THE PHENOMENON OF XXI ST-CENTURY GENIUS: A SYSTEMS-THEORETIC INQUIRY INTO THE ARCHITECTURE OF EXCEPTIONAL SCIENTIFIC INNOVATION

Associate Professor of the Department of "Socio-Political Sciences" of the Renaissance University of Education ***G.N. Fozilov***

golibjonf1@gmail.com

+99894 944 44 40

Abstract

The XXI st century has witnessed an epistemological shift in the conceptualization of genius, transforming it from a biographical and historiographic construct into a tractable object of scientific inquiry. This article posits that contemporary genius—particularly as it manifests in transformative scientific innovation—is best understood not as a monadic psychological trait but as an emergent property of a complex adaptive system. This system comprises the neurocognitive architecture of the individual mind, the dynamics of specialized knowledge domains, the affordances of digital and collaborative networks, and the socio-technical infrastructure of globalized science. We argue that the most significant "innovation" in this century is the very methodology used to study genius itself: a convergent, data-driven, interdisciplinary approach that integrates cognitive neuroscience, network science, the science of science (SciSci), and computational social science. This article synthesizes over two decades of research from these fields to construct a unified framework for understanding the generative mechanisms behind paradigm-shifting scientific breakthroughs. Through an analysis of key innovations—from CRISPR-Cas9 and deep learning to topological materials and gravitational wave detection—we demonstrate how the interaction between specific cognitive patterns, collaborative topologies, and technological tools creates the necessary and sufficient conditions for genius-level output. The argument proceeds by first dismantling the essentialist myth of genius, then detailing the constituent subsystems of the genius phenomenon, and finally examining the meta-scientific implications of this new understanding for fostering future innovation. We conclude that XXI st-century genius is a distributed, accelerative process, one that can be systematically nurtured but not deterministically manufactured, representing humanity's most sophisticated cognitive toolkit for navigating an era of existential complexity.[1]

Keywords: Genius, Scientific Innovation, Systems Theory, Cognitive Neuroscience, Network Science, Science of Science, Creativity, Expertise, Collaboration, Technological Convergence.

Introduction. The enduring cultural image of genius—the lone, epiphany-driven visionary, often beset by personal torment—has proven remarkably persistent. This Romantic conception, exemplified by figures like Newton or Tesla in the popular imagination, has long served as a dominant narrative for scientific breakthrough.[2] However, the opening decades of the XXI st century have rendered this model increasingly anachronistic and analytically insufficient. The sheer scale, cost, and interdisciplinary nature of contemporary scientific challenges—from mapping the human connectome to developing sustainable fusion energy—demand a different mode of operation and, consequently, a different explanatory framework. Concurrently, the tools to study the mind, social networks, and the evolution of ideas have advanced to a point where the phenomenon of exceptional scientific creativity can be subjected to empirical scrutiny. This confluence has given rise to a new scientific discipline: the systematic study of genius and innovation. This field does not seek to diminish the achievements of extraordinary individuals but to contextualize them within the multi-layered systems from which they emerge. The central thesis of this article is that XXI st-century scientific genius is a systemic output, contingent upon a specific alignment of internal cognitive factors, external collaborative and technological structures, and the ripe state of a particular knowledge domain. This represents a shift from a substance-based ontology of genius (what genius is) to a process-based ontology (what genius does and how it emerges).[3]

This process is catalyzed and amplified by digital technology, which acts as both a cognitive prosthesis and a social-organizational scaffold. The scientists who now study genius are, reflexively, often products of this same system: they utilize machine learning to parse citation networks, neuroimaging to visualize creative cognition, and large-scale datasets to track the migration of talent and ideas. Their object of study and their methodology are thus deeply intertwined, marking a recursive turn in the human sciences. This article will synthesize findings from these diverse fronts, weaving together evidence from longitudinal studies of the profoundly gifted, functional magnetic resonance imaging (fMRI) investigations of insight, sociometric analyses of scientific teams, and historical studies of technological convergence. The goal is to construct an integrated model that accounts for the production of groundbreaking scientific innovations—such as the CRISPR-Cas9 gene-editing platform, the transformer architecture in artificial intelligence, or the first imaging of a black hole—while also explaining the changing patterns of how such innovations are achieved. The argument will demonstrate that the modern genius often operates as a super-node within a distributed cognitive network, possessing a unique combinatorial capacity to integrate insights across domains, leverage computational tools, and navigate the social architecture of "team science." Understanding this architecture is not merely an academic exercise; it is a strategic imperative for any society or institution seeking to sustain a pipeline of transformative discovery in an increasingly competitive and complex global landscape.[4]

The first major contribution of XXI st-century science has been to dismantle the reductive equation of genius with a single metric, most commonly a high Intelligence Quotient (IQ). While exceptional general cognitive ability (the g factor) remains a significant predictor of high achievement, particularly in mathematical and scientific domains, it is now understood to be a necessary but insufficient condition.[5] Landmark longitudinal studies, such as the Study of Mathematically Precocious Youth (SMPY), which has tracked thousands of high-IQ individuals for over 45 years, reveal that while cognitive precocity sets a high floor for potential, the ceiling of transformative achievement is determined by a constellation of other factors. These include specific cognitive styles, personality dispositions, and the presence of opportunity structures.[6] Psychometric research has expanded the palette of relevant abilities to include strong working memory capacity—allowing for the mental manipulation of multiple complex variables simultaneously—and high levels of divergent thinking, which is the ability to generate a multitude of novel ideas or solutions to open-ended problems.[7] Perhaps more critically, the concept of deliberate practice, as articulated by Anders Ericsson and colleagues, has been integrated into the model of expertise development. Genius-level mastery in a domain like theoretical physics or molecular biology is seen as the product of thousands of hours of sustained, effortful, and feedback-driven practice, which builds the dense, interconnected schemata of knowledge that enable intuitive pattern recognition and rapid problem-solving.[8] This expertise allows the individual to perceive the underlying structure of a problem in a way that novices cannot, a form of "chunking" information into meaningful wholes.

Concurrently, neuroscience has moved decisively away from the futile search for a localized "genius module" in the brain. Instead, contemporary research focuses on the dynamic interplay between large-scale brain networks. A particularly salient finding is the role of functional connectivity between the Default Mode Network (DMN) and the Executive Control Network (ECN). The DMN, active during mindwandering, autobiographical thought, and spontaneous ideation, is traditionally anti-correlated with the ECN, which is engaged during focused, goal-directed tasks. In highly creative individuals, studies using resting-state and task-based fMRI show that these networks exhibit a more fluid and cooperative interaction.[9] This suggests a neural basis for the ability to seamlessly alternate between generative, associative states (where novel connections are formed) and analytical, evaluative states (where those connections are critically assessed and refined). This cognitive flexibility—the capacity to manage attention in a way that tolerates ambiguity and explores remote associations before homing in on a viable solution—appears to be a key neurocognitive signature of the innovative mind. Furthermore, diffusion tensor imaging (DTI) studies have pointed to differences in white matter tracts, such as the superior longitudinal fasciculus, which may facilitate faster or more efficient communication between distant cortical regions, particularly between frontal and temporal areas involved in idea generation and semantic processing.[10]

The personality architecture of the scientific genius has also been empirically profiled, moving beyond anecdote. Meta-analyses consistently identify Openness to Experience—the trait encompassing intellectual curiosity, aesthetic sensitivity, and attraction to novelty—as the strongest Big Five personality correlate of creative achievement.[11] However, this is tempered by high levels of Conscientiousness, specifically the facet of achievement striving and industriousness, which provides the disciplined persistence required to translate vague intuitions into rigorously tested theories or functional prototypes. This combination defies the stereotype of the disorganized, purely inspiration-driven creator. The role of intrinsic motivation, a concept central to Self-Determination Theory, is paramount; the driving force is a profound absorption in the subject matter itself, a "rage to master" often observed in prodigies, rather than extrinsic rewards like fame or wealth.[12] Angela Duckworth's construct of "grit"—passion and perseverance for long-term goals—has been shown to predict high achievement in challenging contexts, including West

Point and the National Spelling Bee, and it logically extends to the marathon of scientific discovery.[13] Finally, research into the so-called “mad-genius” link has been refined. Rather than positing a direct causal relationship between severe mental illness and genius, modern studies suggest shared endophenotypes, such as cognitive disinhibition or heightened neural hyper-connectivity, that may underpin both certain psychological vulnerabilities and the capacity for novel thought. Mild schizotypy, for instance, has been correlated with enhanced divergent thinking, while the hypomanic energy associated with bipolar spectrum conditions can fuel periods of intense productivity.[14] This nuanced view recognizes that the cognitive style conducive to genius may involve trade-offs, existing on a continuum of neurodiversity rather than representing a pathology.

If the internal architecture of the individual mind provides one subsystem, the external social and technological environment constitutes the other critical component of the genius-generating system. A defining feature of XXI st-century science is the inexorable shift from the solitary investigator to collaborative, often large-scale, teamwork. Quantitative studies of authorship patterns reveal a stark trend: the mean number of authors on papers published in prestigious journals like Science and Nature has risen dramatically, and papers with larger teams now receive a disproportionate share of citations.[15] The groundbreaking 2015 paper announcing the detection of gravitational waves by LIGO, for example, had over 1,000 authors. This is not mere inflation but reflects the genuine complexity of modern experiments, which require expertise in laser physics, vacuum engineering, seismic isolation, data analysis, and astrophysical theory. In this context, the genius of a individual like Kip Thorne or Rainer Weiss lay not only in their theoretical insights but in their decades-long leadership in envisioning, advocating for, and architecting an impossibly complex international collaboration. The role of the genius thus evolves into that of a super-node or linchpin: an individual with deep domain mastery who also possesses the social and intellectual capital to integrate diverse expertise, secure funding, and maintain the collective focus on a monumental goal.[16]

The structure of these collaborative networks is not random. Research in the science of science, leveraging massive bibliographic datasets, shows that the most innovative teams often exhibit a specific topology. They frequently consist of a core of established experts with a strong track record of working together (providing stability and deep trust) and a rotating periphery of newcomers or specialists from other fields (injecting fresh perspectives and novel techniques).[17] This structure optimizes for both efficiency and creativity. Furthermore, the digital infrastructure of science has fundamentally altered the collaborative landscape. Platforms like arXiv and bioRxiv allow for the near-instantaneous dissemination of preprints, accelerating the pace of idea exchange and priority claims. Code-sharing repositories like GitHub have made the tools of analysis—the algorithms, simulations, and data processing pipelines—as shareable as the papers themselves, fostering a culture of open, cumulative, and reproducible science, particularly in fields like machine learning and computational biology.[18] This digital ecology creates a form of distributed cognition, where the intelligence of the field is networked and accessible, allowing a gifted individual to stand on the shoulders of a global, living collective.

The tools themselves act as profound cognitive amplifiers. The genius of a XXI st-century astrophysicist or geneticist is inextricably linked to their mastery of computational methods. Problems that were once analytically intractable—simulating galaxy formation, comparing whole genomes, or searching for exoplanets in stellar light curves—are now routine through high-performance computing and sophisticated algorithms. Access to cloud computing resources democratizes this power, enabling a small team at a startup or a university to leverage computational scales previously reserved for national laboratories. This is exemplified by the 2016 triumph of DeepMind’s AlphaGo. The genius of Demis Hassabis and his team was a combinatorial one: fusing deep knowledge of reinforcement learning, Monte Carlo tree search, and neuroscience with the engineering prowess to build systems capable of self-play on an unprecedented scale.[19] The innovation was as much in the orchestration of known components into a novel, high-performing architecture as it was in a singular theoretical leap. Similarly, the development of cryo-electron microscopy (cryo-EM), recognized by the 2017 Nobel Prize in Chemistry, was a triumph of instrumentation, computation, and biology. The genius of Jacques Dubochet, Joachim Frank, and Richard Henderson was to persevere in refining a technique that others considered a dead end, ultimately creating a tool that revolutionized structural biology by allowing the visualization of biomolecules in near-native states. Their work provided a new "lens" through which the entire scientific community could see, thereby enabling countless downstream discoveries by others.[20]

The institutional and cultural container for this activity remains vital. Certain environments have consistently functioned as "innovation hothouses." The defining characteristics of these spaces, from Bell Labs in the mid-20th century to modern analogs like the Howard Hughes Medical Institute's Janelia Research Campus or the Flatiron Institute, include long-term, flexible funding that tolerates failure; physical architectures designed to foster serendipitous interaction; a critical mass of brilliant, intrinsically motivated peers; and a culture that celebrates intellectual risk-taking over incremental, safe publication.[21] These environments are not merely passive backdrops; they actively sculpt the cognitive and social processes of their inhabitants, providing the "affordances" that allow genius to flourish. They create a permissive space for the long gestation periods often required for profound ideas to mature, protecting them from the short-term accountability cycles that dominate much of academic and corporate research.

To ground this theoretical framework, we examine several iconic XXI st-century innovations through the lens of the systems model, highlighting the interplay of individual cognition, collaboration, and tooling.

The discovery and development of the CRISPR-Cas9 gene-editing system is a paradigmatic case. The foundational genius was not a single "Eureka!" moment but a series of connected insights distributed across a network of researchers. The curiosity-driven basic research of Francisco Mojica, who first identified the strange repeating sequences in archaea and hypothesized their adaptive immune function, was essential.[22] The biochemical characterization of the system by Emmanuelle Charpentier's lab, and her pivotal collaboration with structural biologist Jennifer Doudna, led to the critical realization that the Cas9 protein could be programmed with a single guide RNA to cut any DNA sequence. Their 2012 paper in Science was a masterstroke of synthetic clarity, demonstrating the system's repurposability.[23] Almost simultaneously, Feng Zhang and George Church's labs raced to demonstrate its application in human cells. This story illustrates multiple system facets: the importance of "pure," curiosity-driven research (Mojica's work had no obvious application for years); the catalytic power of interdisciplinary collaboration (microbiology meeting structural biology); the competitive accelerator of simultaneous discovery; and the role of a mature technological context (cheap DNA synthesis and sequencing) that allowed for rapid prototyping and validation. The genius here was a form of connective insight—seeing the potential utility of a microbial defense mechanism for precise genome engineering—that was enabled by a specific point in the evolution of biological knowledge and tools.

In the realm of artificial intelligence, the 2017 paper "Attention Is All You Need" by Vaswani et al. at Google introduced the Transformer architecture.[24] This was not an incremental improvement but a radical simplification that abandoned the sequential processing of recurrent neural networks (RNNs) in favor of a parallelizable "self-attention" mechanism. The cognitive leap was one of elegant minimalism: identifying that the recurrent structure, long thought essential for sequence modeling, was a bottleneck that could be circumvented. The genius of the authors was their profound understanding of the limitations of existing models and their ability to conceptualize a mathematically clean alternative. This individual insight, however, was explosively amplified by the ecosystem. The paper was published openly, and the model architecture was quickly adopted and scaled by the global AI community. The subsequent development of large language models (LLMs) like GPT-3, BERT, and their successors is the product of this open, cumulative, and highly resourced network effort. The original innovator's insight provided a new, more efficient "computational primitive" that the entire field could then build upon, demonstrating how a key individual innovation can trigger a phase transition in a collective endeavor.

The first direct detection of gravitational waves by LIGO in 2015 is a masterpiece of "big science." The theoretical genius of Albert Einstein predicted their existence a century prior. The XXI st-century achievement was an engineering and organizational marvel. The genius of individuals like Rainer Weiss (who conceived the laser interferometer design) and Kip Thorne (who provided the theoretical astrophysics impetus and political will) was channeled into leading a collaboration of thousands. This required sustaining a vision over four decades, solving innumerable technical problems (from fabricating ultra-pure mirrors to filtering out seismic noise), and managing a complex international consortium. The cognitive style required here was one of monumental persistence, systems-level thinking, and inspirational leadership. The detection itself was made possible by advances in unrelated technologies, such as stable high-power lasers and high-performance digital signal processing, showcasing the role of convergent technological readiness. The innovation was the entire LIGO observatory as an instrument—a single, distributed "machine" for listening to the universe, representing the apex of coordinated human ingenuity.[25]

A fascinating recursive loop characterizes this field: the phenomenon under study is also shaping the methods of its investigators. The scientists actively mapping the terrain of XXI st-century genius are themselves embedded in the very systems they analyze. They employ the tools of the digital age to do so. For instance, network scientists like Albert-László Barabási or Dashun Wang use large-scale publication, patent, and citation datasets—processed with machine learning algorithms—to identify patterns of breakthrough, the lifecycle of scientific careers, and the properties of high-impact teams.[26] Their research has revealed, for example, that a scientist's most impactful paper is equally likely to occur at any point in their career, challenging the myth of the young revolutionary, and that high-impact work often comes from taking risks and exploring unconventional combinations of existing ideas.[27]

Cognitive neuroscientists like Roger Beaty or Nancy Andreasen use fMRI and EEG to probe the brain states associated with insight and creative reasoning, moving beyond correlation toward understanding causation through targeted interventions. Psychologists like Dean Keith Simonton apply historiometric techniques, using statistical analysis to identify the developmental and productive patterns of eminent figures across history.[28] This methodological convergence—big data, neuroimaging, and advanced analytics—is itself a XXI st-century innovation in the human sciences. It represents a meta-cognitive turn: science applying its full methodological arsenal to understand its own generative engine. This reflexivity introduces a profound implication: as our understanding of the systems that produce genius improves, we gain the potential, however cautious we must be, to intentionally optimize those systems. This leads to the final and most applied consideration: the stewardship of genius.

If genius is a systemic output, then the goal shifts from identifying rare individuals to cultivating the conditions that allow such individuals to thrive and connect. This has concrete implications. For education, it argues for a move away from curricula overly focused on content mastery and standardized testing, which can stifle curiosity and risk-taking. Instead, it supports models that foster deep, project-based learning, encourage interdisciplinary exploration, and teach metacognitive skills related to creativity and collaboration. Programs for the profoundly gifted must provide intellectual acceleration while also nurturing the socio-emotional and perseverant qualities essential for long-term achievement.[29]

For research policy and funding, the systems model advocates for a portfolio approach. It justifies continued, robust investment in basic, curiosity-driven research (the Mojicas of the future), as this provides the raw material for future applied breakthroughs. It supports funding mechanisms for high-risk, high-reward projects that traditional peer review might reject. It underscores the value of creating and sustaining interdisciplinary research institutes with long time horizons, protected from bureaucratic and publishing pressures. Agencies like DARPA and ARPA-E, with their model of ambitious, time-bound challenges managed by technically savvy program managers, exemplify a structure designed to force innovative convergence.[30]

For institutions, it highlights the importance of designing physical and virtual spaces that promote serendipitous interaction, of developing tenure and promotion criteria that value quality and impact over mere quantity, and of fostering a culture that views intelligent failure as a necessary step in discovery. Leadership must be trained to recognize and support creative talent, providing the resources and autonomy they need while protecting them from administrative overload.

The scientific investigation of XXI st-century genius reveals a phenomenon far richer, more complex, and more hopeful than the antiquated myth of the solitary genius. Genius is not a scarce, mystical substance but a dynamic, emergent potential within a well-tuned system. It is the spark that leaps across the configured gap between a prepared mind, a ripe problem, a collaborative network, and an enabling technology. The most important scientific innovation in this story may be this very framework—a systems-theoretic understanding that demystifies genius while elevating our appreciation for the intricate human and technological ecology that produces it.

The challenges of the coming century—climate change, pandemics, energy transitions, ethical artificial intelligence—will demand genius on a scale we can scarcely imagine. They will require not occasional flashes of individual brilliance but sustained, organized, collective intelligence of the highest order. The task before us, therefore, is not to wait for geniuses to appear, but to build the architectures—cognitive, social, and technological—that allow genius to flourish routinely. This means investing in curious minds, connecting them across disciplines, arming them with powerful tools, and embedding them in cultures of ambition, rigor, and trust. In doing so, we acknowledge that genius, in its highest form, is not a personal attribute but a collective capacity—the capacity of our species to understand and reshape its world through the relentless, collaborative, and deeply human pursuit of knowledge. The study of XXI st-century genius ultimately leads us to this empowering conclusion: the future of innovation lies not in finding the next Einstein, but in building the next ecosystem in which an Einstein, or a Curie, or a da Vinci, would be almost certain to emerge and thrive.[31]

References

1. This systemic perspective is synthesized from several converging fields. Key foundational texts include: Simonton, D. K. (1999). Origins of Genius: Darwinian Perspectives on Creativity. Oxford University Press [Book]; and Sawyer, R. K. (2012). Explaining Creativity: The Science of Human Innovation (2nd ed.). Oxford University Press [Book].

2. For a critique of the Romantic “lone genius” myth in science, see: Schlesinger, J. (2009). Creative mythconceptions: A closer look at the evidence for the “mad genius” hypothesis. Psychology of Aesthetics, Creativity, and the Arts, 3(2), 62–72. [Journal Article]

3. The process-based ontology is articulated in: Glăveanu, V. P. (2013). Rewriting the language of creativity: The Five A's framework. Review of General Psychology, 17(1), 69–81. [Journal Article]

4. The "super-node" concept is explored in network science applied to innovation: Uzzi, B., & Spiro, J. (2005). Collaboration and creativity: The small world problem. American Journal of Sociology, 111(2), 447–504. [Journal Article]

5. The necessity but insufficiency of high g is discussed in: Kell, H. J., Lubinski, D., & Benbow, C. P. (2013). Who rises to the top? Early indicators. Psychological Science, 24(5), 648–659. [Journal Article]

6. See the definitive summary of SMPY findings: Lubinski, D., Benbow, C. P., & Kell, H. J. (2014). Life paths and accomplishments of mathematically precocious males and females four decades later. Psychological Science, 25(12), 2217–2232. [Journal Article]

7. On divergent thinking and creativity: Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. Creativity Research Journal, 24(1), 66–75. [Journal Article]

8. Ericsson, K. A., & Pool, R. (2016). Peak: Secrets from the New Science of Expertise. Houghton Mifflin Harcourt. [Book]

9. Beaty, R. E., Benedek, M., Silvia, P. J., & Schacter, D. L. (2016). Creative cognition and brain network dynamics. Trends in Cognitive Sciences, 20(2), 87–95. [Journal Article]

10. Jung, R. E., et al. (2010). White matter integrity, creativity, and psychopathology: Disentangling constructs with diffusion tensor imaging. PLoS ONE, 5(3), e9818. [Journal Article]

11. Feist, G. J. (1998). A meta-analysis of personality in scientific and artistic creativity. Personality and Social Psychology Review, 2(4), 290–309. [Journal Article]

12. On intrinsic motivation and creativity: Amabile, T. M. (1996). Creativity in Context. Westview Press. [Book]

13. Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. Journal of Personality and Social Psychology, 92(6), 1087–1101. [Journal Article]

14. A sophisticated treatment of the link: Kyaga, S., et al. (2013). Mental illness, suicide and creativity: 40-year prospective total population study. Journal of Psychiatric Research, 47(1), 83–90. [Journal Article]

15. Wuchty, S., Jones, B. F., & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. Science, 316(5827), 1036–1039. [Journal Article]

16. Pentland, A. (2014). Social Physics: How Good Ideas Spread—The Lessons from a New Science. Penguin Press. [Book]

17. Guimera, R., Uzzi, B., Spiro, J., & Amaral, L. A. N. (2005). Team assembly mechanisms determine collaboration network structure and team performance. Science, 308(5722), 697–702. [Journal Article]

18. On the impact of arXiv and open science: Larivière, V., Sugimoto, C. R., & Bergeron, P. (2013). In their own image? A comparison of doctoral students' and faculty members' referencing behavior. Journal of the American Society for Information Science and Technology, 64(5), 1045–1054. [Journal Article]

19. Silver, D., et al. (2016). Mastering the game of Go with deep neural networks and tree search. Nature, 529(7587), 484–489. [Journal Article]

20. Nobel Prize in Chemistry 2017 – Advanced Information. NobelPrize.org. Retrieved from https://www.nobelprize.org/prizes/chemistry/2017/advanced-information/ [Online Resource]

21. An analysis of Bell Labs as an innovation ecosystem: Gertner, J. (2012). The Idea Factory: Bell Labs and the Great Age of American Innovation. Penguin Press. [Book]

22. Mojica, F. J. M., Díez-Villaseñor, C., García-Martínez, J., & Soria, E. (2005). Intervening sequences of regularly spaced prokaryotic repeats derive from foreign genetic elements. Journal of Molecular Evolution, 60(2), 174–182. [Journal Article]

23. Jinek, M., et al. (2012). A programmable dual-RNA–guided DNA endonuclease in adaptive bacterial immunity. Science, 337(6096), 816–821. [Journal Article]

24. Vaswani, A., et al. (2017). Attention is all you need. Advances in Neural Information Processing Systems, 30, 5998–6008. [Conference Paper]

25. Abbott, B. P., et al. (LIGO Scientific Collaboration and Virgo Collaboration). (2016). Observation of gravitational waves from a binary black hole merger. Physical Review Letters, 116(6), 061102. [Journal Article]

26. Barabási, A. L. (2016). Network Science. Cambridge University Press. [Book]; Wang, D., & Barabási, A. L. (2021). The Science of Science. Cambridge University Press. [Book]

27. Sinatra, R., Wang, D., Deville, P., Song, C., & Barabási, A. L. (2016). Quantifying the evolution of individual scientific impact. Science, 354(6312), aaf5239. [Journal Article]

28. Simonton, D. K. (2009). Varieties of (scientific) creativity: A hierarchical model of disposition, development, and achievement. Perspectives on Psychological Science, 4(5), 441–452. [Journal Article]

29. Subotnik, R. F., Olszewski-Kubilius, P., & Worrell, F. C. (2011). Rethinking genius: A developmental view of giftedness. Gifted Child Quarterly, 55(4), 279–285. [Journal Article]

30. The DARPA model is analyzed in: Azoulay, P., Fuchs, E., Goldstein, A. P., & Kearney, M. (2019). Funding breakthrough research: Promises and challenges of the "ARPA Model". Innovation Policy and the Economy, 19, 69–96. [Journal Article]

31. This concluding vision aligns with arguments in: Bloom, N., Jones, C. I., Van Reenen, J., & Webb, M. (2020). Are ideas getting harder to find? American Economic Review, 110(4), 1104–1144. [Journal Article]