The Psychology of Pollution Control

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Pollution control is fundamentally affected by how people evaluate the harm of pollution. In many legal contexts, psychological processes contribute to an intuitive undervaluation of the harms of pollution, particularly where those harms are diffuse in space and time, complex in character, and/or accrue to nonhuman stakeholders. Psychological processes that impact people's perception, understanding, and response to pollution can therefore affect how—and how effectively—pollution is controlled. Understanding those psychological processes can thus pay explanatory and prescriptive dividends, including by informing how pollutants are defined, when pollution is tolerated, and how pollution control instruments operate.

INTRODUCTION

One of the greatest challenges in environmental law is the puzzle of how to manage pollution, which is the greater-than-desired concentration of dangerous or impure substances. Which substances are dangerous or impure enough to qualify as pollutants, and in what quantity? What harms can pollution cause to humans or the environment, and with what certainty can those harms be predicted? How much harm from pollution should be tolerated—and why, by whom, and over what time period? How should harms from pollution be prioritized against economic or other harms, or against any benefits gained from polluting activity? Can markets be trusted to manage pollution harms—and if not, when, why not, and with which instruments should those harms be managed instead?

For scholars of pollution control, these questions are familiar, as are many of the conventional answers, which have been enriched by interdisciplinary insights from environmental science, environmental economics, and environmental ethics. Perhaps surprisingly within such an interdisciplinary field, however, there is no existing tradition addressing the *psychology* of pollution control: that is, considering how the perception of pollution relates to the ability to effectively control pollution generation, exposure, and distribution. Indeed, while law and psychology has become an increasingly

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important methodology in many areas of law—most notably in criminal law, evidence, and contracts—it remains a relatively rare method within environmental law.

This is a pity. As we have described at some length in a recent book, *The Psychology of Environmental Law*, environmental injuries in general present psychologically distinctive elements that should be accounted for within environmental law and policy.[1] Environmental injury tends to be diffuse through space and time, complex in character, and to involve nonhuman stakeholders and processes. These characteristics trigger a constellation of psychological phenomena that make it difficult for people to see, understand, and value environmental harms. Recognizing the challenges people face in perceiving and processing environmental injury can help make environmental laws more effective at achieving the ends they seek, and can assist policymakers in better predicting and shaping human behaviors that affect the environment.

This article builds on the book,[2] focusing in on the specific psychology of pollution control. The article begins by articulating the diffuse, complex, and nonhuman characteristics of many pollution harms, before identifying three more distinctive psychological aspects of pollution perception—purity and disgust, source effects, and positional judgments—that should also be understood as important contributors to how pollution is seen, understood, and valued—and therefore, controlled. Finally, the article reflects on the implications of psychology for effective pollution control. In particular, it identifies ways that instrument choice, environmental justice, and the selection and use of decision-making procedures (including cost-benefit analysis and the precautionary principle) are affected by the psychology of pollution perception.

I. THE PSYCHOLOGY OF ENVIRONMENTAL INJURY

It is no surprise to environmental scholars that pollution routinely presents harms that are diffuse, complex, and nonhuman in character.[3] What is less well-understood is the psychological implications of these characteristics,

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1. *See generally* ARDEN ROWELL & KENWORTHEY BILZ, THE PSYCHOLOGY OF ENVIRONMENTAL LAW (2021).

2. *See id.* at 149–80.

3. *See, e.g.*, Richard Lazarus, *Restoring What's Environmental About Environmental Law in the Supreme Court*, 47 U.C.L.A. L. Rev. 703 (2000) (describing key features of environmental injury).

which make it difficult for people to see, understand, and value the harms of pollution.[4]

A. Diffusion

First, consider the psychological implications of the fact that there is often distance between where and when a pollutant is generated or emitted, and where and when harm accrues. In many cases, this "distance"—whether spatial or temporal—obscures the existence and importance of pollution's effects.[5] In other cases, the diffusion of cause and effect may lead to diffusion of responsibility,[6] and opens space for motivated reasoning.[7] All of these impacts have the effect of reducing the psychological weight of pollution harms.

The "out of sight, out of mind" quality of the harms of pollution can create consistent challenges for even well-meaning actors to fully internalize the impacts of polluting activity.[8] The air pollution from a coal plant in Illinois may waft many miles into Indiana, Michigan, and Canada; the harm of asingle-use plastic straw may accrue hundreds or even thousands of miles away, imbedded into distant wildlife or shedding microplastics into far away oceans; and the climate harms from both industrial and individual greenhouse gas emissions will accrue largely to foreign (and future) people and ecosystems. The distant nature of these harms reduces their cognitive availability,[9] and thus affects how likely people are to think that harm will actually result.

Of course the consequences of pollution are often temporally distant as well; there can be considerable latency between pollution exposure and harm.[10] This can trigger problems with inconsistency of preferences and valuation across time, often in ways that depart from what rational-actor

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4. *See* ROWELL & BILZ, *supra* note 1, at 31–116 (discussing the psychological implications of these characteristics).

5. *Id.* at 63-92 (discussing the psychological implications of diffuse environmental injuries).

6. John M. Darley & Bibb Latané, *Bystander Intervention in Emergencies: Diffusion of Responsibility*, 8 J. PERSONALITY & SOC. PSYCH. 377 (1968).

7. *See generally* Ziva Kunda, *The Case for Motivated Reasoning*, 108 PSYCH. BULL. 480 (1990).

8. *See* ROWELL & BILZ, *supra* note 1, at 32–35 (discussing the psychology of externalities).

9. Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases,* 185 SCI. 1124 (1974).

10. Richard L. Revesz, *Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives*, 99 COLUM. L. REV. 941, 949 (1999).

economics would predict.[11] As a result, *when* you ask people to value an environmental good can affect *how much* people value it. For example, people's discount rates in most instances are "hyperbolic"—that is, they decline as the temporal period increases. This can create inconsistent preferences: people might prefer $1 today to $2 a week from now but prefer $2 in a year-plus-a-week from now to $1 in a year. This is a form of "present bias," where people attach a special premium to instant gratification.[12]

This presents special challenges to meaningfully eliciting people's preferences about future pollution control. Especially where preferences are expressed in monetary terms—which is necessary for the type of cost-benefit analysis that often informs U.S. environmental regulation—such elicitations must be careful to indicate the time period in which they are operating.[13] In more general pollution control contexts, temporal inconsistencies mean both that polluters may disproportionately prefer to avoid paying immediate costs to reduce harms, and the public may disproportionately fail to demand such reductions because the harms they experience will be in the distant future. These distortions only increase the further in the future a pollution impact occurs.[14]

The challenges people face in processing the diffuse quality of pollution harm is further exacerbated by the existence of multiple contributing causes. Pollution harms with multiple interacting causes are familiar in pollution control; a classic example is nonpoint source water pollution. While the emission of fertilizer and municipal waste into the Mississippi River might present no significant problem if it were engaged in by one farm or one town, when thousands of actors introduce nitrogen and other nutrients into the river, the cumulative result is the massive dead zone in the Gulf of Mexico.[15] Polluters themselves may never see the harms of their actions with their own eyes; and as noted, this will tend to reduce the availability and importance of those harms in their minds. In addition, the significant number of other polluters makes coordination to limit the problem particularly challenging. This is true not only from a practical perspective, because increased numbers

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11. Shane Frederick et al., *Time Discounting and Time Preference: A Critical Review*, 40 J. ECON. LIT. 351, 351–53 (2002); David Laibson, *Golden Eggs and Hyperbolic Discounting*, 112 Q.J. ECON. 443, 451 (1997).

12. Ted O'Donoghue & Matthew Rabin, *Doing It Now or Later*, 89 AM. ECON. REV. 103, 103 (1999); Frederick et. al., *supra* note 11, at 360–61.

13. *See generally* Arden Rowell, *The Cost of Time: Haphazard Discounting and the Undervaluation of Regulatory Benefits*, 85 NOTRE DAME L. REV. 1505 (2010).

14. Richard Thaler, *Some Empirical Evidence on Dynamic Inconsistency*, 8 ECON. LETTERS 201, 205–06 (1981).

15. *See* ROWELL & BILZ, supra note 1, at 151–52.

of actors increase classical economic transaction costs, but also from a psychological perspective, because the existence of potentially responsible actors may trigger diffusion of responsibility and bystander effects.[16] Similar problems arise in multiple other critical areas, including climate change, plastics pollution, and use of motor vehicles.

B. Complexity

The effects of pollution exposure and the implications of various pollution-control regimes are complex in a number of ways. Psychological research suggests that people process complex problems differently than they do simple ones. In particular, they tend to deploy simplifying heuristics designed to break difficult problems down into easier chunks. While these heuristics are frequently adaptive, they also can lead us astray. The more underlying complexity in a system or a cause-and-effect relationship, the more distortion simplifying heuristics create.

And the causes and effects of pollution can be very complex indeed. In part, this complexity flows from a point made above-- that pollution can accumulate from the actions of many individual actors. This makes it harder to isolate the contributions of any one source. The problem is even worse when either the causes or the consequences of a pollutant are either infinitesimally small or colossally large, because people are simply not very good at comprehending scale at such extremes.[17] Assessing the causes and effects of pollutants is also often a matter of probabilities and quantitative analysis—and unfortunately, the problem of innumeracy (the numerical analogue to "illiteracy") is distressingly commonplace.[18] Adding to the cognitive difficulties of assessing causes and effects, emotions and desires can distort our analysis as well. People frequently suffer from "motivated reasoning,"[19] where people are more likely to credit bad outcomes to causes they already believe are harmful or morally bad, and they are reluctant to believe that things they like or think are good could lead to bad outcomes. For instance, a polluter who relies on a particular pesticide or industrial chemical to make their living will be reluctant to recognize the harms it may

16. *See* supra notes 7, 8 and accompanying text.

17. *See* Ellen Peters et al., *Numeracy and Decision Making*, 17 PSYCH. SCI. 407, 407 (2006).

18. *Id.*; DANIEL KAHNEMAN, THINKING, FAST AND SLOW (2011); NATHAN DIECKMANN, NUMERACY: A REVIEW OF THE LITERATURE (2008); *see also* Arden Rowell and Jessica Bregant, *Numeracy in Legal Decision Making*, 46 Ariz. St. L. J. 191 (2014) (exploring the implications of numeracy research on legal decision making)

19. *See generally* Kunda, supra note 7.

inflict on the environment. This reluctance may lead the polluter to sincerely but erroneously undervalue the environmental impacts of their actions.

Next, both humans and the environment itself can adapt—at least partially—to some pollution.[20] These adaptations make the environment either better or worse for humans and other living things, and further complicate the clean identification of causes and effects, as well as the process of responding to them adequately and appropriately. In other words, human actions and environments are interactive. Furthermore, humans themselves may respond to pollution in ways that have unexpected consequences and spillover effects. For instance, a recent study of China's attempted regulation of particulates and secondary aerosols demonstrated an *increase* in overall pollution, since much of the regulated industrial activity that produced those pollutants was simply outsourced to other locations with less efficient technologies and lower environmental standards.[21]

Finally, pollution is subject to nonlinear relationships between quantity and harm. That is, the harm caused by pollution is prone to "tipping points," where the harm does not occur until exposure to the pollutant reaches a certain toxic level, at which point the harm manifests rapidly and decisively—and may be difficult or impossible to reverse.[22] Moderate quantities of nutrient pollution in a waterway, for example, may have limited measurable effects on local water quality, whereas excessive quantities of the same nutrients can suddenly cause eutrophication, low levels of oxygen dissolved in the water, and complete destruction of aquatic ecosystems.[23] With some pollutants the problem is especially acute, as some substances are beneficial at small doses but deadly at larger ones—like chlorine in drinking water, which acts as a disinfectant against potentially dangerous pathogens, even as it presents cancer and other morbidity risks in larger quantities.[24] Failing to recognize such complexity in pollution may fundamentally

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20. *See* RICHARD V. SOLÉ & JORDI BASCOMPTE, SELF-ORGANIZATION IN COMPLEX ECOSYSTEMS (2006); John Copeland Nagle, *Good Pollution: A Response to Arden Rowell, Allocating Pollution*, 79 U. CHI. L. REV. 31 (2013).

21. Delin Fang et al., *Clean Air for Some: Unintended Spillover Effects of Regional Air Pollution Policies*, 5 SCI. ADVANCES, 1, 5–7 (2019).

22. Vasilis Dakos et al., *Ecosystem Tipping Points in an Evolving World*, 3 NATURE ECOLOGY & EVOLUTION 355, 356–57 (2019); *see* SOLÉ & BASCOMPTE, *supra* note 20.

23. *See, e.g.*, *Northern Gulf of Mexico Hypoxic Zone*, EPA (Aug. 26, 2022), https://www.epa.gov/ms-htf/northern-gulf-mexico-hypoxic-zone [https://perma.cc/6483-X7JX] (charting the size of the "dead zone" in the Gulf of Mexico, which is caused by nutrient pollution in the Mississippi River; in 2021, the dead zone was charted as extending over 6,334 square miles, an area larger than the state of Connecticut).

24. *See* ROWELL & BILZ, *supra* note 1, at 65; Nagle, *supra* note 20, at 37.

undermine the law's ability to effectively regulate it.[25] And yet human psychology makes it especially hard to recognize this kind of complexity—we are prone, for instance, to focus on the most recent or most salient effects of a substance,[26] or perhaps on the most "unnatural" causes of a particular outcome.Indeed, studies show that American laypeople tend to believe that natural substances are safer than artificial ones, and that the danger of exposure to a substance is independent of dose.[27] Such heuristics may operate reasonably well for individuals working within noncomplex systems, but they may also inadvertently lead decision makers astray when facing complex questions in pollution control.

At its heart, the regulation of pollution requires the assessment of trade-offs between the usefulness of the activities that produce pollution (such as most industrial processes) and the harm the pollution can cause—but these assessments can be a matter of significant disagreement, not just as a matter of cognition (how big/likely is the harm or benefit?) but also of value (how good/bad is it, really?). Trading between the countervailing benefits and drawbacks of the polluting activity can generate cognitive dissonance, making it mentally costly to process the question of what to tolerate, and how much. All of this can lead to surprising results in what kinds and amounts of pollution people end up tolerating, versus what they take action to reduce or eliminate entirely. As we will discuss further in the last part of this paper, the psychological implications of the complexity of pollution harms may play a particularly important role in which substances and quantities are tolerated and which are reviled.

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25. Cass R. Sunstein, *The Arithmetic of Arsenic*, 90 GEO. L.J. 2255 (2002) (discussing the way that uncertainties in estimating the harms of a pollutant—specifically arsenic—impact policy and decision making procedures, including cost-benefit analysis); *see* Arden Rowell, *Allocating Pollution*, 79 U. CHI. L. REV. 985 (2012) (arguing that how pollution exposures are distributed across a population can affect the quantity of harm caused, and that failures to account for the dose-response relationships of pollutants can generate unnecessary harm); *see also* CASS R. SUNSTEIN, RISK AND REASON: SAFETY, LAW, AND THE ENVIRONMENT (2002) (arguing that courts and legal institutions need to recognize complexity in risk analysis).

26. E. Tory Higgins, *Activation: Accessibility, Applicability, and Salience*, *in* SOCIAL PSYCHOLOGY: HANDBOOK OF BASIC PRINCIPLES 133 (E. Tory Higgins & Arie W. Kruglanski eds., 1996); Denise Howel et al., *Public Views on the Links Between Air Pollution and Health in Northeast England*, 91 ENV'T. RSCH. 163, 167–70 (2003).

27. Nancy Kraus, Torbjörn Malmfors & Paul Slovic, *Intuitive Toxicology: Expert and Lay Judgments of Chemical Risks*, *in* THE PERCEPTION OF RISK 285, 290–91 (Paul Slovic ed., 2000).

C. Nonhuman Character

Finally, pollution control often implicates both nonhuman processes and the possibility of harm to nonhuman plants, animals, and ecosystems. People face psychological barriers to attention and empathy for harms to nonhumans that they do not face for harms to humans.[28] In pollution-control contexts, this may contribute to distorting, neglecting, or minimizing the impacts of pollution on nonhuman animals, plants, and ecosystems.

As a general matter, the more people notice, identify with and care about nonhuman entities in the environment, the more likely they are to value them, both economically and otherwise. Indeed, eople notice, identify with and value various nonhuman animals and physical environments for different reasons and to different degrees. Roughly speaking, the psychological literature suggests that humans tend to value nonhuman aspects of the environment along four axes of determination: the degree to which an entity is similar to them, the degree to which it is salient, the degree to which it is perceived as scarce, and the degree to which it is seen as possessing inherent or intrinsic value.

First, some nonhuman entities are similar to us, and it is psychologically easier to empathize with and object to harms suffered by those who look like us or act like us. Research has shown that people show greater physiological empathetic responses to, in descending order, humans, primates, quadrupeds, and birds in distress.[29] People also empathize more with animals that share features with human babies;[30] such features trigger some of the same emotions and social cognition that humans use to understand and care about other humans. This ability to connect emotionally with anthropomorphized aspects of the nonhuman environment may be a double-edged sword, however, where it leads people to ascribe human motivations and feelings to nonhuman entities. It may also shape the portfolio of ecosystem features and species to which people pay attention and attach value. For instance, though we know of no direct test of this hypothesis, we would predict that people would feel more of an urge to protect—again in descending order—an ape, an insect, a tree, and a rocky outcropping from exposure to a caustic pollutant.

Second, some nonhuman entities are more noticeable than others,[31] and so are more likely to inspire our protective impulses. It is easy to think about the

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28. *See* ROWELL & BILZ, *supra* note 1, at 93–116.

29. H. Rae Westbury & David L. Neumann, *Empathy-Related Responses to Moving Film Stimuli Depicting Human and Non-Human Animal Targets in Negative Circumstances*, 78 BIO. PSYCH. 66, 67–71 (2008).

30. John W. S. Bradshaw & Elizabeth S. Paul, *Could Empathy for Animals Have Been an Adaptation in the Evolution of Homo Sapiens?*, 19 ANIMAL WELFARE 107, 107–10 (2010).

31. Higgins, *supra* note 26, at 133–68.

Colorado Rockies as they loom above us or stare down at us from picturesque landscapes hung on our walls. It is much harder to detect and imagine, and thus to care about, the microbial and fungal ecosystems buried deep beneath the ground, or even the marine and aquatic ecosystems teeming below the surface of our rivers, lakes, and oceans. Similarly, large and charismatic species may generate greater attention—and thus greater protection—than small, hidden, or homely species: good news for elephants, perhaps, but bad news for earthworms.[32] This matters because the less psychologically salient a nonhuman process or entity is, the more likely it is not only to be ignored in the development of personal preferences, but also to be omitted from policy analyses. Especially where individual preferences and valuations drive environmental policy – as is often the case in U.S. federal pollution control, where cost-benefit analysis routinely relies on elicitations of individuals' economic valuations of environmental goods[33] – these impacts can create important implications for pollution policy regarding nonhuman stakeholders.

Third, humans value things to the degree they are perceived as scarce or even unique.[34] This can have obvious effects when it comes to environmental goods. People may seek to travel to Yosemite precisely because it is both unique and scarce, but the resulting overtourism and attendant pollution damages the very thing that people so value.[35] Interestingly, perceived scarcity increases concentration on the target, which can increase the ability to address threats to it. [36] But at the same time, such concentration can become "tunnel vision," leading to a prioritization of short-term fixes over long-term solutions, and to ignore possibly more widespread and dangerous pollutants affecting the less-rare entities.[37]

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32. *See* ROWELL & BILZ, *supra* note 1, at 198–203 (analyzing differential protections under the Endangered Species Act).

33. *See* Arden Rowell, *Quantitative Valuation in Environmental Law*, 96 Notre Dame L. Rev. 1539 (2021) (discussing psychological aspects of quantitative valuation in U.S. environmental law).

34. Luigi Mittone & Lucia Savadori, *The Scarcity Bias*, 58 APPLIED PSYCH. 453, 453–68 (2009) (discussing the impact of perceived scarcity on valuation);*see generally* Bruce M. Hood & Paul Bloom, *Children Prefer Certain Individuals Over Perfect Duplicates*, 106 COGNITION 455 (2008) (finding that perceived uniqueness increases subjective valuation).

35. Charlotte Simmonds et al., Crisis in Our National Parks: How Tourists Are Loving Nature to Death, GUARDIAN, (Nov. 20, 2018), https://www.theguardian.com/environment/2018/nov/20/national-parks-america-overcrowding-crisis-tourism-visitation-solutions [https://perma.cc/X5VP-R87G].

36. SENDHIL MULLAINATHAN & ELDAR SHAFIR, SCARCITY: WHY HAVING TOO LITTLE MEANS SO MUCH 21–24 (2013).

37. *Id.* at 27–32.

Fourth, people prefer to protect entities that are perceived to have intrinsic, even spiritual or religious value. There are cross-cultural differences not only in what is considered valuable and how much citizens will care about different entities' exposure, but also in what counts as polluting at all. Some Native American tribes[38] and people who practice the animist Japanese Shinto religion[39], for instance, might particularly care about damage to landscapes or waterways, even where such damage could have no appreciable effect on humans.

In addition to being *targets* of pollution, nonhuman entities can also be *sources* of pollution. Indeed, as we have noted, there is a common intuition that "natural" substances are less dangerous than manmade or artificial ones.[40] That is, people distinguish between human and nonhuman sources of pollutants, regarding the latter with less disdain or fear—despite the fact that many potentially dangerous substances (such as woodsmoke and arsenic) have both natural and manmade origins.

II. THE PSYCHOLOGY OF POLLUTION

Thus far we have discussed features of pollution harm—diffusion, complexity, nonhuman character—that other types of environmental injuries, such as those encountered in ecosystem degradation or climate disruption, also share.[41] But pollution also has features that trigger a distinctive set of psychological phenomena, the recognition of which may help in understanding the particular challenges presented by pollution-control law and policy, or even offer opportunities for improving them. To that end, we flag three further lines of psychological research that we believe may be particularly helpful in explaining and understanding how perceptions of pollution risk develop and how people respond to them: (1) the psychology

38. *See, e.g.*, George Nicholas, *Protecting Indigenous Heritage Objects, Places, and Values: Challenges, Responses, and Responsibilities*, 28 INT'L J. HERITAGE STUD. 400, 403–04 (2022).

39. *See, e.g.*, Sonoda Minoru, *Shinto and the Natural Environment*, *in* SHINTO IN HISTORY: WAYS OF THE KAMI 32, 36 (John Breen & Mark Teeuwen eds., 2000).

40. *See* Nagle, *supra* note 20, at 6; PETER THORSHEIM, INVENTING POLLUTION: COAL, SMOKE, AND CULTURE IN BRITAIN SINCE 1800 19 (2006); Michael Siegrist & Bernadette Sutterlin, *Human and Nature-Caused Hazards: The Affect Heuristic Causes Biased Decisions*, 34 RISK ANALYSIS 1482, 1482 (2014); Nancy Kraus, Torbjörn Malmfors & Paul Slovic, *Intuitive Toxicology: Expert and Lay Judgments of Chemical Risks*, *in* THE PERCEPTION OF RISK 285, 290–91 (Paul Slovic ed., 2000).

41. For treatments of distinctive features of other areas of environmental law, *see* ROWELL & BILZ, *supra* note 1, at 180–218 (addressing ecosystem management), 219–60 (addressing climate change law and policy).

of disgust and impurity, (2) source effects, and (3) role-relative risk perception.

A. Pollution, Purity & Disgust

The world is full of substances and phenomena that pose some risks of some kinds in some situations.[42] To choose among these risks requires the ranking of some sources of danger or impurity as worse than others.[43] One man's cologne is another man's stench; one woman's pristine, sanitized swimming pool is another woman's chlorinated hellhole. For decades, the smell of chocolate wafted over Chicago, becoming one of the distinct and delightful characteristics of downtown—that is, until an anonymous complaint to the EPA forced the chocolate factory that produced it to eliminate the odor, to the dismay of almost everyone else.[44] In this sense, the choice to categorize any substance as "pollution" is a choice, whether conscious or not.

What gets perceived as dangerous or impure enough to constitute "pollution"?[45] One way of answering this question stems from a sister social science, anthropology. Anthropologists have characterized responses to pollution as a recoiling from the unclean.[46] What counts as "polluted" or "unclean" is informed not only by individual perception, but also by underlying normative values. It is thus socially constructed.[47] Indeed, in their influential work *Risk and Culture: An Essay on the Selection of Technical and Environmental Dangers*, anthropologist Mary Douglas and political

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42. *See generally* JOHN D. GRAHAM & JONATHAN BAERT WIENER, RISK VS. RISK: TRADEOFFS IN PROTECTING HEALTH AND THE ENVIRONMENT (1997) (proposing a framework for "risk tradeoff analysis" that decisionmakers can apply to address various risk problems—including risks presented in diverse fields of medicine, food, transportation, energy, and environmental protection).

43. *See P*aul Slovic, *The Perception of Risk*, *in* THE PERCEPTION OF RISK (2000) (presenting a "psychometric" paradigm to explain people's differing reactions to different types of risk, including pollution risk); *see also* Kraus, Malmfors & Slovic, *supra* note 27, at 285–315 (describing a study exploring the discrepancies between expert and lay views of chemical risks).

44. Maggie Sieger, Chicago's Chocolate War, TIME, Feb. 14, 2006, http://content.time.com/time/nation/article/0,8599,1159401,00.html [https://perma.cc/83S4-UB47].

45. *See* Rowell, *supra* note 25, at 989–95 (providing an early version of this argument).

46. *Id.* at 990; *see* MARY DOUGLAS, PURITY AND DANGER: AN ANALYSIS OF CONCEPTS OF POLLUTION AND TABOO 9 (1966). *See generally* MARY DOUGLAS & AARON WILDAVSKY, RISK AND CULTURE: AN ESSAY ON THE SELECTION OF TECHNOLOGICAL AND ENVIRONMENTAL DANGERS (1982).

47. Rowell, *supra* note 25, at 990–91; Nagle, *supra* note 20, at 31–33; *see generally* DOUGLAS & WILDAVSKY, *supra* note 46.

scientist Aaron Wildavsky argued that pollution is perceived as "risky" because it is embedded with highly tailored individual conceptions of things that are dangerous, unclean, or impure.[48] Supporting their theory, substantial empirical work has now established that individuals who hold different social values actually have different beliefs about riskiness.[49] For example, individuals with more egalitarian and solidaristic values perceive global warming, nuclear power, and environmental pollution as riskier than do individuals with individualistic or hierarchical values.[50]

Importantly, the specific substances and phenomena that people think of as "polluting" vary significantly across culture and worldviews, as well as through history.[51] Early Americans, for example, worried much more about spiritual and cultural pollution than environmental pollution,[52] whereas modern Americans think about pollution as "the introduction of harmful substances or products into the environment."[53] But while what counts as unclean or polluted can vary,[54] the psychology of the response to perceived uncleanliness appears to be generalizable.

In psychological terms, once something is identified as polluted, the response to it becomes affective: sudden and emotionally laden.[55] Such responses are automatic and can be quite powerful, and they can even cause measurable physical reactions.[56] Feelings of disgust are an obvious example. In one famous experiment by Rozin et al.,[57] experimenters offered participants a free glass of fruit juice. Before getting the glass, however,

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48. *See* Dan M. Kahan & Donald Braman, *Cultural Cognition and Public Policy*, 24 YALE L. & POL'Y REV. 149, 151–52 (2006); *see generally* DOUGLAS & WILDAVSKY, *supra* note 46.

49. *Id.* at 150; see *generally* Dan M. Kahan et al., *Culture and Identity-Protective Cognition: Explaining the White-Male Effect in Risk Perception*, 4 J. EMPIRICAL LEGAL STUD. 465 (2007).

50. *See* Kahan & Braman, *supra* note 48, at 154. *See generally* Kahan et al., *supra* note 49.

51. *See* John Copeland Nagle, *The Idea of Pollution*, 43 U.C. DAVIS L. REV. 1 (2009). *See generally* DOUGLAS, *supra* note 46.

52. Nagle, *supra* note 51, at 7–16; *see* Adam W. Rome, *Coming to Terms with Pollution: The Language of Environmental Reform, 1865-1915*, 1 ENV'T HIST. 6 (1996).

53. RANDOM HOUSE REFERENCE, RANDOM HOUSE WEBSTER'S UNABRIDGED DICTIONARY 1498 (2d ed. 2001); Rowell, *supra* note 25, at 991.

54. Nagle, *supra* note 51, at 28–29.

55. Paul Slovic et al., *The Affect Heuristic*, 177 EUR. J. OPERATIONAL RSCH. 1333, 1334 (2007).

56. Paul Rozin, Jonathan Haidt & Clark McCauley, *Disgust*, *in* HANDBOOK OF EMOTIONS 815, 816–17 (Lisa Feldman Barrett, Michael Lewis & Jeannette M. Haviland-Jones eds., 4th ed. 2016).

57. Rozin, Haidt & McCauley, *supra* note 56, at 818. *See generally* Paul Rozin, Linda Millman & Carol Nemeroff, *Operation of the Laws of Sympathetic Magic in Disgust and Other Domains*, 50 J. PERSONALITY & SOC. PSYCH. 703 (1986).

participants watched experimenters dip a carefully sterilized cockroach into the juice. Participants not only were uninterested in drinking the juice; some were so disgusted that they reported feelings of nausea. Indeed, we might reasonably speculate that many of them felt little desire for a glass of juice for some time afterward.[58]

Importantly for pollution control policy, disgust characteristically creates a distinctive "all-or-nothing" affective response. Something is either repulsive or it is not, and a glass of juice might well strike most people as just as disgusting if one-quarter of a sterilized cockroach were dipped into it as if the whole bug were submerged. In the context of toxic substances, this same all-or-nothing response means that most people care far more about whether they have been exposed to pollution at all than about the amount of any exposure.[59]

It is in part because of these psychological phenomena that laypeople and experts think very differently about pollution risks.[60] Laypeople tend to act like "intuitive toxicologists" when presented with dangerous substances. In comparison with professional toxicologists, laypeople are more likely to think that "[t]he fact of exposure to a pesticide is the critical concern, rather than the amount of exposure".[61] Toxicology is based on the idea that "the dose makes the poison," and much of what toxicologists do is to develop sophisticated techniques to explore the complex relationships between amount of a substance and the harm that exposure to it might cause.[62] The same dose-response-based reasoning suggests that—counterintuitively-- it might sometimes cause less harm overall to spread pollution over more people or time.[63] Yet the intuitive response of recoil from pollution makes

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58. *See* Andrea C. Morales & Gavan J. Fitzsimons, *Product Contagion: Changing Consumer Evaluations Through Physical Contact with "Disgusting" Products*, 44 J. MKTG. RSCH. 272, 272–83 (2007) (finding that a feeling of disgust is easily transferred to items associated with the object of disgust).

59. Kraus, Malmfors & Slovic, *supra* note 27, at 310–11; *see also* Sunstein, *supra* note 25, at 2261–63 (discussing gaps in expert/lay toxicology).

60. Kraus, Malmfors & Slovic, *supra* note 27, at 289–96, 309 (describing and comparing laypeople's and toxicologists' approach to toxic substances, and describing laypeople as "intuitive toxicologists"); SUNSTEIN, *supra* note 25, at 53–78I; s*ee generally* Cass Sunstein, *Misfearing: A Reply*, 119 HARV. L. REV. 1110 (2006); Nancy Kraus, Torbjörn Malmfors & Paul Slovic, *Intuitive Toxicology: Expert and Lay Judgments of Chemical Risks*, *in* THE PERCEPTION OF RISK 285, 290–91 (Paul Slovic ed., 2000)

61. *See* Kraus, Malmfors & Slovic, *supra* note 27, at 291 (comparing lay and public perceptions of risk); *see also* Sunstein, *supra* note 25, at 2261–63; SUNSTEIN, *supra* note 25, at 28–52.

62. Michael A. Gallo, *History and Scope of Toxicology*, *in* CASARETT & DOULL'S TOXICOLOGY: THE BASIC SCIENCE OF POISONS 1, 9 (Curtis D. Klaasen ed., 8th ed. 2013).

63. *See generally* Rowell, *supra* note 25, at 1107–11.

this approach politically challenging. In this sense, the psychology of pollution can work against effective environmental policy.

The divide between laypeople and experts can also create other significant challenges. Regulators must decide how much of a dangerous substance will be tolerated, and to do so they often rely both on quantitative risk analysis (which looks very carefully at the relationship between exposure level and harm) and on cost-benefit analysis.[64] The regulation of arsenic in drinking water is a good example of how this can play out. When the EPA considered relaxing regulations on arsenic in drinking water, the decision was met with significant public controversy, with many members of the public concerned by the existence of any quantity of the infamous poison in their drinking water.[65] Or consider a more colorful example, where the city of Portland, Oregon, decided to drain 38 million gallons of clean drinking water from its reservoir after a teenager was caught on video urinating into it.[66] In defending their actions, the Water Bureau spokesman stated, "Our customers don't anticipate drinking water that's been contaminated by some yahoo who decided to pee into a reservoir."[67]

B. Source Effects

Another important aspect of the psychology of pollution relates to how the perceived risks of pollution vary according to the source of that pollution, a phenomenon known as the "source effect."[68]

Generally, people are less disgusted by sources they view as familiar.[69] Mothers, for example, regard their own baby's fecal smell as less disgusting than that of someone else's baby,[70] and people are less disgusted by odors and emanations from their parents, partners, friends, and acquaintances than

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64. *See* CASS R. SUNSTEIN, THE COST-BENEFIT STATE: THE FUTURE OF REGULATORY PROTECTION (ABA 2002); SUNSTEIN, *supra* note 25, at 2263; Rowell, *supra* note 34, at 1548-1557 (discussing the role of quantitative valuations in environmental law, in cost-benefit analysis and beyond)

65. Sunstein, *supra* note 25, at 2261–62; s*ee generally* SUNSTEIN, *supra* note 25.

66. Noah Rayman, *Portland Dumps 38 Million Gallons of Water After Man Pees in Reservoir*, TIME (Apr. 17, 2014, 09:43 AM), https://time.com/66459/portland-reservoir-pee/ [https://perma.cc/68H6-CWPP].

67. *Id.*

68. Val Curtis, Robert Aunger & Tamer Rabie, *Evidence that Disgust Evolved To Protect from Risk of Disease*, 271 (Supp. 4) PROC. BIO. SCI. S131, S132 (2004).

69. Min Peng et al., *Physiological and Behavioral Responses to Strangers Compared to Friends as a Source of Disgust*, 34 EVOLUTION & HUM. BEHAV. 94, 97 (2013).

70. Trevor I. Case et al., *My Baby Doesn't Smell as Bad as Yours: The Plasticity of Disgust*, 275 EVOLUTION & HUM. BEHAV. 357, 360 (2006).

from those of strangers.[71] People also find their own pollution (such as bodily malodors) less disgusting than that of strangers.[72] Some researchers have suggested these adaptations are evolutionarily valuable as a behavioral response to potential disease, which is more likely to be dangerous when carried by strangers who may carry microbes to which the immune system has not yet had a chance to develop resistance.[73]

Another instantiation of the source effect is the perceived distinction between risks perceived as "natural" and those perceived as artificial.[74] We've already mentioned that modern Americans typically perceive manmade risks as more dangerous.[75] They also perceive "natural" disasters as less damaging than identical "manmade" disasters.[76] As a result, they are more likely to categorize a substance as "pollution" when it has some connection to human behavior or when humans are perceived to be the source.[77] Consider again the example of the Portland reservoir. The city of Portland chose to drain its reservoir after a single person was caught urinating in it—but no similar actions are considered or undertaken in response to bird and animal urine, though both substances are likely similarly biologically sterile, and the quantities of animal urine in any given reservoir are presumably much larger.[78] Or consider that the same Water Bureau that drained the reservoir because of human urine does not drain it when (as often happens) dead animals— rodents, birds, fish, etcetera—are found floating in it, despite the fact that such carcasses are undoubtedly *not* biologically sterile.[79] As one official explained, "We look at that as part of the business of

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71. *Cf.* Tatiana Bužeková & Monika Išová, *Disgust and Intimacy*, 20 HUM. AFF. 232, 238 (2010) (describing how people are less disgusted by odors and emanations from their parents, partners, friends, and acquaintances than from strangers); Peng et al., *supra* note 69, at 97.

72. Richard J. Stevenson & Betty M. Repacholi, *Does the Source of an Interpersonal Odour Affect Disgust? A Disease Risk Model and Its Alternatives*, 35 EUR. J. SOC. PSYCH. 375, 380 (2005).

73. Carlos D. Navarette & Daniel M.T. Fessler, *Disease Avoidance and Ethnocentrism: The Effects of Disease Vulnerability and Disgust Sensitivity on Intergroup Attitudes*, 27 EVOLUTION & HUM. BEHAV. 270, 279 (2006); Peng et al., *supra* note 69, at 97.

74. Nagle, *supra* note 20, at 6; THORSHEIM, *supra* note 40.

75. DOUGLAS & WILDAVSKY, *supra* note 46, at 32.

76. Siegrist & Sutterlin, *supra* note 40.

77. JAMES P. COLLMAN, NATURALLY DANGEROUS: SURPRISING FACTS ABOUT FOOD, HEALTH AND THE ENVIRONMENT 1 (2001).

78. Brad Schmidt, *Portland Reservoir Urination Raises Few Health or Scientific Concerns – But It Is Pee*, OREGONIAN (June §16, 2011), https://www.oregonlive.com/portland/2011/06/portland_reservoir_urination_r.html [https://perma.cc/BZP8-VLMP].

79. *Id.*

open reservoirs."[80] This tolerance of pollution risks perceived as natural—and hyper-vigilance towards human-made risks—affects pollution policy in concrete ways.

C. Positional Judgments of Pollution Risk

Individuals can be polluters (who themselves create or spread pollution) and/or pollutees (who are affected by their own or others' pollution). In each of these roles, common psychological phenomena may combine to lead people to cognitively minimize the externalities of pollution.

1. Polluter Psychology and the Case of the "Sincere Polluter"

Polluters may exhibit distinctive psychological responses related to both their role in generating harm and to the particularly diffuse kind of harm that most pollution creates. These responses may happen both to individuals engaging in industrial-level pollution as well as to the casual picnicker who opts to leave her trash in the park rather than carry it out for disposal.

One such psychological response has to do with the consequences of creating externalities. Polluters may experience cognitive dissonance at the thought that they are harming other people, and they may therefore diminish that unpleasant sensation by mentally underestimating the total harm that their pollution causes—a tendency sometimes called the egocentric bias.[81] Sometimes, even when they accept they are inflicting harm, they engage in self-serving justifications that minimize and excuse their behavior.[82] Although not yet well studied in pollution contexts, this reaction would fall comfortably within the more general realm of "cognitive distortion," in which people avoid conscious confrontation with the negative impacts of their own behavior on others by cognitively minimizing them.[83] Such distortions have been associated with a higher likelihood of actively engaging in behavior that

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80. *Id.*

81. *See* Lisa L. Shu et al., *Dishonest Deed, Clear Conscience: When Cheating Leads to Moral Disengagement and Motivated Forgetting*, 37 PERSONALITY & SOC. PSYCH. BULL. 330 (2011).

82. Shaul Shalvi et al.*, Self-Serving Justifications: Doing Wrong and Feeling Moral*, 24 CURRENT DIRECTIONS PSYCH. SCI. 125, 128 (2015); Albert Bandura, *Selective Moral Disengagement in the Exercise of Moral Agency*, 31 J. MORAL EDUC. 101, 110 (2010).

83. DAVID D. BURNS, THE FEELING GOOD HANDBOOK: USING THE NEW MOOD THERAPY IN EVERYDAY LIFE 452 (1989); Bandura, *supra* note 82, at 110; Petra Helmond et al., *A Meta-Analysis on Cognitive Distortions and Externalizing Problem Behavior*, 42 CRIM. JUST. & BEHAV. 245 (2015).

harms others.[84] One study, for instance, demonstrated that in a simulated overfishing context, people do engage in self-serving biases—and indeed, the more egocentric they were, the more they overfished.[85] Since we can only speculate whether these findings would apply to polluters choosing to pollute, further research on the extent to which this effect operates in applied contexts—and how it might be interrupted—would be valuable.

Another disturbing possibility of the egocentric bias concerns how pollution harms are allocated. Law offers a number of potential methods for allocating pollution,[86] which can be used to reduce its harm. For example, where there are nonlinearities in pollution's impacts, we could "bunch" pollutants that cause high damage in low doses to minimize the total amount of harm done[87]. But allocation techniques can also be used to cause extra harm or to distribute harm in ways that are targeted or inequitable. Individuals who pollute might seek out justifications for the harm that they do by targeting individuals or groups whom they perceive as undeserving or as "other," and offload pollution harms onto them. Such allocation decisions could of course be affected by stereotyping, prejudice, and discrimination.[88] And indeed, environmental justice research shows that environmental risks, such as those created by locally undesirable land uses that result in pollution like landfills and incinerators, tend to be disproportionately allocated in a way that harms minorities and communities of color.[89]

D. The Psychology of Pollutees

Individuals who are affected by the polluting behaviors of themselves or others—"pollutees"—may exhibit some distinctive psychological phenomena of their own. First, people who are potentially impacted by pollution may experience cognitive load and anxiety at the thought of having

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84. Helmond et al., *supra* note 83.

85. Kimberly A. Wade-Benzoni et al., *Egocentric Interpretations of Fairness in Asymmetric, Environmental and Social Dilemmas: Explaining Harvesting Behavior and the Role of Communication*, 67 ORG. BEHAV. & HUM. DECISION PROCESSES 111, 111–12 (1996).

86. *See generally* Rowell, *supra* note 25.

87. *Id.* at 1010.

88. *See generally* Susan T. Fiske, *Stereotyping, Prejudice, and Discrimination at the Seam Between the Centuries: Evolution, Culture, Mind, and Brain*, 30 EUR. J. SOC. PSYCH. 299 (2000); TODD D. NELSON, HANDBOOK OF PREJUDICE, STEREOTYPING, AND DISCRIMINATION (2009).

89. ROBERT D. BULLARD, THE QUEST FOR ENVIRONMENTAL JUSTICE: HUMAN RIGHTS AND THE POLITICS OF POLLUTION 256 (2005); DAVID SCHLOSBERG, DEFINING ENVIRONMENTAL JUSTICE: THEORIES, MOVEMENTS, AND NATURE 47 (2009); Dorceta E. Taylor, *The Rise of the Environmental Justice Paradigm: Injustice Framing and the Social Construction of Environmental Discourses*, 43 AM. BEHAV. SCI. 508, 523 (2000).

been exposed to pollution.[90] This anxiety can be significant enough to generate harm in its own right.[91] Indeed, an Estonian study of 1,000 adults found that, for at least some pollutants, the belief that an exposure level was hazardous was more predictive of psychic harm than the exposure itself was.[92] To manage this stress, people may be tempted to conform their perceptions to match their preferences—meaning they might underplay the importance of real pollutants to which they might be exposed, and (fail to) act accordingly.

Another aspect of pollutee psychology may arise out of the cognitive link between familiarity and risk perception.[93] Studies have shown that people tend to perceive familiar risks as less dangerous or risky than unfamiliar ones.[94] This may help to explain how individuals sometimes tolerate living in highly polluted areas even when alternatives are available to them. As evidence at least consistent with this possibility, note that studies show a weak or even negative relationship between living close to a refinery and self-reported health symptoms over time,[95] and that students chronically exposed to smog are more likely to deny or ignore its existence compared to newcomers to the pollution.[96]

Finally, individuals' responses to polluted conditions may sometimes be informed by the phenomenon of "learned helplessness," whereby repeated exposure to a negative circumstance that a person feels like they cannot manage makes them feel increasingly out of control and therefore immobilized from correcting it.[97] Tragically and characteristically, people experiencing learned helplessness don't always regain their feeling of agency even when control is restored to them.[98] Such feelings of helplessness in the face of pollution may interfere with individuals' ability to act to address it even after control becomes possible. This possibility is particularly disturbing in environmental justice contexts: people in poor communities and

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90. Kati Orru et al., *The Role of Perceived Air Pollution and Health Risk Perception in Health Systems and Disease: A Population-Based Study Combined with Modelled Levels of PM10*, 91 INT'L ARCHIVES OCCUPATIONAL & ENV'T HEALTH 581, 582–87 (2018).

91. *Id.*

92. *Id.* at 582.

93. Slovic et al., *supra* note 55, at 1336.

94. *See* Slovic, *supra* note 43, at 94.

95. Isaac N. Luginaah et al., *A Longitudinal Study of the Community Health Impacts of a Refinery*, 50 SOC. SCI. & MED. 1155, 1165 (2002).

96. Gary W. Evans et al., *Psychological Reactions to Air Pollution*, 45 ENV'T RSCH. 1, 2 (1988).

97. *See, e.g.*, Steven F. Maier & Martin E. Seligman, *Learned Helplessness: Theory and Evidence*, 105 J. EXPERIMENTAL PSYCH. 3 (1976).

98. *Id.*

communities of color who accurately perceive that they have been subjected to additional pollution risks relative to their whiter or richer fellow citizens may be particularly at risk for developing feelings of immobilization and lack of control, making them less able to fight legitimate inequities. And again, such feelings could persist even after opportunities arise that would allow them to remedy the underlying inequity.

III. LEGAL AND POLICY PAYOFFS

Above we have pointed to a series of psychological phenomena that can affect how people perceive, understand, and value the harms of pollution. This Part argues that being informed by a psychological approach offers concrete legal and policy payoffs for at least three stages of pollution control. First, it often offers guidance at the identification stage, in deciding when and how to categorize a substance as dangerous or impure enough to count as a pollutant. Second, it may help in determining how much, if any, of the pollutant can be tolerated. And third, it may help in instrument choice, when policymakers must select some mechanism or tool (whether social, legal, or personal) to resolve the part of the pollution that they have decided is intolerable. Because each of these regulatory stages requires cognitive selection and processing, we believe psychology plays a critical, and sometimes even determinative, role throughout.

A. What Counts as a "Pollutant"?

The categorization of a substance as a pollutant is subject to psychological phenomena that inform what people think of as polluting. In many cases, this is a function of social or personal norms, such as the belief that "manmade" pollutants are dangerous or impure, whereas "natural" pollutants are not. Other times it is because one pollutant is salient, while other (even similar!) pollutants are not.

In legal contexts, the categorization of a substance as a pollutant is typically the legal trigger for action. Prior to that categorization, however, not only may the substance not be controlled, it may even be promoted through legal and policy means. Consider that when the powerful insecticide DDT was first developed, it was hailed as a miracle rather than a pollutant.[99]

99. *See, e.g.*, Vincent Landon, *DDT: From Miracle Chemical to Banned Pollutant*, SWI (May 6, 2003), https://www.swissinfo.ch/eng/ddt--from-miracle-chemical-to-banned-pollutant/3253684 [https://perma.cc/5M3E-Z66L].

Proponents—including many governments—celebrated it as an extraordinary protection against deadly insect-borne diseases like malaria and typhus, as well as a convenient boost to food production by efficiently killing crop pests.[100] As a result, early deployment of DDT was broad and largely indiscriminate. It was used liberally in crop and livestock production; in vast aerial sprays over American towns, forests, and farmlands; and in institutions, gardens, homes—as if it were not a pollutant at all.[101]

It was not until Rachel Carson's influential account of these impacts—in her poetic and evocative *Silent Spring*[102]—that most people developed the conception of environmentally persistent toxic substances like DDT as pollutants at all. The United States banned DDT in 1972 partly in response to Carson's book.[103] Gradually, many other countries around the world followed suit, and in 2001, more than 100 countries signed the Stockholm Convention on Persistent Organic Pollutants (POPs), committing to eliminate the use of 12 of the POPs of greatest concern to the global community, including DDT.[104]

Perhaps unsurprisingly, modern American toxics statutes—including the Toxic Substances Control Act of 1976; Federal Insecticide, Fungicide, and Rodenticide Act of 1972; and Emergency Planning and Community Right-to-Know Act of 1986—postdate the reconceptualization of POPs spurred by Carson's book. Until such substances were perceived as dangerous, there was no need to seek control of them as pollutants (though early regulations did regulate other risks, such as from misbranding).

Clearly, whether a substance is perceived as a pollutant or a miracle worker will affect how it is regulated, and the categorization of a substance as a pollutant is a critical trigger for legal action to control it. But as we emphasize and discuss further below, how regulators decide what counts as a pollutant will often be subject to psychological phenomena. As a result, psychology has an important role to play in determining when, why, and how pollution control addresses substances as pollutants.

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100. *Id.*

101. *Id.*

102. RACHEL CARSON, SILENT SPRING (1962).

103. EPA, EPA–540/1–75–022, DDT, A REVIEW OF SCIENTIFIC AND ECONOMIC ASPECTS OF THE DECISION TO BAN ITS USE AS A PESTICIDE (1975), https://archive.epa.gov/epa/aboutepa/ddt-regulatory-history-brief-survey-1975.html [https://perma.cc/SWW5-W5RX].

104. *See generally* Peter L. Lallas, *The Stockholm Convention on Persistent Organic Pollutants*, 95 AM. J. INT'L L. 692 (2001).

1. "Natural" and "Unnatural" Pollution

First, let us once again reconsider the psychological tendency to regard "natural" substances and sources to be safer and less polluting than artificial or "manmade" substances and sources. This tendency generates challenges for regulators, not least because many substances perceived as pollution when emitted by humans are in fact also naturally occurring in some quantity. Indeed, a brief browse through the periodic table will reveal a number of "natural" but toxic substances, including lead, arsenic, and mercury. Soil, for example, commonly contains detectable quantities of both lead and arsenic, which are released into the air by several natural occurrences, including forest fires.[105] In fact, the American West, which is very prone to forest fires, has particularly rich deposits of naturally occurring mercury, arsenic,[106] and lead .[107]

Consider also that radiation occurs naturally in soil, water, air, and vegetation, and humans are routinely exposed to measurable levels of cosmic radiation from space. As the United Nations has explained, "The exposure of human beings to ionizing radiation from natural sources is a continuing and inescapable feature of life on the earth."[108] The worldwide average natural dose of radiation is about 2.4 mSv per year, about four times the average dose from artificial sources (0.6 mSv/year). That said, average natural background exposure varies across the globe. The city of Ramsar in Iran, for example, has unusually, but naturally, high levels of radiation—as high as 260 mSv/year, or enough to increase chromosomal abnormalities of inhabitants by more than 50%.[109]

Yet conceptions persist that pollution necessarily results (only) from artificial or manmade sources. This belief is reflected in several influential environmental statutes. The Clean Water Act, for instance, defines pollution as the "man-made or man-induced alteration of the chemical, physical,

105. *Learn about Lead*, EPA (Apr. 25, 2022), https://www.epa.gov/lead/learn-about-lead [https://perma.cc/6Y8A-SBRC]; Communications and Publishing, *Widespread Mercury Contamination Across Western North America*, USGS (Sept. 14, 2016), https://www.usgs.gov/news/featured-story/comprehensive-study-finds-widespread-mercury-contamination-across-western-north [https://perma.cc/J27R-GXZP]; *USGS Background Soil-Lead Survey: State Data*, EPA (Apr. 8, 2022), https://www.epa.gov/superfund/usgs-background-soil-lead-survey-state-data [https://perma.cc/25Y8-YMG9].

106. *Widespread Mercury Contamination Across Western North America*, *supra* note 105.

107. *Learn about Lead*, *supra* note 105 (reporting natural levels of lead in U.S. soil range between 50 and 400 parts per million).

108. U.N. Sci. Comm. on the Effects of Atomic Radiation, Sources and Effects of Ionizing Radiation, at 223, U.N. Doc A/63/46 (2008).

109. M. Ghiassi-nejad et al., *Very High Background Radiation Areas of Ramsar, Iran: Preliminary Biological Studies*, 82 HEALTH PHYSICS 87, 87 (2002).

biological, and radiological integrity of water"[110]—a definition entirely dependent upon comparing the impacts of human activity with some presumptive prehuman baseline.[111]

The perception that "natural," versus artificial, substances are less polluting, or less unclean, has the potential to be quite dangerous. As an example, consider the now perennial problem of widespread wildfires in the American West. In many cases, these wildfires leave huge swaths of the West Coast's population centers blanketed in highly polluted air—in recent years, with higher levels of air pollution even than notoriously polluted cities like Beijing.[112] The high level of fine particulate matter exposure in these incidents is extraordinarily dangerous, particularly (though not exclusively) for people with preexisting breathing issues and for the elderly.[113] In fact, recent estimates suggest that about 33,000 people globally now die each year from air pollution from wildfires.[114] If current climate changes continue, further exacerbating wildfire seasons,[115] U.S. deaths from fire-related air pollution could double by the end of the century.[116] Yet individual and policy response to wildfire risks may be muted insofar as wildfires seem "natural" and therefore less risky. This tendency may only be exacerbated by still another psychological phenomenon—the belief that omissions are somehow less bad or harmful than commissions.[117] And there is evidence of exactly this kind of perverting effect on policy: the emissions from "natural" wildfires have long been exempt from the calculus of whether a state is meeting its obligations under the National Ambient Air Quality Standards in

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110. 33 U.S.C. § 1362(19).

111. Nagle, *supra* note 51, at 46.

112. *Cf.* Amy McKeever, Ryan Morris & Brian T. Jacobs, *The West Coast Had the World's Most Polluted Cities in September*, NAT'L GEOGRAPHGIC (Sept. 24, 2020), https://www.nationalgeographic.com/science/article/west-coast-had-worlds-most-polluted-cities-this-month#:~:text=The%20pollution%20from%20the%20wildfires,high%20levels%20of%20particulate%20pollution [https://perma.cc/L5BU-T5UA].

113. *See Particle Pollution*, AM. LUNG ASS'N (Apr. 20, 2020), https://www.lung.org/clean-air/outdoors/what-makes-air-unhealthy/particle-pollution [https://perma.cc/6DJY-MREA] (providing an overview of recent research on the health impacts of particle pollution).

114. *See* Gongbo Chen et al., *Mortality Risk Attributable to Wildfire-Related $PM_{2.5}$ Pollution: A Global Time Series Study in 749 Locations*, 5 LANCET PLANET HEALTH e579, e583 (2021).

115. *See generally* Rongbin Xu et al., *Wildfires, Global Climate Change, and Human Health*, 383 NEW ENG. J. MED. 2173 (2020) (providing an overview of the interactions between wildfires, climate change, and human health).

116. B. Ford et al., *Future Fire Impacts on Smoke Concentrations, Visibility and Health in the Contiguous United States*, 2 GEOHEALTH 229 (2018); *see id.*

117. *See Why Don't We Pull the Trolley Lever?*, THE DECISION LAB, https://thedecisionlab.com/biases/omission-bias [https://perma.cc/5UZP-VZ2M].

the Clean Air Act, while those from controlled ("unnatural") burns are counted toward pollution-control standards.[118]

2. Salience and Valence: Woodsmoke Candles and "Pollutants of the Month"

Another factor to consider in the psychology of pollutant categorization is the role of salience and availability. Many types of pollutants lack cognitive salience, as we discussed, in part because of the diffuse character of their distribution and harm, and in part because their relationship to causing injury can be complex—multicausal, interactive, and nonlinear. Consider the example of wood fire from the previous section: burning wood indoors or out generates fine particulate matter, which the EPA regulates as a criteria pollutant under the Clean Air Act because of its danger to human health, and which the World Health Organization estimates kills—in conjunction with a variety of other toxic pollutants—7 million people a year.[119] The harm from fine particle exposures is likely cumulative over time.[120] Moreover, the dose-response rate to each of the substances emitted may be nonlinear, or even interactive, and thus complicated to understand, and harms from exposure are likely to be latent for people without acute respiratory diseases.[121]

Yet the complexity of identifying the dangers of woodsmoke, combined in no small part with the emotional association people may have with its scent (cue happy memories of campfires and being in the outdoors, and the cozy feeling of snuggling up next to a warm fireplace), means that many or even most people may struggle to identify it as a deadly pollutant.[122] Indeed,

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118. *See generally* Kirsten Engel & Andrew Reeves, *When "Smoke Isn't Smoke": Missteps in Air Quality Regulation of Wildfire Smoke*, *in* WILDFIRE POLICY: LAW AND ECONOMICS PERSPECTIVES 127 (Karen M. Bradshaw & Dean Lueck eds., 2012); Kirsten H. Engel, *Perverse Incentives: The Case of Wildfire Smoke Regulation*, 40 ECOLOGY L.Q. 623 (2013); Courtney A. Shultz, Sarah M. McCaffrey & Heidi R. Huber-Stearns, *Policy Barriers and Opportunities for Prescribed Fire Application in the Western United States*, 28 INT'L J. WILDLAND FIRE 874 (2019).

119. *Air Pollution*, WORLD HEALTH ORG., https://www.who.int/thailand/health-topics/air-pollution#tab=tab_1 [https://perma.cc/2P6U-C2Q5].

120. C. Arden Pope III & Douglas W. Dockery, *Health Effects of Fine Particulate Air Pollution: Lines that Connect*, 56 J. AIR & WASTE MGMT. ASS'N, 709, 718 (2006).

121. *Id.* at 722–32.

122. *See, e.g.*, *How Smoke from Fires Can Affect Your Health*, EPA (Nov. 16, 2021), https://www.epa.gov/pm-pollution/how-smoke-fires-can-affect-your-health [https://perma.cc/YWW4-Q8NC] (recognizing that "[s]moke may smell good, but it's not good for you").

"woodsmoke" is a popular candle scent.[123] As a result, people may be less likely to take any self-protective actions against it that they might readily take in response to more recognizable pollutants. Still less are they likely to demand regulatory action to diminish the risks more generally.

While psychological processes may obscure some types of pollution, other risks—particularly novel risks, or ones made salient by extended media—sometimes gain hypersalience. Such occurrences can cause what Timur Kuran and Cass Sunstein have called "availability cascades": self-reinforcing processes of collective belief formation, in which an expressed perception triggers a chain reaction that gives the public the perception of increasing plausibility through rising availability in public discourse.[124] This can result in, among other things, what Kuran and Sunstein have called the "pollutant of the month" syndrome, where "expressed concerns about a particular substance fuel growing anxieties, which then generate an irresistible demand for regulation. These anxieties remain in the headlines until they are bumped off by a new perceived hazard."[125]

A well-known example of this type of over-salience—and overzealous regulatory response—is the extraordinary public concern regarding Alar, a pesticide long used on apples, after an alarmist 60 Minutes episode and a dubious report about its carcinogenicity by the Natural Resources Defense Council.[126] Another example is the extreme public concern about hazardous waste sites after the broad coverage of the discovery of toxic waste under the Love Canal community, despite experts suggesting that "hazardous waste sites pose an almost negligible risk to human health when compared with the many more fundamental risks we face."[127]

Even when there are legitimate environmental and health concerns attached to a pollutant, availability cascades may help to explain why "all of a sudden" there is attention to long-neglected pollutants—often even as similar pollutants continue to slide under the public's radar. This may explain the quick social shift following Rachel Carson's *Silent Spring* from categorizing DDT as a cure-all to categorizing it as a dangerous pollutant. A

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123. *See* Hillary Kelly, *No Fireplace? These Are the 5 Best Candles that Smell Like Woodsmoke*, WASHINGTONIAN (Nov. 2, 2015), https://www.washingtonian.com/2015/11/02/the-5-best-smoky-woodsy-candles-if-you-dont-have-a-fireplace/ [https://perma.cc/7ELY-L6ZS].

124. Timur Kuran & Cass R. Sunstein, *Availability Cascades and Risk Regulation*, 51 STAN. L. REV. 683 (1999).

125. *Id.* at 698; *see generally* AARON WILDAVSKY, BUT IS IT TRUE?: A CITIZEN'S GUIDE TO ENVIRONMENTAL HEALTH AND SAFETY ISSUES (1995).

126. Daniel E. Koshland, Jr., *Credibility in Science and the Press*, 254 SCI. 629 (1991); Kuran & Sunstein, *supra* note 124, at 698–701.

127. W. KIP VISCUSI, RATIONAL RISK POLICY: THE 1996 ARNE RYDE MEMORIAL LECTURES 23 (1996); Kuran & Sunstein, *supra* note 124, at 697.

more recent example is the explosion of attention paid to the inclusion of bisphenol A (BPA) in plastics. BPA, invented over 130 years ago, has a number of useful manufacturing qualities, and it has been used in very large quantities around the world for many decades.[128] In the mid-2000s, however, concern over BPA's health impacts exploded, and the National Toxicology Program issued a report concluding that there was "some concern for effects on the brain, behavior, and prostate gland in fetuses, infants, and children at current human exposures."[129] Countries, states, and eventually the U.S. federal government responded with a series of laws meant to curtail BPA exposure.[130] These actions, and the simultaneous media coverage, have led to the now highly familiar—and availability-reinforcing—labels commonly seen on plastics indicating they are "BPA free." They have also been credited with the ban on BPA in baby bottles in the United States, Canada, and the EU.[131]

While the increasing cognitive availability of BPA risk may have led to more protective environmental regulation in this instance, it is worth noting that the selective attention generated by availability cascades may struggle particularly in addressing the problem of substitutes—which may be as dangerous (if not more so) than the original item. Their danger may be neglected because they lack any availability cascade of their own. In the context of manufacturing plastics, the attention and concern about the potential toxicity of BPA to humans, for example, led many manufacturers to switch from bisphenol A to other bisphenols—bisphenol F (BPF) and bisphenol S (BPS) in particular.[132] Little to no public attention has attached to these substitutes. Though exposure to them is ubiquitous, very little is known about their health and environmental impacts, and they share many

128. Sarah A. Vogel, *The Politics of Plastics: The Making and Unmaking of Bisphenol A "Safety"*, 99 AM. J. PUB. HEALTH S559, S559 (2009).

129. *See* Nat'l Toxicology Program, *NTP-CERHR Monograph on the Potential Human Reproductive and Developmental Effects of Bisphenol A*, NAT'L INSTS. HEALTH 1, 38 (2008).

130. *See* Vogel, *supra* note 128.

131. *See* Food and Drug Admin., *Indirect Food Additives: Polymers*, 77 Fed. Reg. 41899 (2012) (banning BPA-based polycarbonate resins in baby bottles and sippy cups); Regulation (EU) No 10/2011 (banning BPA in baby bottles in the EU); Canada Consumer Product Safety Act, S.C. 2010, c.21, Schedule 2, § 5 p. 37(1)(c)(15) (2010) (banning BPA in baby bottles in Canada).

132. *See* Hans-Joachim Lehmler et al., *Exposure to Bisphenol A, Bisphenol F, and Bisphenol S in U.S. Adults and Children: The National Health and Nutrition Examination Survey 2013-2014*, 3 AM. CHEM. SOC'Y OMEGA 6523, 6523 (2018).

physical and chemical properties with BPA.[133] BPA, then, remains highly salient and mentally categorized as a pollutant, while substitutes for BPA, despite extraordinary chemical similarities to BPA, remain in the mental background, their possible dangers languishing in cognitive obscurity.

3. Definitions of "Pollution" and Regulatory Discretion

Perhaps because of the conceptual difficulty in developing consensus-based accounts of what should count as a pollutant, environmental statutes are sometimes characterized by extraordinarily broad definitions of "pollution," leaving the practical work of specification within the hands of environmental agencies. The Clean Air Act, for example, defines an air pollutant merely as "any air pollution agent . . . including any physical, chemical, biological, [or] radioactive . . . substance or matter which is emitted into or otherwise enters the ambient air."[134] While this type of comprehensive legislative delegation gets the trouble of defining pollution out of the hands of legislators, it passes a hot potato: agencies still have to figure out what types of substances or phenomena are dangerous or impure enough to deserve treatment as pollutants, or as in this case, "pollution agents."

In exercising their broad discretion to answer the complex question of which substances do and do not qualify as "pollution," regulators—like anyone else—are inevitably subject to the constraints of their own psychology. For example, where issues are factually complex, political appointees at the top of agency food chains may suffer from motivated reasoning,[135] and they may therefore be particularly subject to interpreting facts in ways that align with their political preferences. And whatever they decide is likely to stick. In the United States, the judicial role in second-guessing agency categorizations of what counts as a "pollutant," and under what circumstance, is limited by the broad discretion generally granted to

133. *See* Shalenie P. den Braver-Sewradj et al., *Substitution of Bisphenol A: A Review of the Carcinogenicity, Reproductive Toxicity, and Endocrine Disruption Potential of Alternative Substances*, 50 CRIT. REV. TOXIC. 128, 128 (2020) (reviewing ninety-nine known substitutes, noting that data on endocrine disruptor potential, carcinogenicity, and reproductive toxicity was "very limited or even absent" for all the selected alternatives).

134. Clean Air Act of 1963, 42 U.S.C. § 7602.

135. *See generally* Kunda, *supra* note 7 (presenting research suggesting that people's desires affect their reasoning process).

agencies interpreting statutes in their area of expertise.[136] Even where judicial review occurs, judges, too, may be influenced by motivated reasoning.[137]

As an example of how motivated reasoning could interact with both agency and judicial decision making about what counts as a pollutant, consider the landmark case of *Massachusetts v. EPA*, in which the Supreme Court considered whether the EPA had appropriately refused to categorize carbon dioxide as a "pollutant" or an "air pollution agent" under the Clean Air Act.[138] With little additional guidance from the act about what constitutes pollution, the two institutions came to different conclusions about the same pollutant.[139] The EPA, with its head appointed by a president reluctant to act on climate change, concluded that carbon dioxide was not a pollutant, while the Supreme Court concluded that carbon dioxide "fit well within the Clean Air Act's capacious definition of air 'pollutant.'"[140] Notably, it is rare for courts to second-guess agency categorizations of pollutants. One way to understand the opinion in *Massachusetts v. EPA* is that the court was correcting for a decision that had been overly influenced—consciously or not—by the EPA's politics at the time. An optimistic account of this might be that courts might create structural safeguards, not just for traditional political overreach by the other branches, but also for cognitive bias. Or a more cynical interpretation might be that the Supreme Court merely substituted its own motivated reasoning for that of the agency. Regardless, it is clear that the psychologically informed process of determining which substances qualify as pollutants can have far-reaching policy impacts.

B. When is Pollution Tolerated?

In addition to illuminating when, why, and how substances and conditions are targeted as dangerous pollutants and deemed worthy of control, psychology can also help explain pollution-control "gaps," where potential pollutants, harms from pollution, and pollutant sources are minimized or tolerated by individuals and/or by the legal structures that individuals implement.

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136. *See* Chevron USA, Inc. v. Nat. Res. Def. Council, 467 U.S. 837, 838 (1984); Massachusetts v. EPA, 549 U.S. 497, 527 (2007).

137. *See* CASS R. SUNSTEIN ET AL., ARE JUDGES POLITICAL? AN EMPIRICAL ANALYSIS OF THE FEDERAL JUDICIARY 148–49 (2006).

138. *Massachusetts*, 549 U.S. at 528.

139. *Id.* at 558.

140. *Id.* at 532.

1. Hometown Pollution: Grandfathering, Environmental Federalism, and the Polluter Pays Principle

Pollution levels that people are accustomed to may fade into the cognitive (if not the environmental) background, becoming a familiar part of the accepted status quo. This may help to explain the common phenomenon of environmental "grandfathering," where existing pollution types and sources are regulated less stringently than new sources or types of pollution. The grandfathering of old sources remains a common though controversial approach to regulating pollution.[141] In the United States, the Clean Air Act is particularly (in)famous for its decision to exempt pre-1970 sources of air pollution from the vast majority of the statute's controls, and particularly from New Source Performance Standards.[142] That said, modified grandfathering is also common throughout several other pollution-control regimes around the world and even throughout many land use schemes.[143]

Although grandfathering has been addressed by environmental scholars through a number of interdisciplinary lenses, including political science and economics,[144] it has not, to our knowledge, been addressed from a psychological perspective. Yet the psychological explanation for grandfathering—for why policy makers would give existing sources preferential treatment, and for why stakeholders might tolerate such policies—is a relatively straightforward application of research on risk perception, familiarity, and the source effect. Simply put, policy makers and stakeholders may actually perceive old, familiar pollution as less risky than new pollution. As a result, policy makers may draft preferential treatment of what they perceive as less risky behavior, and stakeholders (like voters) may tolerate that structure because it fits their own perception of relative risks.

Similar effects may occur where people are asked to judge the relative riskiness of pollution generated by sources they view as familiar or as falling within their in-group—what we might think of as a "hometown pollution effect." As we have discussed, first, familiar risks are likely to be perceived

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141. Maria Damon et al., *Grandfathering: Environmental Uses and Impacts*, 13 REV. ENV'T ECONS. & POL'Y 23, 25–39 (2019).

142. Jonathan Remy Nash & Richard L. Revesz, *Grandfathering and Environmental Regulation: The Law and Economics of New Source Review*, 101 NW. L. REV. 1677, 1682–83 (2007).

143. Daniel H. Cole & Elinor Ostrom, *The Variety of Property Systems and Rights in Natural Resources*, *in* PROPERTY IN LAND AND OTHER RESOURCES 37, 52–57 (Daniel H. Cole & Elinor Ostrom eds., 2012).

144. Damon et al.*, supra* note 141, at 24.

as less risky[145] and the pollution thus generated as less disgusting.[146] Second, people may view pollution itself as less risky and as less disgusting when it emanates from a source with whom they identify.[147] And third, people may adopt minimization strategies to avoid the stress and anxiety of believing themselves, or people they care about, to be exposed to (or generating) pollution.[148] All of these factors may obscure the real risks people face from local pollution from familiar sources. The effect may be especially pronounced for people who have a particular attachment to their hometown or place of residence. For example, researchers found that impressions of the level of pollution on local beaches in England was a function of perceivers' attachment to their local towns or to their nation, with those who were more attached being less likely to see their beachfronts as polluted.[149] This hometown pollution effect could even attach to polluters, who may be all the more likely to exhibit cognitive distortion, avoiding conscious confrontation with the negative impacts of their pollution on themselves and their neighbors.[150]

Exploring the parameters of such a hometown pollution effect would be a valuable line for future research, not least because it could have important implications for environmental federalism, which seeks to identify the optimal level of government intervention to address environmental problems. The environmental federalism literature attempts to navigate between two countervailing risks: the risk of central governments imposing a one-size-fits-all policy that ignores local heterogeneity and the risk that local jurisdictions will ignore interjurisdictional spillovers.[151] This latter risk, however, is commonly understood to be primarily economic in character. In other words, the typical presumption throughout the literature is that local jurisdictions will actually understand their own risks and conditions better than the central government, and that although they may simply seek to externalize pollution (and other) harms out of self-interest, those attempts to externalize will be conscious and strategic.

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145. *See* Paul Slovic et al., *Facts and Fears: Understanding Perceived Risk*, *in* SOCIETAL RISK ASSESSMENT: HOW SAFE IS SAFE ENOUGH? 181, 211 (Richard C. Schwing & Walter A. Albers eds., 1981).

146. *Cf.* Peng et al., *supra* note 69, at 97.

147. *Cf.* Bužeková & Išová, *supra* note 71, at 238; Peng et al., *supra* note 69, at 97.

148. Evans et al., *supra* note 96, at 13.

149. Marino Bonaiuto et al., *Identity Processes and Environmental Threat: The Effects of Nationalism and Local Identity upon Perception of Beach Pollution*, 6 J. COMM. & APP. SOC. PSYCH. 157, 170–72 (1996).

150. *Cf.* Bandura, *supra* note 82, at 110–15; Helmond et al., *supra* note 83, at 247–50.

151. Wallace E. Oates, *A Reconsideration of Environmental Federalism*, *in* RECENT ADVANCES IN ENVIRONMENTAL ECONOMICS 1, 20–23 (John A. List & Aart de Zeeuw eds., 2002).

A psychological approach to pollution, however, suggests that this account may miss an important aspect of local decision making. Local governments may sincerely believe that the likely externalities of their polluting behaviors, or the polluting behaviors of their residents, are less than they actually are, both because of the externality-minimizing psychological strategies we discussed earlier and also because of psychological strategies that lead them to discount the familiar-seeming risks of their hometown pollution. In this sense, their understanding of their own impacts may be *worse* than those of central governments, who can assess pollution impacts without the barriers of overfamiliarity, egocentric bias, or the temptation to psychologically minimize harm to avoid cognitive dissonance.

Alternatively, consider the implications of a hometown pollution effect on the "polluter pays" principle, which is the notion that environmental laws should make the party who produces the pollution responsible for paying for the damage done by that pollution. The principle is incorporated into many U.S. laws,[152] and it also plays a central role in many environmental laws around the world. It is particularly foundational in the European Union (EU), where it has been incorporated into the Treaty on the Functioning of the EU.[153] Although exact formulations of the principle vary by context, a common and generally uncontroversial economic formulation emphasizes that it forces the internalization of pollution externalities[154]—which the hometown pollution effect would distort.

This disruption could prove problematic for several reasons. Consider that a core goal of forcing polluters to internalize the externalities of their pollution is to encourage them to engage in socially optimal behaviors, such that they only pollute when the likely harms of the pollution are greater than the marginal harm of pollution abatement.[155] If the hometown pollution effect interferes with the ability of polluters to accurately identify harms, it will lead polluters to blithely pollute more than the socially optimal level. Liability regimes that enforce a polluter pays principle may not be successful at incentivizing the socially optimal level of pollution under these conditions,

152. Eric Thomas Larson, *Why Environmental Liability Regimes in the United States, the European Community, and Japan Have Grown Synonymous with the Polluter Pays Principle*, 38 VAND. J. TRANSNAT'L L. 541, 551–55 (2005).

153. JOSEPHINE VAN ZEBEN & ARDEN ROWELL, A GUIDE TO EU ENVIRONMENTAL LAW 7 (2021).

154. Edwin Woerdmanet et al., *Emissions Trading and the Polluter-Pays Principle*, 4 REV. L. & ECON. 565, 567–68 (2008); s*ee* WILLIAM J. BAUMOL & WALLACE E. OATES, THE THEORY OF ENVIRONMENTAL POLICY 155–58 (2d ed. 1988); Jonathan Remy Nash, *Too Much Market? Conflict Between Tradable Pollution Allowances and the "Polluter Pays" Principle*, 24 HARV. ENV'T L. REV. 465, 533–34 (2000).

155. *See generally* Ronald H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

because the polluter may honestly believe themselves to be acting efficiently. Even worse, the polluter pays principle may face legitimacy concerns. That is because estimates—even accurate estimates—of the harm polluters cause may strike polluters as unfair, even ludicrous, in comparison to their own deflated estimates of the same harm.[156]

2. Indoor Pollution

Another aspect of the psychology of pollution control may go to the definition of which spaces or places deserve protection and which do not. Indeed, some spaces may trigger exceptional, even foolhardy, tolerance for pollution. On this front, consider the fact that environmental laws are often widely understood to apply only outside, while indoor pollution risks are widely neglected—or when addressed, managed through regulatory schemes like the Occupational Safety and Health Act or municipal building codes, rather than through environmental laws. The EPA, for instance—though clearly tasked through the Clean Air Act with regulating air pollutants—does not regulate indoor air quality at all.[157] This is despite the fact that most people spend over 90% of their time indoors,[158] that millions of people are routinely exposed to air pollutants at levels that are not allowed outdoors,[159] and that there are well-established, serious health impacts resulting from poor indoor air quality about which the EPA is fully aware. This includes lung cancer from radon exposure, Legionnaire's disease, carbon monoxide poisoning, airborne infections, secondhand smoke, and the exacerbation of existing respiratory issues such as asthma and chronic obstructive pulmonary disorder from mold and excessive moisture.

The result is that the expansive environmental protections of the Clean Air Act apply in backyards, front porches, and outside open windows—but no federal environmental regime regulates air quality on the inside of the open window, or once a person steps through the front door into her home. Such a sharp regulatory distinction should be particularly disturbing given risk

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156. Bandura, *supra* note 82, at 110–15.

157. *Regulatory and Guidance Information by Topic: Air*, EPA (June 21, 2022), https://www.epa.gov/regulatory-information-topic/regulatory-and-guidance-information-topic-air [https://perma.cc/8C9A-RDKB].

158. *PHILIP E. CONVERSE, ET AL.,* THE USE OF TIME; DAILY ACTIVITIES OF URBAN AND SUBURBAN POPULATIONS IN TWELVE COUNTRIES 112–144 (Alexander Szalai ed. 1972); J.A. Leech, et al., *The Canadian Human Activity Pattern Survey: Report of Methods and Population Surveyed*, CHRONIC DISEASES CAN. 118 (1996).

159. Nate Seltenrich, *Take Care in the Kitchen: Avoiding Cooking-Related Pollutants*, 122(6) ENV'T HEALTH PERSP. A154, A155 (2014).

perception research suggesting, again, that people tend to discount risks that are familiar,[160] such as presumably those that arise in their own homes. Notably, minimization of self-created indoor pollutants—such as from one's own cooking[161]—might also be expected to combine with the egocentric tendency to find one's own pollution less risky,[162] and even less disgusting.[163]

This suggests that indoor air pollution may be subject to a double whammy of minimization: there may be little demand for regulation of indoor environments given people's perception of those environments as falling outside of classic environmental protection, even as there is also too little self-management of indoor pollution risks where those risks appear familiar and thus benign. Of course, decisions about what and where to regulate in environmental law are necessarily normative decisions, about which psychology can provide only limited guidance. That said, the choice to have pollution-control laws apply only outdoors may be at least partially a psychological artifact rather than an all-things-considered, deliberate determination.

3. Human Health vs. Environmental Impacts of Pollution

Another aspect of how psychology may affect which pollution risks are tolerated, and to what extent, is the question of whether the pollution has primarily human or nonhuman impacts. One common characteristic of pollution-control schemes in the United States is their focus on the human health impacts of pollution.[164] The Clean Air Act, for example, sets National Ambient Air Quality standards—the centerpiece of the Act—at a level "requisite to protect public health" with "an adequate margin of safety."[165] This focus on human impacts has sometimes been criticized as minimizing or de-emphasizing the nonhuman effects of pollution.[166]

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160. Slovic et al., *supra* note 145, at 2–5.

161. *See generally* Seltenrich, *supra* note 159.

162. *See generally* Shu et al., *supra* note 81 (finding research subjects exhibit more moral leniency in evaluating their own choices than when evaluating the same choices in others).

163. *Cf.* Stevenson & Repacholi, *supra* note 72, at 397–99 (finding research subjects less disgusted where the disgust elicitor was generated by themselves rather than others, indicating a general trend of lenience towards one's own disgust-eliciting behavior).

164. Tracy Bach, *Protecting Human Health and Stewarding the Environment: An Essay Exploring Values in U.S. Environmental Protection Law*, 3 MICH. J. ENV'T. & ADMIN. L. 249, 259 (2014); VAN ZEBEN & ROWELL, *supra* note 153, at 5–8.

165. 42 U.S.C. § 7409(b)(1).

166. David M. Uhlmann, *Environmental Law, Public Health, and the Values Conundrum*, 3 MICH. J. ENV'T. & ADMIN. L. 231, 240 (2014).

This choice of focus was not inevitable. After all, scientists have chronicled an extraordinary number, magnitude, and scope of pollution impacts on nonhuman animals, plants, and ecosystems.[167] Rather, it reflects a set of normative choices about what environmental law should seek to do.[168] Again, psychology has little to say about the selection of appropriate normative goals of environmental law, and that includes the question of what the appropriate weight is to attach to human and nonhuman interests in pollution-control contexts. That said, people do not value what they do not notice; and as we have emphasized, common psychological phenomena present barriers to empathy and attention toward nonhuman animals and ecosystems. Egocentric bias may also lead humans—polluters—to cognitively minimize even those harms that they recognize they inflict on nonhumans.

The combination of these psychological phenomena may contribute to a normative choice to focus on human impacts, and to ignore possibilities for pollution-control regimes that are directed toward nonhuman targets. These psychological phenomena also make it easier to underplay or even entirely dismiss impacts to nonhumans that have become impossible to ignore.

C. Mechanisms of Control

A final consideration in pollution-control law and policy is the question of how—that is, with which tools, instruments, and principles—pollution will be controlled. We have noted several such examples throughout this chapter; here, we give three further examples of the dividends a psychological analysis of law can pay in addressing pollution control.

1. The Psychology of Instrument Choice

Policymakers have access to a variety of tools for addressing pollution risks to common pool resources. Many of these—including command-and-control regulatory regimes, *ex post* liability regimes, economic incentives, and information regimes—are matters of law, while others—including social norms and consumer-driven protections—are not.[169] Still others—such as

167. *See generally* BILL FREEDMAN, ENVIRONMENTAL ECOLOGY: THE IMPACTS OF POLLUTION AND OTHER STRESSES ON ECOSYSTEM STRUCTURE AND FUNCTION (1989).

168. Bach, *supra* note 164, at 258–59 (explaining that environmental law focuses on human impacts because studies showed that "the public health focus was the most likely to elicit emotional reactions consistent with support for climate change mitigation and adaptation").

169. *See generally* POLICY INSTRUMENTS IN ENVIRONMENTAL LAW (Kenneth R. Richards & Josephine van Zeben eds., 2020).

psychologically informed behavioral tools like nudges[170]—can be deployed by public or private actors.

As valuable as nudges and other behavioral tools have proven to be within environmental contexts, psychology has still more to offer instrument choice in environmental law. Psychological research can also help inform regulators how best to structure and implement tools. Loewenstein, Sunstein, and Golman, for instance, have carefully documented ways to increase the effectiveness of information disclosure regimes (including—though not focused on—pollution risks).[171] For example, disclosure regimes may fail in the face of limited or motivated attention,[172] but it is possible to improve them by using techniques such as standardizing disclosure formats, simplifying the information presented, and using vivid, high-salience imagery.[173]

Psychology may also help inform debates within the instrument choice literature. A perennial debate in environmental law and policy is how far markets and consumer choice can be trusted to generate a satisfactory level of environmental quality. Here, the psychology of pollution perception has important implications, as it provides significant additional reason for skepticism about individuals' ability to intuitively perceive, understand, or attach value to the harms from pollution. At a basic level, people's intuitions about environmental harm are often distorted. Instruments that rely on people's intuitive environmental judgments embed those distortions into public policy.

This basic observation can both point us away from practices and instruments that are psychologically questionable and toward those that look—from a psychological perspective—increasingly heroic. As a general matter, the more questionable instruments will be those that rely upon intuitive estimates of pollution harm, while the better-looking instruments will be those that encourage deliberative estimates of such harms.

Let us take more questionable instruments first. Think of environmental contracting, such as was famously proposed by Ronald Coase, as a way of addressing the externalities of pollution. In the classic case, a polluter has the

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170. *See* RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS 6 (2009) (describing a nudge as "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives"); *see also* ARDEN ROWELL, BEHAVIORAL INSTRUMENTS IN ENVIRONMENTAL REGULATION 1 (Ken Richards & Josephine van Zeben, eds., 2019).

171. *See generally* George Loewenstein, Cass R. Sunstein & Russell Golman, *Disclosure: Psychology Changes Everything*, 6 ANN. REV. ECON. 391 (2014).

172. *Id.* at 396.

173. *Id.* at 405–10.

option of negotiating with the community around it, and—absent transaction costs—the parties will negotiate to the socially optimal outcome.[174] Reams have been written about the various implications and forms of transaction costs that are relevant to such situations. Here, we add that such cases would also have to contend with a particular set of cognitive, emotional, and motivational transaction costs that would distort the parties' ability to meaningfully identify, understand, and value the pollution harms about which they are negotiating. The polluter may well sincerely but erroneously underestimate the harm from pollution, and—perhaps counter-intuitively—the pollutees may well do the same, especially where the pollution is familiar. Meanwhile, non-environmental costs faced by the community members will not be subject to the same distortions. This is likely to lead to undercounting of the pollution harms, and to more pollution than would be socially optimal under a deliberate policy.

Distortions in perception can lead to overprotection against some pollutants, too, especially where individuals' intuitive choices about environmental harm are given policy weight. If consumer choice about organic produce is driven primarily, or even partially, by a disgust response to pesticides, for example, consumer and indeed political pressure may be higher than what a more deliberate or reflective policy might recommend. People's economic valuations of environmental amenities may also be suspect—potentially adding additional question marks around the best practices for using such valuations to inform regulatory cost-benefit analysis.

While there are special reasons to be concerned about individual decision-making, it is possible to tell institutional stories about instrument choice that are also informed by the psychology of pollution control. Consider, for instance, that pollution-control regimes in the United States have long been criticized for an overreliance on "command-and-control" instruments such as bans and mandates.[175] Some scholars have provided a qualified defense of command-and-control, or "traditional" regulation,[176] while others have provided non-psychological accounts for why command-and-control has

174. Coase, *supra* note 155; *see also Coasian Bargaining*, ENV'T JUST. ORGS., LIABS., & TRADE, http://www.ejolt.org/2015/09/coasian-bargaining-2/ [https://perma.cc/8CLY-SBVF].

175. Bruce A. Ackerman & Richard B. Stewart, Comment, *Reforming Environmental Law*, 37 STAN. L. REV. 1333, 1333–40 (1985); Nathaniel O. Keohane, Richard L. Revesz & Robert N. Stavins, *The Choice of Regulatory Instruments in Environmental Policy*, 22 HARV. ENV'T. L. REV. 313, 313–17 (1998) (comparing "command-and-control" instruments—like technological design standard requirements, or maximum pollution limits for a given source—to "market-based" or "economic-incentive" instruments—like pollution taxes or systems of tradeable permits).

176. *See generally* DAVID DRIESEN, THE ECONOMIC DYNAMICS OF ENVIRONMENTAL LAW (2003).

been so durable, despite a number of theoretical and economic challenges to its efficacy.[177] A psychological account of the continued popularity of command-and-control in pollution-control contexts may be complementary, or perhaps even more convincing: namely, command-and-control of pollution often straightforwardly satisfies the intuitive psychological responses of disgust and recoil. This may be particularly true for bans, which seek to eliminate substances or pollutants entirely, regardless of expected exposure levels, and regardless of the potential costs of the ban.[178]

It is similarly possible to tell a psychological story about the general preference for pollution prevention (sometimes called source reduction) in U.S. environmental law, versus recycling, treatment, disposal, or release. Many U.S. pollution-control statutes mandate pollution prevention of various kinds, and the strategy remains particularly central to approaches to solid and hazardous waste under the Resource Conservation and Recovery Act.[179] More generally, the Pollution Prevention Act formalizes pollution prevention as the most preferred policy option throughout federal environmental law, saying that "pollution should be prevented or reduced at the source whenever feasible"—and only then turns to alternative forms of management.[180]

Of course, there may be a number of policy benefits to pollution prevention, and it may in fact be that pollution prevention is the normatively best approach to controlling pollution in many circumstances. One additional psychological benefit it has, however, is preventing the production of something that may trigger a visceral response to perceived uncleanliness. Or in other words, the relative appeal of recycling, treatment, and disposal may be diminished by the fact that all such alternate strategies permit the psychologically repellant pollution to be generated in the first place. Similarly, and particularly when paired with disgust, highly-salient pollutants may trigger extreme responses—especially when paired with policy frameworks such as the precautionary principle, which allow for selective invocation of precautionary measures against some risks.[181] This may, for

177. Keohane, Revesz & Stavins, *supra* note 175, at 319–25.

178. ROWELL & BILZ, *supra* note 1, at 176.

179. Resource Conservation and Recovery Act, 42 U.S.C. § 6901.

180. Pollution Prevention Act of 1990, 42 U.S.C. § 13101.

181. *See* CASS SUNSTEIN, LAWS OF FEAR: BEYOND THE PRECAUTIONARY PRINCIPLE 13 (2006) (arguing that the precautionary principle is subject to selective invocation against highly salient risks).

example, be one way to understand the European Union's extreme precautions against genetically modified organisms.[182]

All else equal, then, the psychology of pollution perception should generate additional skepticism about market-based instruments that imbed people's intuitive valuations of environmental harm, since those valuations are so prone to distortion. Environmental negotiations look particularly fraught, given the role-relative risk perception of polluters and pollutees. Polluters in particular may systematically underestimate the damage they cause, and even pollutees may be motivated to underperceive total impact. It might also generate special concern about unreflective imbedding of individual economic valuations of environmental amenities into regulatory decision-making, since such valuations may be based on particularly problematic intuitions about a type of harm—the harm from pollution—that people struggle to process. And it may provide a psychological account of the surprising appeal of bans, the precautionary principle, and prevention when it comes to pollution harms.

Finally, consider the instruments and decision procedures that gain in appeal after an analysis of the psychology of pollution perception. Psychology gives us special reason to be appreciative of approaches that demand systematic calculation and analytical rigor. Such careful, deliberate analyses are more likely to insulate decision-makers from disgust-based recoil from apparent pollutants, which in turn shields them from precipitous policy decisions. On this front, the National Environmental Policy Act of 1969—which requires federal agencies to assess the environmental effects of their proposed actions using a relatively regimented method for assessing expected harms—looks particularly wise.[183] Highly regimented systems for calculating the harms of pollution—such as the Regulatory Impact Analyses generally undertaken by the EPA prior to regulating major pollutants—also appear especially sensible.[184]

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182. *See generally GMO Legislation*, EUR. COMM'N, https://food.ec.europa.eu/plants/genetically-modified-organisms/gmo-legislation_en [https://perma.cc/D9ZN-DLZ4].

183. 42 U.S.C. § 4331; *Environmental Programs: National Environmental Policy Act*, U.S. GEN. SERV. ADMIN. (Feb. 26, 2019), www.gsa.gov/nepa [https://perma.cc/M93F-K9DH].

184. *See generally Regulatory Impact Analyses for Air Pollution Regulations*, EPA (July 21, 2022), https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/regulatory-impact-analyses-air-pollution [https://perma.cc/7Y7L-REB9].

2. Hotspots, Distribution, and Environmental Justice

Because it is not possible to reduce all pollution to zero, pollution control also necessarily embeds normative choices about where pollution will be tolerated and who will be forced to bear its burden. One fraught issue related to the distribution of harms is the creation of hotspots, or areas where pollution is concentrated. In some cases—such as the infamous "Cancer Alley" in Louisiana, an eighty-five-mile stretch of land along the Mississippi river that accounts for 25% of the petrochemical production in the United States—the risks of such concentration are significant, and in many cases, those risks are borne disproportionately by poor communities and communities of color.[185]

There are two distinct reasons to care about hotspots. One is that they may cause more harm than if the same pollution emissions occurred elsewhere to a different, less vulnerable population, or were more dispersed across a larger swath of the population. A second reason is that hotspots can generate unfairness or inequity. This objection is the focus of environmental justice work. Unfortunately, both perceptions of the extent of harm caused by pollution and perceptions of fairness of pollution exposures are likely subject to significant psychological distortions that may contribute to the continued existence of hotspots and to the fact that poor communities and communities of color continue to bear disproportionate risk.

Site selection for polluting land uses—sometimes called "LULUs" or "locally unwanted land uses"—is particularly fraught with conflict, and it frequently implicates the "NIMBY" ("not in my backyard") phenomenon, where individuals and communities compete to keep out new land uses they find repellent.[186] The analysis above suggests that a portion of NIMBYism may flow from the emotional response that many people feel to uses and substances they find disgusting, such as (new) waste dumps or incinerators. This may also help to explain the relative intractability of many NIMBY

185. James Pasley, *Inside Louisiana's Horrifying 'Cancer Alley,' an 85-Mile Stretch of Pollution and Environmental Racism That's Now Dealing with Some of the Highest Coronavirus Death Rates in the Country*, BUS. INSIDER (Apr. 9, 2020, 05:42 PM), https://www.businessinsider.com/louisiana-cancer-alley-photos-oil-refineries-chemicals-pollution-2019-11 [https://perma.cc/B86W-KY83]; *see, e.g.*, Robert D. Bullard, *Solid Waste Sites and the Black Houston Community*, 53 SOCIO. INQUIRY 274, 276–77 (1983); Vicki Been, *What's Fairness Got to Do with It? Environmental Justice and the Siting of Locally Undesirable Land Uses*, 78 CORNELL L. REV. 1001, 1002–03 (1992); Vicki Been, *Locally Undesirable Land Uses in Minority Neighborhoods: Disproportionate Siting or Market Dynamics?*, 103 YALE L.J. 1383, 1406 (1994).

186. Denis J. Brion, *An Essay on LULU, NIMBY and the Problem of Distributive Justice*, 15 B.C. ENV'T AFF. L. REV. 437, 437–38 (1988).

issues, perhaps most famously in the case of the functional elimination of the nation's centralized nuclear waste storage facility at Yucca Mountain on the basis of local objections.[187] As we discussed earlier, people may also seek to reduce the cognitive dissonance they feel about inflicting harms on others by not only minimizing the nature of harms inflicted, but possibly also by underplaying the entitlement those others have not to experience harm.[188] Due both to learned helplessness and actual lack of power, poor and minority communities are not only more likely to be saddled with LULUs,[189] but also to be the victims of unfair psychological rationalizations for receiving them—such as, perhaps, that they didn't pay as much for their residences, don't mind being subject to the pollution, or don't produce enough to deserve protection. Such justifications may be further exacerbated by in-group/out-group bias and othering.[190]

V. CONCLUSION

Even in a world where everyone agrees that pollution is a problem that law should try to help solve, there is still a great deal of confusion and disagreement how to go about actually controlling it. As it turns out, psychological research has much explanatory power about the sources of this disagreement, and better still, how to overcome it.

By reviewing research on motivation, emotion and cognition, we can see that disagreement about pollution control may often be caused by disagreement about what counts as polluting or how bad it really is, or by differences in the visibility of different sources or effects of pollution across different populations or across time and space. Some types of pollution and even some polluters are relatively invisible—or the opposite—because of their emotional valence, their ties to our identity, or the sheer difficulty of perceiving them given their complexity.

Psychological research can be helpful in explaining and predicting these disagreements. Better still, it can help shed light on the solutions selected to control that pollution. Decision-makers have a wealth of instruments

187. *Commercial Nuclear Waste: Effects of a Termination of the Yucca Mountain Repository Program and Lessons Learned*, U.S. GOVERNMENTAL ACCOUNTABILITY OFF. (Apr. 8, 2011), https://www.gao.gov/products/gao-11-229 [https://perma.cc/QQ3C-JD77].

188. *See* Shu et al., *supra* note 81, at 331–32.

189. BULLARD, *supra* note 89, at 256; SCHLOSBERG, *supra* note 89, at 47; Taylor, *supra* note 89, at 536.

190. Rowell & Wexler, *supra* note 13, at 254 (noting that "out-group bias or othering can allow individuals to treat the risks of out-groups with much less sensitivity than the risks of those they perceive as insiders").

available to them to manage pollution policy. Some of the most commonly used instruments (such as bans) have been derided as inefficient, but perhaps can be better justified with reference to psychological processes such as disgust. Other techniques, such as disclosure or information-focused solutions, could be improved with an appreciation of cognitive and emotional limitations on attention; that is, psychological research might be used to better tailor such regimes to increase their effectiveness. Psychology might also give us reason to be skeptical of market-based solutions that fail to fully account for similar cognitive and emotional limitations on perceiving sources of pollution or the magnitude of its harm.

In short, psychological research suggests that pollution may trigger a constellation of psychological phenomena that drive pollution policy in some directions over others. Understanding the psychology of pollution perception and response can be helpful in improving pollution control by illuminating which substances get identified as pollutants, when pollutants may be tolerated, and how mechanisms for pollution control can and do operate.