

Single Sample Heuristics under Uncertainty: From the Fermi Paradox to Cognitive Warfare

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Human decision-making often relies on heuristic shortcuts, especially under conditions of uncertainty and incomplete information. Among these, *Single Sample Heuristics*—where individuals draw inferences from a single event or the absence of events—represents a particularly potent yet understudied bias. This review synthesizes theoretical and applied perspectives by connecting the *Fermi Paradox* as a naturalistic manifestation of this heuristic with *Cognitive Warfare* as its engineered exploitation in military and informational contexts. Drawing from cognitive psychology, decision science, and neuroscience, we explore how both domains reveal vulnerabilities in human reasoning, highlight the shared mechanisms that lead to overgeneralization from limited data, and propose strategies for cognitive resilience. By bridging a purely scientific problem with a tactical operational threat, we aim to illuminate the broader implications of single sample reasoning for both epistemic inquiry and strategic defense.

Keywords: Single Sample Heuristic, Fermi Paradox, Cognitive Warfare, Information Scarcity, Decision-Making Bias

INTRODUCTION

Uncertainty is a pervasive feature of human decision-making, from scientific inquiry to battlefield command. When reliable, abundant data are unavailable, individuals frequently resort to cognitive shortcuts, or heuristics, to arrive at judgments quickly (Gigerenzer & Gaissmaier, 2011; Tversky & Kahneman, 1974). While these heuristics can be adaptive, they also open the door to systematic errors and cognitive biases (Kahneman, 2011).

One particularly striking but underexplored phenomenon is the Single Sample Heuristic (SSH)—a cognitive shortcut where conclusions about an

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entire domain are drawn from a single observed event, or even the absence of such events (Hertwig et al., 2005; Tversky & Kahneman, 1974). This reasoning pattern is especially likely to emerge under conditions of uncertainty, limited sampling, and sparse feedback, where decision-makers rely on small or highly salient cues in place of broader statistical information (Tversky & Kahneman, 1973).

The Fermi Paradox exemplifies the natural occurrence of single sample reasoning in the domain of astrobiology and cosmology. It poses the question: given the vast age of the universe and the probabilistic expectation of extraterrestrial life, why have we not observed any evidence of intelligent civilizations? The absence of detection is often implicitly taken as evidence of absence, revealing the human tendency to overgeneralize from a single observational outcome (Ćirković, 2009; Lingam & Loeb, 2019).

In contrast, Cognitive Warfare (CW) represents the deliberate exploitation of similar reasoning patterns in adversarial contexts. By presenting a single vivid incident—such as a selective combat image, an isolated terrorist attack, or a strategically framed intelligence report—opponents can induce disproportionate threat assessments and strategic misjudgments (Masakowski & Blatny, 2023; Claverie & Du Cluzel, 2022). In these contexts, the SSH is weaponized, often in combination with other cognitive biases such as availability and representativeness.

This review seeks to integrate these two seemingly disparate domains—scientific paradox and military strategy—under a unified cognitive framework. Specifically, we argue that the Fermi Paradox provides a theoretical model for understanding the mechanisms and consequences of SSH, while CW demonstrates its tactical exploitation. We begin by reviewing the theoretical background of single sample reasoning, then examine its manifestations in the Fermi Paradox and in CW, and finally discuss implications for cognitive resilience and defense strategies.

This article is intended as a narrative and conceptual review rather than a systematic review. The sources discussed were selected for their theoretical and empirical relevance to reasoning under uncertainty, particularly in relation to the Fermi Paradox, CW, and the SSH.

Theoretical Background

SSH: Definition and Cognitive Mechanisms

The SSH refers to the cognitive tendency to generalize from a single observation—or even the absence of an observation—to an entire population. In the present paper, SSH refers to a reasoning tendency in which: (a) a judgment is based on a single observed instance or a single non-observation, (b) that instance is granted disproportionate inferential weight relative to the broader evidentiary context, and (c) the resulting conclusion is generalized beyond what the available evidence can justify. In this framework, the absence of evidence may itself function as a psychologically operative sample when it is treated as if it were informative enough to justify a broader conclusion. Unlike statistical reasoning, which incorporates variability and sampling error, this form of inference treats one event as representative of the whole (Hertwig et al., 2005; Tversky & Kahneman, 1974).

The bias is most pronounced under conditions of information scarcity. When reliable data are unavailable, individuals are forced to rely on minimal evidence, granting disproportionate weight to a single instance. If that instance is highly vivid or emotionally charged, its salience further enhances accessibility, thereby magnifying its influence on subsequent

judgments. Time pressure and cognitive load exacerbate this effect by reducing the capacity for deliberative analysis, allowing intuitive shortcuts to dominate. In such environments, single events acquire explanatory force far beyond their statistical relevance (Kahneman, 2011; Gigerenzer, 2008).

Neuroscientific evidence suggests that this tendency is mediated by the interaction of the amygdala and prefrontal cortical regions. Emotionally salient stimuli heighten amygdala responses, which can bias value computation and attenuate the probabilistic reasoning normally supported by prefrontal circuits (Krawczyk, 2002; Phelps et al., 2014). Daw et al. (2006) found that increased bilateral frontal lobe activity was associated with exploratory behavior in a risk-taking context, suggesting a role for frontal systems in managing uncertainty and alternative-option evaluation. Using a behavioral economics paradigm, higher frontal lobe activity reflected a greater tendency to explore alternative options in pursuit of higher potential rewards.

Although closely related to the representativeness heuristic—where judgments are guided by similarity to a prototype—the SSH is distinct in its reliance on one instance rather than an inferred distribution (Grabbe, 2020). It also overlaps with the availability heuristic when the single event is particularly memorable, leading individuals to inflate frequency or probability estimates (Tversky & Kahneman, 1973).

SSH overlaps with availability and representativeness heuristics, but it is conceptually narrower. Availability concerns the ease with which instances come to mind, and representativeness concerns similarity to a prototype, whereas SSH specifically concerns inferential overextension from a single instance—or a single absence of observation—under conditions of limited evidence. Accordingly, although SSH is related to the representativeness heuristic, it is distinct in that it centers not on similarity to an inferred distribution, but on the overextension of a single case into a broader conclusion (Grabbe, 2020). It also overlaps with the availability heuristic when the focal event is especially vivid or memorable, thereby inflating judgments of frequency or probability (Tversky & Kahneman, 1973).

Singular Event Reasoning and Absence of Evidence

Grabbe (2020) introduced the notion of *singular event reasoning* in the context of the Fermi Paradox, emphasizing how the absence of observed extraterrestrial signals is often taken as decisive evidence against their existence. Such reasoning reflects a deeper cognitive bias: humans frequently underestimate the possibility that non-observation may arise from detection limitations or chance rather than genuine absence.

The epistemic risk lies in conflating limits of observation with ontological claims. To assume that what has not been seen does not exist is to disregard the asymmetry between evidence and non-evidence—a caution long noted in the philosophy of science. This pattern extends well beyond cosmology. In risk assessment and military intelligence, the failure to observe enemy activity is too often misinterpreted as confirmation of safety (Williams, 2010). In such high-stakes environments, a single incident—or its absence—can decisively shape strategic decisions, even when the evidentiary basis is fragile. A comparison can be drawn between risk-taking behavior in warfare and findings from economic task-based studies of risk-taking behavior (Huettel et al., 2006). In their examination of the neural correlates of risk-taking, less impulsive individuals were more likely to consider alternative options. When viewed through the lens of the SSH, reliance on a single example may imply assumptions of

normality and certainty. Therefore, further research is warranted to examine the role of impulsivity in decision-making processes involving SSH.

At root, both the Fermi Paradox and these operational misjudgments reflect an overreliance on limited evidence. Cognitive load, pervasive uncertainty, and the absence of statistical context magnify the appeal of single-event reasoning. Recognizing this shared vulnerability establishes the foundation for linking scientific paradox and strategic manipulation: both reveal how the same heuristic bias can either emerge naturally or be deliberately exploited.

The Fermi Paradox as a Naturalistic Case

The Fermi Paradox remains one of the most compelling puzzles in astrobiology and the philosophy of science. First posed informally by physicist Enrico Fermi in the mid-twentieth century, the paradox emerges from a simple probabilistic intuition: given the immense number of stars in the galaxy, the significant fraction of those likely to host planets in habitable zones, and the considerable age of the universe, the probability of extraterrestrial intelligent life should be high (Čirković, 2009; Lingam & Loeb, 2019). Yet, despite decades of systematic efforts—including the Search for Extraterrestrial Intelligence (SETI)—no confirmed signals or artifacts of alien civilizations have been detected.

This absence of evidence has often been taken—implicitly or explicitly—as evidence of absence. In cognitive terms, the paradox exemplifies a deeply rooted SSH: the null observation itself is treated as the defining sample for the entire cosmic population. Although the probability of detection depends on numerous variables—such as signal strength, observational windows, and technological compatibility—people often underweight prior information and overgeneralize from limited evidence when making probabilistic judgments under uncertainty (Stengård & Van den Berg, 2022; Yang & Wu, 2020).

From a psychological perspective, this pattern aligns with research on availability and representativeness heuristics (Tversky & Kahneman, 1973, 1974). The ease with which the absence of observations can be recalled, coupled with the prototypical expectation of “a galaxy teeming with civilizations,” distorts probability estimates. This distortion is further compounded by base-rate neglect, where prior probabilities—such as the realistic likelihood of detection given current technology—are underweighted in favor of salient but sparse evidence (Bar-Hillel, 1980). Neurocognitive research supports this account, showing that in situations of data scarcity the medial and ventromedial prefrontal cortex integrate incomplete information with prior beliefs, often producing overconfident judgments (De Martino et al., 2006; Krawczyk, 2002). In the context of the Fermi Paradox, prior expectations about the abundance of life bias interpretations of observational null results, reinforcing the impression of paradox rather than prompting reassessment of the search framework.

Although the paradox arises in cosmology, its cognitive dynamics are not confined to the stars. Analogous patterns emerge in domains such as intelligence analysis, epidemiology, and disaster preparedness, where the absence of observable indicators is prematurely equated with the absence of threat. In each case, reliance on a single instance—or its absence—creates vulnerabilities in judgment. As such, the Fermi Paradox provides a theoretically rich, non-adversarial context in which to study the mechanics of single sample reasoning. Understanding its operation in this

naturalistic domain establishes a baseline against which more adversarial contexts, such as CW, can be meaningfully compared.

SSH should not be understood as a definitive solution to the Fermi Paradox. Instead, it offers a useful interpretive lens for understanding how the absence of observed signals may be cognitively overextended into broader conclusions, alongside other influential explanations such as the Great Filter hypothesis (Haqq-Misra et al., 2020) and Rare Earth accounts (Ward & Brownlee, 2000).

CW as an Engineered Case

While the Fermi Paradox exemplifies a naturally occurring instance of SSH, CW represents its deliberate, strategic exploitation. CW refers to the systematic targeting of human cognition, perception, and decision-making, often leveraging psychological biases to achieve advantage without direct kinetic force (Claverie & Du Cluzel, 2022; Masakowski & Blatny, 2023). Unlike scientific inquiry, where data scarcity is the byproduct of observational limits, CW operates in environments where scarcity or salience is intentionally engineered. By shaping the content, framing, and frequency of information, adversaries induce disproportionate judgments from a single vivid episode or a narrow set of stimuli.

A hallmark of CW is the construction of “cognitive anchors.” Carefully curated images, narratives, or incidents dominate memory retrieval, ensuring that one or two salient events define broader threat assessments. This practice exploits the availability heuristic (Tversky & Kahneman, 1973; Hertwig et al., 2005), as vividly recalled episodes outweigh more representative but less accessible data. During the Russian–Ukrainian conflict, for example, striking footage of isolated airstrikes, repeatedly circulated across media platforms, magnified perceptions of omnipresent threat even where the statistical likelihood of such strikes remained low (Jang, 2022; Mankoff, 2022). The cognitive dynamic mirrors that of the Fermi Paradox, except here the single observation is not incidental but deliberately curated.

Importantly, the SSH rarely operates in isolation. CW magnifies its influence through synergy with other biases: representativeness, where a single prototypical event defines the adversary profile; anchoring, where early reports serve as reference points that bias all subsequent interpretations (Donnelly, 2004; Johnson et al., 2019); confirmation bias, where recipients attend selectively to information consistent with the initial example (Cao et al., 2021; Nickerson, 1998); and priming, where repeated exposure to narratives conditions individuals to perceive ambiguous signals as confirming the threat (Molden, 2014). The orchestration of these mechanisms ensures that even contradictory evidence struggles to dislodge initial impressions.

The psychological and neural architecture of CW makes such effects particularly potent. Under stress and information overload, intuitive “System 1” processes dominate over deliberative “System 2” reasoning (Kahneman, 2011). Neuroimaging studies reveal that emotionally salient single events activate the amygdala, enhancing consolidation while biasing value computations in the ventromedial prefrontal cortex (Phelps et al., 2014; Sharot & Sunstein, 2020). Adversaries exploit this architecture by crafting stimuli that are simultaneously emotionally evocative and cognitively “sticky,” ensuring that a handful of curated events shape the mental model of the entire conflict.

Operational history illustrates how CW translates these principles into practice. During the 2003 Iraq War, coalition forces circulated targeted disinformation suggesting Baghdad as the primary defensive stronghold, anchoring Iraqi planning around a single assumption and exposing vulnerabilities elsewhere (Donnelly, 2004; Johnson et al., 2019). In the realm of terrorism, isolated attacks are repeatedly amplified to cultivate the perception of omnipresent danger despite statistical rarity (Whiteaker & Valkonen, 2022). Hybrid warfare similarly leverages selective reporting of minor battlefield successes to demoralize adversaries, even when operational significance is limited (Kim, 2025). Across contexts, the common feature is the weaponization of single sample reasoning to shape perception, distort judgment, and secure advantage.

Comparative Analysis

At first glance, the Fermi Paradox and CW occupy radically different domains—one embedded in cosmological inquiry, the other in adversarial strategic operations. Yet both reveal a shared cognitive vulnerability: the human propensity to generalize from a single instance or its absence. Juxtaposing these contexts highlights common mechanisms, critical distinctions, and the implications that emerge when natural cognitive tendencies are strategically weaponized.

Shared Mechanisms

In both cases, judgments about highly uncertain and complex environments are derived from a single observation—or the lack thereof. The salience and cognitive accessibility of such an instance exert disproportionate influence on probability estimates and strategic conclusions (Tversky & Kahneman, 1974; Hertwig et al., 2005). Importantly, this bias rarely acts alone. In each domain, single sample reasoning interacts with other well-documented biases—availability, representativeness, and confirmation—thereby reinforcing distorted judgments (Gigerenzer & Gaissmaier, 2011; Nickerson, 1998). The vulnerability is heightened in environments characterized by uncertainty and scarce verifiable data, where intuitive reasoning easily displaces statistical inference (Kahneman, 2011).

Divergences

The divergence lies not in the cognitive mechanisms themselves but in the conditions under which they manifest. The Fermi Paradox provides a “clean” instance: a naturally arising case where non-observation is mistakenly generalized to ontological conclusions, absent any manipulative intent. CW, by contrast, represents the engineered amplification of the same vulnerability. Here, scarcity or salience is deliberately constructed—through curated images, narratives, or events—such that single sample reasoning is not an incidental byproduct but the intended outcome.

Strategic Implications

This comparison underscores a crucial translational bridge. The Fermi Paradox offers theoretical clarity on how humans reason under information scarcity, serving as a model for identifying when SSH are most likely to emerge. CW, in turn, demonstrates how adversaries can exploit these tendencies for operational gain, showing the practical stakes of an otherwise abstract bias. Recognizing this continuity allows insights to flow in both directions: from theory to practice, by informing predictive models

of cognitive vulnerability; and from practice to prevention, by guiding the development of training, education, and resilience programs to mitigate errors rooted in single sample reasoning.

By integrating the theoretical purity of the Fermi Paradox with the applied urgency of CW, we arrive at a more comprehensive understanding of SSH—one that is both scientifically rigorous and operationally relevant.

Implications for Cognitive Resilience

The convergence of insights from the Fermi Paradox and CW underscores the urgent need for proactive measures to mitigate the risks posed by SSH in decision-making under uncertainty. In practice, this imperative translates into strengthening cognitive resilience—the ability to sustain accurate situational assessments despite incomplete, biased, or emotionally charged information (Korteling et al., 2018; Kozyreva et al., 2020).

One avenue of defense lies in cultivating probabilistic reasoning skills. Training in base-rate utilization, Bayesian updating, and statistical inference has been shown to reduce overgeneralization from single events (Sedlmeier & Gigerenzer, 2001). For example, a computerized training program that taught participants to translate probabilistic information into natural frequencies improved Bayesian reasoning performance in less than two hours, suggesting a practical model for decision training in military or intelligence settings (Sedlmeier & Gigerenzer, 2001; Hoffrage et al., 2015). Military decision-making programs could embed scenario-based simulations that expose participants to partial or even misleading reconnaissance data, requiring them to continuously update threat assessments in light of new information (Williams, 2010).

Yet resilience cannot rest solely on statistical literacy. Because CW often relies on curated media, enhancing media literacy and verification skills is equally critical. Personnel and civilians alike must learn to identify selective framing, cross-reference sources, and employ structured analytic techniques (Heuer, 1999; Lewandowsky et al., 2012). Embedding verification drills into intelligence briefings—where a single anchor incident is juxtaposed against statistical baselines—encourages more balanced evaluation.

Cognitive resilience also depends on managing the conditions that exacerbate heuristic reliance. High cognitive load and stress accelerate the use of shortcuts, including SSH (Kahneman, 2011). Stress-inoculation protocols and structured decision “hygiene” checklists can help maintain analytical rigor even under operational pressure (Klein, 2017). Neuroscientific findings indicate that such measures reduce hyperactivation of the amygdala, thereby allowing prefrontal regions to exert greater regulatory control over reasoning processes (Pessoa, 2009).

Emerging technological tools further expand the resilience toolkit. Advances in natural language processing and sentiment analysis allow AI systems to flag disproportionately salient or emotionally charged narratives in near real time (Nguyen & Hekman, 2024). NATO’s experimental frameworks, for example, employ automated narrative mapping to detect when a single incident is being over-amplified and to trigger targeted counter-narratives that reintroduce statistical context (Masakowski & Blatny, 2023).

Finally, the Fermi Paradox itself may serve as a conceptual training model. By illustrating the dangers of inferring existence from absence of evidence, it provides a debiasing exercise that can be incorporated into military and intelligence education. The paradox underscores a

fundamental lesson: the absence of observation should not be conflated with the absence of phenomena.

In sum, building resilience against SSH requires a multi-layered approach—combining cognitive skills, organizational protocols, and technological interventions. By embedding these strategies into both military and civilian training pipelines, societies can preempt the exploitation of single sample reasoning by adversarial cognitive operations, thereby securing decision-making processes against one of the most insidious vulnerabilities of the human mind.

CONCLUSION

This review has sought to unify two domains that appear distant at first sight—the Fermi Paradox in cosmology and CW in modern conflict—under the shared cognitive mechanism of SSH. In the naturalistic case, the Fermi Paradox illustrates how humans overgeneralize from the absence of evidence, often overlooking the probabilistic and observational constraints inherent to the search for extraterrestrial intelligence. In the engineered case, CW demonstrates how the same bias can be deliberately weaponized, with singular, salient events curated or amplified to distort judgment and influence strategic decision-making.

By juxtaposing these contexts, we achieve both theoretical clarity and operational urgency. The Fermi Paradox offers a baseline model for understanding how SSH emerges in conditions of uncertainty absent adversarial intent, while CW shows how those mechanisms can be intensified and targeted through deliberate manipulation. Recognizing this continuity underscores the necessity of countermeasures that address both the underlying cognitive vulnerability and its adversarial exploitation.

The Fermi paradox heuristic may also be applied to CW and warrants further investigation as a parallel framework within behavioral economics. Comparable dynamics can also be observed in behavioral finance, where investors may overgeneralize from salient success cases and treat recent winners as representative of broader future opportunities. Such tendencies are consistent with evidence on investor overreaction and representativeness-based belief formation (Barberis et al., 1998; De Bondt & Thaler, 1985). A comparable pattern can be observed in the interpretation of unique military actions, where atypical circumstances may be mistakenly assumed to reflect average or normative conditions.

Building cognitive resilience thus becomes a strategic imperative. Probabilistic reasoning training, media literacy, cognitive load management, and AI-supported content monitoring represent complementary approaches to mitigating the risks of SSH. Moreover, incorporating the Fermi Paradox as a conceptual debiasing tool in education and training can cultivate awareness of the limitations of single-event inference, equipping decision-makers to resist manipulation in high-stakes environments.

As the informational and cognitive dimensions of human activity grow increasingly contested, the capacity to recognize and mitigate SSH will be vital. Future research should extend this framework into empirical studies that evaluate resilience interventions across both scientific reasoning and operational decision-making contexts. Only by bridging theory and practice can we hope to secure the cognitive domain—against both inadvertent errors and deliberate exploitation.

REFERENCES

- Barberis, N., Shleifer, A., & Vishny, R. (1998). A model of investor sentiment. *Journal of financial economics*, 49(3), 307-343.
- Bar-Hillel, M. (1980). The base-rate fallacy in probability judgments. *Acta Psychologica*, 44(3), 211-233.
- Brunyé, T. T., Martis, S. B., & Taylor, H. A. (2018). Cognitive load during route selection increases reliance on spatial heuristics. *Quarterly Journal of Experimental Psychology*, 71(5), 1045-1056.
- Cao, K., Glaister, S., Pena, A., Rhee, D., Rong, W., Rovalino, A., Bishop, S., Khanna, R., & Saini, J. S. (2021). Countering cognitive warfare: Awareness and resilience. *NATO Review*, 20.
- Ćirković, M. M. (2009). Fermi's paradox—the last challenge for Copernicanism? *Serbian Astronomical Journal*, 178, 1-20.
- Claverie, B., & Du Cluzel, F. (2022). The cognitive warfare concept. *Innovation Hub Sponsored by NATO Allied Command Transformation*, 2, 1-11.
- Daw, N. D., O'doherty, J. P., Dayan, P., Seymour, B., & Dolan, R. J. (2006). Cortical substrates for exploratory decisions in humans. *Nature*, 441(7095), 876-879.
- De Bondt, W. F., & Thaler, R. (1985). Does the stock market overreact?. *The Journal of finance*, 40(3), 793-805.
- Deck, C., & Jahedi, S. (2015). The effect of cognitive load on economic decision making: A survey and new experiments. *European Economic Review*, 78, 97-119.
- De Martino, B., Kumaran, D., Seymour, B., & Dolan, R. J. (2006). Frames, biases, and rational decision-making in the human brain. *Science*, 313(5787), 684-687.
- Donnelly, T. (2004). *Operation Iraqi Freedom: A strategic assessment*. American Enterprise Institute.
- Gigerenzer, G. (2008). Why heuristics work. *Perspectives on psychological science*, 3(1), 20-29.
- Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology*, 62(1), 451-482.
- Grabbe, J. W. (2020). The Fermi Paradox as a Heuristic in Cognitive Science: The Search for Extraterrestrial Intelligence Influences the Study of Terrestrial Intelligence. *North American Journal of Psychology*, 22(1).
- Haqq-Misra, J., Kopparapu, R. K., & Schwieterman, E. (2020). Observational constraints on the great filter. *Astrobiology*, 20(5), 572-579.
- Hertwig, R., Pachur, T., & Kurzenhäuser, S. (2005). Judgments of risk frequencies: Tests of possible cognitive mechanisms. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 31(4), 621-642.
- Heuer, R. J. (1999). *Psychology of intelligence analysis*. Center for the Study of Intelligence.
- Hoffrage, U., Krauss, S., Martignon, L., & Gigerenzer, G. (2015). Natural frequencies improve Bayesian reasoning in simple and complex inference tasks. *Frontiers in psychology*, 6, 1473.
- Huetzel, S. A., Stowe, C. J., Gordon, E. M., Warner, B. T., & Platt, M. L. (2006). Neural signatures of economic preferences for risk and ambiguity. *Neuron*, 49(5), 765-775.
- Jang, S. (2022). *Analysis & prospects on Russia's invasion of Ukraine: Russia's perceptions, goals, strategies*. INSS Strategy Report.
- Johnson, D. E., Schaefer, A. G., Allen, B., Cohen, R. S., Gentile, G., Hoobler, J., Schwill, M., Sollinger, J. M., & Zeigler, S. (2019). *The US Army and the battle for Baghdad: Lessons learned—and still to be learned*. RAND Corporation.
- Kahneman, D. (2011). *Thinking, fast and slow*. macmillan.
- Kim, D. (2025). Psychological Mechanisms of Cognitive Warfare on Decision-Making. *North American Journal of Psychology*, 27(2).
- Klein, G. A. (2017). *Sources of power: How people make decisions*. MIT press.
- Kozyreva, A., Lewandowsky, S., & Hertwig, R. (2020). Citizens versus the internet: Confronting digital challenges with cognitive tools. *Psychological Science in the Public Interest*, 21(3), 103-156.

- Korteling, J. E., Brouwer, A.-M., & Toet, A. (2018). A neural network framework for cognitive bias. *Frontiers in Psychology, 9*, 1561.
- Krawczyk, D. C. (2002). Contributions of the prefrontal cortex to the neural basis of human decision making. *Neuroscience & Biobehavioral Reviews, 26*(6), 631–664.
- Lewandowsky, S., Ecker, U. K., Seifert, C. M., Schwarz, N., & Cook, J. (2012). Misinformation and its correction: Continued influence and successful debiasing. *Psychological Science in the Public Interest, 13*(3), 106–131.
- Lingam, M., & Loeb, A. (2019). *Life in the cosmos: From biosignatures to technosignatures*. Harvard University Press.
- Mankoff, J. (2022). *Russia's war in Ukraine: Identity, history and conflict*. Center for Strategic and International Studies.
- Masakowski, Y., & Blatny, J. M. (2023). *Mitigating and responding to cognitive warfare*. NATO Technical Report.
- Molden, D. C. (2014). Understanding priming effects in social psychology: What is “social priming” and how does it occur? *Social Cognition, 32*, 1–11.
- Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology, 2*(2), 175–220.
- Nguyen, D., & Hekman, E. (2024). The news framing of artificial intelligence: a critical exploration of how media discourses make sense of automation. *AI & society, 39*(2), 437–451.
- Pessoa, L. (2009). How do emotion and motivation direct executive control? *Trends in Cognitive Sciences, 13*(4), 160–166.
- Phelps, E. A., Lempert, K. M., & Sokol-Hessner, P. (2014). Emotion and decision making: Multiple modulatory neural circuits. *Annual Review of Neuroscience, 37*(1), 263–287.
- Sedlmeier, P., & Gigerenzer, G. (2001). Teaching Bayesian reasoning in less than two hours. *Journal of Experimental Psychology: General, 130*(3), 380–400.
- Sharot, T., & Sunstein, C. R. (2020). How people decide what they want to know. *Nature Human Behaviour, 4*(1), 14–19.
- Stengård, E., Juslin, P., Hahn, U., & Van den Berg, R. (2022). On the generality and cognitive basis of base-rate neglect. *Cognition, 226*, 105160.
- Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology, 5*(2), 207–232.
- Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*(4157), 1124–1131.
- Ward, P. D., & Brownlee, D. (2000). *Rare Earth: Why complex life is uncommon in the universe*. New York, NY: Springer New York.
- Whiteaker, J., & Valkonen, S. (2022). *Cognitive warfare: Complexity and simplicity*. In *Cognitive warfare: The future of cognitive dominance* (pp. 11–15). NATO STO Press.
- Williams, B. S. (2010). Heuristics and biases in military decision making. *Military Review, 90*(5), 40–52.
- Yang, Y. Y., & Wu, S. W. (2020). Base rate neglect and neural computations for subjective weight in decision under uncertainty. *Proceedings of the National Academy of Sciences, 117*(29), 16908–16919.