DREADING CRISPR: GMOS, HONEST BROKERS, AND MERTONIAN TRANSGRESSIONS

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Newly arriving biotechnologies are beginning to force us all—scientists, policy makers, and the public—to confront questions of extraordinary difficulty. We will urgently need scientists to act as "honest brokers" to help educate, enrich debate, and inform policy. Our problem is that honest brokerage in the disciplines most directly related to biotechnology has been a casualty of the last two decades of rhetorical warfare over genetic engineering. My aim here is to consider what honest brokers are and how we lost them.

The source of these challenging new questions is a genetic-engineering technology called CRISPR.[1] CRISPR is a "genome editor," differing from conventional genetic engineering which is based on recombinant DNA.[2] Rather than cobbling together a recombinant DNA package to be implanted randomly, CRISPR operates directly on the DNA of the target organism, using programmable proteins to cut DNA at precise locations. It can knock out, activate, or alter genes. This is an extraordinary power indeed, and the claims of possible CRISPR feats are astonishing, even by the breathless standards of biotech rhetoric: it may save the world from hunger, eliminate malaria, cure cancer, treat HIV, make pig organs for humans, cure blindness. Of the many questions these claims raise, the most knotty concern CRISPRing humans. In a 2015 TED talk, CRISPR pioneer Jennifer Doudna displayed a speculative image of a smiling baby "edited" not just for lowered disease risk, but for improved eyesight, IQ, athletic prowess, and musical ability. Her message: let's use it "wisely." My question: who gets to decide what is "wise"? In 2017, the U.S. National Academies of Science issued a report advocating modifying human germlines—meaning that the changes would be heritable—once "proper restrictions are in place" and "relevant safety and efficacy issues have been resolved" (Reardon 2017). Again: who gets to determine what is "proper" and "efficacious," and when issues are "resolved"? I know of no more profound and pressing questions in science policy today.

These questions would be vexing even if the technology were static, but it is developing at dizzying speed. Therefore, we have to debate uses not just of the technology we have but what we predict it may become in the future. And the future, as Yogi Berra reminds us, is one of the hardest things to predict (1998).

To make policy, to form opinions, and to know how to use our votes and consumer dollars wisely, we all need informed opinion on the new

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biotechnology. "Basic" scientists—here meaning academic or independent scientists whose brief it is to further general knowledge—are obviously not the only source of such guidance, but they are particularly valuable for three reasons.

The first has to do with sheer knowledge: basic scientists tend to know the technology and underlying science. Their fact checking and explanations are badly needed, as the mainstream media has floundered in separating the well-informed concerns from the implausible, and even deranged, claims with past genetic engineering. With genome editing, I fear the media will not only flounder, but founder.

The second has to do with epistemology: key CRISPR issues are riddled with uncertainty, and a defining feature of basic science is the rigor with which it deals with uncertainty (Stone 2015a). Scientific disciplines have rules, both codified and normative, that make transparent how and to what extent anything is "known." Anti-GMO activists and pro-GMO corporate executives are not bound by such epistemological constraints, nor do they claim to be.

The third pertains to the nature of career reward structures. Most basic scientists work at academic institutions that enjoy an implicit contract with society: titles, esteem, career protections like tenure, and financial benefits of tax exemption in exchange for pedagogy, knowledge production, and service as a "protective institution of society" (Stone 2014). Professional reward structures are calibrated accordingly, or so argued Robert Merton in his seminal analysis of scientist behavior (1942). Merton held that institutional policies and communal self-policing enforce the basic norms of "universalism" (truth claims are independent of social identity), "communism" (scientists are rewarded for disclosure), "disinterestedness" (spurious claims are prevented by accountability to the academic community) and "organized skepticism" (truth claims are scrutinized by peers).

Merton's famous analysis still serves as a touchstone for discussions of science honest brokerage, although he did not actually use that term. But Roger Pielke did. His *The Honest Broker: Making Sense of Science in Policy and Politics* categorizes different approaches scientists may take as interlocutors to the public and policy makers (2007). The defining feature of his honest brokerage is providing information to expand and clarify a scope of choice, but allowing others to make decisions according to their own values. Pielke contrasts the honest broker to the "stealth issue advocate," who cites "authority of science" to cloak partisanship for a particular position. Pielke's account is not ideal; it focuses on policy decisions and neglects scientists' broader influence on public understanding of science, which is crucial with CRISPR. Pielke's analysis also annoys science studies scholars; Jasanoff, for instance, points out that sometimes an honest broker's contribution should be to narrow a scope of choice (2008). Nevertheless, his contrast between openness to different conclusions and stealth advocacy is invaluable for the present discussion.

As the public debates on GMOs have escalated over the last two decades, the roster of partisan (often militant) proponents has grown to include not only industry executives and public relations operatives, but academic basic bioscientists as well. With few exceptions, molecular biologists who are active as public intellectuals on GMO issues fit the definition of stealth issue advocates, claiming scientific knowledge as a sole motivation, while acting as belligerents in a polarized war of rhetoric. They have compiled a record of claims that have long since left behind any semblance of honest brokerage or Mertonian norms. This forum lacks space for a detailed account of such claims (I and others have provided examples elsewhere; see, for example, Stone 2014), but a sample of well-known examples includes:

1 Repeatedly insisting that "all our food is genetically modified."
2 Depicting genetic modification as the tidy, even surgical, transfer of traits between organisms.
3 Claiming "GMOs are safe."
4 Blaming a 2002 southern African famine on European anti-GMO zealotry.
5 Branding Greenpeace activists as criminals for blocking vitamin-enhanced "Golden Rice."
6 Claiming gene flow into wild and landrace populations to be harmless.
7 Citing any agronomic improvements where GM crops are adopted as evidence of the efficacy of those crops.

On these points, an honest scientific broker would point out that:

1 There are narrow similarities, but many key differences, between crop domestication and insertion of recombinant DNA.
2 Parts of the process of genetic modification are very tidy (e.g., where DNA is cut), but parts are uncontrolled (e.g., insertion into the target organism's genome) and unpredictable (e.g., multiple unintended effects—"pleiotropy"—is one of the problems with Golden Rice).
3 We currently have no strong evidence of harm from the handful of GMO technologies in crops so far, but each GMO is unique and long-term effects are very difficult to detect—as DDT researchers found (Stone 2015b).
4 Some African countries are having difficulty developing policies on GM crops, but the oft-cited famine never occurred.
5 Although a promising idea,[3] Golden Rice has proven difficult to make work and after over twenty-five years of research, still will not be ready for years.
6 Gene flow does not necessarily have unwanted effects, but it is unpredictable and poorly understood, and escape of transgenes into weeds is an enormous problem.

7 Insecticide use has decreased where GM crops have been adopted, but herbicide sprayings have increased even more; yields have increased in many cases, but often at the same rate yields were increasing before.

Since Merton, some writers ("neo-Mertonians") have pointed out that his normative model is a poor fit for the actual behavior of scientists in some situations. Joseph Ben-David writes that specifically when embroiled in controversies, scientists "act like litigants concerned more with putting together a convincing case than with ultimate truth...[t]hey are not, and are not expected to be, dispassionate;" indeed they become "willing to transgress practically all the norms enumerated by Merton" (Ben-David 1991, 480). But while passion and transgression may be expected, they may severely undermine scientific integrity. As Reiner Grundmann points out, this "controversy exception" leaves the door wide open to many questionable practices (2013, 75). The door is also open as to when the exception applies; some degree of controversy attaches to all manner of scientific issues. What is left of that contract with society when scientists morph from disinterested skeptics into passionate litigants who "transgress practically all" Mertonian norms as soon as a fight breaks out?

The nature of controversy varies from case to case, and so do scientists' passions and transgressions. Grundmann's case study is of climate scientists enmeshed in the 2009 "Climategate" affair. The global-warming controversy led these scientists to adopt a "bunker mentality" that disrupted Mertonian self-policing by scientists and peer reviewers. The scientists also lost points by failing to understand the changed nature of debate in the electronic age and by reacting to critics with secrecy and recalcitrance (Grundmann 2013, 71). Whether they technically committed fraud is debatable, but their lax skepticism, media ineptitude, and secrecy combined to erode their own position and mar the public face of science.

The GMO controversy is quite different from—indeed, in many ways the opposite of—the climate debate, and the nature of scientists' Mertonian transgressions is distinctive. Far from lacking media savvy, several of the basic scientists most active as GMO interlocutors regularly huddle with Monsanto executives and public relations operatives to craft messages, formulate strategy, and receive funding for "outreach" (Lipton 2015). And where climate scientists were guilty of inattentive self-policing, interlocuting GMO scientists engage in selective hyperpolicing: they not only avoid criticism of pro-GMO findings, but reflexively attack unfavorable published findings, often through vicious extracurricular charges of misconduct and incompetence (Waltz 2009). Merton's "organized skepticism" is not simply transgressed, but caricatured: the "organized" part is elevated to a frenetic din of blogs, retweets, editorials, and petitions, while the "skepticism" part is replaced by brazen boosterism and motivated thinking (Stone 2013).

We need basic bioscientists as honest brokers, but we have lost them. Just how this happened is a long story but I will note three highlights in the answer, and connect them to the coming CRISPR debate where possible.

Regulation And Self-Policing

External regulation has been a stone in the biotechnologists' shoe since the very beginning of genetic engineering. Most genetic engineers believe that their field has successfully self-policed ever since the 1975 Asilomar conference, when scientists convened to discuss safety issues and established a moratorium on certain hazardous experiments. From this regulatory origin myth has grown a widespread conviction that external regulation has been excessive and misguided, with anti-GMO alarmists to blame. Frustration on this point has fueled scorn for imposed precautions, scorn that is already transferring to the CRISPR debate—as in the *Newsweek* headline "GMO Scientists Could Save the World From Hunger, If We Let Them" (Parrett 2015). In January 2015, Asilomar was reprised (sort of) when biologists conferred in Napa to urge a "prudent path forward" (Baltimore and others 2015). The subsequent "Napa statement" included a nod to considerations beyond biology and even ethics; such a consideration was omitted from Asilomar but it is now unavoidable with CRISPR, given the looming specter of editing human embryos (Baltimore and others 2015, 37).

This self-policing imperative reifies the notion of a society-serving institution called "science," while obscuring the most important question we face with transgenic or CRISPRed organisms: who will control the technology and what are their interests? The Napa statement cites the potential to cure disease and "reshape the biosphere for the benefit of the environment and human societies," noting that such rewards justify high risks (Baltimore and others 2015, 37). One thinks of Edward Tatum's 1958 Nobel speech, predicting future "processes which we might call biological engineering" that "may permit the improvement of all living organisms." The future did bring biological engineering, but not the imaginary scientists who would show up for work asking, "Which organism should I try to improve today?" Scientists use the technology for what their employers reward. The corporation that has dominated the use of genetic engineering is Monsanto, and the main use has been in creating crops resistant to Monsanto herbicide, dramatically increasing the company's herbicide sales. The rewards cited in the Napa statement—the ones worth high risk—seem to pertain to human therapeutics. But the key CRISPR pioneers at both the University of California, Berkeley, and the Massachusetts Institute of Technology have started their own companies, where rewards will be profits. As an honest broker, the scientist should be the first one to point out that their job is not necessarily to improve living organisms or make people healthy, but to use the tools of science for the rewards their employer seeks and for which their employer rewards them. It is those rewards that should be compared to risks worth taking, not the rewards of the imaginary scientist whose overriding concern is human health or food supply.

MUST BE THE MONEY?

Bioscientists who militate in favor of GMOs are often branded as "shills," but this is a misleading charge that obscures the cultural component of GMO advocacy. There is more to it than money.

It is true that the influence of capital on the loyalties and motivations in basic science has been amplified with the rise of the biotechnology. Genetic engineering's enormous commercial potential can only be realized with enormous research undertaken at universities—hence the rise of the "biotechnology university-industrial complex" since the 1970s (Kenney 1986). Today, many basic scientists are funded by, and are in some senses employees of, bioscience corporations, while retaining status as faculty and the appearance of a basic scientist's reward structure. Direct funding ranges from research sponsorship to consultant stipends to unrestricted donations. Indirect supports come from industry-supported chairs, data sharing, patent allowances, and publicity, which affect tenure, promotion, and salary.

But does this mean bioscientists have given up on honest brokerage because they are shills? To shill is to act as an accomplice specifically for compensation not disclosed to an audience. The lack of disclosure part of the definition often fits: scientists are required to disclose research funding in their publications, but not those stipend payments or donations. Scientists may even dissemble about these payments, as reported recently in a major article headlined "Industry Swaps Grants for Lobbying Clout" (Lipton 2015). But the professors are not offering their services simply for a payday, and the emails in this case between land grant professors, Monsanto, and PR operatives do not look like shilling. The professors sound less like conniving hirelings than like athletes begging to be sent into the game: they are acting out of conviction. To understand why, I suggest we consider a phenomenon known as schismogenesis.

SCHISMOGENESIS

Gregory Bateson's concept of schismogenesis refers to the self-amplifying process of divergence: I respond to your extreme position with my own extreme position, leading you to take a more extreme position, and so on (1972). As schismogenesis progresses, nuanced differences become disagreement, then disapproval, exasperation, and even hatred. Schismogenesis is a group phenomenon: individuals do not respond to claims in isolation, but react against or align with groups making claims. Most GMO discourse has not been a contest of separate ideas, but a clash between imagined communities that have come to see themselves as bonded against common enemies.

Social bonding against a common enemy is a powerful and well-known force. Every drill sergeant knows this; we even know a bit about the underlying neurology (Stone 2013). But it corrodes honest brokerage as basic scientists come to see themselves as comrades in arms with corporate GMO proponents whose allegiance is not with basic science but with sales and industry propaganda. If the controversy exception leaves open the door to questionable practices, checking one's scientific objectivity at that door is the most questionable. Effort that might otherwise go to honest brokerage goes to maintaining the image of an ignorant, Luddite lumpen manipulated by irresponsible activism and Whole Foods hucksterism. But if those forces do exist at the anti-GMO end of biotech schismogensis, they are certainly not bound by the same rules as basic scientists. If bioscientists suit up with industry operatives and take the field against an imagined enemy comprising all critics of the biotechnology project, we have lost them. Unfortunately, they do, and we have.

SOMETHING TO DREAD?

As CRISPR rushes at us with its load of difficult questions, we will find ourselves in a situation of unprecedented need of honest brokerage by expert interlocutors. But as I take stock of the behavior of basic scientist/interlocutors on the current genetic-engineering technology, I find the dominant pattern of activity very troubling. My aim has not been to add to the polarization by demonizing scientists—I have intentionally left names out of it—but rather to explain it, to contextualize it with theories of scientist behavior, and to comment on its implications going forward.

For the (probably few!) partisan biologists reading this, thoughts will turn defensively to the polarized reality of public GMO battles. They will say that any frank accountings of genetic engineering's—including genome editing's—many unknowns would just be seized by activists and waved before a gullible public. Perhaps, but if you withhold a frank accounting out of fear of activists, then you are still withholding a frank accounting. If you don't do the job of honest brokering, who will?

I must admit to some trepidation, and even a touch of dread, for where we will find ourselves as we go through the CRISPR door. This is certainly not because of CRISPR per se, which is a fascinating and powerful technique. It is because of the devastatingly difficult questions straddling boundaries of science, ethics, culture, and policy that society will surely address very poorly, largely bereft of the science honest brokers that we need.

NOTES

[1] For an introduction see Doudna (2015). The technology is often referred to as CRISPR-Cas9 in reference to the Cas9 protein that does the actual genome editing. But other proteins will be used in the future, so I simply use the term CRISPR here. Note that CRISPR is not the first genome editor; other technologies such as TALENs and Zinc Finger Nucleases have been in use for years, but they are much more expensive and less precise.

[2] The most widely commercialized form of genetic engineering is in crops. The process involves stitching strands of DNA from disparate organisms together into a ring structure (plasmid) that is inserted into cells of a target plant either with a special bacterium or a gene gun. The insertion process is largely uncontrolled, so the scientist needs a sifting method to isolate cells in which the foreign DNA has lodged and hopefully works as intended.

[3] I was an early defender of Golden Rice as a good—if overhyped—idea (Stone 2002).

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