number system (ANS), which is an evolution-grounded capacity to make ordinal distinctions between small numbers or volumes. Peters weaves discussions of the ANS into her narrative and dedicates a whole chapter to it in the middle of the book. One might have preferred to see a brief review of the ANS early on and then to let it go. The ANS is a building block of numeracy proper, but it plays a minor role in the life-and-death decisions Peters is ultimately concerned about.

Numeracy proper intersects uncomfortably with the popular two-system paradigm in the psychology of judgment and decision making. Peters works in this tradition, and she tries to make it fit. Why doesn't she fully succeed? There are two difficulties. First, there is no single coherent two-system theory. Any talk of a two-system "architecture" of mind is somewhat loose and metaphorical, as Kahneman (2011) himself conceded (see Krueger, 2012, for a review). There are many parochial two-system theories, whose architects squabble among themselves about the relative merits of their theories, providing a united front only when the very idea of two systems is being challenged. One might then expect a commitment, *expressis verbis,* on which two-system theory is being considered. Peters appears to favor Epstein's (1990) cognitive–experiential self-theory. This is a sensible choice because Epstein recognized the complex role of affect in decision making and the relevance of personality-based individual differences.

This theoretical heritage could have been made clearer. Readers bringing the usual two-system expectations are otherwise left to puzzle over how individual differences intersect with systems of thought. An—admittedly heuristic—characterization of the generic two-system model is that System 1 thinking is intuitive, fast, reflexive, and affective, whereas System 2 thinking is analytical, slow, reflective, and cognitive. Alas, these features are not neatly clustered into two camps, as assumed by the two-system metatheory (Melnikoff & Bargh, 2018). At least, in Epstein's theory, it makes sense to explore individual differences in experiential (System 1) and cognitive–reflective (System 2) reasoning. Yet most two-system approaches treat System 1 thinking as a matter of general psychology, not differential psychology. Tversky and Kahneman (1974) set the tone when equating cognitive errors with optical illusions. This rhetorical flourish is problematic because it implies that poor thinking is irredeemable (Krueger, 1998) while placing the burden of making corrections on System 2. Slow thinking yields nothing but afterthoughts, but still, researchers are free to explore individual differences in how well people are able to think these afterthoughts.

Measurement

Working in the tradition of Epstein, Stanovich, and Fischhoff, Peters treats numeracy like a personality trait (Bruine de Bruin, Parker, & Fischhoff, 2020; Stanovich & West, 2000). She notes its heritability and its amenability to improvement through hard work. The elephant in the room is general intelligence. Assuming that we know what general intelligence is and how it is best measured (questions that remain open to debate after more than a century), we wonder whether numeracy is a distinctive mental trait or a special kind of subintelligence. Peters favors the latter. This is a sensible view; it would be refuted only if correlations between intelligence and numeracy were extremely high or very low or negative. How high are they? The book reveals little. Peters asks repeatedly whether numeracy predicts (negatively) decision errors and life outcomes independently of intelligence. Any evidence of incremental predictive validity vindicates numeracy, although one would still want to know whether numeracy is a stronger or weaker predictor than general intelligence. Some studies show no incremental validity. Peters is undeterred because numeracy might be related to the outcomes by way of its association with general intelligence. By this standard, a rejection of the numeracy hypothesis would require negative correlations with outcomes.

Although treating numeracy as a mental trait is generally a sound strategy, Peters acknowledges some open psychometric questions. Numerous numeracy scales exist. Some of this material is presented in the appendix, giving readers an opportunity to reflect on the contents of the construct and to test themselves. A brief review of scale development research and its outcomes (e.g., estimates of reliability) would have been welcome.

Causality

Correlations between numeracy and rational decision making or desirable life outcomes are one thing; causality is another. There would be—one assumes—no book if there were not enough evidence to make the causal claim at least plausible. It is notoriously difficult to extract causal mechanisms from correlational data, although it might be possible to do this more effectively than previously thought (Grosz, Rohrer, & Thoemmes, 2020). All told, the notion that the more numerate make better medical and financial decisions would almost have to be true, or the construct has no validity. Peters (p. 115) concludes that "we know by now that the more objectively numerate are better decision makers than the less numerate," and she defends the claim that numeracy causes good decisions. Experimental studies are rare and hard to do because at the limit, they would require manipulations of a personality trait. To appreciate this difficulty, ask how you might demonstrate the causal force of intelligence in an experiment in which half of the participants are temporarily made more intelligent. This leaves natural experiments of the type that can be done when differences in schooling occur. Peters does not say as much, but one wonders whether some of the education in mathematics, as it exists today, should be replaced by courses that directly target the mitigation and elimination of innumeracy.

A more delicate question is whether subjective numeracy causes better performance. Subjective numeracy is to objective numeracy (numeracy proper) what confidence is to ability. A review of Moore's (2020) book on confidence research provides a sketch on how the two are related (Krueger & Heck, 2021). It is very difficult to demonstrate that confidence per se has a causal effect. If people are underconfident, that is, if they think they are less numerate than they actually are, raising their confidence may allow them to perform at levels corresponding to their ability. Then, however, the question remains what the cause was: the increase in confidence or actual ability. If people are overconfident, failures are more likely than successes, where the latter should not occur given that true ability was not up to the task. Confidence alone cannot cause good outcomes, and Peters (p. 173) concedes that "persisting more on an impossible task is wasted effort." When persistence pays off, it does so in settings where subjective numeracy is lower than objective numeracy.

Anomalies

Peters's master narrative is that numeracy is useful and benign. The data are largely consistent with this view. There are exceptions, though, and it is worth asking whether these exceptions are random or whether they are anomalies pointing to a more nuanced psychological reality. After all, anomalies cease to be anomalies when there are many of them. Peters finds several domains where high numeracy yields poor outcomes. Some numerical problems fool everyone, which recalls the old optical illusion metaphor. Other problems make it look like the highly numerate explicitly compute expected values, when in fact they seem to rely on simple (heuristic!) cues. Still other problems stimulate confirmation bias, considered by some to be the mother of all cognitive sins. When the highly numerate are most likely to bend the evidence to their wishes, one should take note. Perhaps what we see is an intrusion of Machiavellian intelligence (Bereczkei, 2018). These complexities caution against any hasty equation of numeracy with System 2 thinking and innumeracy with System 1 thinking.

Advice

Having made her case for the causal power of numeracy, Peters dedicates four chapters (15–18) to the mitigation of innumeracy. A more numerate world would be heathier, wealthier, and happier, or so it is hoped. There is a suite of potential interventions, ranging from sensible communication and "information architecture," to the replacement of numbers with adequate words and stories, to the use of compelling visuals, and of course to more schooling. Only the latter strategy confronts innumeracy head-on. The other strategies, though promising, are designed to bypass innumeracy and thereby conceal its presence. Surprisingly, Peters overlooks the burgeoning literature on "nudging" and its less paternalistic cousin of "boosting" (Hertwig & Grüne-Yanov, 2017), which have evolved to address some of the same issues presented here as instances of innumeracy (e.g., attribute framing effects).

Conclusion

Innumeracy in the Wild is a timely and important book. Although there are some conceptual and structural concerns, Peters delivers an up-to-date review of the available research. The importance and the potential dangers of innumeracy are still not as evident to large sections of the public as they should be. As Peters notes, it is easier to joke about one's lack of mathematical understanding than about one's lacking reading skills. Alas, we still have gallows humor. Consider President Donald Trump, who, in a televised interview on August 3, 2020, failed to grasp the difference between the death rate relative to the number tested and the death rate relative to the size of the population (Krueger, 2020). The president argued that the high number of tests for COVID-19 put the United States in a negative light in international comparison. He failed to see that reducing the number of tests would not affect the proportion of the population that had died and that, in fact, reduced testing would increase the proportion of dead relative to the tested, thus making the United States look *worse*. Numeracy sought!

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NOTE

1. This quote can be found here: https://en.wikiquote.org/wiki/Carl_Friedrich_Gauss.

REFERENCES

Bereczkei, T. (2018). Machiavellian intelligence hypothesis revisited: What evolved cognitive and social skills may underlie human manipulation. *Evolutionary Behavioral Sciences, 12,* 32–51.

Bruine de Bruin, W., Parker, A. M., & Fischhoff, B. (2020). Decision-making competence: More than intelligence? *Current Directions in Psychological Science, 29,* 186–192.

Epstein, S. (1990). Cognitive–experiential self-theory. In L. A. Pervin (Ed.), *Handbook of personality: Theory and research* (pp. 165–192). Guilford.

Fiedler, K., & Krueger, J. I. (2012). More than an artifact: Regression as a theoretical construct. In J. I. Krueger (Ed.), *Social judgment and decision-making* (pp. 171–189). Psychology Press.

Grosz, M., Rohrer, J. M., & Thoemmes, F. (2020). The taboo against explicit causal inference in nonexperimental psychology. *Perspectives on Psychological Science*. doi:10.1177/174569162091521

Hertwig, R., & Grüne-Yanoff, T. (2017). Nudging and boosting: Steering or empowering good decisions. *Perspectives on Psychological Science, 12,* 973–986.

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.

Krueger, J. (1998). Enhancement bias in the description of self and others. *Personality and Social Psychology Bulletin, 24,* 505–516.

Krueger, J. I. (2012). Reviewing, fast and slow. Review of *Thinking, fast and slow* by Daniel Kahneman. *American Journal of Psychology, 125,* 382–385.

Krueger, J. I. (2020). The innumerati. *Psychology Today Online*. Retrieved from https://www.psychologytoday.com/us/blog/one-among-many/202008/the-innumerati

Krueger, J. I., & Heck, P. R. (2021). The end of overconfidence. Review of *Perfectly confident* by Don A. Moore. *American Journal of Psychology, 134*. Retrieved from https://psyarxiv.com/twrh5

Melnikoff, D. E., & Bargh, J. A. (2018). The mythical number two. *Trends in Cognitive Sciences, 22,* 280–293.

Moore, D. A. (2020). *Perfectly confident: How to calibrate your decisions wisely*. HarperCollins.

Peters, E. (2012). Beyond comprehension: The role of numeracy in judgments and decisions. *Current Directions in Psychological Science, 21,* 31–35.

Poulos, J. A. (1988). *Innumeracy: Mathematical illiteracy and its consequences.* Hill and Wang.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2002). The affect heuristic. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 397–420). Cambridge University Press.

Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Sciences, 23,* 645–665.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185,* 1124–1131.

NUMERACY MATTERS: RESPONSE TO "DO THE MATH" BY JOACHIM I. KRUEGER

Ellen Peters, University of Oregon

I appreciated Joachim Krueger's thoughtful review, including his conclusion that "*Innumeracy in the Wild* is a timely and important book." Writing primarily for researchers, I had three main goals: to explore psychological mechanisms linking innumeracy with poorer judgments and choices, to review its associations with life outcomes (e.g., in health and personal finances), and to examine methods to help people use numbers more effectively.

In the book, I discuss three qualitatively different ways people can be numerically competent: through objective numeracy, numeric confidence, and numerical acuity (which underlies ability to distinguish numerical magnitudes, including in decisions). More research has linked the former two constructs to decision outcomes, although, to be fair, numerical acuity research is newer. Krueger is also correct that the book did not thoroughly cover dual process theories, which are complex and deserve multiple books. Numeracy findings are generally consistent with dual process theories including default interventionist (Stanovich, 2009; Kahneman, 2003), interactionist (Epstein, 1994), and fuzzy trace (Reyna, 2004) theories. However, Peters, Fennema, and Tiede (2019) highlighted theory-consistent and theory-inconsistent evidence. For example, greater objective numeracy (presumably a System 2 ability) was linked with worse judgments and greater affect to numbers (presumably a System 1 response), respectively a result and interaction of the two systems not anticipated by default interventionist theories. Thus, numeracy research can be used to question and potentially improve theory.

Numeracy and decision-making studies often control for education, literacy, or factors including nonnumeric intelligence measures, which correlate modestly with numeracy (r = .26–.50; Peters et al., 2006; Peters, Baker, Dieckmann, Leon, & Collins, 2010). Numeracy results sometimes diminish with education controls, and I argue it is more useful to control for nonnumeric intelligence due to education's causal effects on numeracy itself. Chapter 18 reviews existing causal studies in numeracy research; more studies are needed.

Krueger questions whether numeracy anomalies highlight psychological mechanism. In one example (chapter 6), anomalies such as the bets effect demonstrate a bias of the highly numerate but, more importantly, highlight information processing inclinations that generally underlie their superior decision making (Peters et al., 2019). The more objectively numerate also do simpler calculations than perhaps expected. Unlike Krueger, I would characterize such operations as them adaptively using their numeric capacity to meet goals, in this case accuracy with less effort. Other nonaccuracy goals presumably lead to their greater confirmation biases emerging under some circumstances. Additional anomalies point toward potential range limitations of current measures or the importance of "diagnosing" both the person (their numeracy) and the situation (its mathematical difficulty). For example, some decisions pose such numeric difficulty that interventions assist only the highly numerate (Chapman & Liu, 2009). The information presentation techniques in chapters 15–17 put the onus on communicators to recognize innumeracy in their communications and correct them responsibly.

Conclusion

The typical view of STEM education leading to better jobs and improved economy ignores numeracy's importance to everyday people, the quality of their decisions, and the health, wealth, and other outcomes they experience. Mathematics education should more directly target innumeracy, with students proceeding to other courses only after they have deep understanding of numeric concepts linked with decisions and life outcomes (e.g., arithmetic, algebra, probabilistic reasoning; Peters et al., 2017; Sinayev & Peters, 2015).

REFERENCES

Chapman, G. B., & Liu, J. (2009). Numeracy, frequency, and Bayesian reasoning. *Judgment and Decision Making, 4,* 34–40.

Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *American Psychologist, 49,* 709–724.

Kahneman, D. (2003). Maps of bounded rationality: Psychology for behavioral economics. *American Economic Review, 93*(5), 1449–1475.

Peters, E., Baker, D. P., Dieckmann, N. F., Leon, J., & Collins, J. (2010). Explaining the effect of education on health: A field study in Ghana. *Psychological Science, 21,* 1369–1376.

Peters, E., Fennema, M. G., & Tiede, K. E. (2019). The loss-bet paradox: Actuaries, accountants, and other numerate people rate numerically inferior gambles as superior. *Journal of Behavioral Decision Making, 32,* 15–29.

Peters, E., Shoots-Reinhard, B., Tompkins, M. K., Schley, D., Meilleur, L., Sinayev, A., . . . Crocker, J. (2017). Improving numeracy through values affirmation enhances decision and STEM outcomes. *PLOS ONE, 12*(7), e0180674. Retrieved from https://doi.org/10.1371/

Peters, E., Västfjäll, D., Slovic, P., Mertz, C. K., Mazzocco, K., & Dickert, S. (2006). Numeracy and decision making. *Psychological Science, 17,* 407–413.

Reyna, V. F. (2004). How people make decisions that involve risk: A dual-processes approach. *Current Directions in Psychological Science, 13,* 60–66.

Sinayev, A., & Peters, E. (2015). The impact of cognitive reflection versus calculation in decision making. *Frontiers in Psychology, 6,* 532. doi:10.3389/fpsyg.2015.00532

Stanovich, K. E. (2009). Distinguishing the reflective, algorithmic, and autonomous minds: Is it time for a tri-process theory? In *In two minds: Dual processes and beyond* (pp. 55–88). Oxford University Press.

THE CRIPPLED MIND: REBUTTAL OF PETERS

Formulas are crutches; if we were logical, we wouldn't need them.

—Professor Theodor Harder, sociologist and methodologist, University of Bielefeld, ca. 1980

Theo Harder, with his typical pithiness, captured the tension between humans and their numbers. Once infants realize that the world offers countable things, all hell breaks loose: There are absolute and relative numbers, transformations, derivatives, and eventually imaginaries. It is easy to trip up even the Harders of this world if we make the problem hard enough. This presents a problem for psychological theory and research. How much and what kind of numerate skill may we demand? How much of this skill should be automatized in a System 1 kind of way, and how much should remain in the domain of effortful reflection? With the rise of technology, we must also ask about the symbiosis of humans with their spreadsheet programs and their apps. For example, I find an app on my phone, seductively labeled "Numbers." Who knows what it might do for me?[1] Psychologists of my generation remember doing analyses of variance with pens on paper. Are we more numerate than our students who dance with their data on platforms such as JASP (Love et al., 2018)? Do they know what they are doing? We wonder. Do they know what a mean squared error is? Do they need to?

Sure, I find myself in broad agreement with Ellen Peters. We both think there is a thing called numeracy, and that, in general, more of it is better than less of it. Whether numeracy maps well enough on a two-system model of mind is less clear to me than it is to her. I am not even sure that there is a thing deserving to be called System 2. The mind, I think, flows along heuristically and adaptively (Krueger, 2012). Mistakes occur, and they are as much a matter of the ecology as a matter of mind (Gigerenzer, 2014). You can count on it.

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NOTE

1. Upon googling it, I learned that Numbers is a spreadsheet program.

REFERENCES

Gigerenzer, G. (2014). Risk savvy. How to make good decisions. Penguin.

Krueger, J. I. (2012). The (ir)rationality project in social psychology: A review and assessment. In J. I. Krueger (Ed.), Social judgment and decision-making (pp. 59–75). Psychology Press.

Love, J., Selker, R., Marsman, M., Jamil, T., Dropmann, D., Verhagen, A. J., . . . Wagenmakers, E. J. (2018). JASP: Graphical statistical software for common statistical designs. Journal of Statistical Software, 88(2), 1–17. doi:10.18637/jss.v088.i02

CALLING MARIA'S BLUFF

The Biggest Bluff: How I Learned to Pay Attention, Master Myself, and Win

By Maria Konnikova. London: Penguin Press, 2020. 352 pp. Hardcover, $16.99.

The first thing I'm assuming readers spotted is that *The Biggest Bluff* is not the kind of book that normally gets reviewed in the *American Journal of Psychology*. But there is a good deal of overlap between Maria Konnikova, who has a PhD in social psychology from Columbia University, where she studied with Walter Mischel, the world of poker which she enters and currently thrives in, and my background. It's enough to make this essay appropriate for the *AJP*.

We'll get to the book but first, I need to lay out my bona fides. I'm a cognitive psychologist with a long-standing interest in the cognitive unconscious. My career began in the 1960s and continues today, well into my retirement. I'm also a poker player. Like Konnikova, I've won tournaments, cashed at the World Series of Poker (WSOP), and still play (or did until the COVID-19 threat shut down our home game). I've had a sideline as a freelance writer. I was a columnist for several gambling magazines and websites, authored or coauthored more than 200 articles and three books on gambling and poker, wrote a novel where the protagonist is a poker player (Reber, 2015), and developed a novel framework within which to view the issue of gambling (Reber, 2012). When we lived in Brooklyn, I was a regular at several underground poker rooms, and I've met Erik Seidel, Konnikova's mentor and coach, who plays a prominent role in the book.

Konnikova's dissertation research (Konnikova, 2013), which is still unpublished, is an exploration of the role of self-control and confidence in decision making. She found that people with higher self-control, who normally perform better than those with lower, do poorly when making decisions that involve risk and, critically, when they have no actual control over the outcomes. High–self-control people tend to have higher confidence in their abilities and are prone to what she calls illusory self-control. The findings are very much in line with Mischel's overall framework in that personality traits don't always show cross-situational consistency.

Put in concrete terms, in the poker world having high levels of self-control can, paradoxically, be a disadvantage because it increases the likelihood that you won't grasp the level of risk involved, overestimate your control of the game, and underestimate the impact of the turn of a "lucky" (or "unlucky") card. Those who have high levels of Konnikova's "illusory" control are more likely to have problems assessing reality in a game like poker, one marked with high risk and partial information. For example, every successful poker player understands that what are called "bad beats" happen. You have the best hand with one card to come. All the chips are in the pot and the cards are face-up. There are only two cards out of the 44 left in the deck that can change this outcome. With crushing statistical accuracy, one of them will hit the table and you will lose. Successful players are almost