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THE PROBLEMS WITH DECISION-MAKING

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Our society faces major challenges in numerous areas, including climate change and healthcare. Addressing these problems with technological advances are of great importance. Increasingly, however, consumers are resisting or rejecting such technological interventions based on inappropriate assignment of risk. In other words, the consumer assessment of risk is not in line with evidence-based assessment of risk. This

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article focuses on two controversial areas, vaccines and genetically engineered food, as examples in which consumers assign a high risk despite an evidence-based assessment of low risk. This article describes how empirically tested decision-making theories explain why consumers inappropriately assign risk. While these prevailing theories and strategies are meritorious, this article suggests that changes in modern day society need to be considered as variables in how consumers assign risk. This is a tough problem to solve and current risk communication strategies appear insufficient. This leads to the central issue addressed in this article, which is that risk communication/policy implementation needs to address emergent variables in modern society, including (1) rise of hyper individualism, (2) role of the internet, and (3) economic interests. After discussing how these variables likely apply to consumer risk assessment, this article proposes an important new direction, both normatively and empirically, to highlight the problem and analyze consumer decision-making.

INTRODUCTION

This article examines, critiques, and reconciles multiple decision-making theories as they help us understand a disconnect between consumer perceptions of risk and evidence-based assessment of risk in biotechnology. It is not just that consumers do not behave as expected by the incentives created by policies, which we already know is a problem. The problem is two-fold: (1) people inappropriately assign risk regardless of the presentation of evidence-based assessment of risk; and (2) people seek policies (and attendant behavior) that support their assessment of risk, even when that assessment of risk is wrong. One example of this is seen with vaccines. As it applies to the first fold, people decide not to vaccinate even though the evidence-based assessment of risk supports vaccination. As it applies to the second fold, people are seeking exemptions to vaccination laws. Another example of this is seen with genetically engineered food (colloquially called "GMOs"). As it applies to the first fold, people believe that GMOs are unsafe, even though the evidence-based assessment of risk establishes that GMOs are safe. As it applies to the second fold, people seek labeling of foods and stricter regulation. This article seeks to understand the influences that create these problems and proposes approaches to allow consumers to appropriately assign risk as part of their decision-making processes.

Opponents to vaccines and GMOs utilize decision-making theories in a way that does not allow consumers to appropriately assign risk. To date, experts agree on one thing—we have not done enough to combat the spread of mis-information.[1] Or, at least, we have not reached consumers in a way that allows them to determine which information is accurate and which information is not. This article suggests that simply providing correct information is not enough. This issue is a tough problem to solve. This article suggests what may be viewed as radical departures from the norm; the norm being that we provide accurate information and hope that people make informed and rational decisions. This article proposes that additional steps need to be taken, including, but not limited to, exposing the entities that spread misinformation for what they are doing—they are

1. *See, e.g.*, L.Z.G. Touyz, *Genetically Modified Foods, Cancer, and Diet: Myths and Reality*, 20 CURR. ONCOL. e59, e59 (2013); Tara C. Smith, *Vaccine Rejection and Hesitancy: A Review and Call to Action*, 4 OPEN F. INFECTIOUS DISEASES 1, 1–2 (2017).

manipulating the way we understand how people make decisions. In addition, accurate information can be communicated in a way that recognizes how people make decisions. This, in and of itself, is manipulative, to be sure, which is why it should be studied and assessed before any implementation.

Decision-making is complicated and many theories exist to explain this complex process. This article focuses on a specific set of theories that are discussed and utilized in the legal literature. These are: (1) ambiguity aversion; (2) affect; (3) cultural cognition; and (4) dual process/heuristics.[2] This is not an exhaustive list and is not intended to discount or ignore other decision-making theories. It is simply not possible to address every decision-making theory, nor is it needed. To the extent that this article attempts to reconcile how multiple decision-making theories can be applicable to addressing the problem in which people inappropriately assign risk, the same tools can be used to extend to and incorporate other theories as well. This article is a beginning, not an end. The purpose is to launch a cohesive and collaborate platform that is subject to vetting, change, and progress.

The decision-making theories addressed in this article have empirical support that can be utilized in assessing how these theories are used to explain a disconnect between consumer perceptions and evidence-based assessment of risk in certain policies. This article discusses some current roadblocks, or at least heavy bumps in the road, that help explain why people might inappropriately assign risk. These variables are (1) the rise of individualism; (2) misinformation on the internet; and (3) economic forces seeking to undermine the application of biotechnology. These variables demonstrate the problems with decision-making. Or, perhaps, more accurately, support the large body of decision-making research that demonstrates that people do not behave rationally. The theories discussed within this article are robust and can withstand the challenge of these variables. The larger issue addressed in this article is how to address these variables in a way that allows people to make decisions in which their assessment of risk is in line with evidence-based assessment of risk. This does not determine the actual decision that people will make, for example, eat food from GMOs, but it allows them to appropriately assign risk to food from GMOs (i.e., they are safe) when making food choices. With a correct assessment of risk, the person may still choose to eat non-GMOs. In other words, this article is concerned with risk assessment and perception, not necessarily the final decision.

While this article limits the discussion of controversial examples to vaccines and GMOs, the concepts are applicable to other controversial areas such as dietary supplements, fluoridated water, and other areas of scientific inquiry and exploration. Something more is happening than mistrust of scientists or industry—something much more fundamental is happening. This article seeks to explore a much more complicated underbelly of this social phenomenon and attempts to expose and discuss a much more complicated array of decision-making currents that ultimately need to be explicitly

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2. Daniel Ellsberg, *Risk, Ambiguity, and the Savage Axioms*, 75 Q. J. ECON. 643, 657 (1961); Paul Slovic, *What's Fear Got to Do With It? It's Affect We Need to Worry About*, 69 MISS. L. REV. 971, 971 (2004); Dan M. Kahan, *Cultural Cognition as a Conception of the Cultural Theory of Risk*, *in* HANDBOOK OF RISK THEORY 726, 726–28 (S. Roeser et al. eds., 2012) [(hereinafter Kahan (2012)]; Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, *in* JUDGEMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 3 (Daniel Kahneman, Paul Slovic & Amos Tversky eds., 1982).

addressed.

Part I of this article describes four major decision-making theories: (1) ambiguity aversion; (2) affect; (3) cultural cognition; and (4) dual process/heuristics. This section is necessarily descriptive. A large body of research supports these theories—both normatively and empirically. Part II highlights some tools for policy implementation that recognize how people make decisions. These tools use tactics to push people to make the decision that the policy seeks to accomplish. The examples discussed in this article are (1) nudging; (2) public participation through notice and comment, and (3) risk communication and risk perception. Part III describes two controversial areas of biotechnology, vaccines and GMOs, as examples of how the decision-making theories help to explain why some people inappropriately assign risk. These examples are chosen because both vaccines and GMOs have an evidence-based assessment of low risk, but sectors of the public inappropriately assign a high risk. Part IV describes how three important variables: rise of individualism, misinformation on the internet, and economics, need to be considered as disrupting the ability for people to make decisions in which they appropriately assign risk. This article addresses how these variables actually speak to the very way that people make decisions and manipulate people into inappropriately assigning risk. This article concludes with thoughts about how to apply what we know from decision-making theories and risk perception to provide information in a way that allows people to make an assessment of risk that is in line with evidence-based assessment of risk.

I. DECISION-MAKING THEORIES

By decision-making theories, this article refers to thinking processes that impact risk perception.[3] This is distinct from motivations or challenging so-called rational norms. While numerous thinking theories exist, this article focuses on a subset that either are regularly referred to in the legal literature, discussed in the social science literature with reference to policy, or both. With these criteria, this article focuses on ambiguity, affect, cultural cognition, dual process/availability heuristics—all of which are empirically tested to impact risk perception. Of note, these theories will be discussed separately from tools for policy implementation, *infra* Part II, such as nudging and risk communication. This section is necessarily descriptive of the theories; an application of these theories to vaccines and GMOs will be discussed in Part III.

A. Ambiguity Aversion

Daniel Ellsberg's seminal work on ambiguity aversion provides insights that people prefer options with known risks even if another option exists that is likely less risky, but the subject is not familiar with the unknown risk.[4] In his work, Ellsberg demonstrated that

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3. Decision-making is complicated. Some theories address motivations, while other theories help us understand the thinking process especially as it relates to risk assessments. *See, e.g.*, *How we change what others think, feel, believe, and do*, CHANGING MINDS (last visited Jan. 22, 2020), http://changingminds.org/explanations/theories/a_decision.htm (listing and linking to a variety of decision-making theories and separating them into different categories).

4. Ellsberg, *supra* note 2, at 657 ("Responses from confessed violators indicate that the difference is not to be found in terms of the two factors commonly used to determine a choice situation, the relative desirability of the possible pay-offs and the relative likelihood of the events affecting them, but a third dimension of the problem

given a choice between betting on an urn with a known ratio of red and black marbles compared to betting on an urn with an unknown ratio, subjects preferred to bet on the urn with the known ratio.[5] Additional work elucidated this theory and helped us to understand how ambiguity aversion underscores a person's perception of risk.[6] The underlying thinking process is that a person has a hard time assigning risk when an unknown variable is presented, thus they revert to a known risk, even if that risk is higher.

Later studies demonstrate that ambiguity aversion underscores additional risk perception problems. When people are presented with ambiguous information, they have trouble sorting through the likely risk assessment and are inclined to assign a high risk and low benefit, even in the face of evidence that the risk is low and the benefit is high.[7] A salient example, discussed further below, is vaccine hesitant parents ("VHPs").[8] When presented with information regarding risks from vaccines, even if the risk is not evidence-based (e.g., link to autism) and also with information that no risk of autism exists, the parent may assign a high risk and decide not to vaccinate. The information about a link of vaccines with autism clearly comes from an unreliable source, but the parent is unable to discount that information. They receive ambiguous information, believe that their child is at a possible future risk for autism, and decide not to vaccinate. The parent has inappropriately assigned a high risk to a side effect that does not even exist and assigned a low benefit to the prevention of the vaccine preventable disease, e.g., measles.[9] This

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of choice: the nature of one's information concerning the relative likelihood of events. What is at issue might be called the *ambiguity* of this information, a quality depending on the amount, type, reliability, and 'unanimity' of information, and giving rise to one's degree of 'confidence' in an estimate of relative likelihoods.").

5. Ambiguity aversion helps us understand why people will choose the option with a known higher risk, even if the other option likely has a lower risk. It is the unknown that creates the aversion, even when the unknown is likely less risky. *Id.* at 656.

6. *Id.* at 658–62, 666 ("In contrast, the ambiguities surrounding the outcome of a proposed *innovation*, a departure from current strategy, may be more noticeable. Different sorts of events are relevant to its outcome, and their likelihoods must now be estimated, often with little evidence or prior expertise; and the effect of a given state of nature upon the outcome of the new action may itself be in question. Its variance may not appear any higher than that of the familiar action when computed on the basis of 'best estimates' of the probabilities involved, yet the meaningfulness of this calculation may be subject to doubt. The decision rule discussed will not preclude choosing such an act, but it will definitely bias the choice away from such ambiguous ventures and toward the strategy with '*known risks.* '"); Colin Camerer & Martin Weber, *Recent Developments in Modeling Preferences: Uncertainty and Ambiguity*, 5 J. RISK & UNCERTAINTY 325, 333–41 (1992) (describing empirical studies of ambiguity). One study provided scenarios in which a new form of technology, likely with a lower risk, was provided as an option compared to a known, likely higher, risk. Participants who indicated aversion to ambiguous information as assessed by their responses to predictor questions also demonstrated an aversion to choosing a new technology, even if the risk was communicated as lower. Joanna K. Sax & Neal Doran, *Ambiguity and Consumer Perceptions of Risk in Various Areas of Biotechnology*, 42 J. CONSUM. POL'Y 47, 54–56 (2019) [hereinafter Sax & Doran (2019)].

7. *See* Camerer & Weber, *supra* note 6, at 325–33 (discussing modeling uncertainty and ambiguity); Sax & Doran (2019), *supra* note 6, at 55–57 ("As hypothesized, we found that participants who showed an initial aversion to ambiguous information were significantly more likely to choose the response options that indicated a high assessment of risk, even when alternative choices had a high benefit or a likelihood of low risk.").

8. Laura L. Blaisdell, Caitlin Gutheil, Norbert A. M. Hootsmans & Paul K. J. Han, *Unknown Risks: Parental Hesitation about Vaccination*, 36 MED. DECISION MAKING 479, 480 (2016) ("Whether perceptions of and aversion to ambiguity might play a role in vaccine hesitancy is an important question given the vast amount of vaccine-related information to which parents are exposed and which is often incomplete, conflicting, and changing.").

9. *See id*. at 482 ("Parents in the groups also minimized the subjective risk of harms from [vaccine preventable diseases] by citing various factors that they believed reduced these risks.").

assignment of high risk and low benefit is completely at odds with the scientific assessment—which is low risk and high benefit for vaccines.

In sum, ambiguity aversion helps explain how a person makes a decision to assign a high risk when they receive competing information.[10] The aversion to the ambiguous information means that they will assign a high risk even if some of the information presented establishes an evidence-based low risk. Any information that creates ambiguity, even if it is a small amount of information, impacts how the person perceives risk.

B. Affect Heuristics

Paul Slovic's work on the decision-making theory called affect heuristics helps us to understand how a faint whisper of emotion underscores a person's perception of risk.[11] For example, the feeling of dread associated with the consequences of the malfunction of a nuclear power plant underscores a person's assessment that nuclear power is high risk and low benefit.[12] However, risk assessment supports that nuclear power is clean and safe, or, in risk perception terms, nuclear power is low risk and high benefit[13] The probability of a meltdown of a nuclear power plant is extremely low. The risks from regular use of coal energy are high. But, the mental visual of people melting or dying of cancer from a nuclear power plant breakdown is simply too much emotion for people to decide that nuclear power is low risk and high benefit.[14] This is compounded, of course, by actual meltdowns of nuclear power plants such as Chernobyl and Fukushima.[15]

Work by Slovic and others demonstrates that negative words or feelings impact

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10. Ellsberg, *supra* note 2, at 657.

11. Paul Slovic & Ellen Peters, *Risk Perception and Affect*, 15 CURRENT DIRECTIONS PSYCHOL. SCI. 322, 322 (2006) (comparing strong emotions, such as fear and anger, with subtler feelings: "Fortunately, most of the time people are in a calmer state, being guided by much subtler feelings. We shall focus this review on a 'faint whisper of emotion' called *affect*. We use the term affect to mean the specific quality of 'goodness' or 'badness' (a) experienced as a feeling state (with or without consciousness) and (b) demarcating a positive or negative quality of a stimulus. We have used the term 'the affect heuristic' to characterize reliance on such feelings."); Paul Slovic, Melissa L. Finucane, Ellen Peters & Donald G. MacGregor, *The Affect Heuristic*, 177 EUR. J. OPERATIONAL RES. 1333, 1333–35 (2007).

12. Paul Slovic, *Perception of Risk*, 236 SCI. 280, 285 (1987) [hereinafter Slovic (1987)]; Slovic & Peters, *supra* note 11, at 322–23 ("Those studies showed that feelings of dread were the major determiner of public perception and acceptance of risk for a wide range of hazards. This explained, for example, why the public judges radiation exposure from nuclear power plants (highly dreaded) as far riskier than radiation from medical X-rays—an assessment not shared by risk experts. In today's world, terrorism has replaced nuclear power at the top of the list of widely dreaded risks."); *see also* Joanna K. Sax, *Biotechnology and Consumer Decision-Making* 47 SETON HALL L. REV. 433, 437 fn. 6 (2017) [hereinafter Sax (2017)]; Slovic, *supra* note 2, at 977–78.

13. Slovic (1987), *supra* note 12, at 281; *see also* Michael Siegrist & Bernadette Sutterlin, *Human and Nature-Caused Hazards: The Affect Heuristic Causes Biased Decisions*, 34 RISK ANALYSIS 1482, 1482–92 (2014) (comparing participants' assessment of risk in human-made and natural disasters, using nuclear power as an example of human-made hazard).

14. *See* Slovic & Peters, *supra* note 11, at 322 ("fear amplifies risk estimates"); Slovic (1987), *supra* note 12, at 283, 285 ("Factor 1, labeled 'dread risk' is defined at its high (right-hand) end by perceived lack of control, dread, catastrophic potential, fatal consequences, and the inequitable distribution of risks and benefits. Nuclear weapons and nuclear power score highest on the characteristics that make up this factor."); Siegrist & Sutterlin, *supra* note 13, at 1483, 1488–89.

15. Interestingly, the accident at Three Mile Island, another example of a problem at a nuclear power plant, did not result in a single direct fatality or a higher percentage of latent cancer fatalities, but the accident itself caused serious externalities in perceptions of risk. Slovic (1987), *supra* note 12, at 283.

consumer risk assessment.[16] If consumers feel that the use of a new technology may cause cancer, such as the misinformation provided about eating food from GMOs, then the person rejects such technology and assigns a high risk and low benefit. The feeling or affect overwhelms the ability to accept the evidence-based assessment of low risk and high benefit.[17] Not surprisingly, those skilled in marketing take advantage of the affect heuristic to sway consumer confidence.

Positive feelings also impact consumer decision-making.[18] If home shoppers see a home that makes them feel positive, they might be more likely to buy it. Furthermore, consumers want to re-experience positive feelings. So, when shopping for clothes or other items, a positive feeling might sway consumers to make purchases. These positive feelings also underscore consumer risk perception. If consumers have a positive affect, they tend to assign a low risk and high benefit, regardless of evidence-based risk assessment.[19]

Additional studies utilize the theory of affect heuristics to understand implicit assessments.[20] In these studies, subjects are asked how they associate positive or negative words with a particular subject.[21] The positive or negative associations demonstrate underlying or implicit responses even when an explicit response might be different. For example, a subject may think they are "woke" and would not discriminate, but their implicit assessment suggests otherwise. This important work demonstrates that we can socialize people to make non-discriminatory choices, even if they have implicit negative associations.

Interestingly, but not surprisingly, Paul Slovic and others, collaborate with other scholars to harmonize or suggest ways in which the affect heuristic and other decision-making theories are at play in consumer responses to policy and to policy decisions in and

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16. *See* Ellen Peters, Daniel Vastfjall, Tommy Garling & Paul Slovic, *Affect and Decision Making: A "Hot" Topic*, 19 J. BEHAV. DECISION MAKING 79, 81–82 (2006) [hereinafter Peters (2006)].

17. Slovic & Peters, *supra* note 11, at 323 (describing work by Alhakami and Slovic in which they found an inverse relationship between perceived risk and perceived benefit, in other words, that people assign a low benefit to a perceived high risk. "This finding implies that people judge a risk not only by what they think about it but also by how they feel about it. If their feelings toward an activity are favorable, they tend to judge the risks as low and the benefits as high; if their feelings toward the activity are unfavorable, they tend to make the opposite judgment-high risk and low benefit (i.e. the affect heuristic [internal citation omitted].").

18. Peters (2006), *supra* note 16, at 80 ("First, affect can act as information: at the moment of judgment or choice, decision makers consult their feelings about a choice and ask, 'How do I feel about this?' The feelings act as information to guide the judgment or decision processes." [internal citations omitted]); Slovic & Peters, *supra* note 11, at 322 ("Pleasant feelings motivate actions that people anticipate will reproduce those feelings. Unpleasant feelings motivate actions that people anticipate will avoid those feelings.").

19. Peters (2006), *supra* note 16, at 82 ("In four studies, [Caruso and Shafir] show that thoughts about mood, regardless of its valence, increases choices of alternatives that promote a good mood, even if those options would have been rejected otherwise (when not thinking about mood).").

20. Michael Siegrist, Carmen Keller & Marie-Eve Cousin, *Implicit Attitudes Toward Nuclear Power and Mobile Phone Base Stations: Support for the Affect Heuristic*, 26 RISK ANALYSIS 1021, 1023–25 (2006) (studying implicit attitudes toward nuclear power).

21. *See, e.g.*, Michael Siegrist, Carmen Keller & Marie-Eve Cousin, *Implicit Attitudes Toward Nuclear Power and Mobile Phone Base Stations: Support for the Affect Heuristic*, 26 RISK ANALYSIS 1021, 1023–25 (2006) (assessing whether "negative attributes are more strongly associated with nuclear power and that positive attributes are more strongly associated with hydroelectric power."); *see also* Alexa Spence & Ellen Townsend, *Implicit Attitudes towards Genetically Modified (GM) Foods: A Comparison of Context-Free and Context-Dependent Evaluations*, 46 APPETITE 67, 67 (2006) (using the Go No-Go task to investigate explicit and implicit attitudes toward foods from GMOs).

of themselves.[22] This underscores an important point of this article, which is that multiple decision-making processes are at work at the same time—even the experts know this. Allowing consumers to appropriately assign risk requires a holistic approach to addressing consumer decision-making.

C. Cultural Cognition

Cultural cognition, with a large amount of work led by Dan Kahan, theorizes that group values impacts risk perception.[23] Put differently, the cultural outlook of a group, including the culture's world view, impacts the risk perception of the individuals within that group.[24] Cultural theory, the underlying theoretical framework posits two basic claims: (1) if a participant in a group engages in conduct that is perceived as a harm to the collective group, that participant will face censure or blame, and (2) participants in a group perceive risk in a way that advances the way of life to which they participate.[25]

The cultures to which cultural cognition refer to are not the layman cultures, such as European, Korean, Jewish, etc. Rather, they group or grid based on philosophical categories, such as individualism, hierarchy, communitarianism, and egalitarianism.[26] This allows researchers to test the role of philosophy/culture as groups, instead of demographic factions. Although, admittedly, a demographic characteristic may place a person in one cultural group. Put differently, white males may be more individualistic given their place in history.[27] Kahan and others recognize that individuals may associate with one or more categories, but that the individual's perceptions of risk would associate closely with the group to which they most closely identify.[28] A simplified example is a

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22. DANIEL KAHNEMAN, THINKING FAST AND SLOW 137–45 (2011) [hereinafter Kahneman (2011)] ("Paul Slovic probably knows more about the peculiarities of human judgment of risk than any other individual. His work offers a picture of Mr. and Ms. Citizen that is far from flattering: guided by emotion rather than by reason, easily swayed by trivial details, and inadequately sensitive to differences between low and negligibly low probabilities.").

23. Dan Kahan attributes that cultural cognition is a variety of interpreting the work of cultural theory of risk as was set forth by Mary Douglas and Aaron Wildavsky. Kahan (2012), *supra* note 2, at 726–28 ("This entry examines two related frameworks for the study of popular risk perceptions: the *cultural theory of risk*, associated with the work of Douglas and Wildavsky (1982); and the *cultural cognition* of risk, a focus of recent work by various researchers including myself.").

24. Kahan (2012), *supra* note 2, at 727 (explaining the grid/group scheme that predicts how an individual's perception of risk that reflects and reinforces their cultural way of life).

25. *Id.* at 728 ("The cultural theory of risk makes two basic claims about the relationship between cultural "ways of life" so defined and risk perceptions. The first is that discrete constellations of perceived risk tend to cohere better with one or another way of life. Forms of conduct understood to inflict collective harm invite restriction, and the people who engage in such behavior censure and blame (Douglas 1992). [. . .] The second claim of cultural theory is that individuals gravitate toward perceptions of risk that advance the way of life to which they are committed."); MARY DOUGLAS & AARON WILDAVSKY, RISK AND CULTURE: AN ESSAY ON THE SELECTION OF TECHNOLOGICAL AND ENVIRONMENTAL DANGERS 1, 8 (Univ. Cal. Press 1982) ("Risk taking and risk aversion, shared confidence and shared fears, are part of the dialogue on how best to organize social relations.").

26. *Id.* at 727 fig.28.1 (showing the group-grid scheme); *id.* at 731 fig.28.3 (showing scales).

27. *Id.* at 741. Kahan explains the "white male effect" by suggesting (maybe concluding) that this can be understood by placing the white males on the scale to explain the underlying reason why white males might be grouped together by their risk perception.

28. *Id.* at 734–35 ("A certain measure of heterogeneity among individuals is perfectly consistent with there being aggregations of persons who exert a dominant influence on social structures and affiliated worldviews (Braman et al. eds., 2005). Under either of these conditions, we would expect individuals to form packages of

participant's perception of climate change: a communitarianism-oriented participant might support combatting climate change because of the effect on the group and future generations whereas a participant associated with individualism might oppose combatting climate change because it impacts their business with additional regulatory compliance. Underscoring this is that each participant's association with their culture demonstrates their perception of the risk of climate change. Empirical studies testing cultural cognition place participants on a "group-grid" scheme and reliably predict the respondents' perception of risk.[29]

Notably, Dan Kahan collaborates closely with Paul Slovic (discussed above as the pioneer of the affect heuristic), which allows cross-pollination discussion and testing of the interplay of multiple decision-making theories. Kahan recognizes that the psychological concepts and cultural associations are mechanisms that can both exist at the same time.[30]

Interestingly, Kahan and colleagues found that even when subjects were not familiar with a specific technology, such as nanotechnology, they still assessed or assigned risk in a way that broke them into their cultural groups.[31] This could suggest that risk perception is based on cultural identity either much more so or exclusive of familiarity. Or, as Kahan suggests, that those with more individualistic groupings are more likely to learn about nanotechnology and then see it as low risk.[32] And, this cultural grouping explains why they become familiar with the technology and then are able to assign a low risk.

Work by Kahan and others suggests that simply providing people with information will not change their risk assessment. To do so, information must be provided in a way that affirms their cultural identities, only then can the subjects have a better chance of appropriately assigning risk.[33] In other words, opposing groups can come to the same conclusion depending on how the information is presented.[34] In this way, risk perception

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risk perceptions characteristic of their groups in proportion to the strength or degree of the attachment to the cultural groups with whom they are most closely affiliated (cf. Manton et al. 1992). That's basically what our measures are designed to show.").

29. Kahan (2012), *supra* note 2, at 740 fig.28.8 (showing that perceived risks are correlated with world views).

30. *Id.* at 739 ("Whether or not viewed as faithful to Douglas's vision, studies using psychometric concepts and methods have identified a variety of discrete mechanisms of cultural cognition."); *See, e.g.*, Dan M. Kahan, Donald Braman, Paul Slovic, John Gastil & Geoffrey Cohen, *Cultural Cognition of the Risks and Benefits of Nanotechnology*, 4 NATURE NANOTECHNOLOGY 87, 89 (2008) [hereinafter Kahan et al. (2008)] ("Social psychology is making important advances in identifying techniques for framing information on controversial policy issues in a manner that makes it possible for people of diverse values to derive the same factual information from it.").

31. Kahan et al. (2008), *supra* note 30, at 87 ("Holding cultural-worldviews constant (at the sample mean), information exposure does not have a significant effect on the likelihood that either a subject who is relatively unfamiliar with nanotechnology or one who is relatively familiar with it will perceive the benefits of nanotechnology to be greater than its risks.").

32. *Id.* at 88 ("The second finding sheds some light on what the influence—or set of influences—might be. Regressing self-reported familiarity with nanotechnology on various individual characteristics revealed that being *simultaneously hierarchical and individualistic* predicted greater familiarity with nanotechnology.").

33. Kahan (2012), *supra* note 2, at 753 ("Cultural-identity affirmation hypothesizes that you can get the same effect when you communicate information about risk in a way that affirms rather than threatens their cultural worldview.").

34. *Id.* (describing an experiment in which subjects were presented with information about global warming that threatened or affirmed their world view and found "biased assimilation with a vengeance.").

can be aligned with evidence-based risk assessment even if participants lean towards one cultural group versus another.

D. Heuristics and Dual Process Theory

Amos Tversky and Daniel Kahneman's important work on decision-making is ground-breaking.[35] While an enormous body of literature surrounds their work, this article seeks to simplify their work in an effort to make it digestible. Their work can be broken down into two related categories: heuristics and dual process.[36] These categories help to explain each other.

The first category addresses preferences as signals of risk aversion and is known as heuristics. This theory provides that people rely on heuristics principles to simplify assessing probabilities, but that sometimes these heuristics lead to errors.[37] Underscoring this theory are biases that impact decision-making discussed in turn below.

The first bias is Representativeness.[38] In this bias, people associate certain characteristics with a particular class.[39] For example, if a person is described as shy, withdrawn, and very helpful, and then people are asked to choose from a likely occupation that the person is a librarian or physician, people are likely to associate the person as being a librarian.[40] This is true, even though there are many more physicians than librarians, but people do not consider such an important factor in their assessment.[41] In other tested scenarios, Tversky and Kahneman note that other probabilities, such as sample size, misconceptions of chance, and predictability, are also ignored in this bias.[42]

The second bias is Availability.[43] In this bias, people are influenced by the ease with

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35. *See generally* Kahneman (2011), *supra* note 22 (book summarizing Kahneman's contributions to this field).

36. *Id.* at 8 (describing a publication in Science that provided research based on years of collaboration and experimentation: "It described the simplifying shortcuts of intuitive thinking and explained some 20 biases as manifestations of these heuristics – and also as demonstrations of the role of heuristics in judgment.").

37. Tversky and Kahneman, *supra* note 2, at 3 ("This article shows that people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors.").

38. *Id.* at 4 (Representativeness refers to when "probabilities are evaluated by the degree to which A is representative of B, that is, by the degree to which A resembles B.").

39. *Id.* (providing an example in which a person is described as follows: "Steve is very shy and withdrawn, invariably helpful, but with little interest in people, or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail." Participants are then asked the probability that Steve is engaged in a particular profession by choosing from a list of professions. Tversky and Kahneman demonstrated that people order the likelihood of a particular profession by the degree to which Steve represents a typical person in that profession.).

40. *Id.* (describing Steve, as noted in the previous footnote, and learning that people think Steve is a librarian).

41. *Id.* ("This approach to the judgment of probability leads to serious errors, because similarity, or representativeness, is not influenced by several factors that should affect judgments of probability.").

42. Tversky & Kahneman, *supra* note 2, at 4–11 (describing insensitivities, misconceptions, and illusions that contribute to the representativeness bias).

43. *Id.* at 11 ("Availability is a useful clue for assessing frequency or probability, because instances of large classes are usually reached better and faster than instances of less frequent classes. However, availability is affected by factors other than frequency and probability. Consequently, the reliance on availability leads to predictable biases, some of which are illustrated below.").

which the frequency or probability of an event can be brought to their mind.[44] In their work, Tversky and Kahneman use the example that a person may assess the risk of a heart attack in a middle-aged person by calling to the front of their mind whether any of their middle-aged acquaintances have had heart attacks.[45] But, as Tversky and Kahneman note, this decision-making process leads to biases.[46] These biases can be based on the ability to retrieve information, which leads to probability or frequency biases.[47] Other deficiencies include the effectiveness of a search set, the ability to construct probabilities, and pairing events that are not necessarily correlated.[48]

The third bias is Adjustment and Anchoring.[49] In this bias, people start with an initial value and then adjust.[50] This is problematic if either the initial value or the adjustment is incorrect.[51] People can be given different initial values, but if they make the same adjustment, they will conclude different results. Other problems with this bias include difficulty evaluating conjunctive and disjunctive events and subjective probability distribution.[52]

In sum, this category/theory is concerned with cognitive biases that impact the heuristic to which people rely on to make decisions and perceive risk.[53] In other words, subjective probability is different than actual probability. People do this without realizing it and begs the larger question as to whether these heuristics can be overcome to allow people to make risk assessments that are in line with evidence-based risk assessments.

The second category, Dual Process theory, addresses the distinction between thinking fast and slow or, in other words, the subconscious versus the conscious.[54] Daniel

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44. *Id.* ("There are situations in which people assess the frequency of a class or the probability of an event but the ease with which instances or occurrences can be brought to mind.").

45. *Id.* ("For example, one may assess the risk of heart attack among middle-aged people by recalling such occurrences among one's acquaintances.").

46. *Id.* at 11–14.

47. Tversky & Kahneman, *supra* note 2, at 11 (providing a good example: "It is a common experience that the subjective probability of traffic accidents rises temporarily when one sees a car overturned by the side of the road.").

48. *Id.* at 12–14 (describing how other biases lead to systematic errors).

49. *Id.* at 14 ("in many situations, people make estimates by starting from an initial value that is adjusted to yield the final answer. The initial value, or starting point, may be suggested by the formulation of the problem, or it may be the result of partial computation. In either case, adjustments are typically insufficient (Slovic & Lichtenstein, 1971). That is, different starting points yield different estimates, which are biased toward the initial values. We call this phenomenon anchoring.").

50. *Id.*

51. *Id.*

52. Tversky & Kahneman, *supra* note 2, at 14–18 (discussing the problems, including biases, in anchoring and adjustment).

53. *Id.* at 18–20 ("This article described three heuristics that are employed in making judgments under uncertainty: (i) representativeness, which is usually employed when people are asked to judge probability that an object or event A belongs to class or process B, (ii) availability of instances or scenarios, which is often employed when people are asked to assess the frequency of a class or the plausibility of a particular development, and (iii) adjustment from an anchor, which is usually employed in numerical prediction when a relevant value is available. These heuristics are highly economical and usually effective, but they lead to systematic and predictable errors. A better understanding of these heuristics and of the biases to which they lead could improve judgments and decisions in situations of uncertainty.").

54. Kahneman (2011), *supra* note 22, at 20–21 ("*System 1* operated automatically and quickly, with little or no effort and no sense of voluntary control. *System 2* allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective

Kahneman describes this theory as what happens when someone compares facial recognition, which is usually done quickly, with multiplying multi-digit numbers, which usually requires effort.[55] Of course, the more a person must slow down to think about something, the more effort that must be dedicated to such a decision. The quick thinking, or in this example facial recognition, is referred to as system 1.[56] The slow thinking, or this example multiplying multi-digit numbers, is referred to as system 2.[57]

The limitations of the fast thinking (system 1) are that a person utilizes what they can quickly recall without the time or effort to obtain additional information.[58] Kahneman refers to this as natural intuition, which serves humans well at least in some circumstances.[59] But, intuition leads to mistakes.[60] This is not necessarily distinct from the biases discussed under Heuristics, described above, since these biases are the bases of quick thinking.[61]

The slow thinking (system 2) is what we generally refer to as analytical and logical.[62] Some describe this slower thinking as based on algorithms, for example, which allow multiple inputs, control for variables, and then reasoned probabilities.[63] But, biases can still underscore assumptions which create the very algorithms to which the slow thinking person relies on, even if the bias is unconscious.[64] Nevertheless, even if biases are present in both fast and slow thinking, dual process theory still has legs because other parts of the cognitive process are different. The slower thinking process is thought to have procedures to override the subconscious mind that is driving the fast thinking.[65]

At issue in the dual process theory is how people learn to think slow.[66] Is it through age? Is it through education? Is it though experience? Is it from an internal mechanism? Is it from an external mechanism? Can people be taught to think consciously? Pierre Noel

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experience of agency, choice, and concentration.").

55. *Id.* at 19–20.

56. *Id.* at 20–21.

57. *Id.*

58. *Id.* at 25 ("The division of labor between System 1 and System 2 is highly efficient: it minimizes effort and optimizes performance. The arrangement works well most of the time because System 1 is generally very good at what it does: its models of familiar situations are accurate, its short-term predictions are usually accurate as well, and its initial reactions to challenges are swift and generally appropriate. System 1 has biases, however, systematic errors that it is prone to make in specified circumstances.").

59. Kahneman (2011), *supra* note 22, at 25–30.

60. *Id.*

61. Pierre Noel Barrouillet, *Dual-Process Theories and Cognitive Development: Advances and Challenges*, 31 DEVELOPMENTAL REV. 79, 79–80 (2011) ("The famous studies by Kahneman and Tversky on judgment and decision making (Kahneman, Slovic & Tversky 1982) completed the portrait of reasoning driven by a set of heuristics that departs from any logic or normative theory. Overall, the so-called 'heuristics and biases' literature deeply disconfirmed the presumed rationality of adult human beings.").

62. Barrouillet, *supra* note 61, at 80 ("Inherently deliberative, conscious, controlled, slow, and demanding in working memory resources, this second type of processing or system is probably unique to humans and assumed to underpin analytical, logical reasoning and normative responses.").

63. *Id.* at 81–84 (describing studies addressing dual process thinking); Kahneman (2011), *supra* note 22, at 29–30.

64. Kahneman (2011), *supra* note 22, at 109–18 (describing how the law of small numbers can create a bias in system 1, and even system 2, thinking).

65. Barrouillet, *supra* note 61, at 81 (describing the work of Jonathan Evan's work regarding dual process thinking).

66. Kahneman (2011), *supra* note 22, at 354–62.

Barrouillet, in a discussion of the facets of dual process theory, raises the variable that biases perhaps increase with age along with experience, and thus even though we expect adults to have more of a handle on slow thinking, it is possible that reliance on intuition can increase with age.[67] This query is spurred by the work of Reyna and Brainerd, which refers to this as the fuzzy-trace theory.[68]

In sum, both heuristics and dual process theory differentiate between intuition or sub-conscious decisions with deliberate or conscious decisions. Scholarship in this area acknowledges that biases and heuristics cannot be divorced from these thinking processes and might even be layered into them.[69] Some may question whether the slow and deliberative thinking necessarily leads to better decisions, which for the purposes of this paper, refers to decisions that appropriately assign risk.[70]

E. The Problem with Decision-Making

All of these theories are empirically tested and so there is no reason to reject that they help us to understand how people make decisions. The problem is that they can be in conflict and lead to different results, which begs the question about which theory may explain a particular decision at a given time. For example, a vaccine hesitant parent (VHP) may decide not to vaccinate, but at the same time may be concerned about climate change and make decisions for the good of the community. These are inconsistent results if only explained by the cultural cognition theory. The cultural cognition theory likely predicts that someone who trends towards egalitarianism on climate change (i.e., good for the community) would similarly decide the same way about long-standing vaccines—also a community-oriented position.[71] Cultural cognition, as valid and compelling as it is, is not the only explanation for decision-making.

One concern about decision-making is that the strength of the processes underlying any decision is not static. At times, affect may be the prevailing thinking process which could conflict with how the person would make the decision if cultural cognition was the only thinking process at play. Perhaps this is not a controversial idea; certainly none of the proponents of each theory propose that their theory is the only theory. But, it begs the question of how to know which theory (or theories) are most likely dominating for any particular decision—especially when the person inappropriately assigns risk—so that policies can be communicated to that person in such a way that they can appropriately assign risk.

Another problem, perhaps, is how changes in society impact how people make

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67. Barrouillet, *supra* note 61, at 83–84.

68. *Id.* at 84 ("As all the other dual-process theories, the fuzzy-trace theory distinguishes between analytical thinking, which is slow and conscious, and intuition that operates quickly, out of consciousness.").

69. Kahneman (2011), *supra* note 22, at 109–95 (discussing how bias and heuristics explain system 1 and system 2 thinking).

70. An example is the Invisible Gorilla experiment in which participants are engaged in an engrossing task and may not see the person wearing the gorilla suit enter the picture. Daniel Kahneman, *Of 2 Minds: How Fast and Slow Thinking Shape Perception and Choice [Excerpt]*, SCI. AM., (June 15, 2012), https://www.scientificamerican.com/article/kahneman-excerpt-thinking-fast-and-slow/.

71. It is possible that a vaccine made from new technology might be seen as riskier by the communitarian-egalitarianism group-grid. Work by Kahan suggests that this group-grid might be more risk adverse. Kahan (2012), *supra* note 2, at 740 fig.28.8.

decisions, if at all. How, for example, does the internet impact how we assess these theories, at least with respect to a variable within an empirical study? Are VHPs finding a community of other VHPs on-line? Research already demonstrates that those that group towards communitarianism already perceive technology as more-risky and now they can find a group with like-minded perceptions.[72] Or, is it receipt of information online leading to fear of vaccination leading to life-long debilitating side effects (for which there is zero evidence) that impacts the decisions made by VHPs?

Over the past seventy years, our society has moved towards an individualistic society.[73] How does the movement towards individualism impact decision-making? In the 1950s, for example, people lived in smaller communities and had some stake in their communities.[74] This, of course, had all sorts of externalities by promoting racism and bigotry, for example, and with the change towards expressing feelings and individualism, we moved away from racism (sort of), but an entirely new set of problems arose.[75] Perhaps we moved too far away from community and a person's perception of their place in a larger community may be distorted.[76] This begs the question as to how the prevailing decision-making theories can incorporate this. Most likely, they can.

In addition, well-funded groups create confusion in the marketplace.[77] A large anti-GMO campaign, for example, undoubtedly contributes to the inappropriate assignment of risk to this technology. These anti-GMO groups provide misinformation in a way that exploits how people make decisions, using fear, for example.[78]

These variables: (1) individualism, (2) internet, and (3) economics, provide factors that impact the way people make decisions as it relates to risk perception. A further discussion of this problem, along with suggestions to address the problem, is the subject of Part IV. Before that discussion, this article acknowledges that strategies exist to implement policies that seek to align the public's perception of risk with evidence-based assessment of risk.

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72. *Id.* at 744 (discussing how participants respond to information about a new technology in a "biased manner supportive of a *predisposition* toward risk.").

73. *See* DAVID BROOKS, THE SECOND MOUNTAIN 6–20 (2019).

74. *Id.* at 4–7.

75. *Id.* at 6 (describing a city as a "collection of villages" but also admitting that "this culture had failings, which ultimately made it intolerable. This moral ecology tolerated a lot of racism and anti-Semitism. Housewives felt trapped and stifled, and professional women faced daunting barriers. In 1963, Betty Friedman described a problem that had no name, which was the flattening, crushing boredom of many female lives. The culture had an emotionally cold definition of masculinity; men had trouble expressing love for their wives and children. The food was really boring. People felt imprisoned by the pressure of group conformity and tortured by the intolerant tyranny of local opinion. Many played out their assigned social roles, but they were dead inside.").

76. *Id.* at 18 (discussing the problem of the Instagram life and stating: "The problem is that the person in the aesthetic phase sees life as possibilities to be experienced and not projects to be fulfilled or ideals to be lived out. He will hover above everything but never land. In the aesthetic way of life, each individual day is fun, but it doesn't seem to add up to anything.").

77. *See, e.g.*, U.S. RIGHT TO KNOW, (last visited Jan. 22, 2020), https://usrtk.org/ (a well-funded anti-GMO group); *see also*, Alex Berezow & Gary Ruskin, *GMO Labeling Movement Funded by Anti-Vaxxers*, AM. COUNCIL ON SCI. & HEALTH, (May 8, 2017), https://www.acsh.org/news/2017/05/08/gary-ruskin-gmo-labeling-movement-funded-anti-vaxxers-11245.

78. MARK LYNAS, SEEDS OF SCIENCE 140–44 (2018) (describing how anti-GMO activists make claims about the side effects of eating GMOs, including, for example, that children will be born with the head of a corn plant). Although, admittedly, the manufacturers of GMO seeds, such as Monsanto, are also well-funded. But, Monsanto does not appear to be able to manipulate consumers into choosing foods from GMOs.

II. POLICY IMPLEMENTATION

The following highlights tools used for policy implementation in which the purpose is for the consumer to make a decision in line with expert analysis of risk. These tools are designed to change behavior, although they do so in different ways. Although numerous tools exist, this article focuses on those that interact with decision-making theories. Below is a descriptive narrative with a discussion in Part IV regarding how these tools adequately or inadequately accomplish their goals in light of decision-making, particularly in the area of emerging biotechnology. The three main tools discussed include nudging, risk communication and risk perception (Risk Hybrid), and public participation through notice and comment.

A. Nudging

Nudging is defined as "liberty-preserving approaches that steer people in particular directions, but that also allow them to go their own way."[79] An example of nudging is automatic enrollment in a retirement plan—this "nudges" a person to save for retirement, but the person can also opt out.[80] The person is not required to save for retirement, but the auto enrollment steers the person to do so. The hallmark of nudging is that it allows the person freedom of choice and transparency with generally low (or no) cost.[81] This makes nudging distinct from rules or government decisions that are coercive or hidden from public scrutiny.[82]

Importantly, effective nudges need to be based on evidence.[83] Effective nudges are those that understand how people will respond, or in other words, how people will make decisions. In his work, Cass Sunstein describes ten important mechanisms of nudges: (1) default rules (e.g., auto-enrollment in retirement plan); (2) simplification (e.g., easy to navigate); (3) uses of social norms (e.g., behave this way because most others do); (4) increase in ease and convenience (e.g., healthy food options most visible); (5) disclosure (e.g., environmental harm with dirty energy use); (6) warnings (e.g., cigarette labels); (7) precommitment strategies (e.g., committing to a future action such as smoking cessation); (8) reminders (e.g., text message reminder); (9) eliciting implementation intentions (e.g., will you vaccinate your child?); and (10) informing people of the nature and consequences of their own past choices (e.g., how much they spent on electricity last year).[84]

The problem with nudging is that it assumes people will respond appropriately to the nudge. Of course, Cass Sunstein and others acknowledge that nudges need to be empirically tested, and it is possible that a particular nudge does not create the result intended.[85] If that is the case, then the nudge needs to be changed. This provides a

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79. Cass R. Sunstein, *Nudging: A Very Short Guide*, 37 J. CONSUMER POL'Y 583, 583 (2014).

80. *Id.* (describing examples of nudges, including: informing customers that a bill is due, automatic enrollment in a retirement plan, auto pay options for credit cards, and mortgages).

81. *Id.* at 584 (providing the rationale and examples of how nudges allow people to maintain freedom of choice and that nudges should be "transparent and open rather than hidden and covert.").

82. *Id.*

83. *Id.* at 585 ("For all policies, including nudges, it is exceedingly important to rely on evidence rather than intuitions, anecdotes, wishful thinking, or dogmas.").

84. Sunstein, *supra* note 79, at 585–87 (describing ten important nudges).

85. *Id.* at 585 ("But some policies, including some nudges, seem promising in the abstract but turn out to fail

tremendous amount of flexibility in the implementation of any policy that seeks particular behaviors and can be accomplished in a cost-effective manner.

Emerging technologies present a distinct issue because of risk perception. People tend to prefer a known risk even if it is higher than a likely lower risk with a new technology.[86] Nudging people to take the new, likely lower risk, creates challenges. It is possible to increase the ease and convenience of buying foods from GMOs, but this nudge may not be effective given the overwhelming marketing done by the organic food industry. It is not that a nudge could not work, but it raises questions of efficacy in the biotechnology arena that need to be explored.

B. Risk Hybrid

Perhaps a hybrid of decision-making theory and policy implementation, the concept of Performativity helps explain the effect of risk communication on a person's assignment of risk. Work by P. Marijin Poorvliet, Kai Purnhagen, and others attempt to distinguish between risk as perception and risk as analysis although as a reality, they acknowledge these categories are not realistically exclusive and suggest the term risk hybrid.[87] In this way, Poorvliet and Purnhagen frame the real problem, which is how risk communication impacts risk assessment.[88]

The idea of risk hybrid, in which the subjective and objective communication of risk meet, is particularly apt in controversial areas. Political views, divergent perspectives, industrial parties, and scientists may have divergent perceptions.[89] How these modalities are communicated to people impact the development of the risk debate.[90] This perception of risk helps to explain or understand how people make decisions in which they appropriately or inappropriately assign risk.[91] While it may seem that objective risk assessment should be the preferred method of communication in order for people to make an appropriate assessment of risk, the reality is that people receive both objective and subjective information. To further complicate matters, even an objective risk assessment may really be a probability; thus, some range of risk exists depending on a number of assumptions that may or may not hold.[92] Therefore, any discussion of risk communication

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in practice.").

86. *Cf.* Ellsberg, *supra* note 2, at 657.

87. P. Marijn Poortvliet, Martjin Duineveld & Kai Purnhagen, *Performativity in Action: How Risk Communication Interacts in Risk Regulation*, 7 EURO. J. RISK REG. 213, 214 (2016) ("Objectified and perceived risks will be difficult – if not sometimes impossible – to separate in practice. As an alternative we introduce the concept of *risk hybrids*, which combines objectified risk (how the risk is represented in risk analysis) and a perceived risk and nullifies the a-priory made distinction between the two.").

88. *Id.* ("By observing how different risk communications perform different risk hybrids in the various contexts in which they emerge, we show how the concept of risk hybrids can offer a richer understanding of risk communication practices.").

89. *Id.* at 213 ("Numerous reasons, such as divergent perspectives, ways of communication, and interests, explain why involved actors often find themselves locked in a controversy.").

90. *Id.* ("For instance, in the GMO debates environmental politicians, NGOs, industrial parties, consumers, and GMO scientists have exerted very distinct ways of communication, resulting in a highly polarized and contested gene-risk landscape").

91. *Id.* ("A key conceptual distinction made within such debates, among academics, in the literature, and in wider society, is one between *perceived or subjective* risks on the one hand, and *factual or objective* risks on the other.").

92. Poortvliet, *supra* note 87, at 214 ("In risk assessment many different conceptualizations of risk and

and the impact thereof must acknowledge this reality.

How risk is communicated to people is extremely important for policy implementation. In general, good government policy is supported by an evidence-based risk assessment. In some cases the evidence-based risk assessment is correct. But, what happens when it is wrong? People may lose trust in the government and its policies. This potential distrust can also sway a balance in a risk hybrid communication scenario, where people might believe perceived risks over objective risks, especially if they distrust that an objective risk assessment is possible.

Even assuming *arguendo* that people do not distrust, or have no reason to distrust, an objective risk assessment, research demonstrates that people do not necessarily make rational decisions.[93] In other words, perceived risks help us to understand why people may inappropriately assign risk (e.g., assigning a higher risk to flying than driving a car).[94]

Because government actors are not the only communicators of risk, studying how risk communication impacts people's risk assessment is quite challenging. The media may pick up a story and their risk communication can insert a different ratio in the risk hybrid—either more objective or more perceived. Other interested actors, say those that oppose a particular regulation, may also communicate risk. Obtaining an understanding of these influences and how to communicate evidence-based risk assessment poses an enormous challenge.

C. Notice and Comment

Public participation through notice and comment may also present a way for the public to engage and be informed in regulatory policy creation and implementation. Important work by Ed Rubin and others analyze the mechanisms in which agencies can implement policies either through voluntary guidance documents or a formal rulemaking process with notice and comment.[95] Without describing the intricate machinations of how an agency knows whether to use guidance or formal rulemaking, the larger message is the ability for the public to engage with the agency through the notice and comment process.

Rubin proposes that, in cases in which the policy addresses an issue subject to public controversy, agencies should engage in notice and comment.[96] The purpose is not just for

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uncertainty can be used. Examples of risk concepts include risk as an expected value, as a probability distribution, as an expected disutility, as an epistemic or stochastic uncertainty, as a simple threshold level for when a substance is deemed to be hazardous and so forth.").

93. *Id.* at 213–14 (discussing the difference between perceived and actual risk).

94. *Id.* at 215 ("For example, some travelers are quite worried about the safety of taking a plane but [sic] not even consider the – statistically much greater – risk of driving to the airport.").

95. Edward L. Rubin & Joanna K. Sax, *Administrative Guidance and Genetically Modified Food*, 60 ARIZ. L. REV. 539, 566 (2018) ("In our system, the specific technique to which the term 'guidance' has generally been attached is a type of rule under the APA. Section 553 of the APA prescribes procedures for two types of rulemaking: formal rulemaking, which must follow the same trial-type procedures as adjudications under section 556 and 557 of the statute, and informal rulemaking, which must follow only the much less demanding notice and comment procedure specified in section 553 itself."). This article was co-authored, but the intellectual muscle related to administrative law is properly attributed to Ed Rubin.

96. *Id.* at 582 ("A remedially oriented approach to the review of guidance documents would satisfy both the instrumental and normative goals of notice and comment procedure and the countervailing goal of rulemaking flexibility. To begin with, this approach suggests that notice and comment rulemaking should only be imposed on agency pronouncements to the general public.").

good government practices; rather, it is a way for the public to participate and to (hopefully) be educated in the process. Both the engagement and the education may allow people to appropriately assign risk when the final rule, for example, is implemented.

Agencies should rely on evidence-based assessments to support any policy implementation. In addition, the actors within the agency are supposed to be able to differentiate between scientific support and consumer misperception. Assuming the actors within the agency behave this way, an assumption that may not always stand, the final policy should assign the evidence-based risk assessment. But, the process to obtain the final policy is what could allow people to come to the same conclusion as the agency or, at least, be educated through the process. Then, once the policy is enacted, through a final rule or other mechanism, the space between the agency's evidence-based assessment of risk and the person's own risk assessment should align.

D. Overview of Risk-Communication Strategies

The strategies outlined above describe a mere sampling of ways to attempt to align people's perceptions of risk with evidence-based assessment of risk. This is a non-exclusive list; rather, its purpose is to describe some thoughtful and well-studied mechanisms for policy implementation that consider behavior and decision-making. Additional examples exist but are not necessarily needed to support the main thesis of this article, which is to assess the problems with decision-making as it relates to the implementation of policies for biotechnology and the attempt to reconcile this issue with ways to align people's perceptions of risk with evidence-based assessment of risk.

Aligning people's perceptions of risk with evidence-based assessment of risk is not an easy task. A tremendous amount of money is spent to sway people in a particular direction. The organic food industry, for example, has an economic interest in steering people away from bioengineered food. This is an intentional example where big money in a big industry is at play. Other examples are much less intentional. The anti-vax movement, for example, may not have the same economic incentives (although perhaps there is big money in holistic and snake oil applications), but the impact on people is similar. In both of these cases, large groups of people inappropriately assign risk to areas in which the scientific assessment of risk is low. This begs the important question raised in this article, which is: how do we align risk perception with risk assessment?

III. CONTROVERSIAL AREAS IN BIOTECHNOLOGY

Biotechnology in some ways faces a unique problem and in other ways faces the same problem as any other decision. The unique fact is that biotechnology is often future facing, which means some risks will always be unknown.[97] From a scientific perspective, these unknowns are not problematic. Scientists can predict the likelihood of risk. But, this is highly problematic for consumers who may want to hear that there is no chance of future harm. For example, scientists reached a consensus that food in the marketplace that is from

97. Sax (2017), *supra* note 12, at 474 ("[S]cientific uncertainty is part of the scientific process. Unknowns always exist in science, but this is different than having enough information to be able to assign a probability of risk. Consumers may have trouble differentiating between scientific uncertainty and risk.").

genetically engineered organisms (colloquially known as GMOs) is as safe as conventional food.[98] But, scientists cannot unequivocally state that GMOs will never have any risk in the future. Similarly, scientists cannot unequivocally say that conventional and organic food products will never present a harm in the future. This is not how evidence-based risk assessment works. Not only do consumers have a difficult time assigning risk, but this scientific process is exploited by opponents to biotechnology.[99] Opponents can communicate to consumers something as provocative as "Even the scientists cannot tell you with 100% certainty that the food you are eating is safe."[100] This creates all sorts of problems that influence decision-making.

Discussed below are examples of areas of biotechnology that are not controversial in the scientific community, but generate great controversy in the public sphere. Included in this discussion are empirical studies in which decision-making theories help to explain the discrepancy between consumer perception of risk and evidence-based assessment of risk, to the extent that such empirical studies are available. In addition, this section will highlight how different theoretical modes of decision-making, discussed in Part I, are implicated in the disconnect between consumer perception of risk and evidence-based assessment of risk. Furthermore, this section will discuss the thread within this article that decision-making is complicated and that more than one theoretical basis may help to explain the disconnect. In other words, we cannot think of the problem as silos; instead, this article argues that it has to be addressed as a wholescale problem.

A. Genetically Engineered Food

One of the most controversial areas of biotechnology in the modern world are crops

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98. Chelsea Snell et al., *Assessment of the Health Impact of GM Plant Diets in Long-term and Multigenerational Animal Feeding Trials: A Literature Review*, 50 FOOD & CHEMICAL TOXICOLOGY 1134, 1145 (2012); Pamela Ronald, *Plant Genetics, Sustainable Agriculture and Global Food Security*, 188 GENETICS 11, 12 (2011); Press Release, American Association for the Advancement of Science, Statement by the AAAS Board of Directors on Labeling of Genetically Modified Foods (Oct. 20, 2012), http://www.aaas.org/sites/default/files/migrate/uploads/AAAS_GM_statement.pdf [hereinafter Statement by AAAS]; Yan Song et al., *Immunotoxicological Evaluation of Corn Genetically Modified with* Bacillus thuringiensis Cry1Ah *Gene by a 30-day Feeding Study in BALB/c Mice*, 9 PLOS ONE 1, 10 (2014) http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0078566; Yanfang Yuan et al., *Effects of Genetically Modified T2A-1 Rice on the GI Health of Rats After 90-day Supplement*, 3 SCI. REP. 1, 6–7 (2013), http://www.nature.com/srep/2013/130611/srep01962/pdf/srep01962.pdf; Xueming Tang et al., *A 90-Day Dietary Toxicity Study of Genetically Modified Rice T1C-1 Expressing Cry1C Protein in Sprague Dawley Rats*, 7 PLOS ONE 1, 6 (2012), http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0052507; *see also* Philip D. Brune et al., *Safety of GM Crops: Compositional Analysis*, 1 J. AGRIC. & FOOD CHEMISTRY 8243, 8245 (2013); William D. Price & Lynne Underhill, *Application of Laws, Policies, and Guidance from the United States and Canada to the Regulation of Food and Feed Derived from Genetically Modified Crops: Interpretation of Composition Data*, 1 J. AGRIC. FOOD & CHEMISTRY 8349, 8353 (2013); Declan Butler, *Hyped GM Maize Study Faces Growing Scrutiny*, NATURE INT'L WKLY. J. SCI. (2012), http://www.nature.com/news/hyped-gm-maize-study-faces-growing-scrutiny-1.11566 (rejecting paper that found adverse health events in rats fed GM corn); Mischa Popoff et al., *Organics versus GMO: Why the debate?*, GENETIC LITERACY PROJECT (Oct. 15, 2013), http://www.geneticliteracyproject.org/2013/10/15/organics-versus-gmo-why-the-debate/; A. Mukherjee et al., *Preharvest Evaluation of Coliforms,* Escherichia coli*,* Salmonella*, and* Escherichia coli *O157:H7 in Organic and Conventional Produce Grown by Minnesota Farmers*, 67 J. FOOD PROTECTION 894, 894–900 (2004).

99. *See infra* Part IV.C.

100. *Cf.* Slovic & Peters, *supra* note 11, at 322 (explaining how the use of emotion can lead to an inappropriate assignment of risk).

produced from the application of biotechnology.[101] These are colloquially called GMOs, but this term is completely inadequate because some crops created through the use of biotechnology are not genetically modified organisms. While the term 'bioengineering' is a more apt description, and the one being used by the United States Department of Agriculture (USDA) in implementing the new labeling law, consumers recognize and utilize the term GMO.[102] In addition, the label "GMO-free" means something to consumers. For this reason, this article will use the colloquial term "GMO," not only due to its familiarity, but also for the reason that it will more likely be read by consumers who are interested in learning about GMOs.

Plants have highly dynamic genomes, and it may surprise a non-scientist to learn that plants have a lot of changes occurring to their DNA all of the time.[103] Actually, this is one of the reasons that GMOs do not pose any higher risk compared to conventional breeding techniques.[104] A small change to a plant's DNA through biotechnology techniques is less invasive than what happens through traditional breeding techniques.[105] Either way, if the change to the genome through biotechnology or traditional breeding techniques creates genomic instability, the plant will simply die. If the plant can withstand the change, it will survive and grow.[106]

For some crops, the genomes are already highly selected through traditional breeding techniques, and the only way to obtain another favorable trait is through the application of techniques in biotechnology. This is particularly true for clonally propagated and highly heterozygous crops, which already have highly selected background.[107] No form of traditional breeding technique can likely achieve such a result, or even if it could achieve it theoretically, the likelihood that traditional breeding could

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101. William Saletan, *Unhealthy Fixation: The war against genetically modified organisms is full of fearmongering, errors, and fraud. Labeling them will not make you safer.*, SLATE (July 15, 2015 5:45 AM), http://www.slate.com/articles/health_and_science/science/2015/07/are_gmos_safe_yes_the_case_against_them_is_full_of_fraud_lies_and_errors.html.; *cf.* Gregory Conko, Drew L. Kershen, Henry Miller & Wayne A. Parrott, *A Risk-Based Approach to the Regulation of Genetically Engineered Organisms*, 34 NATURE BIOTECHNOLOGY 493, 493 (2016) (promoting a risk based regulatory approach).

102. *See* Pub. L. No. 114-216, 130 Stat. 834 (July 29, 2016) (codified at 7 U.S.C. § 293(a)(1)) (directing the Secretary of the USDA to "establish a national mandatory bioengineered food disclosure standard with respect to any bioengineered food and any food that may be bioengineered . . . ." within two years of the date of enactment of this law); *see also* USDA, *Establishing the National Bioengineered Food Disclosure Standard*, U.S. DEP'T OF AGRIC. (last visited Jan. 22, 2020), https://www.usda.gov/media/press-releases/2018/12/20/establishing-national-bioengineered-food-disclosure-standard.

103. Steven H. Strauss & Joanna K. Sax, *Ending Event-Based Regulation of GMO Crops*, 34 NATURE BIOTECHNOLOGY 474, 476 (2016) ("These studies show evidence of far greater structural, epigenetic and gene-expression variation than had been expected, in general, far exceeding those imparted by genetic engineering (e.g., refs. 11,24,25,26).").

104. *Id.* ("Gene insertion appears to be a small impact by comparison to the ongoing dynamic variation in gene and genome structure during evolution and breeding" and citing references 22 and 24 therein); Natalie Weber, et. al., *Crop Genome Plasticity and Its Relevance to Food and Feed Safety of Genetically Engineered Breeding Stacks*, 160 PLANT PHYSIOLOGY 1842, 1842 (2012) [hereinafter Weber (2012)].

105. *Id.* ("Thus, the risk of unintended expression of endogenous toxic proteins from genetic engineering is no greater than conventional breeding, and in most cases far less."); *see also* Conko et al., *supra* note 101, at 493–99.

106. *See* Conko et al., *supra* note 101, at 494 (providing a history of genetic modification); Weber (2012), *supra* note 104, at 1848–89 (discussing the reasons why both large-scale mutations during breeding and genetic engineering techniques do not cause safety issues).

107. Strauss & Sax, *supra* note 103, at 475.

obtain it through mutation or otherwise is so remote that it is simply not a feasible approach.[108]

The science behind GMOs is probably the most fascinating part of the relatively easy explanation as to why food from GMOs is as safe as conventional food.[109] Oddly, some people do not even have an inkling that all of our crops are genetically modified because we grow domesticated crops—which by definition are genetically modified.[110] The label "organic" does not mean that it is a wild-type variety.[111] Rather, it is a genetically modified crop that is grown under "organic" farming techniques.[112] In other words, everything we eat is genetically modified. That people are concerned about GMOs because it is "messing" with the DNA demonstrates a complete lack of understanding about our food supply.[113] Ignorance is not the only explanation; however, the complications in decision-making and risk assessment are critical in this misunderstanding as well.

The controversy around GMOs has not been ignored by those interested in decision-making and consumer perceptions of risk. One study tested whether the theory of ambiguity aversion might help to explain the disconnect between consumer risk perception and evidence-based risk assessment.[114] This study found that participants who responded to predictor questions in a way that suggested aversion to ambiguous information likewise responded to scenarios about foods from GMOs as being high risk and low benefit.[115] In addition, participants who indicated an initial bias against foods from GMOs, similarly assigned high risk and low benefit to scenarios in which the risk of a food from a GMO was described as low.[116] This study suggested that one component of decision-making, at least with respect to the disconnect over foods from GMOs, might be a result of ambiguity

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108. *Cf. id.* (describing the Artic Apple and Innate Potato as examples of this).

109. Rubin & Sax, *supra* note 95, at 543–48 (describing the science of genetically engineered food).

110. *Id.* at 543 ("People have been systematically altering the genetic composition of the food they eat for thousands of years. Many of the plant and animal products that appear in even the earliest historical records resulted from centuries, if not millennia, of selective breeding and vary greatly from anything that could be found in nature.").

111. *See, e.g.*, David Newland, *Sorry Hipsters, That Organic Kale Is a Genetically Modified Food*, SMITHSONIAN MAG (Sept. 10, 2014), http://www.smithsonianmag.com/science/sorry-hipsters-organic-kale-genetically-modified-food-180952656/?no-ist.

112. *See* USDA, *Organic Agriculture* (last modified Jan. 9, 2015), http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=organic-agriculture.html (describing organic agriculture).

113. Strauss & Sax, *supra* note 103, at 475–76 (2016) ("In recent years, as knowledge of genomes has increased, it has become clear that DNA undergoes extensive and dynamic changes in nature and under conventional breeding. These studies show evidence of far greater structural, epigenetic and gene expression variation than had been expected, in general, far exceeding those imparted by genetic engineering. Moreover, the variations observed are of little consequence for food safety.").

114. Sax & Doran (2019), *supra* note 6, at 49 ("The present study was designed to evaluate whether a presentation of missing or conflicting information creates ambiguity and predicts how people make decisions about biotechnology. In this way, a general theme of ambiguity aversion, also referred to herein as openness to missing or conflicting information, may help explain the existing disconnect between scientific consensus and consumer perceptions of risk.").

115. *Id.* at 55 ("Overall, participants in this study indicated aversion to implementing new technology even with a description indicating that that it was likely low risk and high benefit.").

116. *Id.* at 56 ("Interestingly, participants showed the most ambiguity aversion to the food category. It is possible that the current debate about foods from GMOs makes this category more salient to consumers compared to other issues.").

aversion.[117] These results allow policymakers to consider this decision-making process in generating and communicating policies regarding GMOs.[118]

The role of affect in risk perception in various areas of technology is supported by numerous empirical studies. Specifically, for GMOs, studies indicate that implicit attitudes and affect impact how consumers perceive GMOs.[119] These studies have some imperfections but at least provide some sense of how affect impacts risk perception and helps to explain why consumers perception of risk is different than evidence-based assessment of risk.

One study analyzed whether fear or disgust served as the affective predictor in attitudes towards GMOs.[120] This study used survey methodology and employed predictor questions to understand a range of responses to particular events, such as stepping on dog poop or seeing a cockroach run across the floor, to score affective measures of disgust.[121] Using these predictive measures, the authors could analyze the affective response to new technologies, including GMOs.[122] The authors learned that participants demonstrated more of a *creeped out* feeling towards GMOs compared to a tendency to be *disgusted*. This tendency to be *creeped out* indicates that fear might be driving the opposition to GMOs as compared to disgust.[123] The authors tied in the results of the study with other research demonstrating that when people understand technology, they do not tend to be as fearful or *creeped out*.[124]

Cultural cognition may also help to explain people's differing views on GMOs.[125] The application of cultural cognition is done by analogy to other areas of technology in which researchers seek to understand consumer decision-making, such as nanotechnology. In one study the researchers found that providing balanced information about nanotechnology did not support a finding that familiarity with the subject might predict the assignment of risks and benefits.[126] Instead, the authors found support that the participants' attitudes towards nanotechnology could be explained by "psychological

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117. *Id.* at 55–57.

118. *Id.* at 56 ("This study also provides important insights for the mechanism of implementing evidence-based policies. Consumers can find conflicting information on the internet, for example, about vaccines and autism. However, the scientific evidence is clear that no link exists. Understanding why and how consumers respond to the presentation of information and misinformation, which is demonstrated by inappropriately assigning risk, may provide important information to develop communication and other strategies to close the divide between consumer perceptions of risk and scientific assessment of risk.").

119. Edward Rozyman, Corey Cusimano & Robert F. Leeman, *What Lies Beneath? Fear vs. Disgust as Affective Predictors of Absolutist Opposition to Genetically Modified Food and Other New Technologies*, 12 JUDGEMENT & DECISION MAKING 466, 472 (2017) ("First, our data indicate that Scott et al.'s (2016) original result–traditionally assessed trait disgust is a modest yet significant predictor of absolutist opposition to genetically modified food – is quite robust."); *but see* Spence & Townsend, *supra* note 21, at 72.

120. Rozyman et al., *supra* note 119, at 467–68.

121. *Id.* at 469–70.

122. *Id.* at 470–71.

123. *Id.* at 471.

124. *Id.* at 472–74.

125. Kahan and colleagues assessed perceptions of risk as it relates to GMOs, although the study that did this was more focused on nanotechnology. Kahan (2012), *supra* note 2, at 744. Additional empirical studies are needed.

126. Kahan et al. (2008), *supra* note 30, at 87–88 ("Finding no support for the familiarity hypothesis, the study instead yielded strong evidence that public attitudes are likely to be shaped by psychological dynamics associated with cultural cognition.").

dynamics associated with cultural cognition."[127] The authors hypothesized that even with balanced information, participants will not "adopt uniformly positive attitudes, as the familiarity hypothesis suggests, [rather] members of the public who hold relatively egalitarian and communitarian worldviews will perceive its risks to be greater, and its benefits smaller, than will persons who hold relatively hierarchal and individualistic worldviews."[128] This study found that exposure to information had no discernable effect on the participants' perceptions of risks and benefits.[129] Instead, the participants' worldviews explained the risk assessment.[130] When exposed to information about nanotechnology, it was clear that the participants' world view was the variable that most explained the risk assignment, at least under the experimental conditions.[131] In other words, when provided with information about nanotechnology, participants "conform[ed] information to their predispositions."[132] In this case, participants with a worldview associated with hierarchical and individualistic tended to be skeptical about technological risks. When provided with information about nanotechnology, they behaved as expected and did not assign a high risk.[133] In contrast, participants associated with the egalitarian and communitarian point of view reacted less favorably when information about new technology was brought to their attention.[134]

Although an empirical study is needed, the cultural cognition/nanotechnology study provides some insight as to how people may respond to information about GMOs.[135] Those that are generally skeptical about technological risk will assign a low risk and high benefit when provided information about foods made from GMOs.[136] Whereas, those with a worldview that is skeptical of technology will respond in the opposite direction. This begs the question that is discussed in section IV, which is whether to provide balanced information at all? In other worlds, one might think *a priori* that providing balanced information is the fairest approach. But, if providing balanced information does not allow people to appropriately assign risk, or at least align their risk perception with evidence-based risk assessment, then providing balanced information may not accomplish the goal.[137]

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127. *Id.*

128. *Id.*

129. *Id.* ("Information exposure had no discernable main effect on subjects' perceptions of nanotechnology risks and benefits.").

130. *Id.* at 88 ("These results support the cultural cognition hypothesis but not the familiarity hypothesis. Our subjects did not react uniformly, much less in a uniformly positive manner, when exposed to information. Instead, they reacted divergently, in a manner consistent with their opposing cultural predispositions toward technological risk generally. This finding displays the signature of 'biased assimilation and polarization'—the tendency of persons to conform information to their predispositions and thus to become more, not less, divided when exposed to balanced information.").

131. Kahan et al. (2008), *supra* note 30, at 88.

132. *Id.*

133. *Id.* at 89 ("People who have a protechnology cultural orientation are thus more likely to become exposed to information about nanotechnology and to draw positive inferences from what they discover.").

134. *Id.* ("Individuals who lack that predisposition, in contrast, are less likely to become exposed to information, and when they do become exposed to it they are significantly more likely to react negatively.").

135. This familiarity with nanotechnology correlated with risk perception about GMOs. *See* Kahan (2012), *supra* note 2, at 744.

136. *See* Kahan (2012), *supra* note 2, at 744 fig.28.11.

137. *Id.* at 752–53 (describing that providing balanced information has no effect on risk perception).

Availability heuristics and dual process theory also help to underscore the public opposition to GMOs. With so much marketing against GMOs, it makes sense that consumers' system 1 (or quick thinking) assumes that all GMOs are harmful.[138] Consumers can draw on commercials on television that tout their product is GMO free or the labels in the supermarket clearly stating that a product is GMO free.[139] Even a bottle of carbonated water is labeled as GMO free—which is completely silly.[140] Still, all of this information is instant and present and feeds the system 1 decision-making process to *think* that if it is labeled as GMO free, then there must be a reason for it, and one reason could be safety.[141] The slow thinking process of System 2 is needed to evaluate the scientific consensus that foods from GMOs are as safe as conventional food.[142] In addition, the slow thinking process is needed to analyze the scientific research that the technology is likely beneficial to address malnutrition—the leading cause of death and disease worldwide.[143]

So, how would one get consumers to slow down and process the food labels with System 2? It seems unlikely. This means that some sort of communication method may be needed to support a system 1 process where consumers have a heuristic to draw on that food from GMOs are safe. Perhaps the removal of the GMO free label as misleading is one way, as some have called for. Or, perhaps some sort of label supporting GMOs, which allows consumers to quickly evaluate the safety that is in line with the evidence-based assessment of risk.

Biotechnology presents an interesting application of decision-making theories because it is progressive and new information is discovered and applied. Scientific assessment of risk can never be absolute; it is simply a likely probability that the risk is determined to be high or low. This creates openings to exploit even a minimal risk—and even a much lower risk compared to doing nothing. This is the case with our food supply—we have competing problems that need to be addressed: climate change and a growing population. We need to feed more people in a sustainable way. Doing nothing about how we grow our food is riskier than doing something. Bringing consumers along for this complicated discussion already poses challenges. In Part IV, this article discusses ways to approach this. But, in the vein of this article, another area of biotechnology in which rejecting the technology creates more harm, i.e., not vaccinating, is discussed below.

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138. The NY Times is sometimes aggressively anti-GMO or at the very least equivocal, which is not the scientific consensus. *See, e.g.*, Jane Brody, *Are G.M.O. Foods Safe?*, N.Y. TIMES (Apr. 23, 2018), https://www.nytimes.com/2018/04/23/well/eat/are-gmo-foods-safe.html. (When a consumer conducts an internet search for the safety of GMOs, they can find equivocal or mis-information, the NY Times is just an example.)

139. *Cf.* FDA, *Guidance for Industry: Voluntary Labeling Indicating Whether Foods Have or Have Not Been Derived from Genetically Engineered Plants* (2019), https://www.fda.gov/regulatory-information/search-fda-guidance-documents/guidance-industry-voluntary-labeling-indicating-whether-foods-have-or-have-not-been-derived ("Manufacturers often voluntarily provide information on their labels beyond the information required by the Food, Drug, and Cosmetic Act (the FD&C Act) or FDA regulations. Their reasons for doing so may have to do with marketing or providing information of specific interest to their customers.").

140. *See, e.g.*, Josie Peterson, "*GMO Free Water"? Don't be Fooled by Misleading Labels*, BIOTECHNOW (Sept. 6, 2017), https://www.biotech-now.org/food-and-agriculture/2017/09/gmo-free-water-dont-be-fooled-by-misleading-labels.

141. Peter M. Wiedermann & Holger Schutz, *The Precautionary Principle and Risk Perception: Experimental Studies in the EMF Area*, 113 ENVTL. HEALTH PERSP. 402, 402–05 (2005).

142. *See* Statement by AAAS, *supra* note 98.

143. *Cf.* Lynas, *supra* note 78, at 270.

B. Vaccines

As of late, vaccinating children is a serious and controversial issue.[144] Some parents are hesitant or declining to vaccinate their children, which creates a major health issue for the unvaccinated children and a larger public health issue for the community.[145] The movement against vaccines is surprising to health officials, especially considering the evidence-based research demonstrating that vaccines are safe and effective against vaccine preventable diseases.[146] At first blush, one might simply say that parents who resist vaccinations are dumb (to be blunt), but studies in decision-making demonstrate that it is more complicated.

An interesting study by Blaisdell and colleagues utilized focus groups to analyze whether ambiguity aversion helped to explain the decisions by vaccine hesitant parents (VHPs).[147] In these focus groups, Blaisdell learned that VHPs inappropriately assigned risk because they responded that they were concerned, for example, that once a vaccine is given it cannot be undone.[148] Interestingly, putting aside the need for boosters, this is exactly what medical professionals seek.[149] But, the VHPs expressed that because it cannot be undone, then if there was some side effect, the parents have irreversibly harmed the child.[150] In other words, the parents assigned a high risk and low benefit. Another expressed opinion by VHPs is that if their child gets the disease, then they can just take them to the hospital.[151] VHPs inappropriately assigned a low risk to the actual disease. The study itself is worthy of a close read, but to summarize here, the study provided important insight to help understand how VHPs make decisions regarding whether or not to vaccinate.[152]

Although not explicitly addressed by the Blaisdell study, it is possible that affect also plays a key role.[153] The VHPs may fear that the vaccine will cause irreversible

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144. CDC, *Measles Cases and Outbreaks* (Sept. 16, 2019), https://www.cdc.gov/measles/cases-outbreaks.html.

145. *Cf.* Governor Jerry Brown (CA) executed a law that eliminates some of the exemptions for vaccines. S.B. 277, 2015–16 Reg. Sess. (Cal. 2015); *see also* Tara Haelle, *California Vaccination Bill SB 277 Signed By Governor, Becomes Law*, FORBES (June 30, 2015, 2:14 PM), http://www.forbes.com/sites/tarahaelle/2015/06/30/california-vaccination-bill-sb-277-signed-by-governor-becomes-law/#6091044a1233.

146. *See* CDC, *Vaccine Safety* (last updated Jan. 31, 2019), https://www.cdc.gov/vaccinesafety/index.html.

147. Blaisdell et al., *supra* note 8, at 480 ("We conducted a qualitative focus group study of VHPs with the specific aim of exploring the extent to which they perceive ambiguity in vaccine-associated risks and the thought processes underlying their subjective judgments of risk and uncertainty in decisions about vaccination.").

148. *Id.* at 482 (Others were fearful of the permanence of vaccination decisions and exposures (Table 3).

149. CDC, *Attention Adults: You Need Vaccines Too!* (Feb. 25, 2019), https://www.cdc.gov/features/adultimmunizations/index.html ("Every year in the United States, thousands of adults become seriously ill and are hospitalized because of diseases that vaccines can help prevent.").

150. Blaisdell, *supra* note 8, at 483 tbl.3 (quoting a VHP: "One of the scary things about vaccines is once it's done, it's done. You can't undo it. So you know I have this kid and maybe or maybe not vaccines have an effect on his progression in life at this point.").

151. *Id.* at 484 tbl.5 (quoting a VHP: "I think that now if you catch something, all these dreadful diseases, if you rush to the hospital right away they can probably save your life. So I'd rather go with that and see if something happens then go that way [vaccinate].").

152. *Id.* at 485–87.

153. Sax (2017), *supra* note 12, at 447 ("While the Blaisdell study nicely categorizes the responses by VHPs into risk perceptions based on ambiguity, many of the responses suggest affect could play a role in risk perception.").

damage, such as autism.[154] This feeling of fear (or dread) may also help explain why VHPs assign a high risk and low benefit to vaccines.[155] Feelings of fear and dread are known to impact decision-making and risk perception.[156]

The application of cultural cognition to VHPs presents a few possible explanations. *A priori*, it might seem that persons placed on the "group-grid" associated with the communitarianism-egalitarian viewpoint would vaccinate because this would be best for the community. But, if we think about the study on nanotechnology, those with a community point of view may be skeptical of new technology and perceive a high risk.[157] This could suggest that VHPs in the communitarianism-egalitarian group-grid could actually explain the hesitation to vaccinate, which, in the end, is actually worse for the community. In contrast, those with an individualistic outlook may assess the risk from new technology as low and be more likely to vaccinate. In other words, it is possible that cultural cognition helps to explain risk assessment in a way that helps us to understand VHPs. Alternatively, perhaps vaccines are not as *new* to individuals as nanotechnology. Thus, perhaps drawing on the nanotechnology study is too far a stretch.[158] If so, then the egalitarian point of view favors vaccination because it protects the community. Or, perhaps a more cynical view is that VHPs form their own communities in which they form a consensus that vaccines are risky (making the non-evidence-based association with autism); thus, they either are hesitant to vaccinate or refuse altogether.[159] This conforms with the viewpoint of their community. In sum, it seems that the viewpoint of the community could impact the risk assessment.[160]

Heuristics and dual process theory can be used to explain decision made by VHPs. The system 1 decision-making process may perceive risk and if a person feels or believes that there is a risk to vaccines, such as autism, then that person may be hesitant or resist vaccines.[161] The fear of a life-long condition, such as autism, is the undercurrent for the system 1 reaction against vaccines.[162] Of course, we know that vaccines do not cause autism, but that may not be what a VHP *believes*.[163] Likewise, a VHP, operating under

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154. A.J. Wakefield et al., *Ileal-lymphoid-docular hyperplasia, non-specific colitis, and pervasive developmental disorder in children*, 351 THE LANCET 637, 637–41 (retracted) (1998), *available at* http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(97)11096-0/abstract.

155. Sax (2017), *supra* note 12, at 447 ("If VHPs perceive that a vaccine will harm their child, they will feel 'badness' about making the decision to vaccinate. Or, conversely, a VHP may experience 'goodness' of refusing a vaccine because s/he perceives they have averted a high-risk situation. This scenario nicely fits into Slovic and colleagues' theory that when a subject views the risk as high, they also view the benefit as low.").

156. Slovic & Peters, *supra* note 11, at 322.

157. Kahan (2012), *supra* note 2, at 88.

158. *But see id.* at 744 (chart showing that risk perception related to nanotechnology is correlated with risk perception in other areas).

159. Mara Gordon, *Medical Anthropologist Explores 'Vaccine Hesitancy'*, NPR (Feb. 13, 2019, 5:50 PM) https://www.npr.org/sections/health-shots/2019/02/13/694449743/medical-anthropologist-explores-vaccine-hesitancy ("What makes some families reluctant to vaccinate their children? Sobo, a professor at San Diego State University, says it may be driven in part by the desire to conform in a community where many parents are skeptical of vaccines.").

160. *Id.*

161. IMMUNIZATION ACTION COAL., *Autism* (July 29, 2019), http://www.immunize.org/autism/ ("Claims that vaccines cause autism have led to some parents to delay or refuse vaccines for their children.").

162. *Cf.* Blaisdell et al., *supra* note 8, at 483 tbl.2.

163. A.J. Wakefield et al., *supra* note 154, at 637–41.

system 1, may not fear the vaccine preventable disease.[164] This demonstrates the very problem with a VHP using system 1. It is fear, for example, that might be the crux of the system 1 decision—but in this case, it is the fear of the wrong condition.[165] The VHP should fear the vaccine preventable disease. The system 2 process, in which the VHP, might evaluate the data regarding the safety and efficacy of vaccines, is needed.[166] For a non-VHP, the system 1 process kicks in to make the decision to vaccinate. In this case, the fear of the vaccine preventable disease is easy to process. No system 2 process is needed.

In sum, the decision-making theories described herein all help to elucidate how consumers approach their *thinking* towards a controversial area of biotechnology. Cognitively, it makes sense that a discussion can be had regarding how each theory explains the public's reaction to GMOs and vaccines. What is unclear, however, is whether any person relies more heavily on one theory over another. How do we know which decision-making process is dominant at any time? Or, perhaps, portions of these theories are working concurrently. To add more to the mix, this article raises the concern about how changes in society interact, utilize, or even exploit these decision-making theories in a way that makes it even harder to combat an inappropriate assignment of risk.

IV. MODERN VARIABLES THAT IMPACT DECISION-MAKING

Assuming *arguendo* that all of the decision-making theories described in this article meaningfully describe how people make decisions (and possibly judgements), the salient question becomes how do we allow people to make decisions in which their risk perception is in line with evidence-based risk assessment. This does not mean that people will automatically embrace new technology just because their risk perception is in line with evidence-based risk assessment, but it means that people can make decisions based on accurate information. For example, a person may decide not to vaccinate, for a religious reason, but not based on a perception that vaccines are unsafe, or at least less safe than acquiring a vaccine preventable disease.

It is not that the decision-making theories do not stand—they do. The problem is that they can be used to persuade people into making an incorrect risk assessment. This is quite a concern because the world is facing major problems, such as climate change. This article proposes three categories in modern society that appear to impact consumer perceptions of risk. These three categories, which are variable inputs in people's perception of risk are: (1) rise of individualism, (2) internet, and (3) economics, which are discussed below. This article seeks to expose how these categories impact a person's assignment of risk.

A. Rise of Individualism

In his book, *The Second Mountain*, David Brooks describes changes in society from

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164. Hattie Garlick, *'Worry is contagious': the vaccine-hesitant parents putting children at risk*, THE GUARDIAN (July 13, 2019, 5:01 PM), https://www.theguardian.com/society/2019/jul/13/vaccines-hesitant-parents-threat-to-global-health (discussing how the success of immunizations programs has the effect that people are not as worried about the vaccine preventable disease).

165. *Id.*

166. CDC, *Vaccine Safety* (last updated Jan. 31, 2019), https://www.cdc.gov/vaccinesafety/index.html.

small and tight communities to a more individualistic priority.[167] Brooks acknowledges that this is not all bad. The small and tight communities from the 1950s, for example, bred racism and sexism.[168] Breaking out of those communities, particularly in the 1960s, allowed for the civil rights movement, access to reproductive services, and more individual rights.[169] These changes, which Brooks acknowledges, are positive. But, there are externalities to these changes in society. The movement from community to individualism has changed the level of happiness or joy, according to Brooks.[170] In other words, people feel less connected to other people in their community because of the rise of individualism. Brooks suggests that the pendulum has moved too far, and we need to find a better balance of community and individualism.[171]

This article does not necessarily agree or adopt the pathway laid by Brooks, but it is certainly provocative enough not to ignore. It is clear that society has changed from the 1950s to today. It is correct that individual rights and freedoms are more recognized today compared to seventy years ago.[172] Maybe people are less joyful, as Brooks suggests, although that is a tough one to analyze, and this article will not go down that path. Nevertheless, Brooks certainly targets individualism as a notable component of today's society, and that concept in and of itself is worthy of discussion.

The decision-making theories described herein also face a structural problem in our society, which is how people obtain their information and how they view themselves in society at large.[173] Described eloquently in *The Second Mountain*, David Brooks captures the tone of hyper-individualism and how that keeps us from connecting to one another.[174] The movement from small communities in the 1950s (which he acknowledges allowed for a lot of discrimination) towards individualism leads people to possibly be less happy and engaged in their surroundings.[175] Some people search for connection in new ways, such

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167. BROOKS, *supra* note 73, at 6.

168. *Id.*

169. *Id.* at 10 ("I just want to emphasize that the march toward freedom produced many great outcomes. The individualistic culture that emerged in the sixties broke through many of the chains that held down women and oppressed minorities. It loosened the bonds of racism, sexism, anti-Semitism, and homophobia.").

170. *Id.* at xxix, 10 ("But many ideas become false when taken to the extreme. America has always had a more individualistic culture than other places, which Tocqueville noticed back in the 1830s. But when individualism becomes the absolutely dominant ethos of a civilization—when it is not counterbalanced with any competing ethos—then the individuals within it may have maximum freedom, but the links between the individuals slowly begin to dissolve. The grand narrative of 'I'm Free to Be Myself' has been playing out for about fifty years. It has evolved into a culture of hyper-individualism. This moral ecology is built on a series of ideas or assumptions.").

171. *Id.* at 13 ("There's always a tension between self and society. If things are too tightly bound, then the urge to rebel is strong. But we've got the opposite problem. In a culture of 'I'm Free to be Myself,' individuals are lonely and loosely attached. Community is attenuated, connections are dissolved, and loneliness spreads. This situation makes it difficult to be good—to fulfill the deep human desires for love and connection. It's hard on people of all ages, but it's especially hard on young adults.").

172. *See, e.g.*, Civil Rights Act of 1964, Pub. L. 88-352, 78 Stat. 241 (1964); Obergefell v. Hodges, 135 S. Ct. 2071 (2015).

173. Caitlin Dewey, *36 ways the Web has changed us*, WASHINGTON POST (Mar. 12, 2019), https://www.washingtonpost.com/news/arts-and-entertainment/wp/2014/03/12/36-ways-the-web-has-changed-us/?noredirect=on (describing all the different ways the internet impacts our lives).

174. BROOKS, *supra* note 73, at 13.

175. *Id.* at 6, 19 ("Living online often means living in a state of diversion. When you're living in diversion you're not actually deeply interested in things; you're just bored at a more frenetic pace. Online life is saturated

as online communities. This may, in turn, lead to group thinking, which can make it even harder to assess information and/or impact decision-making.

Research in decision-making is certainly applicable to help us understand how people make decisions in a hyper-individualized society. For example, ambiguity aversion can be used to explain how people in an online group/community (e.g., Facebook group) may receive information about a link between vaccines and autism, which they cannot completely ignore even when a doctor tells them that no such link exists. In essence, the decision-making theories are robust and can continue to explain decision-making even when society changes.

Here is a scenario in which individualism is problematic from a public health standpoint: A VHP decides not to vaccinate because they inappropriately assign a high risk to vaccines and they do not want their child to possibly develop autism. The non-vaccinated child is somewhat protected by herd immunity.[176] But, if too many individuals or VHPs make the same decision, then herd immunity is lost. Actually, these VHPs can form their own community, which makes things worse for the non-vaccinated children in that community.[177] The children now have a much higher risk of contracting a vaccine-preventable disease.

In this scenario, all of the decision-making theories described above can get the VHPs to their decision. Ambiguity aversion is at play because the VHPs receive information that the vaccines work to protect against disease and that autism might be a consequence of the vaccine—this is received as ambiguous information and the VHP inappropriately assigns risk.[178] Affect is at play because the VHPs experience fear that their child will develop autism.[179] Cultural cognition could be at play because the VHP places on the communitarianism-egalitarianism spectrum in the "group-grid," which has been shown to be adverse to new technology, and they assign a high risk to the technology.[180] Finally, availability heuristics and dual process are at play because the VHP may be using their system 1 thinking; the VHP hears about the link between vaccines and autism and immediately concludes the risk is too high.[181] System 2 is needed to fully evaluate the scientific consensus, but we know from Kahneman's work that is unlikely to happen.

A similar scenario can be described with GMOs. The Honey Sweet plum is an excellent example (although it never made it to market). Scientists created a genetically engineered plum that is resistant to plum pox.[182] Due to the regulatory process, the U.S.

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with decommitment devices. If you can't focus your attention for thirty seconds, how on earth are you going to commit for life?").

176. The College of Physicians of Philadelphia, *Herd Immunity*, THE HISTORY OF VACCINES (last visited Jan. 22, 2020), https://www.historyofvaccines.org/content/herd-immunity-0 (animation explaining herd immunity).

177. *See* Gordon, *supra* note 159.

178. *See, e.g.*, Blaisdell et al., *supra* note 8, at 486 ("Second, our study suggests that ambiguity and ambiguity aversion are manifest in varying degrees in VHPs' responses to vaccine-related risks.").

179. *Cf.* Slovic & Peters, *supra* note 11, at 322.

180. *Cf.* Kahan et al. (2008), *supra* note 30, at 88; *see also* Kahan (2012), *supra* note 2, at 744.

181. *Cf.* KAHNEMAN (2011), *supra* note 22, at 19–24.

182. USDA AGRIC. RESEARCH SERV., *Honeysweet Plum Trees A Transgenic Answer to the Plum Pox Problem*, USDA AGRIC. RESEARCH SERV. (Aug. 20, 2019), https://www.ars.usda.gov/oc/br/plumpox/index/ (providing answers to frequently asked questions).

government required that this plum include a pesticide label.[183] From a scientific standpoint, this is completely absurd because the point of the honey sweet plum is to allow it to have internal resistance to plum pox, given that external attempts to control the spread of plum pox virus are not viable.[184] The risk to human health from eating a honey sweet plum approaches zero.[185] Thus, consumers should assign a low risk and high benefit—low risk because less external pesticide (against the aphids that carry the virus) and high benefit because it is a piece of fruit.[186] Nevertheless, consumers are unlikely to purchase a honey sweet plum both due to the label of a pesticide and the inappropriate assignment of risk to genetically engineered food.[187] This is an incorrect risk assessment because genetically engineered crops, such as the honey sweet plum, are likely more sustainable.

Again, individualism is problematic, and all of the decision-making theories described herein may be at play for the consumer at the grocery store. Ambiguity aversion is at play because the consumer receives different information about the safety of genetically engineered foods, especially now that so many products are labeled GMO-free.[188] Why label it if it does not matter? This is what a typical consumer might think, thus the consumer assigns a high risk to genetically engineered food.[189] Affect may be at play because the consumer fears the pesticide label on the honey sweet plum, for example. Who wants to eat a piece of fruit labeled as a pesticide? Cultural cognition may be at play because the consumer inappropriately assigns a high risk as part of their cultural association.[190] Finally, the system 1 (fast thinking) can recall all of the anti-GMO advertising and assigns a high risk to anything related to GMOs. Individualism is problematic because society needs to come together to solve our food supply problems. The risk from GMOs in the marketplace is the same as any other food.

These examples demonstrate that work needs to be done to recognize the rise of individualism and provide information in a way that allows them to appropriately assign risk. The rise of individualism does not negate any of the decision-making theories. Instead, it demonstrates how societal externalities impact the position in which people stand when they make decisions.

Risk communication strategies need to recognize the rise of hyper-individualism in

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183. EPA, *Notice of Pesticide Registration, C5 HoneySweet Plum*, EPA (May 7, 2010), https://www3.epa.gov/pesticides/chem_search/ppls/011312-00008-20100507.pdf.

184. Ralph Scorza et al., *Genetic engineering of* Plum pox Virus *resistance: "HoneySweet" plum–from concept to product*, PLANT CELL TISS ORGAN CULT, https://www.ars.usda.gov/ARSUserFiles/oc/br/plumpox/PCTOC2013.pdf (describing the history and problems with the plum pox virus).

185. *Cf.* Brian Sparks, *EPA Labels Honeysweet Plum as a Pesticide*, GROWINGPRODUCE (June 1, 2010), https://www.growingproduce.com/fruits/epa-labels-honeysweet-plum-as-a-pesticide/.

186. *See* Scorza et al., *supra* note 184.

187. *Cf.* Sparks, *supra* note 185 ("One of the most significant points CEI makes is that labeling HoneySweet as a PIP could lead to consumer confusion.").

188. ACSH Staff, *Why GMO Labeling is Confusing, Misleading, and Ultimately Pointless*, AM. COUNCIL ON SCI. & HEALTH (July 27, 2015), https://www.acsh.org/news/2015/07/27/why-gmo-labeling-is-confusing-misleading-and-ultimately-pointless (quoting Dr. Hamblin: "The central and debilitating fallacy of the right to know argument is the meaningless and misleading nature of what is being known.").

189. *Cf.* Peter M. Wiedermann & Holger Schutz, *The Precautionary Principle and Risk Perception: Experimental Studies in the EMF Area*, 113 ENVNTL. HEALTH PERSP. 402, 402–05 (2005).

190. Kahan (2012), *supra* note 2, at 744.

order to provide information in a way that allows people to appropriately assign risk. The risk communication strategies described above are not necessarily sufficient. The rise of individualism may, in some cases, be in tension with risk communication. People may simply not believe the accurate information. This is discussed further in sub-section B below.

B. Internet

The amount of information and mis-information on the internet poses an enormous challenge. Actually, the depth of this issue is probably unknown.[191] On the one hand, the internet and access to a wide breadth of information is a positive development. On the other hand, the availability of mis-information and a home for "trolling" the unwary is problematic. If a person seeks to find information that supports their position, it is likely available somewhere on the internet. This creates an enormous challenge for people to easily and appropriately assign risk to various areas of biotechnology.

If a parent is hesitant to vaccinate their child, they can find homage on the internet.[192] So many people googled the link between autism and vaccines that Google actively changed its algorithm for this search so that the Center for Disease Control's (CDC) information came up first.[193] The purpose for this change to the algorithm was to bring up the correct scientific information, i.e., no link exists. But, this only addresses the superficial problem. If a VHP wants to find support for their position, they can continue to search the internet for misinformation that supports their position.

Once the mis-information is found on the internet, all of the decision-making theories described within this article support the VHP's assessment of risk. If a VHP searches the internet and finds information linking vaccines to autism, then the VHP may assign a high risk to the vaccine based on ambiguity aversion.[194] Furthermore, a VHP may fear that they will actually harm their child with a vaccine, which suggests that affect is also at play.[195] Cultural cognition theory can also work in a way that leads a VHP to inappropriately assign risk, depending on their group-grid position and the predicted

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191. Michael K. Bergman, *White Paper: The Deep Web: Surfacing Hidden Value*, JOURNAL OF ELEC. PUBL'G (last visited Jan. 22, 2020), https://quod.lib.umich.edu/j/jep/3336451.0007.104?view=text;rgn=main (describing the deep web).

192. Vanessa Lam, Steven Teutsch & Jonathan Fielding, *Refuting A Lie That Won't Die: Taking The Fight For Vaccines Beyond The Doctor's Office*, HEALTH AFFAIRS (Feb. 28, 2019), https://www.healthaffairs.org/do/10.1377/hblog20190226.742851/full/.

193. George Johnson, *The Widening World of Hand-Picked Truths*, N.Y. TIMES (Aug. 24, 2015), http://www.nytimes.com/2015/08/25/science/the-widening-world-of-hand-picked-truths.html?_r=0 ("Google recently tweaked its algorithm so that searching for 'vaccination' or 'fluoridation', for example, brings vetted medical information to the top of the results.").

194. *Cf.* Blaisdell, *supra* note 8, at 483 tbl.2 (quoting VHP, "I honestly haven't done a ton of research only because I feel like you can find something to back up however you feel any time, so what is actually the right and correct information? Because I've been on those Facebook pages that are all about against vaccinations and it scares you to death. . . .I feel like, where do you get the real information? You know?").

195. Steve P. Calandrill, *Vanishing Vaccinations: Why Are So Many Americans Opting Out Of Vaccinating Their Children?*, 37 UNIV. MICH. J. LAW REFORM 353, 388–406 (2014) (describing the growing anti-vaccination movement and stating: "Further, some well-meaning parents systematically misperceive or overperceive the magnitude of the risks involved, causing them to decide that the dangers of vaccinating are worse than the benefits.")

assessment of risk.[196] Finally, the availability of misinformation on the internet can support the system 1 fast thinking in which a VHP will hesitate to vaccinate or not vaccinate at all.[197] The VHP would need to employ system 2 to override the fast thinking. To complicate matters, it is unclear which, if any, of the decision-making processes is dominant at any given time.

A similar scenario exists with food made from GMOs. In some ways, this is worse than the issue with vaccines because society has not felt the long-term benefits of this technology. An enormous amount of money (more on this below) is dedicated to the anti-GMO movement.[198] Internet searches about the safety of foods from GMOs brings up mis-information about the possibility of a link to disease, such as cancer.[199] From a scientific assessment, the risk of foods from GMOs in the market place approaches zero.[200] This is so for a number of reasons, including that the number of mutations introduced through biotechnology are far less than those introduced through traditional techniques. No additional risk is created through the technology.[201]

Not surprisingly, decision-making theories described herein explain why consumers resist foods from GMOs. If a consumer receives competing information on the internet about GMOs, then they will assign a high risk and low benefit pursuant to the theory of ambiguity aversion.[202] If affect is the driving decision-making theory, then the fear of cancer or other potential diseases is sufficient for a consumer to assign a high risk.[203] Cultural cognition may also be at play if a person inappropriately assigns a high risk to technology, even if that technology can help alleviate climate change.[204] Finally, the availability of mis-information about GMOs on the internet allows the system 1 fast thinking to quickly assign a high risk to buying foods that contain GMOs.[205]

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196. Kahan (2012), *supra* note 2, at 744; *cf.* Smith, *supra* note 1, at 1–2 (describing the arguments against vaccination).

197. *Cf.* Smith, *supra* note 1, at 2 ("Many of the 'influencers' rely on the internet to spread their message (together, the individuals and organizations included in Table 2 have more than 7 million Facebook followers, although some overlap in followers may be expected). Recent work has demonstrated that approximately 80% of individuals use the internet yearly to search for health information, and relatively few discuss these findings with a healthcare professional.").

198. *Cf.* AM. COUNCIL ON SCI. & HEALTH, *About ACSH* (last visited Jan. 22, 2020), https://www.acsh.org/about-acsh-0 (describing the mission and problem with anti-science groups).

199. Attempts to debunk this myth are also found. *See e.g.*, L.Z.G. Touyz, *Genetically Modified Foods, Cancer, and Diet: Myths and Reality*, 20 CURRENT ONCOLOGY e59, e60 (2013) ("The recent report claiming that GMFs are causally associated with cancer development in rats has been debunked by informed opinion[.]").

200. Strauss & Sax, *supra* note 103, at 476 ("Thus, the risk of unintended expression of endogenous toxic proteins from genetic engineering is not greater than conventional breeding, and in most cases far less.").

201. Marc Brazeau, *GMOs: An Introduction*, FAFDL (Sept. 3, 2014), http://fafdl.org/gmobb/gmos-an-introduction/ ("We've done animal studies to look for potential unforeseen problems. None have been discovered. In science, you start with manageable studies of rats and mice to see if that generates evidence of something that justifies bigger, more expensive studies. But if there is no proof of concept, there is no interest and no funding for further testing.")

202. Sax & Doran (2019), *supra* note 6, at 56.

203. Lynas, *supra* note 78, at 140–44 ("'Did you know that GMOs can cause cancer and infertility?'").

204. This is an interesting part of cultural cognition. A person may be a communitarian-egalitarian on the "group-grid" and be concerned about the risks of climate change at the same time this group-grid designation predicts that this person will assign a high risk to new technology. Kahan et al. (2008), *supra* note 30, at 88; Kahan (2012), *supra* note 2, at 744.

205. Kahneman (2011), *supra* note 22, at 19–25.

The above is of course a cursory and summary assessment of how information from the internet impacts the way people make decisions. This is a conceptual discussion utilized to press the issue of how to allow people to appropriately assign risk in the face of an enormous body of information and misinformation. Empirical studies are needed to fully analyze the issue and, if possible, to determine how to counteract the applicability of mis-information in decision-making.

C. Economics

High dollar amounts are invested to provide false or misleading information to people.[206] The anti-GMO movement, for example, is well funded. In *Seeds of Science*. Mark Lynas describes how he got swept up in the anti-GMO movement.[207] In his book, Lynas describes how he spent years as an anti-GMO activist.[208] It was not until he researched the science behind climate change that he realized the benefits of genetically engineered food for addressing malnutrition and sustainable agriculture. He had to grapple with his years as an anti-GMO activist and come to terms with the harms caused by Greenpeace and related organizations.[209]

Many of the anti-GMO organizations are non-profit organizations, such as Greenpeace International, Friends of the Earth International, and the Center for Food Safety.[210] Interestingly, these non-profit companies and/or nongovernmental organizations (NGOs) promote themselves as the non-profit seeking and consumer advocates fighting the big for-profit companies, such as Monsanto.[211] In reality, these non-profit and NGOs are well-funded and extremely effective at keeping GMOs out of the market place—especially in areas that are in dire need of staple and stable crops, such as poor areas in African countries.[212] Most of the funding for these non-profits/NGOs is from wealthy individuals in wealthy countries.[213]

The organic industry, which now cannot be described as anything other than Big Agriculture, conducts strong anti-GMO campaigns.[214] This is ironic given that the

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206. *See* AM. COUNCIL ON SCI. & HEALTH, *supra* note 198.

207. Lynas, *supra* note 78, at 14–31 (describing his experience in the anti-GMO movement).

208. *Id.* at 11–31 (describing raids and other tactics to thwart producers and farmers of GMOs).

209. *Id.* at 33–49 (describing how climate change science opened his eyes so that he could accept the science behind GMOs). The anti-GMO movement is not the only side with money. The manufacturers of seeds from GMOs, such as Monsanto, are also well-funded. But, Monsanto does not appear to have sway with consumers in the same way that Greenpeace is able to capitalize.

210. Robert Paarlberg, *A Dubious Success: The NGO Campaign against GMOs*, 5 GM CROPS & FOOD 223, 223 (2014) ("Much of this NGO opposition to GMOs has been led by European-based organizations such as Greenpeace-International, and Friends of the Earth International, both headquartered in Amsterdam.").

211. *Id*. ("Some of these organizations present themselves as advocates for social justice, some as advocates for the rural poor, some as advocates for the environment, some as opponents of corporate-led globalization, and some primarily as advocates for alternative farming methods, for example organic or agroecological methods, which reject the use of GMOs.").

212. *Id.* at 224.

213. *Id.* ("The single most powerful explanation for this continuing blockage of GMOs has been energetic NGO campaigns of disinformation, led and financed mostly by individuals from well-fed countries who do not need the technology themselves.").

214. *See, e.g.*, *Organic Marketing Report*, ACADS. REVIEW (last visited Jan. 22, 2020), https://www.hoards.com/sites/default/files/Academics-Review_Organic-Marketing-Report.pdf_(describing the organic industry) [hereinafter ACADS. REVIEW]; Michelle Miller, *Farm Babe: The Fat Lies and Fatter Wallets*

technology might be highly beneficial for organic farmers.[215] If, for example, an organic farmer seeks to have a higher yield of crop, then a pest-resistant GMO crop allows them to use less external pesticide and hopefully obtain a higher yield. But, for structural and ideological reasons, the larger organic industry opposes crops from GMOs and strongly campaigns against foods containing ingredients with GMOs.[216]

The anti-GMO movements incorporate, even exploit, the ways that people make decisions such that consumers inappropriately assign a high risk to foods from GMOs. For ambiguity aversion, the anti-GMO movement portrays that foods from GMOs may be harmful or that we do not know enough about the crops to determine whether future harms exist.[217] For affect, the anti-GMO movement uses fear—fear of cancer and even fear of homosexuality—to scare people into rejecting crops from GMOs.[218] For cultural cognition, even group minded individuals might decide to reject GMOs as risky, either healthwise or from an environmental standpoint.[219] For heuristics and dual process theory, the availability of anti-GMO rhetoric and the labeling of food as GMO-free exploits the system 1 thinking such that consumers easily recall an anti-GMO sentiment.[220] System 2, much harder to engage, is needed to access the evidence-based safety of foods from GMOs.

The anti-vax movement is supported by money, but it has a deeper explanation, which is a growing distrust of government and scientists.[221] In some ways, this is understandable given mistakes made by governments about the mishandling of major health consequences from drugs made by pharmaceutical companies; Vioxx being a recent example.[222] The anti-vaccine movement is able to exploit this. In addition, research in this area suggests that the rise of individualism is contributing to vaccine hesitancy.[223] What is clear is that few, if any, current public health strategies are effective in the face of the increasing number of vaccine hesitant parents.[224]

Again, our understanding from decision-making theories demonstrates how the anti-vaccination movement is able to take hold. Money is spent by interest groups to promote mis-leading information about the safety of vaccines. Applying ambiguity aversion,

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of Anti-GMO Lobbyists, AG DAILY (Sept. 13, 2016), https://www.agdaily.com/features/farm-babe-fat-lies-fatter-wallets-anti-gmo-lobbyists/.

215. Amjad M. Husaini & Muhammed Sohail, *Time to Redefine Organic Agriculture: Can't GM Crops Be Certified as Organics?*, 9 FRONTIERS PLANT SCI. 1, 3 (2018) (explaining how these new breeding techniques are advantageous and promising for organic farmers).

216. ORGANIC TRADE ASS'N, *Organic and GMOs* (last visited Jan. 22, 2020), https://ota.com/organic-101/organic-and-gmos ("The use of genetically modified organisms (GMOs) is prohibited in organic products.").

217. *Id.* (stating that "Bt crops are engineered to produce toxins"). This demonstrates how the organic industry uses language to confuse the issue. Organic farmers use external pesticides to kill insects. Bt crops are engineered to resist a specific type of pest, without the need to external application of pesticide. *Id.*

218. Lynas, *supra* note 78, at 140 ("Another of the scientists spoke up, adding: 'They said that with this maize, the next generation will have some sexual deformities, their children would have homosexual tendencies as a result of eating this maize. It's really weird.'").

219. Kahan (2012), *supra* note 2, at 744; ACADS. REVIEW, *supra* note 214.

220. Kahneman (2011), *supra* note 22, at 19–25; *cf.* ACADS. REVIEW, *supra* note 214.

221. Eve Dube, Maryline Vivion & Noni E. MacDonald, *Vaccine Hesitancy, Vaccine Refusal and the Anti-Vaccine Movement: Influence, Impact and Implications*, 14 EXPERT REV. VACCINES 99, 109 (2015).

222. *Id.*

223. *Id.*

224. *Id.*

parents receive information about a link between vaccines and autism or they receive information about past harm from vaccines and they assign a high risk to vaccination.[225] Fear of an adverse consequence from vaccines demonstrates that affect is at play for VHPs.[226] Even cultural cognition can explain how group-minded people can be against vaccination due to their assessment/perception of risk.[227] Finally, heuristics and dual process theory help explain how the system 1 thinking in VHPs is at play because the VHPs receive information from the internet promoting an anti-vaccine sentiment.[228] The VHP would need to employ system 2 thinking to assess the evidence-based assessment of risk regarding current vaccines and the greater risk from the vaccine preventable disease.

D. Reconciliation and Transformation

The issues discussed in this article are difficult to address. This article does not seek to upset or challenge any of the prevalent and evidence-based decision-making theories. Instead, this article shows how changes in society make it even harder for people to make decisions in which they appropriately assign risk. Current strategies to align consumer perceptions of risk with evidence-based assessment of risk are largely unsuccessful.[229] Providing correct facts to consumers (e.g., a doctor stating that vaccines are safe) is simply insufficient given the complexity of decision-making and the forces seeking to utilize how consumers make decisions to create the very chaos that this article seeks to address.[230]

This article argues that the term "transformation" can be utilized to achieve risk perception that is in line with evidence-based risk assessment. This term, transformation, is also used in David Brooks' book, *The Second Mountain*, but in that book, he uses the term as a way to find joy. This article takes a different bent on a similar concept, advocating that transformation is an umbrella term, describing how change is needed for consumers to accurately assign risk. As discussed above, additional research is needed to understand how to provide information in a way that allows consumers to appropriately assign risk. This needs to be done in a way that employs multiple decision-making theories and considers the variables of the rise of individualism, the role of internet, and the economics of forces seeking to create confusion and chaos.

The problem addressed in this article is a tough one to solve. This article suggests that the answer lies in the decision-making theories. The anti-vaccination movement and the anti-GMO movement effectively use techniques that drive at the heart of these decision-making theories to obtain their desired results. One response is to use the decision-making theories to undo the anti-science sentiment—this is controversial, to be sure. Simply providing fact sheets from the CDC about the safety of vaccines is completely insufficient.[231] Instead, the information can be provided in a way that diminishes

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225. *See, e.g.*, Blaisdell et al., *supra* note 8, at 483, 485–87.

226. Sax (2017), *supra* note 12, at 447.

227. Kahan (2012), *supra* note 2, at 744; *see* Smith, *supra* note 1, at 1–2.

228. Myths about vaccines linger. *See, e.g.*, PUB. HEALTH, *Vaccine Myths Debunked* (last visited Jan. 22, 2020), https://www.publichealth.org/public-awareness/understanding-vaccines/vaccine-myths-debunked/.

229. Dube et al., *supra* note 221, at 110.

230. *See* Kahan (2012), *supra* note 2, at 753–57.

231. This is a major take-away message of cultural cognition. Kahan (2012), *supra* note 2, at 755–57. According to Kahan, the information has to be presented in a way that conforms to the group-grid ideology,

ambiguity, captures emotion, acknowledges cultural cognition as risk perception, and allows consumers to easily and readily recall information that allows them to appropriately assign risk.

Promoting evidence-based assessment of risk in a way that allows people to appropriately assign risk does have externalities. For example, as mentioned above, Google changed its algorithm such that searches for vaccines and autism brought up the CDC's fact sheets at the top of the search. Having Google change algorithms has major externalities in that it can be quite risky to have a private company control what information people receive.

The issue is how to allow people to make decisions based on an appropriate assignment of risk even in the face of numerous variables seeking to persuade people to inappropriately assign risk. The solution, referred to as Transformation, must include a combination of decision-making theories, risk communication strategies that contemplate how people make decisions, and combatting the variables of hyper-individualism, internet, and economics as they impact assessment of risk. This is a lofty goal, to be sure. To be clear, allowing people to appropriately assign risk is distinct from their ultimate choice. In other words, a person may understand that foods from GMOs are as safe as conventional foods but still choose not to eat foods from GMOs for other reasons. The idea in this article is simply to align consumer perception of risk with evidence-based assessment of risk, but not to take away the autonomy of the final choice.

This article seeks to recognize the complexity of current society and discuss how that complexity impacts decisions regarding risk assessment. In this way, this article raises the need for additional studies that address changes in society as a variable for risk communication and policy implementation methods. How does one, for example, allow a VHP to appropriately assign risk when the VHP is convinced that their online source of information is correct? Recent mandatory vaccination laws have increased the number of vaccinated children, so from a public health perspective, these laws work. But, it does not necessarily provide the VHP with the ability to appropriately assign risk. Mandatory compliance laws will not work with all areas of biotechnology. A state legislature will not, for example, require people to eat food from GMOs. Thus, the bigger question is how to allow people to appropriately assign risk in an increasingly complex society where people obtain information from various sources, not all of which are accurate.

In his book, *Thinking Fast and Slow*, Kahneman recognizes the value of Cass Sunstein's work on nudges. According to Kahneman, nudges assist with the system 1 decisions. For example, if employees are automatically enrolled in a retirement savings plan, then they are nudged into savings. The system 1, or quick thinking, is more likely to go along with the automatic enrollment. System 2 is needed to opt-out because the person would need to slow down and think about both short-term and long-term budgets. Conversely, an opt-in policy for retirement savings is less likely to accomplish the societal goal of saving for retirement. No nudge is created. System 1 may quickly reject an opt-in because it means that the person will receive less per paycheck. In sum, nudging is an effective way to overcome a system 1 process that may lead to an undesirable result.

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otherwise, the person will reject it.

But, it is unclear if nudging is sufficient or desirable to overcome the externalities of hyper-individualism and the internet, especially with respect to emerging technologies. Not enough people believe in climate change, for example. As Neil deGrasse Tyson famously stated: "The good thing about science is that it's true whether or not you believe in it."[232] Climate change is real, whether one believes it or not. Changing our behaviors to address climate change is critical. Agriculture, one focus of this paper, is part of the solution. If people reject GMOs, for example, then our agriculture system will continue to be a major contributing source to climate change. While nudging can be used in some areas, it cannot save us from climate change. It is doubtful that even Cass Sunstein would argue with this assertion.

This begs the question of how to allow people to appropriately assign risk to technology, such as GMOs, even in the face of non-evidence-based opposition. Simply providing the facts is insufficient to allow people to appropriately assign risk.[233] If we want to allow people to appropriately assign risk as part of their decision-making, then we need to understand how the rise of individualism, the role of the internet, and the economics of keeping people from appropriately assigning risk interacts with decision-making. Of course, allowing people to appropriately assign risk is a normative approach—but it seems the most honest approach. It does not require any particular decision; it simply allows the person to have an assessment of risk in line with evidence-based risk assessment.

As previously indicated, this is a hard problem to solve. One suggestion is to utilize the decision-making theories to promote information to consumers in a way that exposes how the anti-vaxxers and anti-GMOers have used these decision-making theories to manipulate consumers. That is, show how the anti-movements use ambiguity, affect, cultural cognition, and prospect theory to advance their position. Expose these groups for what they are actually doing. This can be accomplished through the risk communication tools discussed in this article: nudging, risk hybrid, and public participation.

The risk communication and perception strategies such as nudging, risk hybrid, and public participation in controversial areas can be effectively utilized to provide information in a way that exposes how some private interest groups are manipulating the consumers. The obvious opposition to the above suggestion is that it is manipulative. The argument is that the government or public health agencies should simply provide the facts in a neutral way and allow the consumer to decide. By utilizing the techniques of the anti-vaccination movement or the anti-GMO movement, we are sinking down to their level and manipulating people into making decisions. This argument has merit, to be sure, because it is a form of manipulation. But, by not addressing how the opponents have gained so much momentum in a way that actually pushes back, the harms will continue. One way to address this argument is to be transparent. Actually, all of the risk communication strategies discussed in this article seek transparency.

Empirical studies that include the variables described herein are needed to understand how to align consumer perception of risk with evidence-based assessment of

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232. Neil deGrasse Tyson, *Quotable Quote*, GOOD READS (last visited Jan. 22, 2020), https://www.goodreads.com/quotes/340727-the-good-thing-about-science-is-that-it-s-true-whether.

233. *See* Kahan (2012), *supra* note 2, at 753–57.

risk. Decision-making theories, risk communication, and external factors (individualism, internet, and economics) need to be combined in mega-study. This necessarily draws on important work accomplished by many cited within this article and seeks to move the ball forward incrementally, which is the scientific way. Grafted within this suggestion is the concept of communicating information in a way that complies with how people make decisions, as suggested by Daniel Kahan in his work on cultural cognition.

The normative framework discussed in this article seeks to include changes in society and how we receive information as an integral variable in studies that seek to implement policies grounded in evidence-based assessment of risk. By building on important work in the social sciences, economics, and legal literature, this article moves the discussion forward. The concept is not to state that any decision-making theory or policy implementation tool is better than the other; rather, it is to use the important work done by others to test what is the most effective method given our modern-day circumstances.

CONCLUSION

Our society faces tough problems. Sustainable agriculture and advances in healthcare are major topics. The resistance to some of the emerging technologies in these areas warrants serious evaluation, which is what this article seeks to highlight. In numerous areas, consumers are assigning a high risk to technology even though experts assign an evidence-based assessment of low risk.

This article describes several decision-making theories that help us to understand how people assign risk. In addition, different risk communication and policy implementation strategies are explored. By using two controversial examples, vaccines and GMOs, this article explains why consumers resist these technologies, along with the harms of such resistance. But, this article does not stop there. This article presses the conversation forward by highlighting how changes in society are important variables in understanding how consumers assign risk. The rise of hyper-individualism, information on the internet, and the economics of marketing are all important variables that require specific exploration to help us understand consumer perceptions of risk.

The next phase of research needs to consider the changes in society to augment our understanding of decision-making and consumer perceptions of risk. Furthermore, these variables need to be considered in risk communication and policy implementation strategies. The world is changing and evolving. The problems are increasing. Societies need to collaborate and seek technological solutions to solve our most pressing problems. Policymakers need consumers to be in a position to appropriately assign risk in order to allow governments and citizens to work together to solve issues such as climate change and healthcare.