Endnotes with hyperlinks for the print versions of
AI's Coming Battle with Scientific Orthodoxy: How AI Will Reverse Science's Rapid Decline,
by Doug Bryan

Introduction

1. Ashlee Vance, "Oral History: Geoff Hinton On How AI Came To Be And What We're Supposed To Do With It," *Ashlee Vance,* Substack April 27, 2021; "The Godfather of AI Was Almost a Carpenter," *Bloomberg*, 1 December 2017
2. James Lighthill, "Artificial Intelligence: A General Survey," in *Artificial Intelligence: a paper symposium*, 1973
3. David E. Rumelhart, Geoffrey E. Hinton, and Ronald J. Williams, "Learning Representations by Back-Propagating Errors," *Nature,* 323(6088):533–36, October 9, 1986, doi:10.1038/323533a0
4. Bloomberg BusinessWeek, "This Canadian Genius Created Modern AI," YouTube, June 25, 2018
5. William Nordhaus, "Are We Approaching an Economic Singularity? Information Technology and the Future of Economic Growth," NBER Working Paper 21547, US National Bureau of Economic Research, Sept. 2015; Steve Jurvetson, "Transcending Moore's Law," *CNET*, July 17, 2015
6. Geoffrey Hinton, "The Next Generation of Neural Networks," Google TechTalks, YouTube, November 29, 2007
7. Rory Cellan-Jones, "Stephen Hawking warns artificial intelligence could end mankind," *British Broadcasting Corporation News*, 2 December 2014
8. Arjun Kharpal, "Stephen Hawking says A.I. could be 'worst event in the history of our civilization'," *Consumer News and Business Channel (CNBC)*, November 6, 2017; Stephen Hawking, "Stephen Hawking at Web Summit 2017," Web Summit, YouTube, November 6, 2017
9. National Governors Association's meeting, Providence, Rhode Island USA, July 15, 2017; South by Southwest Conference, Austin, Texas USA, March 11, 2018
10. Paul Krugman, "Why Most Economists' Predictions Are Wrong," *The Red Herring*, 10 June 1998
11. "Chamath Palihapitiya, Founder and CEO Social Capital, on Money as an Instrument of Change," Stanford Graduate School of Business interview, YouTube, Nov 13, 2017, timestamp 21:21; "Ex-Facebook executive Chamath Palihapitiya: Social media is creating a society that confuses 'truth and popularity'," *Consumer News and Business Channel (CNBC)*, 12 Dec 2017

12. Jeff Orlowski (Director), *The Social Dilemma*, Netflix, 2020, timestamp 1:20:00
13. David Streitfeld, "'The Internet Is Broken': @ev Is Trying to Salvage It," *New York Times*, 20 May 2017
14. Niall Ferguson, *The Square and the Tower,* Penguin Books, 2017
15. Ray Dalio, "The Rising Risk of Civil War: Following in the Footsteps of History," LinkedIn, February 3, 2022; Louis Goss, "Ray Dalio believes there's a 35% or even 40% chance of a civil war in the U.S.," *MarketWatch,* Dow Jones, May 16, 2024
16. Alex Wellerstein, "Counting the dead at Hiroshima and Nagasaki," *The Bulletin of Atomic Scientists*, August 4, 2020; Karl Compton, "If the Atomic Bomb Had Not Been Used," *The Atlantic,* December 1946
17. Max Roser et al., "Light at Night," Our World in Data, 2013; "Electrification," Wikipedia
18. National Security Commission on Artificial Intelligence, *Final Report*, Eric Schmidt, chair, Washington, DC: National Security Commission on Artificial Intelligence, March 2021, GOVPUB-Y3-PURL-gpo153246
19. Shana Lynch, "Andrew Ng: Why AI Is the New Electricity," Insights by Stanford Business, Stanford University Graduate School of Business, March 11, 2017

Ascent of AI

1. Roger Allan, "Three amazing micromice: hitherto undisclosed details," *IEEE Spectrum*, Nov. 1978; *Measure*, Hewlett-Packard internal newsletter, November 1978, p. 14; Roger Allan, "The amazing micromice: see how they won," *IEEE Spectrum*, Sept. 1979; Reuben Hoggett, "1977-79 – 'moonlight Special' Battelle Inst. (American)," CyberneticZoo.com blog, May 8, 2010
2. Inflation calculations throughout this book are by the US Federal Reserve Bank of Minneapolis using the consumer price index, and the consumer price index for urban consumers after 1977.
3. Allan, "The amazing micromice"
4. *Wired, "*Mark Zuckerberg's Letter to Investors: 'The Hacker Way'," Feb. 1, 2012
5. Richard Sutton, "The Bitter Lesson," March 13, 2019; Lex Fridman, "Exponential Progress of AI: Moore's Law, Bitter Lesson, and the Future of Computation," *Lex Fridman Podcast*, YouTube, May 13, 2020; Bruce Sterling, "Building-in How We Think We Think," *Wired*, October 28, 2019. For more context, see also: Lindsay Poirier, "Neat Versus Scruffy: How Early AI Researchers Classified Epistemic Cultures of Knowledge Representation," *IEEE Annals of the History of Computing,* 47(2):7–19, April 2025, doi:10.1109/MAHC.2024.3498692

6. Mary Bellis, "Dan Bricklin, Bob Frankston, and the First Spreadsheet," *ThoughtCo*, April 2, 2018; "Dan Bricklin," Wikipedia
7. Michael Schrage, *Serious Play: How the World's Best Companies Simulate to Innovate*, Harvard Business School Press, 1999
8. Assume no user learning curve. ROI = (benefit – cost)/cost where cost is one week and benefit is 52 weeks a year minus 4 weeks vacation minus 2 weeks holidays times 3 years. ROI = ((52 – 4 – 2) * 3 – 1)/1 = 13,700%.
9. "Michael Milken," Wikipedia
10. W. Deringer, "Michael Milken's Spreadsheets: Computation and Charisma in Finance in the Go-Go '80s," *IEEE Annals of the History of Computing*, 42(3):53–69, July 2020, doi:10.1109/MAHC.2020.2982650
11. Deringer, "Michael Milken's Spreadsheets"
12. Deringer, "Michael Milken's Spreadsheets"
13. Board of Governors of the Federal Reserve System (US), Revolving Consumer Credit Owned and Securitized [REVOLNS], retrieved from FRED, Federal Reserve Bank of St. Louis. Thomas Durkin, "Credit Cards: Use and Consumer Attitudes, 1970–2000," Federal Reserve Bulletin, September 2000
14. Khosrow Hassibi, "Detecting payment card fraud with neural networks," in *Business Applications of Neural Networks*, World Scientific, 2000
15. Khosrow Hassibi, Falcon team member, personal conversation, May 2023
16. Neal Bloom, "HNC Mafia," blog, Substack, February 2020
17. Hassibi, "Detecting payment card fraud"
18. Greg Linden, "Early Amazon: Shopping cart recommendations," *Geeking with Greg* (blog), April 25, 2006
19. Ronny Kohavi and Matt Round, "Front Line Internet Analytics at Amazon.com," Emetrics Summit, 2004
20. John Rauser, "The Impact of Website Performance on Conversion," Amazon.com internal research paper, July 5, 2004. Linden refined the result two years later to 1/10th of a second increase in page load time reduced revenue by 1%. Greg Linden, "Make Data Useful," Stanford University Data Mining class (CS345), Nov 28, 2006, retrieved August 10, 2026. Ron Kohavi et al., "Practical Guide to Controlled Experiments on the Web: Listen to Your Customers not to the HiPPO," in *Proceedings of the 13th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining,* Association for Computing Machinery, 2007. Interestingly, Amazon's latency thresholds are about the same as IBM researchers found 22 and 36 years earlier: RB Miller, "Response time in man-computer conversational transactions," in *Proceedings of the Fall Joint Computer Conference*, Association for Computing Machinery, 1968, doi:10.1145/1476589.1476628; W Doherty and

A Thadani, “The Economic Value of Rapid Response Time,” IBM Technical Report GE20-0752-0, Nov 1982, retrieved Sept. 7, 2026.

21. U.S. Patent 6,266,649 B1 - Collaborative recommendations using item-to-item similarity mappings, Sept. 1998; G Linden, B Smith and J York, “Amazon.com recommendations: item-to-item collaborative filtering,” *IEEE Internet Computing*, 7(1):76–80, Jan. 2003; Linden, “Early Amazon: Shopping cart recommendations”; Greg Linden, “Item-to-item collaborative filtering,” *Geeking with Greg* (blog), November 27, 2006; Brian McCullough, “Early Amazon Engineer and Co-Developer of the Recommendation Engine, Greg Linden,” *Internet History Podcast*, April 5, 2015
22. Sutton, “The Bitter Lesson”
23. Paul Jaccard, “The distribution of the flora of the alpine zone,” *New Phytologist,* 11:37–50, 1912
24. “IBM Watson,” Wikipedia; Jo Best, “IBM Watson: The inside story of how the Jeopardy-winning supercomputer was born, and what it wants to do next,” *TechRepublic*, Sept. 9, 2013
25. William Nordhaus, “Are We Approaching an Economic Singularity? Information Technology and the Future of Economic Growth,” NBER Working Paper 21547, US National Bureau of Economic Research, Sept. 2015; CPI Inflation Calculator, U.S. Bureau of Labor Statistics; “Software Developer Salary,” *U.S. News & World Report*
26. Alex Krizhevsky, Ilya Sutskever, and Geoffrey E. Hinton, "ImageNet Classification with Deep Convolutional Neural Networks," in *Proceedings of the 25th International Conference on Neural Information Processing Systems,* Association for Computing Machinery, December 2012, doi:10.1145/3065386. Supplement.
27. Jensen Huang, “GTC March 2024 Keynote with NVIDIA CEO Jensen Huang,” NVIDIA, YouTube, March 18, 2024, timestamp 1:06:16
28. Karl Evers-Hillstrom, “Most expensive ever: 2020 election cost $14.4 billion,” OpenSecrets, Feb. 11, 2021; “Cost of Election,” OpenSecrets
29. Rayid Ghani, Chief Scientist, Obama 2012 re-election campaign
30. Vian Bakir, “Psychological Operations in Digital Political Campaigns: Assessing Cambridge Analytica's Psychographic Profiling and Targeting,” Frontiers Communications, 3 September 2020; Ferguson, *The Square and the Tower*; Aristotle, Inc., “How big data can win you an election,” blog, May 6, 2022; Cambridge Analytica and SCL Group, “Leave.EU: Psychographic Targeting for Britain,” 2015, background paper submitted in written evidence by Brittany Kaiser, Disinformation and "Fake News" inquiry, House of Commons Digital, Culture, Media and Sport Committee, UK Parliament, April 2018
31. “History & Archives,” Unilever
32. Frank van den Driest, Stan Sthanunathan, and Keith Weed, “Building an insights engine: How Unilever got to know its customers,” *Harvard Business Review*, September 2016; Linda

Hoeberigs et al., "Unilever - Creating Data-driven Product Ideas Based Exclusively on Consumer Wants and Needs," Dataiku, September 19, 2022

33. Hoeberigs, "Creating Data-driven Product Ideas"
34. Google's Waymo self-driving car was one of the first to use fuzzing with AI and simulation. Alexis Madrigal, "Inside Waymo's Secret World for Training Self-Driving Cars," *The Atlantic,* August 23, 2017; News Tube, "Inside Waymo's Secret World for Training Self Driving Cars," YouTube, Nov 8, 2017.
35. Jeremy Bogaisky, "GE Says It's Leveraging Artificial Intelligence To Cut Product Design Times In Half," *Forbes,* March 6, 2019
36. Personal conversation, May 22, 2024
37. David Rowan, "DeepMind: inside Google's super-brain - artificial intelligence," *Wired,* June 22, 2015
38. Volodymyr Mnih et al., "Playing Atari with Deep Reinforcement Learning," NIPS Deep Learning Workshop 2013, arXiv, 19 Dec 2013, doi:10.48550/arXiv.1312.5602; V Mnih et al., "Human-level control through deep reinforcement learning," *Nature,* 518:529–533, 2015, doi:10.1038/nature14236; Two Minute Papers, "Google DeepMind's Deep Q-learning playing Atari Breakout!," YouTube, March 7, 2015; Two Minute Papers, "Google DeepMind's Deep Q-Learning & Superhuman Atari Gameplays," YouTube, November 22, 2015
39. James Vincent, "A video game-playing AI beat Q*bert in a way no one's ever seen before," *The Verge*, Feb 28, 2018; Patryk Chrabaszcz et al., "Back to Basics: Benchmarking Canonical Evolution Strategies for Playing Atari," arXiv, Feb. 2018, doi:10.48550/arXiv.1802.08842
40. "Game complexity," Wikipedia
41. E Gibney, "Self-taught AI is best yet at strategy game Go," *Nature*, 18 October 2017, doi:10.1038/nature.2017.22858
42. David Silver et al., "Mastering Chess and Shogi by Self-Play with a General Reinforcement Learning Algorithm," arXiv, 5 Dec 2017, doi:10.48550/arXiv.1712.01815; James Somers, "How the Artificial-Intelligence Program AlphaZero Mastered Its Games," *The New Yorker*, December 28, 2018; Philipp Gerbert, "AI and the 'Augmentation' Fallacy," *MIT Sloan Management Review*, May 16, 2018; David Silver et al., "A general reinforcement learning algorithm that masters chess, shogi, and Go through self-play," *Science*, 362(6419):1140–44, 7 Dec 2018, doi:10.1126/science.aar6404
43. Will Knight, "Alpha Zero's 'Alien' Chess Shows the Power, and the Peculiarity, of AI," *MIT Technology Review*, December 8, 2017
44. Peter Doggers, "AlphaZero Chess: Reactions From Top GMs, Stockfish Author," Chess.com, Oct. 5, 2018
45. "Ruy Lopez," Wikipedia

46. Chess.com, "Alpha Zero's Top 5 Moves Of All Time!!!," YouTube, July 25, 2020

47. BBC News, "Google's 'superhuman' DeepMind AI claims chess crown," 6 December 2017; Mel O'Cinneide, "How Does AlphaZero Play Chess?," Chess.com, Dec. 21, 2017; Chess.com, "Alpha Zero's Top Five Moves," Nov 3, 2020

48. David Silver et al., "Mastering Chess and Shogi by Self-Play with a General Reinforcement Learning Algorithm," arXiv, 5 December 2017, doi:10.48550/arXiv.1712.01815. AlphaZero chess trained for two hours on 5,000 TPU v1s at 92 INT8 trillion operations per second (TOPS) each and 64 TPU v2s at 45 FP16 TOPS each. In September 2026, that's equivalent to 250 TPU v6s with on-demand pricing of $2.75 per hour. 250 TPUs * 2 hours * $2.75 per hour = $1,375.

49. Christof Koch, "How the computer beat the Go master," *Scientific American*, March 19, 2016; David Silver et al., "Mastering the game of Go with deep neural networks and tree search," *Nature,* 529:484–9, January 2016, doi:10.1038/nature16961

50. Sarah Knapton, "AlphaGo Zero: Google DeepMind supercomputer learns 3,000 years of human knowledge in 40 days," *The Telegraph*, 18 October 2017; David Silver et al., "Mastering the game of Go without human knowledge," *Nature,* 550:354–9, October 2017, doi:10.1038/nature24270; E Gibney, "Self-taught AI is best yet at strategy game Go," *Nature*, October 2017, doi:10.1038/nature.2017.22858

51. Sha Sajadieh et al., "The AI Index 2026 Annual Report," AI Index Steering Committee, Institute for Human-Centered AI, Stanford University, arXiv, April 2026, doi:10.48550/arXiv.2606.15708

52. Demis Hassabis and James M. Manyika, "AI as the Ultimate Tool for Science: A Conversation with Demis Hassabis," *Dædalus,* American Academy of Arts & Sciences, Winter/Spring 2026

53. E Callaway, "'It will change everything': DeepMind's AI makes gigantic leap in solving protein structures," *Nature*, 588:203–4, 30 Nov. 2020, doi:10.1038/d41586-020-03348-4; DeepMind, "AlphaFold: a solution to a 50-year-old grand challenge in biology," November 30, 2020; J Jumper et al., "Highly accurate protein structure prediction with AlphaFold," *Nature,* 596:583–9, July 2021, doi:10.1038/s41586-021-03819-2

54. Matthew Sparkes, "DeepMind's protein-folding AI cracks biology's biggest problem," *New Scientist*, 28 July 2022

55. Demis Hassabis, "Putting the power of AlphaFold into the world's hands," DeepMind, July 22, 2022

56. Sparkes, "DeepMind's protein-folding"

57. Callaway, "It will change everything"

58. Seeking Alpha, "Alphabet's AlphaFold Is A Gift To Humanity, Not Investors," July 12, 2022

59. Eric Raymond, *The Cathedral & the Bazaar*, O'Reilly & Associates, 1999

60. Joel Shapiro, "Data Driven at 200 MPH: How Analytics Transforms Formula One Racing," *Forbes*, Jan 26, 2023

61. Michelle, "McKinsey, Formula 1, and the America's Cup," Digital Innovation and Transformation, MBA Student Perspectives, Harvard University, Nov. 27, 2022

62. QuantumBlack, "Inside the Black Box. An introduction to QuantumBlack," (blog), Medium.com, Jan. 21, 2018; Madison Marriage, "QuantumBlack: consultancy's ride from F1 data crunchers to McKinsey," *Financial Times,* 29 January 2019

63. McKinsey & Company, "Flying across the sea, propelled by AI," March 17, 2021; Elaine Bunting, "Radical 75ft flying monohull 'could be fastest America's Cup design ever'," *Yachting World*, November 21, 2017

64. McKinsey, "Flying across the sea." It took AlphaZero 35 times longer to learn Go than to learn chess. David Silver et al., "AlphaZero: Shedding new light on chess, shogi, and Go," DeepMind, 6 December 2018

65. McKinsey, "Flying across the sea"

66. McKinsey & Company, "America's Cup Sailing: Using AI to make Emirates Team New Zealand fly," YouTube, March 1, 2021

67. Ashish Vaswani et al., "Attention Is All You Need," in *Conference on Neural Information Processing Systems,* arXiv, June 12, 2017, doi:10.48550/arXiv.1706.03762

68. Sébastien Bubeck et al., "Sparks of Artificial General Intelligence: Early experiments with GPT-4," arXiv, 22 March 2023, doi:10.48550/arXiv.2303.12712

69. Catie Grasso, "Whataburger: Using LLMs to Hear What Customers Are Saying," Dataiku (blog), April 2024

70. "Back to business event," La Tribune Bordeaux, 18 January 2024

71. Lisa Harkness et al., "How generative AI can boost consumer marketing," McKinsey & Company, December 5, 2023

72. Begum Karaci Deniz et al., "Unleash developer productivity with generative AI," McKinsey & Company, June 27, 2023

73. Fabrizio Dell'Acqua et al., "Navigating the Jagged Technological Frontier: Field Experimental Evidence of the Effects of AI on Knowledge Worker Productivity and Quality," Harvard Business School Working Paper 24-013, Harvard University, September 22, 2023; François Candelon et al., "How People Can Create—and Destroy—Value with Generative AI," Boston Consulting Group, September 21, 2023

74. John W. Ayers et al., "Comparing Physician and Artificial Intelligence Chatbot Responses to Patient Questions Posted to a Public Social Media Forum," *JAMA Internal Medicine*, 183(6):589–596, 2023, doi:10.1001/jamainternmed.2023.1838

75. Meghan Holohan, "A boy saw 17 doctors over 3 years for chronic pain. ChatGPT found the diagnosis," *Today*, NBC, September 2023

76. Andrew Jack, "AI chatbot's MBA exam pass poses test for business schools," *Financial Times*, January 21, 2023; Kristen Fuller, "Two AI chatbots passed the USMLE, doctors react," MDLinx, January 25, 2023; CBS News, "ChatGPT bot passes law school exam," January 25, 2023

77. Leopold Aschenbrenner, "Situational Awareness," June 2024, https://situational-awareness.ai/

78. Matt Bornstein and Rajko Radovanovic, "Emerging Architectures for LLM Applications," Andreessen Horowitz, June 20, 2023

79. Kakaes, Konstantin, "The AI Revolution in Math Has Arrived," *Quanta Magazine*, 13 April 2026

80. Judith-Lisa Lieberum et al., "Large Language Models for Conducting Systematic Reviews: On the Rise, but Not Yet Ready for Use—A Scoping Review," *Journal of Clinical Epidemiology,* 181:111746, May 2025, doi:10.1016/j.jclinepi.2025.111746

81. Matthew Michelson et al., "Artificial intelligence for rapid meta-analysis: case study on ocular toxicity of hydroxychloroquine," *Journal of Medical Internet Research,* 22:8, Aug 2020, doi:10.2196/20007

82. Ioannidis JPA et al., "Meta-research: Evaluation and Improvement of Research Methods and Practices," *Public Library of Science (PLOS) Biology*, 13(10):e1002264, October 2, 2015, doi:10.1371/journal.pbio.1002264

83. OpenAI Academy, "Terence Tao: AI Is Ready for Primetime in Math and Theoretical Physics," March 6, 2026; James Donovan, "Terence Tao and Mark Chen - Fireside Chat with James Donovan," Accelerating Math and Theoretical Physics with AI Workshop, UCLA Institute for Pure and Applied Mathematics, YouTube, March 4, 2026

84. Kakaes, "The AI Revolution in Math"

85. Stephanie Ashe, "AI Outperforms Law Professors in Stanford Law Study," Stanford Law School, Stanford University, June 1, 2026; Alejandro Salinas et al., "Law Professors Prefer AI Over Peer Answers," Social Science Research Network 61, Stanford University, May 27, 2026. Professors were from Stanford University, Marquette University, Yale University, New York University, University of Chicago, Widener University, University of Virginia, Santa Clara University, Drake University, Indiana University, Georgetown University, Purdue Global, St. John's University, Michigan State University, and University of California, Los Angeles.

86. Matthew Schwartz, "Vibe Physics: The AI Grad Student," Anthropic (blog), March 23, 2026

87. Eva Rothenberg, "AI fears overblown? Theoretical physicist calls chatbots 'glorified tape recorders'," CNN, August 13, 2023

88. Claude used 27.5 million input tokens at $5 per million + 8.6 million output tokens at $25 per million = $353.

89. Leyland Cecco, “Air Canada Ordered to Pay Customer Who Was Misled by Airline's Chatbot,” *The Guardian*, February 16, 2024

90. For example, Minkyung Baek et al., "Accurate Prediction of Protein Structures and Interactions Using a Three-Track Neural Network," *Science,* 373(6557):871–76, 2021, doi:10.1126/science.abj8754.

91. William J. Broad, “How Hallucinatory A.I. Helps Science Dream Up Big Breakthroughs,” *The New York Times*, December 23, 2024; The Nobel Prize, “2024 Nobel Prize lectures in chemistry | David Baker, Demis Hassabis and John Jumper,” YouTube, December 8, 2024

92. Google DeepMind, “Gemini 3 Deep Think: Advancing science, research and engineering,” February 12, 2026; Google DeepMind, “Gemini 3 Deep Think: Identifying logical errors in complex mathematics research,” YouTube, February 20, 2026

93. Mark Zuckerberg, “The Future is for Everyone,” Meta, August 10, 2026

94. Timothy Gowers, “A recent experience with ChatGPT 5.5 Pro,” Gowers’s Weblog, May 8, 2026

95. Joseph Howlett, “AI just solved an 80-year-old ‘Erdős problem,’ and mathematicians are amazed,” *Scientific American*, May 21, 2026

96. OpenAI, “An OpenAI model has disproved a central conjecture in discrete geometry,” May 20, 2026

97. J Gottweis et al., “Accelerating scientific breakthroughs with an AI co-scientist,” Google, February 19, 2025; J Gottweis et al., “Accelerating scientific discovery with Co-Scientist,” *Nature,* 655:487–496*,* May 19, 2026, doi:10.1038/s41586-026-10644-y; D Adam, “The AI co-scientist is here,” *Nature Medicine,* 32:772–775, March 16, 2026, doi:10.1038/s41591-026-04275-z

98. Ludovico Mitchener et al., “Kosmos: An AI Scientist for Autonomous Discovery,” arXiv, November 5, 2025, doi:10.48550/arXiv.2511.02824; Ghareeb, A.E., Chang, B., Mitchener, L et al., “A multi-agent system for automating scientific discovery,” *Nature,* 655(8122):497–505, 19 May 2026, doi:10.1038/s41586-026-10652-y

99. Marc Andreessen, “Marc Andreessen,” *Joe Rogan Experience,* #2501, YouTube, May 19, 2026, timestamp 1:45:07

100. Hubert T, Mehta R, Sartran L et al. “Olympiad-level formal mathematical reasoning with reinforcement learning,” *Nature,* 651(8106):607–13, March 2026, doi:10.1038/s41586-025-09833-y

101. Renee Boerefijn, “Digital innovation in the food manufacturing industry," BrightTALK.com, September 10, 2021; Renee Boerefijn personal conversation, May 2022

102. James Kirsch (Director of Software, Simulation, Systems Engineering and Integration Directorate at the US Army Aviation and Missile Center), presented at the Hewlett Packard Enterprise AI/ML Tech Exchange and Expo, Huntsville, AL, November 1, 2022

Descent of science

1. René Descartes, *Discourse on the Method of Rightly Conducting One's Reason and of Seeking Truth in the Sciences,* Leyden, Holland, 1637
2. Thomas McCormack in the publisher's preface of *Discourse on Method,* René Descartes, The Open Court Publishing Company, Chicago, IL, 1899
3. Descartes, *Discourse on the Method,* part 2
4. Descartes, *Discourse on the Method,* part 6
5. Descartes, *Discourse on the Method,* part 5
6. Geoffrey Hinton, "University of Toronto Press Conference - Professor Geoffrey Hinton, Nobel Prize in Physics 2024," University of Toronto, YouTube, Oct 8, 2024, time stamp 21:34
7. For example, Yuval Noah Harari, *Homo Deus: A Brief History of Tomorrow*, Harper, 2017; National Research Council, *A New Biology for the 21st Century,* National Academies Press, 2009, chapter 3. doi:10.17226/12764
8. Bloom, Nicholas et al., "Are Ideas Getting Harder to Find?", NBER Working paper 23782, US National Bureau of Economic Research, Sept. 2017, doi:10.3386/w23782. Later also as, N. Bloom et al., "Are Ideas Getting Harder to Find?," *American Economic Review*, 110(4):1104–44, Apr 2020, doi:10.1257/aer.20180338
9. Bloom, "Are Ideas Getting Harder to Find?", table 6. The next three charts use data from this paper.
10. Peter Cauwels and Didier Sornette, "Are 'Flow of Ideas' and 'Research Productivity' in secular decline?," Research Paper No. 20-90, Swiss Finance Institute, October 22, 2020, doi:10.2139/ssrn.3716939
11. T. S. Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, 1962
12. Jon Marcus, "New analysis shows problematic boom in higher ed administrators," The New England Center for Investigative Reporting, Feb. 6, 2024
13. American Institutes for Research, "Is 'Admin Bloat' Behind the High Cost of College?," blog, 5 February 2014
14. Jeff Denneen and Tom Dretler, "The financially sustainable university," Bain & Company, July 6, 2012

15. Office of Inspector General, National Science Foundation, *Federally Sponsored Research: How Indirect Costs Are Charged by Educational and Other Research Institutions*, OIG 91-2, US National Science Foundation, September 1991

16. Johan Chu and James Evans, "Slowed canonical progress in large fields of science," in *Proceedings of the National Academy of Sciences of the United States of America*,118(41), October 4, 2021, doi:10.1073/pnas.2021636118

17. Ioannidis JPA, "Why Most Published Research Findings Are False," *Public Library of Science (PLoS) Medicine,* 2(8), August 2005, doi:10.1371/journal.pmed.0020124

18. Reva Schwartz et al., "Towards a Standard for Identifying and Managing Bias in Artificial Intelligence," Special Publication 1270, US National Institute of Standards and Technology, March 2022, doi:10.6028/NIST.SP.1270

19. Jonah Lehrer, "The truth wears off," *The New Yorker*, December 13, 2010

20. John LK, Loewenstein G, Prelec D., "Measuring the prevalence of questionable research practices with incentives for truth telling," *Psychological Science*, 23(5):524–32, 2012, doi:10.1177/0956797611430953

21. Simmons JP et al., "False-positive psychology: undisclosed flexibility in data collection and analysis allows presenting anything as significant," *Psychological Science*, 22(11):1359–66, 2011, doi:10.1177/0956797611417632; Head ML et al., "The Extent and Consequences of P-Hacking in Science," *PLOS Biology*, Public Library of Science, 13(3):e1002106, 2015, doi:10.1371/journal.pbio.1002106

22. Ioannidis JPA, "Contradicted and Initially Stronger Effects in Highly Cited Clinical Research," *Journal of the American Medical Association*, 294(2):218–28, July 2005, doi:10.1001/jama.294.2.218

23. Lehrer, "The truth wears off"

24. Kelsey Piper, "Science has been in a "replication crisis" for a decade. Have we learned anything?," *Vox*, Oct 14, 2020

25. Monya Baker, "1,500 scientists lift the lid on reproducibility," *Nature,* 533(7604):452–4, 25 May 2016, doi:10.1038/533452a

26. Wen H, Wang HY, He X, Wu CI, "On the low reproducibility of cancer studies," *National Science Review*, 5(5):619–24, Sept 2018, doi:10.1093/nsr/nwy021

27. Van Noorden R, "Medicine is plagued by untrustworthy clinical trials. How many studies are faked or flawed?", *Nature*, 619(7970):454–8, July 2023, doi:10.1038/d41586-023-02299-w

28. Andrew Follett, "How Much of Science Is Fake?," *National Review,* May 23, 2024

29. Marta Serra-Garcia and Uri Gneezy, "Nonreplicable publications are cited more than replicable ones," *Science Advances,* 7(21), May 2021, doi:10.1126/sciadv.abd1705; Y. Yang et al., "Estimating the deep replicability of scientific findings using human and artificial

intelligence," in *Proceedings of the National Academy of Sciences of the United States of America*, 117(20):10762–68, 2020, doi:10.1073/pnas.1909046117

30. Edward Raff, "Does the Market of Citations Reward Reproducible Work?," arXiv, 8 April 2022, doi:10.48550/arXiv.2204.03829. Also in *Proceedings of the 2023 ACM Conference on Reproducibility and Replicability*, Association for Computing Machinery, 2023, doi:10.1145/3589806.3600041
31. Stuart Ritchie, *Science Fictions: How Fraud, Bias, Negligence, and Hype Undermine the Search for Truth,* Metropolitan Books, 2020
32. Francis Bacon, *The New Instrument of the Sciences,* London: John Bill, 1620
33. British physician James Lind's 1747 test of citrus to treat scurvy on the warship Salisbury is often considered the first modern controlled experiment. Bhatt A, "Evolution of clinical research: a history before and beyond James Lind," *Perspectives in Clinical Research,* 1(1):6–10, Jan. 2010.
34. Bacon, *The New Instrument of the Sciences*
35. TD Sterling, "Publication Decisions and Their Possible Effects on Inferences Drawn from Tests of Significance—or Vice Versa," *Journal of the American Statistical Association*, 54(285):30–34, 1959, doi:10.2307/2282137; TD Sterling et al., "Publication Decisions Revisited: The Effect of the Outcome of Statistical Tests on the Decision to Publish and Vice Versa," *The American Statistician,* 49(1):108–12, 1995, doi:10.1080/00031305.1995.10476125
36. Ioannidis, "Contradicted and Initially Stronger"
37. Ioannidis, "Why Most Published Research Findings Are False"
38. Ed Yong, "Replication studies: Bad copy," *Nature,* 485(7398):298–300, May 2012, doi:10.1038/485298a
39. Daniele Fanelli, "Negative results are disappearing from most disciplines and countries," *Scientometrics,* 90(3):891–904, 2012, doi:10.1007/s11192-011-0494-7
40. Lehrer, "The truth wears off"
41. Baker, "1,500 scientists"
42. Yong, "Replication studies"
43. Thombs BD, Razykov I, "A solution to inappropriate self-citation via peer review," *Canadian Medical Association Journal,* 184(16):1864, 6 Nov 2012, doi:10.1503/cmaj.120597
44. Ferric Fang and Arturo Casadevall, "Retracted Science and the Retraction Index," *American Society of Microbiology Journals, Infection and Immunity,* 79(10):3855–3859, 16 September 2011, doi:10.1128/iai.05661-11; Björn Brembs, "Prestigious Science Journals Struggle to Reach Even Average Reliability," *Frontiers in Human Neuroscience*, 12:37, 20 Feb 2018,

doi:10.3389/fnhum.2018.00037; “Why high-profile journals have more retractions,” *Nature,* 17 Sep 2014, doi:10.1038/nature.2014.15951

45. Fang, “Retracted Science”
46. Piper, “Science has been in a ‘replication crisis’”
47. Brandon Vigliarolo, “Wiley shuts 19 scholarly journals amid AI paper mill problem,” *The Register*, 21 May 2024
48. *Nature Human Behavior,* “Science must respect the dignity and rights of all humans,” Editorial, 6:1029–31, 18 August 2022, doi:10.1038/s41562-022-01443-2
49. Steven Pinker (@sapinker), “Journalists & psychologists take note: Nature Human Behavior is no longer…,” Twitter (X), 26 August 2022, https://x.com/sapinker/status/1563179979667476482
50. Jukka Savolainen, “Nature Human Behavior Editorial Is Anti-Science,” *City Journal*, Manhattan Institute, September 9, 2022
51. Bo Winegard, “The Fall of ‘Nature’,” *Quillette*, 28 Aug 2022
52. Andrew Follett, “Too-Political Science,” *National Review*, July 11, 2022
53. Tom Dietterich (ed.), “Statement on Nature Machine Intelligence,” Oregon State University
54. Neil Lawrence, “Why thousands of AI researchers are boycotting the new Nature journal,” *The Guardian,* 29 May 2018
55. Hoffman W, “Meet Monsieur Cholesterol,” *Update,* University of Minnesota, Winter 1979
56. Hoffman, “Meet Monsieur Cholesterol”
57. “Ancel Keys,” Wikipedia
58. Centers for Disease Control and Prevention, National Center for Health Statistics, HIST293, age-adjusted death-rate tables, retrieved April 8, 2026
59. Keys A, “Atherosclerosis: a problem in newer public health,” *Journal of the Mount Sinai Hospital*, New York, 20(2):118–139, July 1953, retrieved May 27, 2026
60. Keys A et al., *Experimental Starvation in Man: A Report from the Laboratory of Physiological Hygiene*, University of Minnesota, October 15, 1945
61. Keys, “Atherosclerosis”
62. Keys A, Anderson JT, Grande F, “Prediction of serum-cholesterol responses of man to changes in fats in the diet,” *The Lancet*, 273(7003):959–66, 15 Nov 1957, doi:10.1016/s0140-6736(57)91998-0
63. Hoffman, “Meet Monsieur Cholesterol”
64. Columbia Broadcasting System, *To Tell the Truth,* March 6, 1961

65. Select Committee on Nutrition and Human Needs, US Senate, *Dietary Goals for the United States* (McGovern Report), US Government Printing Office, 1977, retrieved September 29, 2026.

66. Keys A et al., "The diet and 15-year death rate in the seven countries study," *American Journal of Epidemiology*, 124(6):903–15, Dec 1986, doi:10.1093/oxfordjournals.aje.a114480; Keys A et al., "The seven countries study: 2,289 deaths in 15 years," *Preventive Medicine*, 13(2):141–54, March 1984, doi:10.1016/0091-7435(84)90047-1. The study also has its own website at Seven Countries Study.

67. Yerushalmy J, Hilleboe HE, "Fat in the diet and mortality from heart disease: A methodologic note," *New York State Journal of Medicine*, 57(14):2343–54, 1957, retrieved here and here May 28, 2026. See also "Keys' Scientific Abandon," CrossFit, December 31, 2018.

68. Menotti A, Puddu PE, "Ancel Keys, the Mediterranean Diet, and the Seven Countries Study: A Review," *Journal of Cardiovascular Development and Disease*, 12(4):141, April 8, 2025, doi:10.3390/jcdd12040141

69. Eyal G. Frank et al., "Campaigning for Extinction: Eradication of Sparrows and the Great Famine in China," NBER Working Paper 34087, US National Bureau of Economic Research, 2025, doi:10.3386/w34087

70. Yudkin J et al., "Diet and coronary thrombosis: hypothesis and fact," *The Lancet*, 270(6987):155–162, July 27, 1957, doi:10.1016/s0140-6736(57)90614-1; Yudkin J, "Dietary fat and dietary sugar in relation to ischaemic heart-disease and diabetes," *The Lancet,* 284(7349):4–5, July 4, 1964, doi:10.1016/s0140-6736(64)90002-9; Yudkin J, *Pure, White and Deadly: How Sugar is Killing Us and What We Can Do to Stop It*, Davis-Poynter, 1972

71. Kearns CE et al., "Sugar Industry and Coronary Heart Disease Research: A Historical Analysis of Internal Industry Documents," *JAMA Internal Medicine,* 176(11):1680–85, November 2016, doi:10.1001/jamainternmed.2016.5394, PMCID:PMC5099084. For a summary see Melissa Bailey, "Sugar industry secretly paid for favorable Harvard research," *STAT News*, Sept. 12, 2016.

72. Kearns, "Sugar Industry"

73. Ian Leslie, "The sugar conspiracy," *The Guardian*, 7 April 2016

74. Siri-Tarino PW et al., "Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease," *American Journal of Clinical Nutrition*, 91(3):535–546, 2010, doi:10.3945/ajcn.2009.27725

75. Chowdhury R et al., "Association of dietary, circulating, and supplement fatty acids with coronary risk: A systematic review and meta-analysis," *Annals of Internal Medicine*, 160(6):398–406, 18 March 2014, doi:10.7326/m13-1788

76. Hooper L, Martin N et al., "Reduction in saturated fat intake for cardiovascular disease," Cochrane Database of Systematic Reviews, 8:CD011737, 2020. doi:10.1002/14651858.CD011737.pub3

77. U.S. Department of Health and Human Services and U.S. Department of Agriculture, *2015–2020 Dietary Guidelines for Americans*, 8th ed., December 2015

78. US Department of Agriculture, Economic Research Service, *Sugar and Sweeteners Yearbook Tables*

79. John Burn-Murdoch, "We may have passed peak obesity," *Financial Times*, Oct. 3, 2024. These rates are based on the old BMI definition of obesity, not the new definition proposed in 2025 that incorporates anthropometric measures.

80. Faizan Ahmed et al., "Trends and Disparities in Obesity-Related Mortality Among U.S. Adults: A CDC WONDER Analysis (1968–2025)," *Obesity Science & Practice*, 12(2), 14 April 2026, doi:10.1002/osp4.70146

81. Ahmed M et al., "Type 2 Diabetes Mellitus-Related Mortality in the United States, 1999 to 2023," *Journal of the American College of Cardiology,* 4(7), July 2025, doi:10.1016/j.jacadv.2025.101882

82. U.S. Department of Agriculture and U.S. Department of Health and Human Services, *Dietary Guidelines for Americans, 2025–2030,* 2026

83. "About Us," True Health Initiative

84. Pett KD et al., "Ancel Keys and the Seven Countries Study: An Evidence-based Response to Revisionist Histories," White Paper, The True Health Initiative, August 1, 2017

85. Collier DA et al., "A novel functional polymorphism within the promoter of the serotonin transporter gene: possible role in susceptibility to affective disorders," *Molecular Psychiatry*, 1(6):453–60, Dec 1996

86. Willis-Owen SA et al., "The serotonin transporter length polymorphism, neuroticism, and depression: a comprehensive assessment of association," *Biological Psychiatry*, 58(6):451–6, 15 Sep 2005, doi:10.1016/j.biopsych.2005.04.050

87. Border R et al., "No Support for Historical Candidate Gene or Candidate Gene-by-Interaction Hypotheses for Major Depression Across Multiple Large Samples," *American Journal of Psychiatry*, 176(5):376–87, May 2019, doi:10.1176/appi.ajp.2018.18070881

88. Ed Yong, "A Waste of 1000 Research Papers," *The Atlantic,* May 17, 2019

89. Scott Alexander [Scott Alexander Siskind], "5-HTTLPR: A Pointed Review," Slate Star Codex blog, May 7, 2019

90. Yong, "A Waste of 1000 Research Papers"

91. Tejada-Vera B et al., "Deaths: Leading Causes for 2023," National Vital Statistics Reports, 74(10), US Department of Health & Human Services, Centers for Disease Control and Prevention, September 16, 2025

92. US Centers for Disease Control and Prevention, National Center for Health Statistics, *Mortality in the United States, 2024*, NCHS Data Brief no. 548, 2025

93. Lesné S, Koh M, Kotilinek L et al., “A specific amyloid-β protein assembly in the brain impairs memory,” *Nature*, 440(7082):352–7, March 2006, doi:10.1038/nature04533

94. Charles Piller, “Blots on a field?”, *Science,* 377(6604):358–63, 21 July 2022, doi:10.1126/science.add9993

95. Derek Lowe, “Faked Beta-Amyloid Data. What Does It Mean?,” *Science*, 25 July 2022

96. Susan Fitzpatrick, “Asking the Right Questions in Alzheimer's Research,” *Issues in Science and Technology,* 35(1):77–79, Fall 2018

97. Sharon Begley, “The maddening saga of how an Alzheimer's 'cabal' thwarted progress toward a cure for decades,” *STAT News*, June 25, 2019

98. Piller, “Blots on a field”

99. Begley, “The maddening saga”

100. C-SPAN, “Severe Acute Respiratory Syndrome,” *Washington Journal*, April 15, 2003

101. United States Executive Office of the President, “Fifteen days to slow the spread : the President’s coronavirus guidelines for America,” Centers for Disease Control and Prevention, March 16, 2020

102. US White House, “Remarks by President Trump, Vice President Pence, and Members of the Coronavirus Task Force in Press Briefing,” National Archives and Records Administration, March 16, 2020; Roll Call Factbase Videos, “Press Conference: Donald Trump Joins the Daily Coronavirus Pandemic Briefing,” YouTube, March 16, 2020, timestamp 54:20

103. Msemburi W et al., “The WHO estimates of excess mortality associated with the COVID-19 pandemic,” *Nature*, 613(7942):130–7, January 2023, doi:10.1038/s41586-022-05522-2; World Health Organization, “14.9 million excess deaths associated with the COVID-19 pandemic in 2020 and 2021,” 5 May 2022; Wang H, Paulson K, Pease S et al., “Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020–21,” *The Lancet*, 399(10334):1513–36, April 16, 2022, doi:10.1016/S0140-6736(22)00621-3; Mathieu E et al., “Excess mortality during the Coronavirus pandemic (COVID-19),” Out World in Data, revised 2024, retrieved Sept 2026

104. Charles Calisher et al., “Statement in support of the scientists, public health professionals, and medical professionals of China combatting COVID-19,” *The Lancet*, 395(10226):e42–e43, March 7, 2020, doi:10.1016/s0140-6736(20)30418-9

105. Jimmy Tobias, “Evolution of a Theory: Unredacted NIH Emails Show Efforts to Rule Out Lab Origin of Covid,” *The Intercept*, January 19, 2023

106. Lucy Johnston, “'The death of science' Professor silenced for suggesting Covid could have escaped from lab,” *Sunday Express*, Jan 15, 2022; Paul Goddard and Angus Dalgleish, *The Death of Science: The retreat from reason in the post-modern world,* Clinical Press, 2023

107. E Bendavid, JPA Ioannidis, J Bhattacharya et al., “COVID-19 antibody seroprevalence in Santa Clara County, California,” medRxiv, April 17, 2020, doi:10.1101/2020.04.14.20062463; Also later as E Bendavid et al., “COVID-19 antibody seroprevalence in Santa Clara County, California,” *International Journal of Epidemiology*, 50(2):410–419, April 2021, doi:10.1093/ije/dyab010

108. Scott Atlas, “The data is in — stop the panic and end the total isolation,” *The Hill,* April 22, 2020

109. Martin Kulldorff, Sunetra Gupta, and Jay Bhattacharya, “Great Barrington Declaration,” open letter, October 4, 2020

110. U.S. House of Representatives, Select Subcommittee on the Coronavirus Crisis (117th Congress), release of emails between Dr. Francis Collins and Dr. Anthony Fauci, December 17, 2021; Michael Lee, “Outgoing NIH director says 'hundreds of thousands would have died' from COVID if US hadn't listened to him,” *Fox News*, December 19, 2021

111. Joel Achenbach, “Proposal to hasten herd immunity to the coronavirus grabs White House attention but appalls top scientists,” *The Washington Post*, October 14, 2020; “How Fauci and Collins Shut Down Covid Debate,” Editorial Board, *The Wall Street Journal,* Dec. 21, 2021; Crystal Hill, “Fauci on coronavirus herd immunity: 'That is nonsense and very dangerous',” *Yahoo News*, October 15, 2020; Associated Press, “Herd immunity to end coronavirus pandemic 'simply unethical,' WHO chief warns,” *Fox News*, October 12, 2020

112. Alper-Doger Scientific Index and Google Scholar, accessed August 13, 2026

113. David Gorski and Gavin Yamey, “Covid-19 and the new merchants of doubt,” *British Medical Journal*, blog, September 13, 2021

114. Naomi Oreskes, “If You Say 'Science Is Right,' You're Wrong,” *Scientific American*, July 1, 2021

115. Matthew Impelli, “Jay Bhattacharya, Stanford Doctor, Calls Lockdowns the ‘Biggest Public Health Mistake ve Ever Made’,” *Newsweek,* March 8, 2021

116. Martin Kulldorff, “Covid, lockdown and the retreat of scientific debate,” *The Spectator*, 12 October 2021

117. Committee on the Judiciary and Select Subcommittee on the Weaponization of the Federal Government, *The Censorship-Industrial Complex: How Top Biden White House Officials Coerced Big Tech to Censor Americans, True Information, and Critics of the Biden Administration*, interim staff report, 118th Cong., U.S. House of Representatives, May 1, 2024, retrieved June 16, 2026

118. Jacob Sullum, “Under Government Pressure, Twitter Suppressed Truthful Speech About COVID-19,” *Reason,* Jan. 2, 2023

119. Yaffa Shir-Raz et al., “Censorship and Suppression of Covid-19 Heterodoxy: Tactics and Counter-Tactics,” *Minerva,* SpringerLink, 61:407–433, Nov. 2022, doi:10.1007/s11024-022-09479-4; Matt Ridley, “The lab-leak cover-up is damaging science,” *Spiked*, 2 April 2024;

Mitchell Liester, “The Suppression of Dissent During the COVID-19 Pandemic,” *Social Epistemology Review and Reply Collective*, 11(4):53–76, 2022; Vinay Prasad and Jeffrey S. Flier, “Scientists who express different views on Covid-19 should be heard, not demonized,” *STAT News*, April 27, 2020

120. Bari Weiss [@bariweiss], “Twitter's Secret Blacklists” thread, tweet 3, Twitter, December 8, 2022, https://x.com/bariweiss/status/1601011428579717121; Bari Weiss et al., “Twitter’s Secret Blacklists,” *The Free Press,* December 15, 2022

121. Gnaneshwar Rajan, “Zuckerberg says Biden administration pressured Meta to censor COVID-19 content,” Reuters, August 27, 2024

122. Harvard University T.H. Chan School of Public Health, “Dr. Anthony Fauci on our country’s anti-science sentiments,” YouTube, August 13, 2020

123. *Wall Street Journal,* “The Lockdown Dissidents,” YouTube, June 9, 2026, timestamp 16:46

124. U.S. House of Representatives, Committee on Oversight and Accountability, *Transcribed Interview of Dr. Anthony S. Fauci (Part 2),* January 9, 2024, page 200. Retrieved August 2, 2026.

125. Kevin Breuninger, “Fauci blasts ‘preposterous’ Covid conspiracies, accuses his critics of ‘attacks on science’,” *Consumer News and Business Channel (CNBC)*, June 9, 2021

126. CBS News, “Dr. Anthony Fauci on ‘Face the Nation',” November 28, 2021

127. Charles Creitz, “Rand Paul rips Fauci following latest hearing fireworks: He doesn't want debate because he 'is science',” *Fox News*, January 11, 2022

128. US Office of the Director of National Intelligence, “Fauci Funded Wuhan Lab Research That Sparked COVID,” News Release No. 11-26, June 18, 2026; DNI Tulsi Gabbard [@DNIGabbard], “Today, on my final day…,” X.com, https://x.com/DNIGabbard/status/2067792184753938484, June 18, 2026; CNN, “Dr. Ashish Jha on COVID-19: 'It probably was a lab leak',” August 2, 2026

129. U.S. Congress, Senate, Committee on Homeland Security and Governmental Affairs, *Tony's Diary*, compiled by Rand Paul, 119th Cong., 2nd sess., 2026, pages 18–19. Retrieved July 28, 2026.

130. Sharon Lerner et al., “NIH Documents Provide New Evidence U.S. Funded Gain-of-Function Research in Wuhan,” *The Intercept*, September 9, 2021

131. Lawrence A. Tabak to James Comer, October 20, 2021, in *An Evaluation of the Evidence Surrounding EcoHealth*, US House Select Subcommittee on the Coronavirus Pandemic, 2024

132. United States Department of Justice, Office of the Pardon Attorney, *Executive Grant of Clemency: Dr. Anthony S. Fauci,* January 19, 2025. Retrieved July 28, 2026.

133. Michael Kratsios, "Inside Trump's Science Agenda: Anti-Science Claims, Fauci's Damage, DEI & China w/ Michael Kratsios," *All-in Podcast*, YouTube, Aug 24, 2026, timestamp 45:38

134. Farida Ahmad et al., "COVID-19 Mortality Update — United States, 2022," US Centers for Disease Control and Prevention, May 5, 2023

135. "COVID-19 Mortality by State," US Centers for Disease Control and Prevention, National Center for Health Statistics, February 15, 2023; Donald Kettl, "States Divided: The Implications of American Federalism for COVID-19," *Public Administration Review*, 80(4):595–602, May 2020, doi:10.1111/puar.13243; The states that never imposed lockdowns are Arkansas, Iowa, Nebraska, North Dakota, South Dakota, Utah, and Wyoming.

136. Jonas Herby et al., "Did Lockdowns Work?," Institute of Economic Affairs, June 2023; Rabail Chaudhry et al., "A country level analysis measuring the impact of government actions, country preparedness and socioeconomic factors on COVID-19 mortality and related health outcomes," *EClinicalMedicine,* 25:100464, July 21, 2020, doi:10.1016/j.eclinm.2020.100464; De Larochelambert Q et al., "Covid-19 Mortality: A Matter of Vulnerability Among Nations Facing Limited Margins of Adaptation," *Frontiers in Public Health,* 8:604339, 18 Nov. 2020, doi:10.3389/fpubh.2020.604339; Loewenthal G et al., "COVID-19 pandemic-related lockdown: response time is more important than its strictness," *EMBO Molecular Medicine*, 12(11):e13171, 5 Nov. 2020, doi:10.15252/emmm.202013171

137. Ong DS et al., "Lack of correlation between school reopening and trends in adult COVID-19 hospitalisations and death rates during the Delta and early Omicron periods: An ecological analysis of five countries," *Journal of Infection,* 90(2), February 2025, doi:10.1016/j.jinf.2024.106390

138. Herby J, Jonung L & Hanke SH, "Were COVID-19 lockdowns worth it? A meta-analysis," *Public Choice,* 203:337–67, 28 November 2024, doi:10.1007/s11127-024-01216-7

139. "Mortality Analyses," Coronavirus Resource Center, Johns Hopkins University, March 10, 2023

140. US CDC/NCHS, National Vital Statistics System

141. Mulligan CB and Arnott RD, "Non-Covid Excess Deaths, 2020-21: Collateral Damage of Policy Choices?," Becker Friedman Institute Working Paper no. 2022-107, University of Chicago, August 2022; An earlier version appeared as: Mulligan CB and Arnott RD, "Non-Covid Excess Deaths, 2020–21: Collateral Damage of Policy Choices?", NBER Working Paper 30104, US National Bureau of Economic Research, June 2022, doi:10.3386/w30104; Rossen LM et al., "Notes from the Field: Update on Excess Deaths Associated with the COVID-19 Pandemic — United States, January 26, 2020–February 27, 2021," US Centers for Disease Control and Prevention, 70(15):570–71, April 16, 2021; Woolf SH et al., "Excess Deaths From COVID-19 and Other Causes in the US, March 1, 2020, to January 2, 2021," *Journal of the American Medical Association,* 325(17):1786–89, April 2, 2021,

doi:10.1001/jama.2021.5199. A life insurance company that I worked with saw similar US non-COVID numbers even after the pandemic.

142. Eugenio Paglino et al., "Excess Natural-Cause Mortality in US Counties and Its Association with Reported COVID-19 Deaths," in *Proceedings of the National Academy of Sciences,* 121(6):e2313661121, Feb. 2024, doi:10.1073/pnas.2313661121

143. Bill Gurley, "Searching for Feynman," *All-In Podcast*, YouTube, Sept 18, 2026; P3 Institute. A link to Gurley's bibliography is in the YouTube video's notes.

Reinventing science

1. Naomi Oreskes, *Why Trust Science?,* Princeton University Press, 2019
2. Saloni Dattani et al., "Life Expectancy," Our World in Data, 2023
3. Erik Brynjolfsson, "The Turing Trap: The Promise & Peril of Human-Like Artificial Intelligence," *Dædalus*, American Academy of Arts & Sciences, 151(2):272–287, Spring 2022, doi:10.1162/daed_a_01915
4. Stanley Lebergott, "Labor Force and Employment, 1800–1960," in *Output, Employment, and Productivity in the United States after 1800*, ed. Dorothy S. Brady, Studies in Income and Wealth, 30:117–204, U.S. National Bureau of Economic Research, 1966
5. Jevons, W. Stanley, *The Coal Question: An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal-Mines*, Macmillan and Co., 1865. Retrieved June 3, 2026.
6. Jevons, *The Coal Question*
7. "Bio and CV | Joel Mokyr," Northwestern University, retrieved Sept. 1, 2026
8. Nobel Prize, "2025 prize lectures in economic sciences | Joel Mokyr, Philippe Aghion and Peter Howitt," YouTube, Dec 8, 2025, timestamp 10:20; Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy*, Princeton University Press, 2002; Nobel Prize, "Prize in Economic Sciences 2025 - Popular information," 27 Aug 2026
9. Nobel Prize, "2025 prize lectures in economic sciences," YouTube, Dec 8, 2025, timestamp 18:38
10. For example, "The World's Most Valuable Resource Is No Longer Oil, but Data," *The Economist*, May 6, 2017
11. Paul Romer, "Endogenous Technological Change," *The Journal of Political Economy*, The University of Chicago Press, 98(5):S71-S102, Oct. 1990; Philippe Aghion et al., "Artificial Intelligence and Economic Growth," in *The Economics of Artificial Intelligence: An Agenda*, ed. Ajay Agrawal, Joshua Gans, and Avi Goldfarb, 237–282, University of Chicago Press, 2019, retrieved June 21, 2026
12. Thomas Jefferson, Letter to Isaac McPherson, August 13, 1813. Retrieved June 21, 2026.

13. Schwartz, “Vibe physics”
14. OpenAI Academy, “Terence Tao: AI Is Ready for Primetime in Math and Theoretical Physics,” March 6, 2026
15. For example: Fountaine, Tim, and Tamim Saleh, “Getting to Scale with Artificial Intelligence,” *McKinsey Podcast*, McKinsey & Company, November 13, 2019; David Allred et al., “Speed, Value, and the Power of the Innovation Flywheel,” Boston Consulting Group, January 12, 2024; McKinsey & Company, “What is AI (artificial intelligence)?,” April 3, 2024
16. Brian Uzzi et al., “Atypical Combinations and Scientific Impact,” *Science,* 342(6157):468–72, October 25, 2013, doi:10.1126/science.1240474
17. Erin Leahey et al., “Prominent but Less Productive: The Impact of Interdisciplinarity on Scientists’ Research,” *Administrative Science Quarterly,* 62(1):105–39, March 2017, doi:10.1177/0001839216665364
18. Jian Wang et al., “Interdisciplinarity and Impact: Distinct Effects of Variety, Balance, and Disparity,” *Public Library of Science ONE,* 10(5):e0127298, 2015, doi:10.1371/journal.pone.0127298
19. Oreskes, *Why Trust Science?*
20. Ronald S. Burt, *Structural Holes: The Social Structure of Competition*, Harvard University Press, 1992; Ronald S. Burt, *Brokerage and Closure: An Introduction to Social Capital*, Oxford University Press, 2005
21. Let x = knowledge per person, p = proportion of pair-wise overlap in the range 0 to 1, and n = number of people. Then total distinct knowledge = x * (1 – (1 – p)^n) / p.
22. Frank Krueger et al., “A Call for Transdisciplinary Trust Research in the Artificial Intelligence Era,” *Humanities and Social Sciences Communications,* 12(1):1124, 18 July 2025, doi:10.1057/s41599-025-05481-9
23. Gottweis, “Accelerating scientific discovery”; Google, *People + AI Guidebook*, accessed July 10, 2026
24. Knight, “Alien Chess”; Chess.com, “Alpha Zero’s top 5 moves”
25. Schwartz, “Vibe physics”
26. Agrawal, Ajay, Joshua Gans, and Avi Goldfarb, *Power and Prediction: The Disruptive Economics of Artificial Intelligence*, Harvard Business Review Press, 2022
27. François Candelon et al., “How People Can Create—and Destroy—Value with Generative AI,” Boston Consulting Group, September 21, 2023; Fabrizio Dell'Acqua et al., “Navigating the Jagged Technological Frontier: Field Experimental Evidence of the Effects of AI on Knowledge Worker Productivity and Quality,” Harvard Business School Technology & Operations Mgt. Unit Working Paper No. 24-013, Harvard University, September 15, 2023, doi:10.2139/ssrn.4573321

28. William Hermanns, *Einstein and the Poet: In Search of the Cosmic Man,* Branden Press, 1983, page 95

29. Zuckerberg, “The Future is for Everyone”

30. Hartshorne JK, Tenenbaum JB, Pinker S, “A critical period for second language acquisition: Evidence from 2/3 million English speakers,” *Cognition,* 177:263–77, Aug. 2018, doi:10.1016/j.cognition.2018.04.007

31. Francois St-Hilaire et al., “A New Era: Intelligent Tutoring Systems Will Transform Online Learning for Millions,” arXiv, March 3, 2022, doi:10.48550/arXiv.2203.03724

32. Modern adaptation of: Xunzi, *Xunzi: The Complete Text*, trans. Eric L. Hutton, Princeton University Press, 2014, page 64

33. Ashe, “AI Outperforms Law Professors”

34. Ayers, “Comparing Physicians and Artificial Intelligence”

35. Joseph Howlett, “An Amateur Just Solved a 60-Year-Old Math Problem—by Asking AI,” *Scientific American*, April 24, 2026; Davide Castelvecchi, “‘It Is Incredible’: How AI Is Transforming Mathematics,” *Nature,* 653(8115):664–65, May 19, 2026, doi:10.1038/d41586-026-01553-1

36. Linus Benedict Torvalds, comp.os.minix Usenet newsgroup, Aug 25, 1991. Retrieved July 2, 2026.

37. Dave Newbart, “Microsoft CEO Takes Launch Break with the Sun-Times,” *Chicago Sun-Times*, June 1, 2001. Retrieved August 2, 2026.

38. Bob Metcalfe, “Linux's '60s Technology, Open-Sores Ideology Won't Beat W2K, but What Will?” *InfoWorld*, June 21, 1999. Retrieved August 2, 2026.

39. Karim Lakhani et al., “The Boston Consulting Group Hacker Survey,” O'Reilly Open Source Conference, July 24, 2002. Retrieved August 2, 2026.

40. Linus Torvalds and David Diamond, *Just for Fun: The Story of an Accidental Revolutionary*. New York: Harper Business, 2001

41. Eric S. Raymond, *The Cathedral & the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*, O'Reilly Media, 2001. Based on an essay of the same title and author presented at the Linux Kongress, Würzburg, Germany, May 27, 1997. Some years later the prestigious Harvard and Oxford professor Niall Ferguson did a historical treatment of the 500-year decentralization megatrend central to Linux’s success in his 2017 book *The Square and the Tower*.

42. Ryan Schoen, “A walk through Project Zero metrics,” Google blog, February 10, 2022

43. Jim Giles, “Internet encyclopaedias go head to head,” *Nature,* 438(7070):900-1, December 15, 2005, doi:10.1038/438900a

44. Thomas P. Hughes, “Einstein the Inventor,” *Invention & Technology,* 6(3), Winter 1991

45. Albert Einstein to E. Holzapfel, March 1951, in *Albert Einstein, The Human Side: Glimpses from His Archives*, ed. Helen Dukas and Banesh Hoffmann, Princeton University Press, 1979, page 57

46. Albert Einstein, “Science and Civilisation,” English translation of a speech delivered at the Royal Albert Hall, London, October 3, 1933, in *Programme: Royal Albert Hall, October Third, 1933*, Refugee Assistance Fund, 1933. Retrieved July 1, 2026.

47. Greg Rosalsky, "Why the AI World Is Suddenly Obsessed with a 160-Year-Old Economics Paradox," *Planet Money*, National Public Radio (US), February 4, 2025; David Sacks, “All-In's 2026 Predictions,” *All-In Podcast*, YouTube, January 9, 2026, timestamp 58:23

48. Brynjolfsson, “The Turing Trap”

49. HipsterVizNinja music hot-100 dataset on Github, accessed November 12, 2022; Dhruvil Dave, “Billboard 'The Hot 100' Songs,” Kaggle, 2021

50. W Nordhaus, “Are We Approaching an Economic Singularity? Information Technology and the Future of Economic Growth,” NBER Working Paper 21547, US National Bureau of Economic Research, Sept. 2015; S Jurvetson, “Transcending Moore's Law,” *CNET*, July 17, 2015; M Kearney, B Hershbein and D Boddy, “The Future of Work in the Age of the Machine - The Hamilton Project,” The Brookings Institution, 2015; W Nordhaus, “Two Centuries of Productivity Growth in Computing,” *The Journal of Economic History*, 67(1):128-159, 2007.

51. Agrawal, *Power and Prediction*

52. Thomas Moore et al., “Variation in the estimated costs of pivotal clinical benefit trials supporting the US approval of new therapeutic agents, 2015–2017: a cross-sectional study,” *BMJ Open,* 10(6):e038863, Jun 11, 2020, doi:10.1136/bmjopen-2020-038863

53. CB Insights, “5 Ways Digital Twins Could Improve Healthcare,” December 17, 2020; CB Insights, “12 Tech Trends to Watch Closely in 2022,” 2022

54. Agrawal, *Power and Prediction*

55. Jean-Paul Carvalho and Robin Nuttall, “AI, strategy, and the future of work: Oxford economist Jean-Paul Carvalho,” McKinsey & Company, May 6, 2026

56. SJ Liebowitz and SE Margolis, *Winners, Losers & Microsoft: Competition and Antitrust in High Technology,* Independent Institute, 1999; N Gandal, S Markovich, and MH Riordan, “Ain’t It ‘Suite’? Bundling in the PC Office Software Market,” *Strategic Management Journal,* 39(8):2120–51, August 2018, doi:10.1002/smj.2797

57. R Seamans and F Zhu, “Responses to Entry in Multi-Sided Markets: The Impact of Craigslist on Local Newspapers,” *Management Science,* 60(2):476–493, Feb 2014, doi:10.1287/mnsc.2013.1785

58. Jay Bhattacharya, “Launching a Second Scientific Revolution,” *Imprimis,* 55(5), Hillsdale College, May 2026

59. Pitney Bowes Inc., “Pitney Bowes Parcel Shipping Index: U.S. Carrier Disruption Is Increasing - And That's Good News for Shippers,” Press release, June 30, 2025, retrieved February 8, 2026

60. Leila Sheridan, “The 1-Employee Billion-Dollar Startup: How AI Is Changing the Face of Solopreneurship,” *Inc.*, April 3, 2026

61. Burt, *Brokerage and Closure*

62. James Kirsch, Director of the U.S. Army Combat Capabilities Development Command Aviation & Missile Center, presented at the AI/ML Tech Exchange and Expo, Huntsville, Alabama, November 1, 2022

63. Chrome Security Team, “Stronger with every update: How we’re making Chrome and the web safer in the AI Era,” Google blog, Jul 30, 2026

64. Nicholas Carlini et al., “Assessing Claude Mythos Preview’s cybersecurity capabilities,” Anthropic blog, April 7, 2026

65. D Fanelli, “Negative results are disappearing from most disciplines and countries,” *Scientometrics*, 90:891–904, March 2012, doi:10.1007/s11192-011-0494-7; DH Reuss, “The State of Null Results: A New Survey of Researchers,” *Springer Nature*, White paper, July 2025

66. RAK Richardson et al., “The Entities Enabling Scientific Fraud at Scale Are Large, Resilient, and Growing Rapidly,” in *Proceedings of the National Academy of Sciences,* 122(32):e2420092122, Aug 2025, doi:10.1073/pnas.2420092122

67. Baptiste Scancar et al., “Machine Learning Based Screening of Potential Paper Mill Publications in Cancer Research: Methodological and Cross Sectional Study,” *British Medical Journal,* 392:e087581, January 30, 2026, doi:10.1136/bmj-2025-087581

68. Demis Hassabis (@demishassabis), “A Framework for Frontier AI and the Dawning of a New Age,” X.com, July 14, 2026, retrieved July 19, 2026

69. James March, “Exploration and Exploitation in Organizational Learning,” *Organization Science,* 2(1):71–87, 1991, doi:10.1287/orsc.2.1.71

70. In November 2024, Anthropic introduced the Model Context Protocol (MCP), which allows AIs to connect to external tools, data sources, and applications in a consistent way. MCP quickly became an industry standard. In August 2026 they introduced the Model Hardware Standard (MHS), a consistent way for AIs to interact with physical scientific equipment. It promises to greatly reduce the time to run physical experiments. Anthropic, “Previewing the Model Hardware Standard,” blog, Aug 27, 2026.

71. E.g., Shicheng Liu et al., “AI-Driven Reproducibility and Analytical Robustness in Scientific Discovery,” arXiv, 16 Oct 2026, doi:10.48550/arXiv.2610.23845; B Le Guellec et al., “Major Revision, Minor Accountability: LLMs as Reviewers of Published Articles in Top-Tier Journals,” arXiv, 22 Oct 2026, doi:10.48550/arXiv.2610.31414; Gary King and Steven

Worthington, “AI Article Reviews Dominate Human Peer Reviews at Their Best: Evidence and Policy Choices”, 2026, retrieved 26 Oct 2026

72. Bhattacharya, “Launching a Second Scientific Revolution”

Counterarguments

1. Pohan Lin, “Amara’s Law and Its Place in the Future of Tech,” *IEEE Computer Society*, September 6, 2024; “Roy Amara,” Wikipedia
2. Ray Kurzweil, *The Singularity is Near,* Viking, 2005
3. Francis Fukuyama, “The End of History?” *The National Interest*, 16:3–18, 1989
4. Gordon Chang, *The Coming Collapse of China*, Random House, 2001
5. Paul Krugman, “Why Most Economists’ Predictions Are Wrong,” *The Red Herring*, 10 June 1998
6. Eva Rothenberg, “AI fears overblown? Theoretical physicist calls chatbots ‘glorified tape recorders’,” CNN, August 13, 2023
7. Clayton M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press, 1997
8. Descartes, *Discourse on the Method,* part 2
9. Aschenbrenner, “Situational Awareness”
10. Bhavesh Naik, “XKeyscore: NSA's Surveillance Program,” Infosec Institute, September 9, 2013; Morgan Marquis-Boire, Glenn Greenwald, and Micah Lee, “XKEYSCORE: NSA's Google for the World's Private Communications,” *The Intercept*, July 1, 2015; Micah Lee, Glenn Greenwald, and Morgan Marquis-Boire, “Behind the Curtain: A Look at the Inner Workings of NSA's XKEYSCORE,” *The Intercept*, July 2, 2015; Sean Gallagher, “Building a panopticon: The evolution of the NSA’s XKeyscore,” *Ars Technica,* Aug 9, 2013; US National Security Agency, *XKeyscore* (PowerPoint presentation, February 25, 2008), American Civil Liberties Union
11. Human Rights Watch, “China: Voice Biometric Collection Threatens Privacy,” October 22, 2017
12. “The Economist Democracy Index,” Wikipedia
13. Mancur Olson, “Dictatorship, Democracy, and Development,” *The American Political Science Review*, 87(3):567–76, 1993, doi:10.2307/2938736
14. “Democracy,” Our World in Data, retrieved August 8, 2024