

On Hypo-Real Models or Global Climate Change: A Challenge for the Humanities

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We, the people, still believe that our obligations as Americans are not just to ourselves, but to all posterity. We will respond to the threat of climate change, knowing that the failure to do so would betray our children and future generations. . . . Some may still deny the overwhelming judgment of science, but none can avoid the devastating impact of raging fires and crippling drought and more powerful storms.

—President Barack Obama¹

The rationality and irrationality of science are questions never only of the present and the past, but also for the *possible future*. We can learn from our mistakes—which also means that an *alternative* science is always possible. Not only an alternative theory, but an alternative *theory of cognition*, an alternative relationship of theory and practice, and an alternative *practice* of this relationship.

—Ulrich Beck²

“Perhaps”—one must [*il faut*] always say *perhaps* for justice. There is an *avenir* for justice and there is no justice except to the degree that some event is possible which, as event, exceeds calculation, rules, programs, anticipations and so forth.

—Jacques Derrida³

By the end of 2013, several new climate-related records had been set: twelve of the warmest years ever recorded had occurred between 1988–2013; Arctic ice was at its smallest measured size; and no one under the age of twenty-eight had experienced a month of below-average global temper-

1. Barack Obama, “Inaugural Address by President Barack Obama,” Whitehouse.gov, 21 Jan. 2013, www.whitehouse.gov/the-press-office/2013/01/21/inaugural-address-president-barack-obama

2. Ulrich Beck, *Risk Society: Toward a New Modernity*, trans. Mark Ritter (Thousand Oaks, Calif., 1992), p. 179; hereafter abbreviated RS.

3. Jacques Derrida, “Force of Law: The ‘Mystical Foundation of Authority,’” trans. Mary Quaintance, *Acts of Religion*, trans. Samuel Weber et al., ed. Gil Anidjar (New York, 2002), p. 257.

ature.⁴ In addition, glaciers had melted; plant and animal seasonal behavior had shifted; heat waves were more frequent; and droughts and intense tropical cyclone activity had increased. Not only are these changes, predicted decades ago by climate scientists, likely to continue, but more changes are expected: increased thaw in permafrost regions; precipitation increases in high latitudes and decreases in subtropical land regions; and decreased water resources in semiarid areas, such as the western United States.⁵

That global warming has been predicted for at least a century and yet little has been done in response—and, even worse, that many in 2013 still did not believe in human-caused global warming—has horrified and perplexed many. Despite the scientific consensus on its existence, a poll by the Georgetown Climate center in 2013 revealed that the majority of the US public (54 percent) did not believe, or were unsure, that humans were responsible for global warming, even though 75 percent of the same Americans surveyed did believe that the globe is getting warmer and 87 percent supported Environmental Protection Agency (EPA) action to establish and enforce greenhouse gas emission reduction targets for power plants and large industries.⁶

To explain this situation, many popular and scholarly analyses have portrayed the debate as one of science versus politics; climate change deniers, they contend, foster, or suffer from, politically motivated irrationality. Such studies and undercover operations have focused on the ways in which the George C. Marshall, the Heartland, and other conservative institutes have helped to produce doubts about the science driving these projections by sponsoring the work of climate change skeptics and by promoting this work in the media and in

4. See Lily Kuo, “If You’re Younger Than 28, You’ve Never Experienced a Month of Below Average Global Temperature,” *Quartz*, 22 July 2013, qz.com/106814/if-youre-under-the-age-of-28-youve-never-experienced-a-month-of-below-average-global-temperature/

5. See National Aeronautics and Space Administration (NASA), “Global Climate Change: Vital Signs of the Planet,” climate.nasa.gov/effects

6. See Georgetown Climate Center, “Polling Released Today by the Georgetown Climate Center Shows Strong Support from Republicans and Democrats for EPA Action,” 24 June 2013, www.georgetownclimate.org/polling-released-today-by-the-georgetown-climate-center-shows-strong-support-from-republicans-and-de

schools.⁷ Investigators have also, as the opening quotation from Obama reveals, taken aim at the irrationality of so-called climate change skeptics, who are not skeptics but deniers. Indeed, these so-called skeptics are in denial, unwilling to acknowledge not only the validity of scientific evidence and models but also the reality—such as raging fires, crippling drought, and more powerful storms—that bites them. Several influential analyses have also linked denials of the existence of global climate change to general criticism and critiques of science; climate change activists such as Hadyn Washington and John Cook have argued that postmodern or poststructuralist theory fuels the deniers' position by justifying their skepticism.⁸ Bruno Latour has, in response to conservative strategies to foment doubt regarding scientific facts, distanced science studies from traditional Enlightenment critique, which “debunk[s],” by calling for a second empiricism that—following Donna Haraway—seeks “to protect and to care.”⁹

Documenting the actions of conservatives to misrepresent the scientific consensus regarding global warming and creating coalitions between scientists and science studies are important, and who can be against caring for and protecting the planet? This essay, however, revisits and reformulates some of the fundamental assumptions driving the debate over global climate change in order to help pave other paths forward. Accepting the debate as one of science versus politics ignores the fact that both sides claim that they are scientific and the other is political. As Naomi Oreskes and Erik Conway have shown, the “merchants of doubt” have been so successful because they themselves are—or have been—scientists.¹⁰ This framing also glosses over questions raised by global climate change about the assumed causal relationships between evidence and reality, reality and truth. These questions not only trouble the separation of science from politics, model from evidence, but also, and more importantly, the normal and normative relationship between understanding and agency. To return to the poll numbers cited earlier, it is fascinating that, whether or not

7. See Hadyn Washington and John Cook, *Climate Change Denial: Heads in the Sand* (New York, 2011); Naomi Oreskes and Erik M. Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* (New York, 2010); Suzanne Goldenberg, “Leak Exposes How Heartland Institute Works to Undermine Climate Science,” *The Guardian*, 14 Feb. 2012, www.theguardian.com/environment/2012/feb/15/leak-exposes-heartland-institute-climate; and Goldberg, “Heartland Institute Claims Fraud after Leak of Climate Change Documents,” *The Guardian*, 15 Feb. 2012, www.theguardian.com/environment/2012/feb/15/heartland-institute-fraud-leak-climate

8. See Washington and Cook, *Climate Change Denial*.

9. Bruno Latour, “Why Has Critique Run out of Steam? From Matters of Fact to Matters of Concern,” *Critical Inquiry* 30 (Winter 2004): 232; hereafter abbreviated “W.”

10. See Oreskes and Conway, *Merchants of Doubt*.

people think that human-caused global warming is true, a vast majority believe that the world is getting warmer, and an even greater majority believe that the EPA should regulate greenhouse gas emissions. (It is also telling that global climate change science is something to be believed in rather than known.) Instead of action following certainty, action seems to precede it; further, truth—causality—does not seem to be necessary for certainty. The Enlightenment model, which framed good action as stemming from correct knowledge and experience, no longer holds (if it ever did). Big data algorithms, which trumpet correlation over causality and which reveal the increasing divide between what is empirically observed (real) and what is true, further demote the place of causality.¹¹ Given that almost any correlation can now be divined, how do we know which correlations are essential and which are accidental? Does causality even matter if supplemental correlations are better predictors and amplifiers of action? Further, what knowledge inspires action? Given this troubling of causal inference, the pressing questions in terms of combatting global climate change are: How can we understand and use this loosening of correlation and causality to register the impacts of global climate change? And how can we act on this desire for regulation rather than prolong inaction by engaging in possibly endless debates about the reasons for inaction?

To answer these questions, I argue we should neither celebrate nor condemn as hyperreal scientific models that are necessary to engage with the invisible, inexperienceable risks that, as Ulrich Beck argued in the mid 1980s, define our modernity (see *RS*). Instead of treating models as capable of replacing the phenomena they represent—instead of assuming that code is everything (reference, legislation, execution)—we should employ them as *hypo-real* tools, that is, as tools for hypothesis. This is especially important because, if models work properly as evidence, they become unverifiable: if we are convinced of their verisimilitude, we will act in such a way that their predicted results can never be corroborated by experience. Indeed, to wait for these models' calculations to be verified—for their accuracy to be proven—is to give up on the future by rewriting political problems as ones that science can (dis-)solve. We need to address uncertainty as enabling rather than disabling, for it is by engaging this changing relationship between what is true and verifiable, theoretical and empirical, that we can form new associations between knowing and doing—new theories of cognition and new habits of correlation—that treat the nonex-

11. I am deeply grateful to conversations with Roberto Tamassia, Joseph Hogan, Steven Lubar, and Harriette Hemmasi on the changing relationship between correlation and causality in light of big data.

act coincidence between scientific predictions and observed reality as the promise, rather than the end, of science and of politics. As I hypothesize at the end of this essay, habits—creative anticipations based on repetition—are key to building responses to combat global climate change and to registering and negotiating unimaginable, invisible, and seemingly inexperienceable causalities and correlations.

Just the Facts, Please

The fact that the earth's atmosphere warms the planet and the fact that hydrocarbons play a key role in this greenhouse effect have been known for almost two centuries. There is no debate about the existence of greenhouse gases. The debate—or controversy—is over the impact of human activity (mostly the burning of hydrocarbons) on the earth's atmosphere, and this debate is as old as the discovery of the earth's atmosphere's warming effect on the planet.¹² Although, as Oreskes notes, the earliest claims that the human burning of fossil fuels could raise global temperatures were radical conjectures, global climate change has moved from conjecture to scientifically accepted fact.¹³ As Michael E. Mann's famous (or infamous) hockey-stick diagram of the Northern Hemisphere mean temperature based on proxy climate indicators and long instrumental records reveals, the earth's temperature has increased dramatically since the 1950s.¹⁴ Although specific weather patterns and events such as volcanic eruptions can certainly affect climate—and they have affected it in the past—they alone cannot explain this increase, which coincides with the accelerating human burning of hydrocarbons.¹⁵ Thus the fact that humans are responsible for global warming—and thus can also do something to mitigate it—is easily and logically inferred. Even scientific research funded by deniers of global climate change has proven its existence. Most famously, the physicist Richard Muller, who received funding from the Charles Koch Foundation to reexamine historical global temperature readings in response to his criticism of Mann's homogenizing of raw data, concluded that the hockey-stick effect was more extreme than initially estimated.¹⁶ Muller's about-face re-

12. See Oreskes and Conway, *Merchants of Doubt*.

13. See Oreskes, "Foreword," in Washington and Cook, *Climate Change Denial*, pp. xi–xvii.

14. See figure 1 in Michael E. Mann, Raymond S. Bradley, and Malcolm K. Hughes, "Global-Scale Temperature Patterns and Climate Forcing over the Past Six Centuries," *Nature*, 23 Apr. 1998, p. 783.

15. See James Hansen, Makiko Sato, and Reto Ruedy, "Perception of Climate Change," *PNAS*, 29 Mar. 2012, www.pnas.org/content/109/37/E2415.full; hereafter abbreviated "PC."

16. See Robert Rohde et al., "Berkeley Earth Temperature Averaging Process," *Geoinformatics and Geostatistics: An Overview*, 2013, scitechnol.com/2327-4581/2327-4581-1-103.pdf

garding the existence of global climate change garnered him an award from *Foreign Policy*.

So, why has this scientific consensus not spurred greater certainty among the public?

Given the concerted effort by scientists, advocates, and even Hollywood directors to spread the message about global climate change, the lack of information is not the issue. If anything, the lingering doubts over the existence of human-caused climate change have revealed the limitations of information dissemination as an effective program for political change; as humanitarian activists have recognized for decades, knowledge does not guarantee action.¹⁷ In response, many activists (and “rogue scientists”) have supplemented this effort by documenting the actions of conservative organizations to create irrational doubt by deploying the same tactics—and in some cases the same consultants—as the tobacco industry.¹⁸ According to Washington and Cook, authors of a popular book and website on the topic, those denying global climate change: (a) construct conspiracy theories about the intentions and actions of climate scientists; (b) cite scientific experts in outside fields; (c) raise impossible expectations regarding what climate science can tell us; (d) misrepresent evidence; (e) employ logical fallacies, and (f) cherry-pick evidence.¹⁹ By doing so, they strive to prolong debate over global climate change and thus delay any proposed regulations. Washington and Cook also link the actions of global climate change deniers to postmodernism: this “ideology,” they contend, creates a fertile atmosphere for denial because, “instead of espousing clarity, certitude, wholeness and continuity . . . [it] commits itself to ‘ambiguity, relativity, fragmentation, particularity and discontinuity.’”²⁰ Postmodernism’s abandonment of rationality and reality, its denial of grand narratives, and its mantra that everything is relative prevents us from dreaming of a solution.²¹ Again, Bruno Latour, in horrified response to the resonances between his critique of scientific facts and Republican strategies, has advocated for constructivism, a “second empiricism” focused on protection and care, rather than debunking and deconstruction (“W,” p. 232).

The guiding assumption—shared by those on either side of the debate—is that uncertainty fosters inaction. This was clearly articulated in a memorandum by Luntz Research Companies, given to the *New York*

17. See Thomas Keenan, “Publicity and Indifference (Sarajevo on Television),” *PMLA* 117 (Jan. 2002): 104–16.

18. See Kuo, “If You’re Younger Than 28, You’ve Never Experienced a Month of Below Average Global Temperature.”

19. See Washington and Cook, *Climate Change Denial*, pp. 43–70.

20. *Ibid.*, p. 113.

21. See *ibid.*, p. 113.

Times by the Environmental Research Group. In it, Frank Luntz, a Republican strategist, states: “should the public come to believe that the scientific issues are settled . . . their views about global warming will change accordingly. Therefore, you need to continue to make the *lack of scientific certainty* a primary issue” (“W,” p. 226). (The *New York Times* reporting of this memorandum inspired Latour’s reformulation of science studies [see “W,” p. 227].)

To what extent, though, does uncertainty drive inaction and undermine science? More pointedly, given the centuries-long debate over the validity of evolution, ongoing questions over the efficacy and ethics of vaccines and vaccinations, and revelations about Nazi science, on what planet is the questioning of science and scientists news? Debate and dispute have been central not only to the historical reception of science but also to scientific progress; from the debate between Ptolemaic and Copernican astronomy to competing theories of genetics (Mendelian and biometric), science has advanced via dispute and uncertainty (hence Thomas Kuhn’s famous paradigm shifts).²² Further, uncertainty is central to causality; we infer something because we do not already know it.²³

If anything, the debilitating debate over climate change continues, not because of the simple existence of scientific disagreement, but rather because of the bizarre notion that scientific issues can ever be settled, that evidence can ever be complete, that understanding requires certainty, and that consensus is the end of a discussion and not, as Jean-François Lyotard has argued, a particular state.²⁴ The debate continues, that is, because of the reification of science as absolute and certain; a significant number of those who have reservations regarding the existence of global climate change are not dupes, ideologues, or postmodern theorists but rather vocal supporters of science.

So Successful It’s Not

According to a 2008 Pew Research Center poll, skepticism about global warming decreases with higher education among Democrats but increases with higher education among Republicans.²⁵ This result seems to fly in the face of two assumptions that buttress debates about global climate change

22. See Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago, 1962).

23. See Gilles Deleuze, *Empiricism and Subjectivity: An Essay on Hume’s Theory of Human Nature*, trans. Constantin V. Boundas (New York, 1991), p. 65; hereafter abbreviated *ES*.

24. See Jean-François Lyotard, *The Postmodern Condition: A Report on Knowledge*, trans. Geoff Bennington and Brian Massumi (Minneapolis, 1984), p. 66; hereafter abbreviated *PC*.

25. See anon., “A Deeper Partisan Divide over Global Warming,” *Pew Research Center for the People and the Press*, 8 May 2008. www.people-press.org/2008/05/08/a-deeper-partisan-divide-over-global-warming/

and about higher education respectively: one, that those uncertain about global climate change are uneducated, and, two, that higher education breeds liberalism. Rather than dismiss this result as a curious fact—or simply as evidence of bad faith by educated conservatives—we need to take it seriously, for it shows the ties between Enlightenment and liberal (and now neoliberal/libertarian) markets. It also reveals the extent to which the climate change debate is not due to the failures of science but rather, as Beck has pointed out, to its successes.²⁶

Educated conservatives' refusal to accept scientific expertise resonates with the Enlightenment motto of "*sapere aude!* Have the courage to use your *own* understanding!"²⁷ Those doubting climate change science are arguably following Immanuel Kant's creed "to make use of one's understanding without the guidance of another" (albeit this questioning is directed at secular, rather than religious, leaders).²⁸ As Michel Foucault has argued in "What Is Critique?" this Enlightenment stance is profoundly political because it is linked to "the art of not being governed so much," that is, how not to be governed like that.²⁹ Through this critical attitude, which separates power from truth, "the subject gives itself the right to question truth concerning its power effects and to question power about its discourses of truth. Critique will be the art of voluntary inservitude, of reflective indocility."³⁰ Foucault's linking of Enlightenment to governmentality also makes clear neoliberalism's Enlightenment—that is, liberal—heritage. Neoliberalism's embrace of "how not to be governed so much" is not an anathema to the Enlightenment but rather its anthem. Thus it is not surprising that the tools of the Enlightenment to support science have, as Latour notes, become tools *against* science: if "the Enlightenment profited largely from the disposition of a very powerful descriptive tool, that of matters of fact, which were excellent for *debunking* quite a lot of beliefs, powers, and illusions, it found itself totally disarmed once matters of fact, in turn, were eaten up by the same debunking impetus" ("W," p. 232).

26. "It is not their failure but their *success* that has *dethroned* the sciences. One could even say, the more successfully the sciences have operated in this century, that much faster and more thoroughly have their original validity claims been relativized. . . . The model of primary scientization is based on the 'naiveté' that the methodical skepticism of the sciences can be institutionalized on the one hand, and yet be limited to the *objects* of the science on the other" (RS, p. 163).

27. Immanuel Kant, "An Answer to the Question: What Is Enlightenment?" in *What Is Enlightenment? Eighteenth-Century Answers and Twentieth-Century Questions*, trans. James Schmidt et al., ed. Schmidt (Berkeley, 1996), p. 58.

28. *Ibid.*

29. Michel Foucault, "What Is Critique?" trans. Kevin Paul Geiman, in *What Is Enlightenment?* p. 384.

30. *Ibid.*, p. 386.

Latour's insight echoes Beck's much earlier analysis of the impact on modernity by imperceptible secondary risks, such as the possibilities of catastrophic environmental damage posed by industrial pollutants (tellingly, the best strategy to combat climate change by the US government has been through the Clean Air Act). Unlike Latour, Beck argues that the deployment of the scientific method against science is not simply bad, for it also demonopolizes science; it represents the success of the scientific method. According to Beck, the methods of science "skepticism" and enlightenment are being employed against science by lay people (who Beck portrays as initially "driven out of their 'hunting grounds' and pushed back into 'reservations' like Indians" during the primary period of scientization) (*RS*, p. 158). Risk society releases the "natives," armed with scientific modes of critique, and this is essential because, as Beck makes clear, science is necessary because risk entails politics.

Writing in the 1980s—in the spirit of, rather than against, postmodern inquiry—Beck revealed that we are living in an era of "reflexive modernization." In this era, which is "post" modernity, "modernization *within* the paths of industrial society is being replaced by a modernization of the principles of industrial society" (*RS*, p. 10). In reflexive modernity, mainly imperceptible secondary effects become primary; what is central is not industrial production but the management of risks produced by industrialization. Reflexive modernity is not about wealth in an era of scarcity but rather pending catastrophe in an era of consumption; risk is a "*systematic way of dealing with the hazards and insecurities induced and introduced by modernization itself*" (*RS*, p. 21). Modernization, that is, has "*consumed and lost its other* and now undermines its own premises as an industrial society along with its functional principles" (*RS*, p. 10). In reflexive modernity, the "sciences are confronted with their own products, defects, and secondary problems" rather than nature per se (*RS*, p. 155). Because of this, what was initially considered private or outside the political—industrial production—becomes a public concern; politics extends to the private management of plants and others (see *RS*, p. 24).

Importantly, these risks and hazards—which define the present and future—are imperceptible to normal human perception and escape the powers of the human imagination. Most bluntly:

Intentionally or not, through accident or catastrophes, in war or peace, a large group of the population faces devastation and destruction today, for which language and the powers of our imagination fail us, for which we lack any moral or medical category. We are concerned with the absolute and unlimited NOT, which threatens us

here, the *un-* in *general*, unimaginable, unthinkable, un-, un-, un-.
[RS, p. 52]

In the world of the NOT—in the world of the unimaginable—what matters most is not what is real, if by real we mean what can be empirically experienced. These risks, which threaten irreversible and invisible harm, can only be causally inferred via physical and chemical formulas using technological devices. This creates an extremely difficult situation in which “second-hand non-experience” guides action and perception (RS, p. 72). These nonexperienced risks have to be believed:

In order to recognize risks at all and make them the reference point of one’s own thought and action, it is necessary on principle that invisible causality relationships between objectively, temporally, and spatially very divergent conditions, as well as more or less speculative projections, be *believed*, that they be *immunized* against the objections that are always possible. [RS, p. 72]

This belief entails accepting as true speculative projections based on evidence taken under divergent conditions (climate proxies). Once they are believed to be true, they become real and immediate: “the invisible—even more, that which is by nature beyond perception, that which is only connected or calculated theoretically—*becomes the unproblematic element of personal thought, perception and experience*” (RS, p. 72).

This situation of the NOT reverses the normal logic of experience, indeed, the very idea that one learns from experience. One no longer moves from personal experience to general judgment; rather,

general knowledge devoid of personal experience becomes the central determinant of personal experience. Chemical formulas and reactions, invisible pollutant levels, biological cycles and chain reactions have to rule seeing and thinking if one wishes to go to the barricades against risks. . . . Furthermore, ultimately *no one* can know about risks, so long as to know means to have consciously experienced.
[RS, p. 72]

Risks pose serious challenges to empirical thought and philosophy, not simply because causes have to be believed—as David Hume among others has argued, inference always entails belief—but also and more importantly because experience (sense impressions) can no longer ground morality or correct our theories and imaginings. Belief, causality, and reason, Gilles Deleuze reminds us, all transcend experience and transfer the past to the future, but “the object of belief [must] be determined in accordance with a past experience” (ES, p. 71). Past experience, in particular the regularity of

contiguous events, correct belief and habit by creating a calculus of quantities (philosophical probability) that can sift the essential from the accidental. With risks, as I discuss later, we lose both the ability of experience to inspire belief through its registering of conjunctive cases (which become causal through habit and anticipation) and its ability to correct causality by grounding philosophical probability.

Risks further challenge empiricism by undermining calculation; these unknowable risks are incalculable, if by calculable one means exact calculation. These risks, however, are estimable, which means that the old relationship between calculability and control no longer holds. One can control and access incalculable secondary effects; one does not need to know exactly in order to control.³¹ Beck stresses that decreasing calculability and increasing estimability are inextricably linked because the

knowledge of secondary effects, by now a sufficiently differentiated branch of knowledge, is always (potentially) present. The broadest variety of consequences and recursive causal patterns must thus be weighed in their meaning for themselves and others. In this way, the *actual* consequences ultimately become more and more incalculable, *because* the possible effects become more and more estimable and their assessment takes place more and more in the research process and in interaction with its inherent taboo zones, and determine those zones in the course of results. [RS, p. 171]

This exactly describes the odd temporality—the lack of verifiability—of models mentioned earlier. Because we can estimate and more importantly act on the possible effects before they happen, estimated effects become unverifiable; but, as Beck stresses, this unverifiability or incalculability does not mean total darkness. Secondary effects—the risks—can be anticipated, even if their consequences cannot be exactly calculated or known. (In Hume’s terms, risks affect experience, but not habit/inference).³² Thus, in terms of global climate change, debating the lack of precision regarding predictions screens the general estimability of this change as well as the dynamic relationship between estimability and calculability.

Crucially, the difference between anticipation and exact consequence does not detract from politics or these models but makes politics possible and these models necessary. Beck stresses that risk society does not simply

31. In many ways, this echoes the position of computer programmers: one does not know all the minute calculations a computer makes, and yet one can still control a computer’s actions. For more on this, see Wendy Hui Kyong Chun, *Programmed Visions: Software and Memory* (Cambridge, Mass., 2011).

32. See Deleuze, *Empiricism and Subjectivity*, pp. 68–9.

rob people of their sense perceptions—it does not simply make the real imaginary and the imaginary real—it also gives them greater access to the science of risks and opens science to nonscientists. Risks must be defined using scientific formulas, but risk—what counts as an acceptable level of risk—is defined politically. Science, that is, “becomes more and more *necessary*, but at the same time, *less and less sufficient* for the socially binding definition of truth” (*RS*, p. 156). Risk society thus entails decision in the most rigorous sense of the word. It entails what Derrida has called the undecidable: “the experience of that which, though foreign and heterogeneous to the order of the calculable and the rule, must . . . nonetheless . . . deliver itself over to the impossible decision while taking account of law and rules.”³³

Remarkably, though, global climate change has been framed as a no-brainer: a decision that should entail no decision. The necessity for a decision has led to an aversion to all decisions and a rewriting of political questions into ones that science can—or more properly should—solve. Even more perversely, this deferral is based on the successes of science and the alleged inevitability of Enlightenment. If Enlightenment tools have been eaten up by the same debunking impetus, it is because of the confidence placed in the outcomes of the Enlightenment, namely the assumption that enlightenment is inevitable should the public be granted “the freedom to make a *public use* of one’s reason in all matters.”³⁴ This confidence in scientific consensus as truth has become amplified in the era of scientific models and *CSI*. In response to the unimaginable and the undecidable, we have produced a scientific and technological imaginary that allegedly needs neither imagination nor decision.

Science: Without Experience

As Washington and Cook contend, doubts regarding global climate change stem in part from the impossible expectations of science. These impossible expectations—which are arguably present on both sides of the debate—expose changing expectations regarding the efficacy of scientific evidence, changes linked to narratives about and of science. Doubts regarding human causes of global warming are the obverse of what lawyers have called the *CSI* effect. The incredibly popular *CSI* franchise (*CSI* was the most watched series in the world in 2012)³⁵ often features fantastic

33. Derrida, “Force of Law,” p. 252.

34. Kant, “An Answer to the Question,” p. 59.

35. See anon., “Most-Watched Television Show in the World Is ‘CSI: Crime Scene Investigation,’” *Huffington Post*, 14 June 2012, www.huffingtonpost.com/2012/06/14/most-watched-tv-show-in-the-world-csi_n_1597968.html

technologies, which allegedly close the gap between conjecture and reality because they definitively reveal what happened and when: DNA extracted from a strand of hair unfailingly exposes the criminal. In these cases, there is little or no deduction—little or no inference—because the evidence speaks for itself, once it has been properly technologically manipulated. Action also naturally follows from evidence because it clearly demarcates what has been done and thus what should be done in response. Because of *CSI*, lawyers are finding juries increasingly unwilling to convict on the basis of circumstantial evidence, of deduction rather than forensics.³⁶ Reasonable doubt is becoming anything that requires human (rather than technological) inference, anything that requires personal experience (rather than chemical formulae) as a basis for judgment. *CSI*—and the logic of preemption that it also makes possible—thus represents one powerful and imagined response to unimaginable risks: the imaginary doing away with the role of the imagination. If risks call inferences into question because they are inexperienceable, *CSI* and the forensic imagination close the gap between scientific result and evidence by making scientific decision—the drawing of a conclusion, the testing of a hypothesis—no decision; technologically mediated evidence (humanly inexperienceable sensation) unfailingly links past to present to future. Instead of inference or probability, there is certainty, where certainty is defined as outside human sensation.

This same aura of certainty and drama also infiltrates media reports of scientific findings. Daily, we read news reports about new scientific discoveries that have “proven” various things, reports that exaggerate both the certainty and the reach of the science. Part of the difficulty thus stems from how science is represented as true and certain. Part of this selling of science is linked to the necessity for funding: scientists need to sell science in order to justify public funding, in order for science to be seen as a public good. This reliance on narrative for justification, however, is not limited to the recent transformation of Big Science into Massive Science. As Lyotard has argued, “scientific knowledge cannot know and make known that it is the true knowledge without resorting to the other, narrative, kind of knowledge, which from its point of view is no knowledge at all” (*PC*, p. 29). According to Lyotard, these narratives of legitimation have traditionally come in two varieties: the first emphasizes “humanity as the hero of liberty”; the second stresses the necessity of cultivating the “speculative

36. See Tamara F. Lawson, “Before the Verdict and beyond the Verdict: The *CSI* Infection within Modern Criminal Jury Trials,” *Loyola University Chicago Law Journal* 41 (Fall 2009): 119–73.

spirit” which restores unity to learning and judges/builds State and Society (PC, pp. 31, 33).³⁷ The second, with its emphasis on knowledge for knowledge’s sake, is fading, and the first, combined with narratives of technology as ever-more efficient and autonomous, is growing stronger.

This selling of science as true, certain, and efficient not only creates goodwill towards and awe of science but also shuts down scientific debate and dialogue by making scientists reluctant to air uncertainties in public for fear of being recruited and celebrated as deniers, and it contributes to a paranoid backlash against science and its models. Consider in this light Jean Baudrillard’s critique of scientific models as “hyperreal,” a thesis that inspired films such as *The Matrix*.³⁸ According to Baudrillard, models of the future—simulacra or copies without originals—now precede what they were supposed once merely to represent. These hyperreal simulations, Baudrillard argues, liquidate all referentials, since the real is no longer necessary to verify these models. Even worse, they artificially resuscitate the real, thus congealing the world in action, so that in the place of real action we have a logic of absolute control, which seeks to freeze everything in place, to reduce everything to its code. Once again, there is no uncertainty. By reducing everything to its essence, its code, one allegedly has the ultimate society of control because the code encapsulates everything: the phenomena it refers to and action itself.³⁹ As I’ve argued elsewhere, this assumption that the code is everything glosses over the vicissitudes of execution: everything machines and humans do to make

37. The first, which Lyotard argues is gaining new vigor, argues that knowledge finds its validity in the emancipation and well-being of man—“knowledge is no longer the subject, but in the service of the subject: its only legitimacy . . . is . . . that it allows morality to become reality” (PC, p. 36). I want to stress, however, that we cannot accept the current conditions for scientific research within the United States as either optimal or inevitable. This essay thus is also a call for a rethinking of how science funding is justified and used. It is thus, alongside other recent essays, a call for rethinking the university so it serves all directly involved—students, teachers, and professors—better and so that it engages everyone in a meaningful way.

38. Jean Baudrillard, *Simulacra and Simulations*, trans. Sheila Faria Glaser (Ann Arbor, Mich., 1994), p. 32. According to Baudrillard, one of the most damning and intriguing effects of simulations is how they usurp the real. Science, he argues, no longer needs its object or nature; an ideal model no longer needs to sample nature or refer to an object because it captures phenomena perfectly. Simulation thus differs from representation because representation “stems from the principle of the equivalence of the sign and of the real (even if this equivalence is utopian, it is a fundamental axiom). Simulation, on the contrary, stems from the utopia of the principle of equivalence, . . . from the sign as the reversion and death sentence of every reference” (p. 6). A simulation therefore has no relationship to reality whatsoever; it is not a copy of anything. For Baudrillard, capitalism inaugurates simulation. Capital stems from the utopia of the principle of equivalence; in a capitalist economy, everything can be compared to everything else on the basis of price.

39. Models are often tested by hindcasting, a process by which they are fed historic data in order to see if it accurately predicts the past.

code and its result coincide. By doing so, it trivializes action and makes action a foregone conclusion.⁴⁰ This notion of the hyperreal buttresses the bizarre assumption that information encapsulates execution.

Regardless, the dovetailing of the hyperreal / *CSI* effect and doubts over global climate change reveals how systems of truth and justice—even as they try to avoid politics—still play out in the court of public opinion, as well as pointing to fundamental similarities between scientific and political decision making. The standards applied to determining global climate change are arguably the same standards used within the US courtroom; one must convict someone if one is sure beyond reasonable doubt that the suspect committed a crime. Institutes such as Heartland have done an excellent job producing doubt. Unreasonable expectations regarding the accuracy and scope of science have made these doubts seem, to some, reasonable; they have made waiting for results—in essence giving up on the future—seem rational. Perversely, these models are condemned because they are not hyperreal enough, and action is deferred not through these models but rather through endless debates about these models. If we are to displace this debate, we need to do something other than repeat the opinions of scientific experts; we need to address public expectations and to provide ways of dealing with uncertainty in nonforensic ways. We need to disentangle knowledge, and action from the knot of programmability.

Science—almost all forms of science, not simply climate science—offers probable explanations rather than ironclad and infallible rules. Forensic proof is provided after an event has happened; a decision will be proven to be true based on changes that occur after it or on molecular analyses that later reveal the chemical pathways, the shapes of the molecules involved in a correlation. After an event, everything seems certain. This is why forensic evidence almost always points to the lack of adequate policing or action; it is far easier to discover a pattern of evidence after a crime, when the search terms are clear. This forensic logic underlies the logic of preemption, which seeks to avoid future events by knowing the present and past, by imposing a grid of control that deters all action. Rather than taking this view—which is good for verification but not for hypotheses—we need to consider the fundamental uncertainties of science and politics: the chain of uncertainties starting from the uncertainty within science itself as it moves from correlations to causality to the uncertain step between scientific opinion and political decisions (see “W,” p. 246).

40. See Chun, *Programmed Visions*, chap. 1.

The Difficulties of Predicting and Experiencing Global Climate Change or the Facts, Again

So what does this all mean in terms of understanding global climate change and generating action to combat it?

First, we need to accept—and disseminate—the fact that climate science, like all sciences, is not exact. Because of the number of known and unknown factors that affect climate and the interactions between them, predicting and understanding climate is extremely difficult. There is, as Sabine Niederer has shown, real debate regarding the eventual effects of global warming.⁴¹ Although the basics of global warming are understood, global climate poses serious challenges to modeling and to experience. Knowing the effects of increased hydrocarbons within a sealed space and knowing their effects in the earth's atmosphere are two very different things. This is because (1) many different factors affect climate / temperature; (2) these many different factors also affect each other; (3) it is difficult to exactly measure factors that affect climate; (4) much of the climate record precedes human-kept records and so we must use historical proxies; (5) climate is not something we immediately experience: we are affected by weather, not climate.

Climate is complex. Climate is the measure and pattern of weather—temperature, precipitation, humidity, wind velocity, sunshine, and more—for a particular region over a significant period of time (usually thirty years). It is affected by the atmosphere, the terrestrial biosphere, the sun, and the oceans. Understanding and predicting climate requires the construction of complex models, which couple these systems together and track the effects of factors such as carbon dioxide. Constructing models of any one of these elements alone is difficult; coupling them in order to understand the feedback between the various systems is even more so. Additionally, different models produce very different predictions regarding the effects of increases in greenhouse gases, in large part because of differing values given to positive feedback (water vapor) between the systems and because of uncertainties regarding the role of clouds.⁴²

Further, it is difficult to measure and estimate each factor that affects global climate. Because human records of climate indicators are fairly recent, we need proxies, such as tree rings and ice samples, to measure tem-

41. See Sabine Niederer, “Global Warming Is not a Crisis!?: Studying Climate Change Skepticism on the Web,” *NECSUS*, 3 June 2013, www.necsus-ejms.org/global-warming-is-not-a-crisis-studying-climate-change-skepticism-on-the-web/

42. See Brian J. Soden and Isaac M. Held, “An Assessment of Climate Feedbacks in Coupled Ocean–Atmosphere Models,” *Journal of Climate* 19 (July 2006): 3354–60, www.gfdl.noaa.gov/bibliography/related_files/bjs0601.pdf

perature not only before human records but also before humans existed. These proxies need to be read, that is, interpreted and standardized. Not only is it difficult to measure historical data for climate but it is also difficult to measure these factors in the present. Consider, for instance, the difficulties of measuring carbon dioxide to determine which parts of the world act as carbon sinks or sources. Carbon in the lower atmosphere is measured by ground stations, which are mainly located near the oceans, since these provide the cleanest signals. However, given that most carbon is produced over land, this is not optimal. Further, there are a limited number of ground stations. Although newer satellite technologies promise more detailed and accurate readings, there are still difficulties to be addressed (in addition to those introduced by satellite technology). To know if a location is a source or a sink (to what extent forests serve to mitigate the amount of CO₂ in the atmosphere), these measurements have to be compared to estimates regarding carbon production (from industry records and others) and be matched against wind patterns. Winds, however, are difficult to predict. Most carbon models now use sixteen models of wind patterns to estimate carbon transport, which creates more uncertainty regarding the effects of carbon sinks/sources. Every factor measured introduces the possibility of error.⁴³

That we experience weather, not climate, makes things even more difficult; climate, like risk, is impossible to experience directly. This explains the conflict between some meteorologists and climate scientists over the existence of global warming (see “PC”). A day’s weather can be affected by any number of local patterns and events; there is no one reason that can account for the strength of a hurricane or the existence or intensity of any given weather event. Climate is an average over at least thirty years. This is why glaciers are so important in illustrating climate change; their size is a measure of climate, not weather. It is perhaps perverse that the measure of global climate change is the mean—an entity devised to filter change by producing an average. Personal experience is further challenged by the fact that in order to combat global climate change we need to act on the basis of models. Again, these models—if they are to work effectively as models—cannot be entirely verifiable. This fact, of course, is not limited to global climate change models; those who believed in the economic model, posited by Carmen M. Reinhart and Kenneth S. Rogoff, which showed that in developed nations a debt/DGP ratio of over 90 percent causes median growth rates to fall by 1 percent, fought for austerity measures to prevent

43. See Kevin Robert Gurney et al., “Towards Robust Regional Estimates of CO₂ Sources and Sinks Using Atmospheric Transport Models,” *Nature*, 7 Feb. 2002, pp. 626–30.

the United States from reaching that level.⁴⁴ In terms of global climate change models and unlike the GDP to debt ratio, it is extremely difficult to reverse climate change.

Climate change skeptics, both within and without the larger scientific community, have exploited these aforementioned uncertainties to deny the very existence of climate change. Here are myths used most against arguments against global warming, according to *Skeptical Science*: the climate's changed before; it's the sun; it's not bad; there's no consensus; it's cooling; models are unreliable; the temperature record is unreliable; animals and plants can adapt; it hasn't warmed since 1988; Antarctica is gaining ice.⁴⁵ "Skeptical" scientists in particular have attacked the logic and reality of representations/simulations of climate change.⁴⁶ They have also challenged the legitimacy and politics of climate scientists, accusing them of being either greedy researchers, who have created global climate scares using various "tricks" in order to get more money, or as socialists with anticapitalist agendas.

Countering these objections through line-by-line rebuttals is important but is not enough because of core challenges posed by global climate change to the relationships between experience and causality, politics and science. These challenges are not limited to global climate change models; they resonate widely, from earthquake prediction to economic models. So, how are we to argue for the productive relationship among models, science, and uncertainty? How can we emphasize their relationship to hypotheses and other forms of reasoning that lie beneath, that are less than reality, but not for that reason less important and scientific? Perhaps one

44. See Carmen M. Reinhart and Kenneth S. Rogoff, "Growth in a Time of Debt," *NBER Working Paper Series* (Jan. 2010), www.nber.org/papers/w15639. On the influence of Reinhart's testimony at the National Commission on Fiscal Responsibility and Reform, see Josh Irons and John Bivens, "Government Debt and Economic Growth: Overreaching Claims of Debt 'Threshold' Suffer from Theoretical and Empirical Flaws," *Economic Policy Institute*, 26 July 2010, www.epi.org/publication/bp271/, and Paul Krugman, "The 1 Percent's Solution," *New York Times*, 25 Apr. 2013, www.nytimes.com/2013/04/26/opinion/krugman-the-one-percents-solution.html?hpw&_r=2&

45. See www.skepticalscience.com

46. Willie Soon and Sallie Baliunas infamously critiqued the hockey-stick graph by arguing that, because proxies represent local climate, they "cannot be combined into a hemispheric or global quantitative composite." Rather, they should be "considered as an ensemble of individual expert opinions," which taken together "reveal that the 20th century is probably not the warmest nor a uniquely extreme climatic period" (Willie Soon and Sallie Baliunas, "Proxy Climatic and Environmental Changes of the Past 1000 Years," *Climate Research* 23 [Jan. 2003]: 89). They divided the evidence by locale and proxy and emphasized the effects of the mini-ice age and the medieval warming period. Although this article was roundly criticized and the editors of *Climate Research* resigned in response to this criticism, Soon and Baliunas's article inspired criticism of Mann's methodology by physicists such as the aforementioned Richard Muller.

way forward is to embrace Latour's insight that "if something is constructed, then it means it is fragile and thus in great need of care and caution" (*W*, p. 246). In this light, science is one of the most powerful creative industries. Perhaps.

Hypo-Real: Created, So Therefore Good

To engage with facts as threadlike and fragile, Latour creates the neologism *factish* from *fetish* and *fact* (both words stem from the Latin word for *made*). Factishes reveal that construction does not equal falsity; rather it is *because* something "is constructed that it is so very real, so autonomous, so independent of our own hands."⁴⁷ A well-constructed factish, in other words, is not "made up" but rather a vibrant and pulsing network that generates "circulating reference, accuracy, and reality" (*PH*, p. 272).⁴⁸ Words and things—numerical representations and the things they refer to—are not separate; reference circulates between the many translations between words and things that underlie scientific research.

Understanding factishes—rather than condemning every approximation and translation as inaccurate proxies—entails engaging with the chains of translation that take place between things and words, as well as with translations between various levels of thought. For instance, to document the relationship between climate and forest growth—and thus also to understand the relationship between forests and carbon dioxide levels—many different measurements are taken. In the tropics, where tree rings do not exist, growth is measured either manually using diameter readings or mechanically using dendrometer bands: both entail field trips to the forest by a team of researchers and workers to record these measurements. To understand the effect of climate on tree growth, one study included readings from every tree with a diameter over one centimeter from four forests (two in Malaysia, one each in Panama and Thailand), and then correlated diameter measurements, taken every five years, against changes in average mean incoming solar radiation, annual total precipitation, and daily minimum temperature at each site.⁴⁹ For climate data, they used monthly data from the National Oceanic and Atmospheric Administra-

47. Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge, Mass., 1999), p. 275; hereafter abbreviated *PH*.

48. Science is the "gaining of access, through experiments and calculations, to entities that at first do not have the same characteristics as humans do. . . . What working scientists want to be sure of is that they *do not make up*, with their own repertoire of actions, the new entities to which they have access" (*PH*, p. 259).

49. See Shirley Xiaobi Dong et al., "Variability in Solar Radiation and Temperature Explains Observed Patterns and Trends in Tree Growth Rates across Four Tropical Forests," *Proceedings of the Royal Society, Biological Sciences* 279 (Oct. 2012): 3923–31.

tion (NOAA) and the National Centers for Environment Prediction's (NCEP) Climate Prediction Center rather than local sources because there were no meteorological stations on site and because they could not verify the quality and accuracy of data obtained from the local meteorological stations.⁵⁰ Estimates for solar radiation forcing were also taken from a US-based source: the International Satellite Cloud Climatology Project (ISCCP). Previous studies had revealed conflicting evidence regarding the effects of long-term temperature changes on forest growth and productivity; one study, based in the Amazon, concluded that changes in climate were stimulating growth and productivity in forests; another, based in Costa Rica, showed the opposite. To resolve this conflict, they turned to those four forests because there existed long term census data for them. To normalize the data, they excluded trees with biologically unrealistic growth rates and trees that had been measured at different heights. The study found that two different and independent variables affected tree growth: minimum temperature and solar radiation. Further, these factors had a greater impact on smaller trees than on more mature ones. These arguably explained the differences reported earlier and thus help elucidate the larger question: to what extent will forests serve as sources or sinks in the future?⁵¹

Many things can affect diameter readings. As well, diameter readings are fast—and thus suitable for large scale measurements—but they are not as accurate as other methods such as dendrometer bands (however, placing these bands on trees takes some skill and surface preparation, and they can become damaged by animals or falling debris). Diameter tape measurements are very good for infrequent measurements and for calculations that do not need extreme accuracy.⁵² In the gathering of physical data, compromises are made in order to negotiate between the various goals:

50. The interactions between Western research scientists and the locations they study is fascinating and too large a topic to be addressed properly here.

51. To answer this question, another set of correlations and references need to be put into place. First, it is assumed that trends and variations in climate affect short-term physiological performance in plants. This in turn affects long-term demographic performance: mortality, growth, and reproductive rates. This in turn affects the long-term structure of the ecosystem and the accumulation of carbon in the ecosystem, which is released through the burning of trees and soil. Each step's assumption builds on the other, and these various levels are intertwined through the chains of reference—the measurements—that circulate between them. In order to create hypo-real models, theory is essential, and theory and practice should shape each other. To understand why solar radiation would play a great factor in tree growth, one needs to understand plant physiology and also forest dynamics, as well as the difference between temperature and solar radiation.

52. See Bobby D. Keeland and Patricia Joy Young, "Construction and Installation of Dendrometer Bands," National Wetlands Research Center, www.nwrc.usgs.gov/Dendrometer/

ease of measurement, accuracy of measurement, the importance of scale, and the soundness of any sample. Also, there are uncertainties introduced by variations in human observers and frequency of observation. The coarseness of data, however, does not necessarily compromise the calculation or the larger estimate or hypothesis. To insist on absolutely accurate data is sometimes to ensure that no measurements and calculations are ever made; further, inaccuracy in tree diameter readings is hardly the limiting factor in understanding the effects of climate on tropical rainforests.

The conclusion reached does raise the question: why are these correlations significant, and are they causal? What other reasons are there for these changes and what other conclusions could be drawn? Clearly, these factors were correlated because of our basic understanding of plant physiology; solar radiation and temperature affect the rate of photosynthesis. However, given that most empirical science works via uncovering correlations, how are we to determine the force and primacy of various correlations? For instance, most news reports that claim that science has “discovered” a gene responsible for a certain action report a discovered correlation rather than a causal relation. That is, such discoveries do not usually include knowledge of the specific chemical pathways involved (this often comes later, if it does) but rather the discovery of a solid correlation between the presence of certain genes (or gene mutations) and certain expressed characteristics. The force of correlation is perhaps most heavily debated and hyped within economic models, such as the controversy mentioned earlier regarding GDP to debt ratio.

All these examples raise the further question: what is the relationship between knowing these correlations and acting on them? In the case of the GDP to debt ratio finding, this “fact” was used constantly by Republicans in the US Congress during debates regarding the budget and the effects of austerity versus stimulus. That this correlation was later called into question when it was vascularized by the team from the University of Massachusetts, Amherst did not change its impact. Mann’s hockey-stick graph became the iconic visual used by the Intergovernmental Panel on Climate Change (IPCC) to explain global climate change. Once attacked, though, it became a lightning rod, an example not of global warming but of bad science.

Correlating Causation

The question of the relationships between correlation and causality, causality and action is especially pressing given the rise of big data and the ways in which it allegedly dispels the very need for causality. As *Wired* editor Chris Anderson has controversially asserted, “the data deluge makes

the scientific method obsolete.” It is not only humanists who are discussing “the end of theory.”⁵³ Anderson’s article remarkably places statistical analysis outside theory, as though statistical analyses designed to recognize significant patterns were not themselves theoretical. It also assumes that data are simply raw and can speak for themselves. (As Lisa Gitelman has shown, “raw data is an oxymoron.”)⁵⁴ Regardless, big data is challenging our common perceptions of causality because clearly noncausal relations—seemingly accidental relations—seem to be better predictors of future behavior than so-called essential relations.

Most forcefully, Viktor Mayer-Schönberger and Kenneth Cukier have argued that “society will need to shed some of its obsession for causality in exchange for simple conditions: not knowing *why* but only *what*.”⁵⁵ They offer as evidence cases that have become widely canonized: FICO’s “Medical Adherence Score,” which determines how likely patients are to take medications regularly based on information such as car ownership; and Target’s “pregnancy prediction” score based on the purchase of vitamin supplements and unscented lotions (*BD*, pp. 56, 58). Based on these cases, they contend that not only do we need to give up on causality because knowing what is happening is more important than why but we also need to give up on causality because often “it’s little more than a cognitive shortcut that gives us the illusion of insight but in reality leaves us in the dark about the world around us” (*BD*, p. 64).⁵⁶ Further, we need to let go of our penchant for accuracy. In terms of big data, accuracy is not needed; it is better to have a lot of noisy data than a smaller set of accurate data. Chaos theory aside, knowing about that butterfly’s flutter in South America does not matter.

The rise of big data in many ways seems antithetical to debates around climate change. Often the very same folk calling into question global climate change on the basis of “poor” data are the very ones celebrating and exploiting big data, poor or not. Similarly, many of those who see the

53. See Chris Anderson, “The End of Theory: The Data Deluge Makes the Scientific Method Obsolete,” *Wired*, 23 June 2008, www.wired.com/science/discoveries/magazine/16-07/pb_theory

54. See “*Raw Data*” *Is an Oxymoron*, ed. Lisa Gitelman (Cambridge, Mass., 2013).

55. See Victor Mayer-Schönberger and Kenneth Cukier, *Big Data: A Revolution That Will Transform How We Live, Work, and Think* (New York, 2013), p. 7; hereafter abbreviate *BD*.

56. Big data, by relying on correlations, can predict the future because it gives up on causality as a limiting factor: “there is nothing causal between car ownership and taking antibiotics as directed; the link between them is pure correlation. But findings as such were enough to inspire FICO’s chief executive to boast in 2011, ‘We know what you’re going to do tomorrow’” (*BD*, p. 56). Mayer-Schönberger and Cukier offer as evidence the already canonical examples of big data’s success: how Target exposed a girl’s pregnancy to her father before she did; statistical methods that produce better translations than grammatical ones; and Amazon’s automatic recommendation system, which resulted in more purchases than its editors’ choices (see *BD*, p. 51).

possible catastrophes predicted by climate scientists as improbable also buy lottery tickets (this is a correlation that should be explored, not be moaned). Importantly, the correlations exposed and exploited by much consumer uses of big data focus on the amplification of consumer behavior; if you've bought this, you probably also want to buy that. The idea is to program customers to act in certain ways (or to predict present conditions or future habits) based on habits already contracted. Because most big data analyses are not interested in changing behavior radically (or in prevention)—but rather in amplifying certain existing behaviors (and preempting others)—big data is not interested in causes but in proxies. Algorithms based on correlations are also used by intelligence gathering services to create lists of probable suspects/potential terrorists. However, as the recent Boston bombings reveal, relying on statistical patterns and probabilities leaves you vulnerable to more improbable suspects, to whom such models grant more safety. The light of big data creates big shadows.

So, how can we use hypo-models not simply to amplify or preempt human behavior but rather to change it? To produce the improbable rather than the probable? How can we make correlations produce understanding and a fundamental openness to the future? That is, how are we to consider the relations between correlation and the future, not to shut down the future—to shape it into what is most statistically probable—but to deal with invisible forces that we cannot entirely know, but need nonetheless to change? To do so, we need to follow Beck's call to create an alternative to the relationship between practice and theory. However, rather than base this alternative on the fact that we can learn from past mistakes (Beck's formulation), we need to start from the fact that it is because we cannot learn from the past—at least not directly—that we need an alternative theory of theory and practice, an alternative approach to the future that approaches invisible causalities through proxies and that creates new habits obliquely through correlations.

This point is made clearly by the more recent work by NASA climatologist Jim Hansen. Hansen, who for years has been warning of global warming and the importance of public information dissemination, in 2012 wrote a remarkable article, "Perception of Climate Change," in which he addressed directly the impossibility of experiencing climate. "The greatest barrier to public recognition of human-made climate change," he contends, "is probably the natural variability of local climate. How can a person discern long-term climate change, given the notorious variability of local weather and climate from day to day and year to year?" ("PC"). This again is the imperceptibility of risks, which Beck addressed. Hansen, however, does not give up on the primacy of human experience. Rather, refer-

ring to a survey that “confirms that public opinion about the existence and importance of global warming depends strongly on their perceptions of recent local climate variations,” Hansen explores the notion, “suggested decades ago . . . that by the early 21st century the informed public should be able to recognize that the frequency of unusually warm seasons had increased, because the ‘climate dice,’ describing the probability of unusually warm or unusually cool seasons, would be sufficiently loaded (biased) as to be discernible to the public” (“PC”). Thus, more important than verifying and explaining models is relating extreme weather events, such as recent heat waves and droughts, to ongoing global warming.

Although Hansen and others “were motivated in this research by an objective to expose effects of human-made global warming as soon as possible,” they used “an empirical approach that does not require knowledge of the causes of observed climate change. We also avoid any use of global climate models, instead dealing only with real world data” (“PC”). They conclude that the climate dice are now so loaded that “the probability distribution for temperature anomalies has shifted more than one standard deviation towards higher values . . . [, which means] that a perceptive person old enough to remember the climate of 1951–1980 should recognize the existence of climate change, especially in summer” (“PC”). The use of “real data” is not outside the use of models, in particular statistical models of probability, and, again, data is never raw. Regardless, the Hansen piece nicely addresses the importance of revealing correlations that imply causality, of using proxies for global mean temperature. Weird weather events are arguably side effects of the rise in global mean temperature; deviations, because they depend on means, are usually determined subsequent to means. These deviations, however, are open to experience and resonate most widely. The experience of the anomaly—of that which cannot be entirely explained and thus invokes new rules to explain it—leads to profound questions about the future and politics. Habitual disruptions of the habitual are key to experiencing the inexperienceable.

Hansen’s work also reveals that the link between correlation and causality may be uncertain (one might say undecidable), but it must be conjectured for a future that is anything other than one programmed by probabilities. By giving up on causality, where causality is understood as X effecting Y (however fraught it is and has always been), we are foreclosing the future; the uncertainty regarding causality does not deride the importance of causality but underscores it. To return to the canonical examples referred to earlier—the Medical Adherence and the pregnancy prediction scores—these metrics reveal the complexities of human culture and the role it plays in creating relations. The buying of certain vitamins during the third month of a pregnancy

shows the extent to which pregnancy in the United States has become carefully managed and programmed. The links between the Medical Adherence score and car ownership are multiple: from the convenience often afforded to automobile drivers over public transport (especially bus) users to simple indicators of socioeconomic class. To put it slightly differently, that causality is fictional—as those who trumpet big data argue—is not the death of causality but rather its potential. Causality, as empiricists have argued, constitutes the “always” through an extension of reason that transcends the given (*ES*, p. 67).

I am willing to wager that the debate over global climate change will be over soon, not because people believe models or means, but because proxies, such as weird global events, will convince the majority of its existence. (And also because geoengineering is becoming a reality.) I am further willing to wager that the end to this debate will not mean the end of global climate change. The challenges that global climate change and big data together pose undermine not only the relationship between the accidental and the essential but also that between reason and action, passion and habit; they undermine the odd assumption that information/code automatically executes.

Habits of Living

To conclude, I want more explicitly to draw together the various threads on causality in this paper through Deleuze’s exposition on Hume, *Experience and Subjectivity*. It is no surprise that Hume—in particular his linking of causality with habit—is the popular big data philosophical reference, appearing in articles in *Wired* magazine and in PowerPoint presentations made by those advising the US intelligence community.⁵⁷ Although this reference often is made glibly, it highlights the importance of habits to understanding how causality, correlation, and anticipation work in the era of risks that defy human experience. Although global climate change and big data are difficult to grasp because they create inferences based on relations that escape human experience, they do not affect the work of habit, in particular, habit as anticipation.

Deleuze, reading Hume in *Experience and Subjectivity* (a text that would have a profound effect on his later work) outlines the linkage of experience and habit in Hume’s theory of causality. Causality, Deleuze explains, does not proceed on the basis of certainty (it is not based on intuition or demonstration) but rather on the basis of probabilities (see *EC*, p. 65). This

57. See Jonah Lehrer, “Trials and Errors: Why Science Is Failing Us,” *Wired*, 16 Dec. 2011, www.wired.com/magazine/2011/12/ff_causation/all/1, and Chris Ray, Bryan Ware, and Gary Nan Tie, “Big Data, Systemic Risk and the US Intelligence Community,” Enterprise Risk Management Symposium, Chicago, IL, 22–24 April 2013, www.ermssymposium.org/2013/concurrent-sessions.php

does not mean that causality is derived from probability; causality forms gradually and is the result of habit, which presupposes experience. According to Hume, “experience is a principle, which instructs me in the several conjunctions of objects for the past. Habit is *another principle*, which determines me to expect the same for the future.” Experience presents cases of constant conjunction to the inspecting mind, but “repetition by itself does not constitute progression” (*EC*, p. 67). Habit allows the mind to transcend experience—to reason about experience, “as it transforms belief into a possible act of the understanding” (*EC*, p. 68). Causality is thus both “the union of similar objects and also a mental inference from one object to another” (*EC*, p. 68).

Crucially, though, habit and experience are not—and do not—always have to be unified. Habit poses the possibility of falsifying experience, for it “can feign or invoke a false experience, and bring about belief through ‘a repetition’ which ‘is not deriv’d from experience’” (*EC*, p. 69). These beliefs, however inevitable, are, Hume stresses, illegitimate; they “form the set of general, extensive, and excessive rules that Hume calls *nonphilosophical probability*” (*EC*, p. 69). To correct these beliefs, the understanding intervenes through a corrective principle that restrains belief to the limits of past experience—to the “rules of *philosophical probability* or the calculus of probabilities” (*EC*, p. 69). So, although “the characteristic of belief, inference, and reasoning is to transcend experience and to transfer the past to the future; . . . it is still necessary that the object of belief be determined in accordance with a past experience” [*EC*, p. 71]). This passage clarifies the challenge posed to understanding by unimaginable risks; in a risk society, understanding can neither draw from experience (the conjunctions of objects from the past) nor be corrected by it. In reflexive modernity, this unleashing of habit from experience does not lead to the end of knowledge—to “errors and lies” (as in Hume’s formulation [*EC*, p. 71])—but rather to unexperienceable yet scientific knowledge. Science, in the era of both global climate change and big data, it would seem, survives via habits (inferences between objects that link the past to the future). In Humian terms, they achieve the creativity of morality and art (see *EC*, p. 71). (Again, science can be seen as a creative industry in a formulation that resonates strongly with post-World-War-Two representations of scientists as creative men.)⁵⁸

Not surprisingly, habits themselves have become the focus of analyses in fields as diverse as critical theory, business psychology, economics, and

58. See Vannevar Bush, “Memex Revisited,” *New Media, Old Media: A History and Theory Reader*, ed. Chun and Keenan (New York, 2006), pp. 85–95.

biology.⁵⁹ As a way to integrate experiences that exceed general rules, the habitual allows us to engage the remainders, or exceptions to, rational choice, experienced or not—from consumers who do not act as game theory would predict to constantly-failing dieters. Habits are how causality (anticipation, belief) persists after rationality.

Habits are strange, contradictory things. Habits are human-made nature; they are practices acquired through time that are seemingly forgotten about as they move from the voluntary to the involuntary, the outer to the inner. As they do so, they penetrate and define a person; a habit was traditionally an outer garment, such as a nun's habit. More darkly, they take on a life of their own, independent of an individual's will (drug habits). William James called habits "the enormous fly-wheel of society, its most precious conservative agent. It alone is what keeps us all within the bounds of ordinance, and saves the children of fortune from the envious uprisings of the poor."⁶⁰ Habit, that is, is ideology in action.⁶¹ At the same time, habits are viewed as central to individuality; they not only mark individual difference, they also give an individual the time she or he needs to attend to other things, to think, while at the same time marking an individual's lack of self-control, since habits are mainly automatic actions prompted by outside stimuli.⁶²

As Catherine Malabou has outlined in her preface to Félix Ravaisson's *Of Habit*, habits are usually understood in two ways:⁶³ first, as mechanical repetition that erodes what is distinctively human; second, as fundamental to life, to how we persist. Although a full explanation of Ravaisson's text is outside the parameters of this essay, Ravaisson, who is firmly in the second camp, stresses that habit is not instinct; it is not a natural, automatic response. Rather, habit signals a change in disposition—indeed a disposition towards change—in a being that does not change, even as it does change. Habit, that is, comes from a change—it is a reaction to a change—that remains beyond that change.⁶⁴ (The current weakness of big data—one

59. See "Habit," a special issue of *Body and Society* 19 (June–Sept. 2013); and Wendy Wood and David T. Neal, "A New Look at Habits and the Habit-Goal Interface," *Psychological Review* 114 (Oct. 2007): 843–63.

60. William James, *Principles of Psychology*, 2 vols. (1890; New York, 2007), 1:121.

61. The idea of habits as ideology in action resonates with Slavoj Žižek's early reformulation of ideology as persisting in action rather than knowledge. Ideology is structured, he argues, as a fetish: I know very well that X is not Y, yet I persist in treating X as Y; see Slavoj Žižek, *The Sublime Object of Ideology* (New York, 1989).

62. See Wood and Neal, "A New Look at Habits and the Habit-Goal Interface."

63. See Catherine Malabou, "Addiction and Grace: Preface to Félix Ravaisson's *Of Habit*," in Félix Ravaisson, *Of Habit*, trans. Clare Carlisle and Mark Sinclair (New York, 2008), pp. vii–xx.

64. Habit, which exists beneath personality and consciousness, takes a change from the outside and makes that change more and more a change generated from the inside, thus turning receptivity into spontaneity and enabling the organism to create its own reward.

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that will probably soon be corrected—is that many of its algorithms assume that habits are stable rather than themselves constantly changing.) Habit occurs when understanding becomes so strong that it is no longer reflected, when an action is so free that it anticipates and escapes will or consciousness, or when a being's repeated actions assuage its own needs. Habit, Ravaillon stresses, is intelligence without will or consciousness.

This move towards habit—in both materialist critical theory and neoliberal economics—should be questioned, but it points to the fact that habit is arguably what culture can be and is in the era of neoliberalism, in an era in which, as Margaret Thatcher argued, there is no society. Society is not a negative entity based on laws that restrict but rather a positive and creative institution that, as Hume argues, integrates human partiality (see *EC*, chap. 2). In place of society and government as positive entities that extend sympathies, create loyalties, and correct inequalities, we have the reification, manipulation, and extension of habits. It is no accident that reactions to environmental disasters have been framed in terms of individual habits: reduce, reuse, recycle. More positively, as Hansen's use of weird weather events reveals, changes to habitual relations are a powerful way of making vivid scientific estimations and thus registering change. More negatively, the focus on habits exaggerates the effects of individual actions, when in fact global climate change stems largely from industrial uses of hydrocarbons.

Habit underscores the elliptical relationship between action and reason. Habit, initially the product of intention, also acts outside intention. Most strongly, habit repeats action in the face of intentions and knowledge. Habit reveals the importance of involuntary memory to both creating time for voluntary thoughts and undermining their impact. Action does not flow from knowledge. As Deleuze points out, reason “does not determine practice: it is practically or technically insufficient. Undoubtedly, reason influences practice, to the extent that it informs us of the existence of a thing, as the proper object of a passion, or the extent that it reveals a connection between causes and effects as means of satisfaction. But we cannot say that reason produces an action, that passion contradicts it, or even that reason thwarts a passion” (*ES*, p. 33). As work done on habit change has revealed, the best way to change habits is through training; that is, a combination of knowledge and repetition can use repetition against repetition.⁶⁵

65. See Bas Verplanken and Wood, “Interventions to Break and Create Consumer Habits,” *Journal of Public Policy and Marketing* 25 (Spring 2006): 90–103, and Clare Carlisle, “Creatures of Habit: The Problem of the Practice of Liberation,” *Continental Philosophy Review* 38 (Apr. 2005): 19–39.

But for Hume and Deleuze, although understanding/causality is key to the formation of the subject, passions are primary. Causality matters when we care about its ends. Further, passions can create new relations; they can take the place of the already existing rules of association and create new associations. For Hume, passions are inextricably linked to human experience because they are affections—impressions of ideas that immediately register in terms of true and false. They underlie the system of morality and justice, which are, fundamentally, creative and created.

Here is our dilemma and the challenges posed to the affective turn. As science increasingly takes the role of culture in building an artificial world around us, passions themselves lose their primacy and their link to experience. Tiziana Terranova's call for a common passion as the zero ground of the political is smart and absolutely correct, but the question is: how to create this passion when affection itself cannot grasp the unimpressionable risks that threaten us?⁶⁶ How to make vivid the creative world of science without resorting to fantastic *CSI*-like representations? Both systems of knowledge and morality are now based on imagination and creativity, so how can we inhabit the world that technology has built? How to inhabit habit? We need ways to register and deal with the effects of habituation (of correlations with effects). We need hypo-theses that model these correlations and offer calculations and rules to follow. And we need to make decisions and coalitions beyond our natural sympathies—and, by doing so, invent new relations and futures.

66. See Tiziana Terranova, *Network Culture: Politics for the Information Age* (London, 2004).