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1. TURTLES ALL THE WAY DOWN

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   Free will belief in children across cultures: Gopnik and Kushnir's work: T. Kushnir et al., "Developing Intuitions about Free Will between Ages Four and Six," Cognition 138 (2015): 79; N. Chernyak, C. Kang, and T. Kushnir, "The Cultural Roots of Free Will Beliefs: How Singaporean and U.S. Children Judge and Explain Possibilities for Action in Interpersonal Contexts," Developmental Psychology 55 (2019): 866; N. Chernyak et al., "A Comparison of American and Nepalese Children's Concepts of Freedom of Choice and Social Constrain," Cognitive Science 37 (2013): 1343; A. Wente et al., "How Universal Are Free Will Beliefs? Cultural Differences in Chinese and U.S. 4- and 6-Year-Olds," Child Development 87 (2016): 666.

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   Driving study: E. Awad et al., "Drivers Are Blamed More Than Their Automated Cars When Both Make Mistakes," Nature Human Behaviour, 4 (2020): 134.

2. L. Egan, P. Bloom, and L. Santos, "Choice-Induced Preferences in the Absence of Choice: Evidence from a Blind Two Choice Paradigm with Young Children and Capuchin Monkeys," Journal of Experimental and Social Psychology 46 (2010): 204.

3. Footnote (p. 6): For overviews of their ideas, see: G. Strawson, "The Impossibility of Moral Responsibility," Philosophical Studies 75 (1994): 5; D. Pereboom, Living without Free Will (Cambridge University Press, 2001); G. Caruso, Rejecting Retributivism: Free Will, Punishment, and Criminal Justice (Cambridge University Press, 2021); N. Levy, Hard Luck: How Luck Undermines Free Will and Moral Responsibility (Oxford University Press, 2011); and S. Harris, Free Will (Simon & Schuster, 2012).

   For a somewhat different take, but in a similar spirit, see B. Waller, Against Moral Responsibility (MIT Press, 2011).

   Similar broad rejection of free will comes in the writings of scientists such as evolutionary biologist Jerry Coyne of the University of Chicago, psychologist/neuroscientists Jonathan Cohen of Princeton University, Josh Greene of Harvard University, and Paul Glimcher of NYU, and molecular biology god the late Francis Crick.

   A small number of legal scholars, such as Pete Alces of William & Mary Law School, break stride with the basic assumptions of their field in also rejecting the existence of free will.

4. M. Vargas, "Reconsidering Scientific Threats to Free Will," in Moral Psychology, vol. 4, Free Will and Moral Responsibility, ed. W. Sinnott-Armstrong (MIT Press, 2014).

5. R. Baumeister, "Constructing a Scientific Theory of Free Will," in Moral Psychology, vol. 4, Free Will and Moral Responsibility, ed. W. Sinnott-Armstrong (MIT Press, 2014).

6. A. Mele, "Free Will and Substance Dualism: The Real Scientific Threat to Free Will?," in Moral Psychology, vol. 4, Free Will and Moral Responsibility, ed. W. Sinnott-Armstrong.

7. R. Nisbett and T. Wilson, "Telling More Than We Can Know: Verbal Reports on Mental Processes," Psychological Review 84 (1977): 231.

2. THE FINAL THREE MINUTES OF A MOVIE

1. Footnote: J. McHugh and P. Mackowiak, “Death in the White House: President William Henry Harrison’s Atypical Pneumonia,” Clinical Infectious Diseases 59 (2014): 990. Harrison’s doctor treated him with an array of medications, which probably hastened his death. There was opium, which, as is known to opium addicts, causes major constipation, allowing the typhoid bacteria to linger longer, dividing. He was also given carbonated alkali, which probably impaired the ability of stomach acids to kill the bacteria. And just for good measure and for no clear reason, he was also given considerable amounts of mercury, which is neurotoxic. McHugh and Mackowiak convincingly suggest that enteric disease from contaminated water made James Polk seriously ill while president and killed Zachary Taylor while in office.

2. Libet published his initial data in B. Libet et al., “Time of Conscious Intention to Act in Relation to Onset of Cerebral Activity (Readiness-Potential): The Unconscious Initiation of a Freely Voluntary Act,” Brain: A Journal of Neurology 106 (1983): 623; “Infamous”: E. Nahmias, “Intuitions about Free Will, Determinism, and Bypassing,” in The Oxford Handbook of Free Will, 2nd ed., ed. R. Kane (Oxford University Press, 2011).

3. P. Sanford et al., “Libet’s Intention Reports Are Invalid: A Replication of Dominik et al. (2017),” Consciousness and Cognition 77 (2020): 102836. This paper was in response to an earlier one: T. Dominik et al., “Libet’s Experiment: Questioning the Validity of Measuring the Urge to Move,” Consciousness and Cognition 49 (2017): 255. Media accounts of the Libet experiment: E. Racine et al., “Media Portrayal of a Landmark Neuroscience Experiment on Free Will,” Science Engineering Ethics 23 (2007): 989.

4. P. Haggard, “Decision Time for Free Will,” Neuron 69 (2011): 404; P. Haggard and M. Eimer, “On the Relation between Brain Potentials and the Awareness of Voluntary Movements,” Experimental Brain Research 126 (1999): 128.

5. J.-D. Haynes, “The Neural Code for Intentions in the Human Brain,” in Bioprediction, Biomarkers, and Bad Behavior, ed. I. Singh and W. Sinnott-Armstrong (Oxford University Press, 2013); S. Bode and J. Haynes, “Decoding Sequential Stages of Task Preparation in the Human Brain,” Neuroimage 45 (2009): 606; S. Bode et al., “Tracking the Unconscious Generation of Free Decisions Using

Ultra-high Field fMRI," PLoS One 6, no. 6 (2011): e21612; C. Soon et al., "Unconscious Determinants of Free Decisions in the Human Brain," Nature Neuroscience 11 (2008): 543. The SMA as a gateway (footnote): R. Sjöberg, "Free Will and Neurosurgical Resections of the Supplementary Motor Area: A Critical Review," Acta Neurochirgica 163 (2021): 1229.

6. I. Fried, R. Mukamel, and G. Kreiman, "Internally Generated Preactivation of Single Neurons in Human Medial Frontal Cortex Predicts Volition," Neuron 69 (2011): 548; I. Fried, "Neurons as Will and Representation," Nature Reviews Neuroscience 23 (2022): 104; H. Gelbard-Sagiv et al., "Internally Generated Reactivation of Single Neurons in Human Hippocampus during Free Recall," Science 322 (2008): 96.

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8. M. Desmurget et al., "Movement Intention after Parietal Cortex Stimulation in Humans," Science 324 (2009): 811.

9. Anarchic hand syndrome: C. Marchetti and S. Della Sala, "Disentangling the Alien and Anarchic Hand," Cognitive Neuropsychiatry 3 (1998): 191; S. Della Sala, C. Marchetti, and H. Spinnler, "Right-Sided Anarchic (Alien) Hand: A Longitudinal Study," Neuropsychologia 29 (1991): 1113.

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14. M. Vargas, "Reconsidering Scientific Threats to Free Will," in Moral Psychology, vol. 4, Free Will and Moral Responsibility, ed. W. Sinnott-Armstrong (MIT Press, 2014).

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25. Caruso explores this idea in a number of publications, most recently in his excellent G. Caruso, Rejecting Retributivism: Free Will, Punishment, and Criminal Justice (Cambridge University Press, 2021). To me, at least, issues of whether preconsciousness and consciousness can exist simultaneously take us into the philosophical underbrush. For true aficionados, this brings up the frothy but influential ideas of philosopher Jaegwon Kim of Brown University. If I understand it: (a) assume that conscious mental states, while the emergent product of underlying physical properties (i.e., thingies like molecules and neurons), are different from them; (b) something like a behavior cannot be caused by both a mental state and its underlying physical bases (which came to be called Kim's "causal exclusion principle"); (c) physical events (like pushing a button or moving your tongue and larynx to tell your generals to start a war) are caused by prior physical events. So mental states don't cause behaviors. I guess this is kind of interesting. Well, maybe not, because in my view, mental states and their underlying physical/neurobiological bases can't be separated—they're just two different conceptual entry points to considering the same processes. More of this in later chapters. Some of his papers: J. Kim, "Concepts of Supervenience," Philosophy and Phenomenological Research

45 (1984): 153; J. Kim, “Making Sense of Emergence,” Philosophical Studies 95 (1995): 3.

26. E. Nahmias, “Intuitions about Free Will, Determinism, and Bypassing,” in The Oxford Handbook of Free Will, 2nd ed., ed. R. Kane (New York: Oxford University Press, 2011).

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31. N. Levy, Hard Luck: How Luck Undermines Free Will and Moral Responsibility (Oxford University Press, 2011).

32. Footnote: H. Frankfurt, “Alternate Possibilities and Moral Responsibility,” Journal of Philosophy 66 (1969): 829.

33. H. Frankfurt, “Three Concepts of Free Action,” Aristotelian Society Proceedings, Supplementary Volumes 49 (1975): 113, quote on p. 122; M. Shadlen and A. Roskies, “The Neurobiology of Decision-making and Responsibility: Reconciling

Mechanism and Mindedness," Frontiers in Neuroscience 23 April (2012): 1, quote is on p. 10.

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34. D. Dennett, Freedom Evolves (Penguin, 2004); the quote comes from p. 276. Dennett also expresses these ideas in a wide variety of his other books, e.g., D. Dennett, Elbow Room: The Varieties of Free Will Worth Wanting (MIT Press, 1984); D. Dennett, Freedom Evolves (Viking, 2003); his lectures, e.g., Dennett, "Is Free Will an Illusion?"; and his debates, e.g., D. Dennett and G. Caruso, Just Deserts: Debating Free Will (Polity, 2021);

35. N. Levy, "Luck and History-Sensitive Compatibilism," Philosophical Quarterly 59 (2009): 237, the quote comes from p. 244; D. Dennett, "Review of 'Against Moral Responsibility,'" in Naturalism, https://www.naturalism.org/resources/book-reviews/dennett-review-of-against-moral-responsibility.

As a theme in this chapter, people have been arguing about Libetian issues for forty years, and the references cited barely scratched the surface of really interesting takes on these issues. Others include: G. Gomes, "The Timing of Conscious Experience: A Critical Review and Reinterpretation of Libet's Research," Consciousness and Cognition 7 (1998): 559; A. Batthyany, "Mental Causation and Free Will after Libet and Soon: Reclaiming Conscious Agency," in Irreducibly Conscious: Selected Papers on Consciousness, ed. A. Batthyany and A. Elitzur (Universitäts-Verlag Winter, 2009); A. Lavazza, "Free Will and Neuroscience: From Explaining Freedom Away to New Ways of Operationalizing and Measuring It," Frontiers in Human Neuroscience 10 (2016): 262; C. Frith, S. Blakemore, and D. Wolpert, "Abnormalities in the Awareness and Control of Action," Philosophical Transactions of the Royal Society B: Biological Sciences 355 (2000): 1404; A. Guggisberg and A. Mottaz, "Timing and Awareness of Movement Decisions: Does Consciousness Really Come Too Late?," Frontiers of Human Neuroscience 7 (2013), doi.org/10.3389/fnhum.2013.00385; T. Bayne, "Neural Decoding and Human Freedom," in Moral Psychology vol. 4, Free Will and Moral Responsibility, ed. W. Sinnott-Armstrong (MIT Press, 2014).

3. WHERE DOES INTENT COME FROM?

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10. For more details about this general topic, see chapter 3 in R. Sapolsky, Behave: The Biology of Humans at Our Best and Worst (Penguin Press, 2017).

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In 1990, the ethologist John Wingfield of the University of California at

Davis, along with colleagues, published an immensely influential paper about the nature of testosterone's effects on aggression. Their "Challenge Hypothesis" posits that not only does testosterone not cause aggression, it doesn't uniformly just amplify preexisting social tendencies toward aggression either. Instead, at times when an organism is challenged for social status, testosterone amplifies whatever behaviors are needed to maintain status. Well, that doesn't seem like much of an elaboration—if you're a male baboon whose rank is being challenged, aggression is what you need to maintain status. But when it comes to humans, there are greater subtleties, because status can be maintained in different ways. For example, in an economic game where status is accrued through generous economic offers, testosterone increases such generosity. See: J. Wingfield et al., "The 'Challenge Hypothesis': Theoretical Implications for Patterns of Testosterone Secretion, Mating Systems, and Breeding Strategies," American Naturalist 136 (1990): 829. The hypothesis helps explain a wide range of testosterone-dependent behaviors: J. Wingfield "The Challenge Hypothesis: Where It Began and Relevance to Humans," Hormones and Behavior 92 (2017): 9. Also see: J. Archer, "Testosterone and Human Aggression: An Evaluation of the Challenge Hypothesis," Neuroscience and Biobehavioral Reviews 30 (2006): 319.

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Experiences (ACE)," in Cambridge Handbook of Violent Behavior and Aggression, 2nd ed., ed. A. Vazsonyi, D. Flannery, and M. DeLisi (Cambridge University Press, 2018), p. 467; G. Graf et al., "Adverse Childhood Experiences and Justice System Contact: A Systematic Review," Pediatrics 147 (2021): e2020021030.

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4. WILLING WILLPOWER: THE MYTH OF GRIT

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of pathology or adaptation. Major early-life adversity produces a brain that, in adulthood, is hyperreactive to threat and stress, has trouble turning off vigilance, is poor at long-term planning and gratification postponement, and so on. Does this constitute a case of a pathologically dysfunctional brain in adulthood? Or is it precisely the sort of brain you want (if this is what your childhood was like, better have this sort of brain in preparation for more of the same in adulthood)? This issue is considered in M. Teicher, J. Samson, and K. Ohashi, "The Effects of Childhood Maltreatment on Brain Structure, Function and Connectivity," Nature Reviews Neuroscience 17 (2016): 652.

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5. A PRIMER ON CHAOS

1. These concepts are discussed in A. Maar, "Kinds of Determinism in Science," Principia 23 (2019): 503.

2. E. Lorenz, “Deterministic Non-periodic Flow,” Journal of Atmospheric Sciences 20 (1963): 130.

3. Laughable folklore: R. Bishop, “What Could Be Worse Than the Butterfly Effect?,” Canadian Journal of Philosophy 38 (2008): 519. Strange attractors as repelling as well as attracting: J. Hobbs, “Chaos and Indeterminism,” Canadian Journal of Philosophy 21 (1991): 141.

4. “A Sound of Thunder” can be found in R. Bradbury, The Golden Apples of the Sun (Doubleday, 1953).

5. Footnote: M. Mitchell, Complexity: A Guided Tour (Oxford University Press, 2009).

6. For a particularly clear discussion of these ideas, see: M. Bedau, “Weak Emergence,” Philosophical Perspectives 11 (1997): 375.

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Footnote (p. 142): S. Wolfram, A New Kind of Science (Wolfram Media, 2002).

Okay, I have a horrible confession to make. On p. 138, there is the picture of the wildly chaotic, thoroughly unpredictable complex cellular automata that can be generated with rule 22. Here’s the confession: this isn’t actually made with rule 22; instead, it’s made with the closely related rule 90. The visual showing a crazily complex wonderful version of rule 22 was of terrible quality, I couldn’t find anything better, made no headway in getting the Wolfram Empire to send a higher-resolution of the visual . . . and in a moment in the dark of night that tests one’s soul, with the clock ticking, I decided to stick in a cool visual generated with rule 90 instead. It makes the same point—knowing the starting state and reproduction rule (90, in this case) gives you zero predictability as to what a complex version is going to look like. In fact, it makes a point about the chaoticism of cellular automata even more powerful—no one (hopefully? please) looking at it could tell

that this complex pattern arose from application of rule 22 or rule 90. Now that's off my chest.

6. IS YOUR FREE WILL CHAOTIC?

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   Footnote: J. Bassingthwaight, L. Liebovitch, and B. West, Fractal Physiology (American Physiological Society, 1994); N. Schweighofer et al., "Chaos May Enhance Information Transmission in the Inferior Olive," Proceedings of the National Academy of Sciences of the United States of America 101 (2004): 4655.

3. Simpsons Wiki, s.v. "Chaos Theory in Baseball Analysis," simpsons.fandom.com/wiki/Chaos_Theory_in_Baseball_Analysis; M. Farmer, Chaos Theory, Nerds of Paradise book 2 (Amazon.com Services, 2017).

4. G. Eilenberger, "Freedom, Science, and Aesthetics," in The Beauty of Fractals, ed. H. Peitgen and P. Richter (Springer, 1986), p. 179.

5. K. Clancy, “Your Brain Is on the Brink of Chaos,” Nautilus, Fall 2014, 144.

6. Farmer quoted in James Gleick, Chaos: Making a New Science (Viking, 1987), p. 251.

7. Steenburg, “Chaos at the Marriage.”

8. Eilenberger, “Freedom, Science, and Aesthetics,” p. 176.

9. A. Maar, “Kinds of Determinism in Science,” Principia 23 (2019): 503. For a comparison of encompassing versus individual determinism, see: J. Doomen, “Cornering ‘Free Will,’” Journal of Mind and Behavior 32 (2011): 165; H. Atmanspacher, “Determinism Is Ontic, Determinability Is Epistemic,” in Between Chance and Choice: Interdisciplinary Perspectives on Determinism, ed. R. Bishop and H. Atmanspacher (Imprint Academic, 2002). To get further into the weeds with the likes of “partial determinism” and “adequate determinism,” see: J. Earman, A Primer on Determinism (Reidel, 1986); S. Kellert, In the Wake of Chaos: Unpredictable Order in Dynamic Systems (University of Chicago Press, 1993).

10. S. Caprara and A. Vulpiani, “Chaos and Stochastic Models in Physics: Ontic and Epistemic Aspects,” in Models and Inferences in Science. Studies in Applied Philosophy, Epistemology and Rational Ethics, vol. 25, ed. E. Ippoliti, F. Sterpetti, and T. Nickles (Springer, 2016), p. 133; G. Hunt, “Determinism, Predictability and Chaos,” Analysis 47 (1987): 129; M. Stone, “Chaos, Prediction and Laplacean Determinism,” American Philosophical Quarterly 26 (1989): 123; V. Batitsky and Z. Domotor, “When Good Theories Make Bad Predictions,” Synthese 157 (2007): 79.

11. W. Seeley, “Behavioral Variant Frontotemporal Dementia,” Continuum 25 (2019): 76; R. Dawkins, The Blind Watchmaker (Norton, 1986), p. 9.

12. W. Farnsworth and M. Grady, Torts: Cases and Questions, 3rd ed. (Wolters Kluwer, 2019).

13. R. Sapolsky, “Measures of Life,” The Sciences, March/April 1994, p. 10.

14. M. Shandlen, “Comment on Adina Roskies,” in Moral Psychology, vol. 4, Free Will and Moral Responsibility, ed. W. Sinnott-Armstrong (MIT Press, 2014), p. 139.

7. A PRIMER ON EMERGENT COMPLEXITY

1. Footnote: For more on this concept, see R. Carneiro, "The Transition from Quantity to Quality: A Neglected Causal Mechanism in Accounting for Social Evolution," Proceedings of the National Academy of Sciences of the United States of America 97 (2000): 12926.

2. For some impressive examples, see: W. Tschinkel, "The Architecture of Subterranean Ant Nests: Beauty and Mystery Underfoot," Journal of Bioeconomics 17 (2015): 271; M. Bollazzi and F. Roces, "The Thermoregulatory Function of Thatched Nests in the South American Grass-Cutting Ant, Acromyrmex heyeri," Journal of Insect Science 10 (2010): 137; I. Guimarães et al., "The Complex Nest Architecture of the Ponerinae Ant Odontomachus chelifer," PLoS One 13 (2018): e0189896; N. Mlot, C. Tovey, and D. Hu, "Diffusive Dynamics of Large Ant Rafts," Communicative and Integrative Biology 5 (2012): 590. For a theoretical approach to ant emergence, see D. Gordon, "Control without Hierarchy," Nature 446 (2007): 143. For a demonstration of how it's not all fun and games being an ant, see: N. Stroeymeyt et al., "Social Network Plasticity Decreases Disease Transmission in a Eusocial Insect," Science 363 (2018): 941 (the authors show that ant networks shift so that sick ants [experimentally infected with a fungus] are ostracized to limit infectivity).

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highly structured, with repeating building blocks; its signal in a frequency spectrum is termed "white noise." This is akin to tight, uniform little interconnected clusters of neurons, isolated from each other. At the other extreme, a pattern that is random produces "brown noise" (named for Brownian motion, explained in chapter 9); these are connections between neurons of random distances, directions, and strengths. And as with porridge that is neither too hot nor too cold, there are patterns poised between the two extremes, termed "pink noise" (or 1/f noise). These are the networks of the brain balanced in scale-free ways between the robustness and efficiency of small, structured local networks and the creativity and evolvability of long-distance ones. The "critical brain" hypothesis posits that brains have evolved to be at this ideal spot and that this "criticality" optimizes all sorts of features of brain function. Moreover, in this model, the brain is able to correct itself as that perfect balancing point shifts with circumstances; this would be an example of the very trendy "self-organized criticality." This can be shown with some mathematically bruising analytical techniques, and a small subfield has grown examining brain criticality in normal and diseased circumstances. For example, there is a tilt toward white noise in epilepsy, reflecting the overly synchronized firing of clusters of epileptiform neurons (and, in fact, there is a remarkable similarity between the distribution of frequency and severity of seizures, and that of earthquakes). Similarly, autism spectrum disorder appears to have a different type of tilt toward white noise, reflecting the relatively isolated peninsulas of function in the cortex. And at the other end, Alzheimer's disease involves a tilt toward brown noise, as the death of neurons here and there begins to break down the patterning (and efficacy) of networks. See: J. Beggs and D. Plenz, "Neuronal Avalanches in Neocortical Circuits," Journal of Neuroscience 23 (2003): 11167; P. Bak, C. Tang, and K. Wiesenfeld, "Self-Organized Criticality: An Explanation of the 1/f Noise," Physics Review Letters 59 (1987): 381; L. Cocchi et al., "Criticality in the Brain: A Synthesis of Neurobiology, Models and Cognition," Progress in Neurobiology 158 (2017): 132; M. Gardner, "White and Brown Music, Fractal Curves and One-Over-f Fluctuation," Scientific American, April 1978; M. Belmonte et al., "Autism and Abnormal Development of Brain Connectivity," Journal of Neuroscience 24 (2004): 9228.

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and B. McEwen, “Social Structure, Adversity, Toxic Stress, and Intergenerational Poverty: An Early Childhood Model,” Annual Review of Sociology 43 (2017): 445, by brothers Craig, sociologist at Bowdoin College, and Bruce, neurobiologist at Rockefeller University. This is interdisciplinary science and family relations at their finest. Bruce, an extraordinarily accomplished scientist, was my PhD adviser, mentor, and father figure for almost forty years. He died in 2020; I still feel his absence.

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10.5. INTERLUDE

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While reading Seierstad's book, I was also reading Masha Gessen's The Brothers: The Road to an American Tragedy (Riverhead Books, 2015), an account of the Boston Marathon bombing carried out by the Tsarnaev brothers. The older brother, Tamerlan, was clearly the dominating force and catalyst of the two; Gessen's profile of him paints someone who seems astonishingly similar to Breivik; as opposite of ideologies as can be found, but the same mediocrities stewing with a sense of being entitled to glory and domination, and externalizing fault when they fall far short—pointless, empty vessels waiting to be filled with some sort of poison that would finally make them someone who could not be ignored. This same point was explored by Tom Nichols in "The Narcissism of the Angry Young

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The U.S.'s 9/11 tragedy and the Breivik rampage were similar, insofar as the two terrorist acts killed roughly the same percentage of the population of the country; in both cases, the head of state addressed the mourning nation in the days afterward, both giving talks roughly five minutes long. Which is where the differences are stark. Bush cited God three times, evil four; for Stoltenberg, there was one mention of evil and none of God. Bush used the words despicable, anger, and enemy. In contrast, Stoltenberg used the words compassion, dignity, and love. Bush stated that this act of terror "cannot dent the steel of American resolve." Stoltenberg addressed the loved ones of victims, saying, "We are weeping with you."

Though the likes of a beheading or a public hanging are things of the past in

the West, they're not all that far past—you could have taken the London subway to attend the last public hanging in the UK, in 1868; while the last guillotining was being carried out in France, you could spend your evening watching a Star Wars movie, dancing to the Bee Gees in a disco, or feeding (or not) your pet rock—1977.

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15. IF YOU DIE POOR

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