Symbolic Matter

DNA AND OTHER LINGUISTIC STUFF

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This is an article about some underlying assumptions for rather old debates between those who think scientists report on facts about the universe and those who believe that inevitably the investigators reveal something of themselves in their discoveries. I have three points I want to press. One is a very simple but I hope disarming response to the luminaries of the scientific method who, jumping up and down, indicate that gravity exists so therefore postfoundationalists should not. A second is a more substantive exploration of symbolic matter, or language as stuff: the importance of seeing that ideas do not simply cause material effects but are always themselves material. And third, I urge those who think that by excluding questions of heuristics from their investigations they are being scientific to reread their Popper, whose *Logic of Scientific Discovery* demands a far more rigorous engagement with concept formation than is currently recognized in a variety of social sciences. The focus in this essay is debates about DNA and racial taxonomies, but this is just one rather convenient example of how research documents about the citizenry change the object of analysis—us. While social scientists have published reams of work verifying, say, the effects of information on electoral decisions, the truly important implications of this rather obvious knowledge have been shunted aside. If we now do not have just the intuition but the SPSX certainty[1] that when the press publishes accounts about political candidates or issues this affects political behavior, then why doubt that when scientific documents publicize various features about different groups, attitudes, aspirations, we too will change our minds, change who we are?[2]

The Problem of Representing Race through DNA

Although genetic research promises numerous benefits, from its inception it has also harbored risks, among which are the consequences of the taxonomies that produce relations of inequality.[3] While the potential individual-based benefits are well understood—ranging from direct gene therapy for individuals' diseases to more and better nutrition through bioengineering of food crops, the risks of group genetic typologies are less easily

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appreciated. The intuition is that scientific discoveries are themselves politically and ethically neutral and that their effects on our quality of life follow from the ways that we collectively and individually use information.

This essay explores some of the attempts to dislodge this dichotomy between values and facts and, in particular, the efforts of those challenging the typologies associated with research on the Human Genome Project (HGP) and the Human Genome Diversity Project (HGDP). I want to reflect on why various perfectly logical arguments offered by eminent researchers in various disciplines are so apparently tangential to the research paradigms of the scientists they seek to influence.[4] I do so by considering an article on so-called gene or allele differences among Amerindians and other groups that appeared in *Vox Sanguinis*, a journal that includes numerous articles on population genetics.[5] This article is an apparently innocuous study of the allele frequencies that may affect immune responses. While studies exist that are more or less contentious on the significance of group-based (especially racially based) genetic differences, I review this article precisely because its low-key, matter-of-fact presentation of difference constitutes and restates the idioms and norms of racial and other typologies, even when these same geneticists disavow genetically constituted racial groups. The lack of apparent animus or racial hostility in pieces such as this makes their paradigms so much more difficult to dismiss than, say, an obviously political project such as Charles Murray and Richard Herrnstein's *The Bell Curve*.[6] I am confident that articles such as this, as their findings are more broadly disseminated, will be the bases of the next generation of eugenics arguments.

To confront the seeming transparency of natural science I want to develop an alternative heuristic for engaging with genetic research. Instead of ceding to natural scientists the phenomenological realm of what is material, instead of reinforcing an old relation between ideas (subjective) and findings (objective), I want to emphasize the materiality of symbols, in particular, the thingness of words. Whereas most studying the sociology of scientific knowledge (SSK)[7] or postfoundationalist critiques of scientific taxonomies have emphasized the discursive quality of objects—for example, the way that sex or race is a quality of the concepts of "sex" and "race"—my project suggests that all symbols, concepts, ideas, heuristics are also material. I am not expanding on a widely made point among various philosophers of science, which is that subjective and politicized concepts and research programs yield concrete effects. The observation is true enough, but for reasons I explain below, its formulations often reinforce a stance of philosophical and political helplessness vis-à-vis the efficacy of scientists. Instead, I explain the significance of the fact that this word, this sentence, this paper are material, that without the carbon in the

pencil, the electronic emissions of the computer, the ink that prints the words, the neurological charges in the brain, these thoughts and symbols and all others do not exist.

Philosophers have debated the question of whether something can exist without a word. Invoking German poet Friedrich Hölderlin, Martin Heidegger writes, "Where the word ends, no thing may be."[8] While ontologists may debate the persuasiveness of this claim, what must be universally conceded is that where the thing ends, no word may be.

I conclude by showing the practical implications of this insight for research on the HGP and the HGDP, returning to the *Vox Sanguinis* article to examine its own thingness, its functions as a piece of information as concrete and material as the DNA it seeks to describe. Rather than simply leave such researchers with a schoolmarmish admonishment that they are hopelessly ideological, which they can easily ignore as they return to using PCR (polymerases chain reaction) and Southern blots, I want to begin to bridge the historical divide that has relatively recently exiled philosophical inquiry from the realm of material experiments and research, a ban that leaves social philosophers with more schadenfreude than influence. I want to reintroduce to these scientists the objects of their own creations: their publications. These, in the form of their status as word-things, comprise a portion of the "missing link" of our communicative techniques that explains the taxonomic structures separating humans from all other creatures.

"Gene Frequencies of the HPA-1 AND HPA-2 Platelet Antigen Alleles among the Amerindians"

Because my purpose in writing this is a practical one, I thought it would be useful to begin with an example or, as some prefer, a sample. This sample is not simply an object of critique but is meant to serve as a lesson for remediation and improvement. As it stands, this article I describe is a thing, and as such it has the potential to produce certain effects. I want to make these effects clear as well as to show how scientists might incorporate these findings into their future research.

Before describing this particular article, a few words about the research tradition of which it is a part are in order. Presently there are dozens of research journals devoted to molecular genetics, many of which include a specific focus on molecular evolution. In addition to the aesthetic impulses underlying the quest for knowledge in itself, two practical considerations explicitly motivate this work. One is potential health benefits thought to derive from correctly assigning biological functions to particular alleles.[9]

The second goal of population genetics is anthropological, to trace the history and patterns of human migration and evolution. Journals are filled with reports on population studies that isolate one or more DNA fragments and compare their frequencies and functions in different groups, ranging from those with idiomatic racial designations to more discrete groups that become racialized through their reiteration as genetically different.[10] A priori there is no reason to believe that a particular DNA fragment is any more "genetic" because of its proximity to genes than it is to think a plastic terminal casing "computational" because of its connection with a computer.[11] As is the case with the articles described in note ten, the *Vox Sanguinis* article mentions both goals: "The differences of the DNA polymorphisms in Amerindian populations are not only of anthropological and genetic interest but have also practical applications when they involve coding regions which may change the functional or immunological features of the protein."[12] In brief, the researchers compared the frequency at which two alleles appeared in 132 members of "six tribes of Amerindians from the Brazilian Amazon" with their frequency in "60 Whites" and "52 Blacks" and found that an allele that is supposedly present in 13.3 percent of Whites and 11.5 percent of Blacks is "absent from the Amerindian populations of South America." Another allele, reported in 10 percent of Whites and 14.8 percent of Blacks, was present in 4.2 percent of Amerindians.[13] As is the case with most articles in *Vox Sanguinis* and related journals, the essay by Covas et al. is short—two pages—and lacks reflexivity on questions of method, research debates, or potential heuristic weaknesses.[14] Rather than evaluate whether this research is valid or useful, I want to place it in the context of current debates on racial classifications involving the U.S. Human Genome Project (HGP) and the Human Genome Diversity Project (HGDP) at Stanford University to show how critics of racial genetic studies either share and reinforce assumptions of the *Vox Sanguinis* article or remain ensconced in a fact/value positioning that taints as utopian, fretful, or fanatical even the most trenchant and logical critique of the fact/value dichotomy (or the related material/discursive dualism).

Background Concepts

Human Genome Diversity Project

Before reviewing the axes of debates about race and the HGP, I want to explain the use of "race" by population geneticists[15] and also characterize more precisely the HGP and the HGDP. One of the interesting conse-

quences of the backlash against racial eugenics is that many of those who do population genetics disavow the existence of race. At a conference held at Tuskegee University, Luigi Luca Cavalli-Sforza, the director of the Human Genome Diversity Project at Stanford University, attempted to "reassure those of you who are worried about genetics" by referring to a widely cited article demonstrating that average within-race DNA differences are larger than average between-race DNA differences.[16] He went on to affirm: "One important conclusion of human population genetics is that races do not exist."[17] Cavalli-Sforza claims to be interested in "populations," not races,[18] an approach he also emphasizes in his major books on genetic diversity.[19] However, although both his address and his books deny the existence of races, Cavalli-Sforza continues to refer to races—the actual word, as well as the concept. For instance: "Racism is defined by many, including me, as the persuasion that some races or racial groups are inherently . . . superior to others" and "differences among populations, races, continents, are very small."[20] Cavalli-Sforza's continued, perfectly idiomatic, use of "race" overshadows the statement that races do not exist, for if they do not exist, then it makes no sense to study the small differences among them.

Similar in its apparent aversion to specifically "racial" heuristics, the *Vox Sanguinis* article primarily refers to "populations," although "ethnic groups" and "stocks" are also mentioned. The racial agenda of the research is betrayed when the authors characterize the discrete populations as follows: "Only individuals who reported an absence of any racial admixture for the four grandparents were included."[21] The point of highlighting the inconsistency is to suggest that race is inevitably a part of these studies, that it is always implicit, and even when efforts are made to repress the concept, the word itself seems not to obey but to sneak in, even when uninvited. Rather than breaking away from "race," these "population studies" are refining and operationalizing the concept in a manner they see as drastically more sophisticated than their racist-minded forebears. In sum, races are studied as ancestral groups associated with a particular geographical territory.[22] Whereas physical phenotypes of skin color, body shape, and hair characterize current idiomatic notions of racial difference and earlier scientific efforts at racial taxonomies, population geneticists today are using DNA segments themselves to characterize different groups. Whereas the craniometric alternative devised by Anders Retzius is something that Cavalli-Sforza dismisses on grounds that its "heritability is probably low and because the [cephalic] index is sensitive to short-term environmental effects," DNA fragments are thought to be stable and inherited.

Rather than make inferences from physiogamy to genes, Cavalli-

Sforza argues that gene frequencies in populations should be studied directly.[23] To be clear, I am emphasizing the ways that the practices of population genetics merge with studies of racial genetics so as to anticipate a possible future moment when "race" or its cognates might not appear in such studies, although the vast majority of research articles on "populations" still use "race."

The HGP largely refers to an assortment of research laboratories that receive grants from a consortium run through the Department of Energy and the National Institute for Health to participate in "mapping" the human genome, though part of this process entails supporting research on the genome maps of other organisms, ranging from single-cell bacteria to dogs. However, there are laboratories around the world—most significantly those funded through the European Human Genome Organization (HUGO) and in Japan—that are also mapping various portions of chromosomes.[24] The chromosomal reference samples for the HGP were taken from sixty-seven northern American and northern European men.[25] The resulting map, at least in its first stage, will code only the relative placement of strings of DNA sequences and will provide no specific information on the function (if any) of these fragments. Coincidental with the HGP are hundreds if not thousands of laboratories—some university-run, many private—that are doing isolated functional coding for particular regions of chromosomes, with the greatest resources being devoted to the study of members of putatively homogeneous groups, for example, Ashkenazi Jews. This is because different family trees with high intergenerational DNA similarities are easier to compare. If a particular chromosome contains a few differences from the same chromosome in someone else, it is easier to spot the relevant mutations than if one's chromosomes differ in many respects.[26] As discussed above, molecular biologists in formal or informal association with the HGDP are studying allele frequencies among what are interchangeably referred to as "populations," "ethnicities," "language communities," "stocks," and "races." The HGDP has an uneasy relation with the HGP. Although in the early 1990s it seemed as though the HGDP would receive funding from the HGP, worries about the political implications of HGDP research (from its potential to patent "native" DNA fragments to its reinforcement of racial thinking) gave the U.S. government administrators pause. However, new work on single nucleotide polymorphisms (SNPs) has led the HGP in this direction, and now the two research groups have a formal working relationship.

Four Claims about Genetic Knowledge

The axes of debate about the implications of the HGP for racial inequality, and for scientific research more generally, can be parsed into four often-overlapping domains. Specification of these highlights the discursive and technological mechanisms by which certain types of concerns are systematically thwarted, as observations about "politics" are overwhelmed by those based on "facts." Two points in particular are important. First, many of those expressing worries about the racial aspects of the HGP also affirm a series of assumptions about science that ultimately weakens the efficacy of their critiques. Second, by failing to bridge the domains between "politics" or "ethics," on the one hand, and "truth" or "use" on the other, it is difficult to concretely specify the form of alternative understandings of population genetics in a manner that might be, in the parlance of these researchers, "operationalized." The space between humanist critiques and scientific research, absent specific mechanisms for conveying understandings of racial assumptions into research designs, leaves the materialists (geneticists) free to develop paradigms in a manner that unthinkingly reiterates racial and racist agendas. The ease and even usefulness of "unthinkingness"—a phrase connoting what scientists refer to as "objectivity"—is also reinforced.

Another reason to develop these heuristic points here—claims applying to many debates about knowledge with long philosophical traditions not touched on in this article—is that the HGP is committed to spending approximately 5 percent of its approximately $350 million annual budget on a program called Ethics, Legal, and Social Issues (ELSI). The ostensible purpose is for experts in these fields to provide guidance to politicians and researchers.[27] Hence, understanding the particular terms of such interprofessional and interdisciplinary conversations is especially relevant to grasping research on race and the HGP.[28] Given the current climate, the ELSI scholars seem to exert some influence in organizing policies to protect against genetic discrimination in employment, in health insurance, and against violations of privacy. However, given the decentralized character of this research, even if the ELSI scholars were to arrive at a clear position on race, there is little chance under prevailing arrangements that they would be able to affect the taxonomic structures of genomics research. Reflecting on how to change this relation between research communities and taxonomies is one goal of this essay.

The four objectives that underlie most claims about the role of race in the HGP might be said to constitute four implicit metaepistemological assumptions about why knowledge is important, assumptions that in turn frame the criteria for what counts as knowledge. These are: truth, political

power, ethics, and use. All genetic research aspires to one of these goals. These epistemological objectives do not map onto substantive claims about race but rather denote the axes of debate and research hypotheses.

Truth

Among those who affirm the use of race, one justification is simply that by dint of objective theories of probability or by transparent practices of perception, we observe racial differences in genes. That is, at the level of alleles and phenotype, there are statistically significant as well as intuitively apparent correspondences of genotypes and phenotypes. Leaving aside issues of perceptions based on directly observing different bodies, geneticists have produced research that shows, for instance, that a "Caucasian" genome has a potential for containing an individual mutant allele that immunizes against HIV that is absent in the genomes of all "Asians" and "Africans." [29] By pointing out this racial difference, one is simply offering a "true" statement about genetics and subpopulations. If someone wants to call this group difference that of a "population" instead of a "race," the scientist pursuing this research might be amenable, but only because he or she is certain that the racial label of the phenomenon of group genetic differences has been replaced by another label that is a near synonym, one that still refers to a correspondence of one's membership in a group with a characteristic set of DNA polymorphisms that is exactly like a race. To such a characterization, a similarly truth-seeking investigator might produce the frequently invoked data on within- and between-race DNA differences and argue that it is logically unsound to continue to use such taxonomies. That is, scientific testing of DNA proves a different truth: races do not exist (see note seventeen).

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Among those who recognize the scientific validity of racial taxonomies, another dispute concerns the ways to incorporate racial categories into genomic research. Some fault the HGP for imputing racial health differences to genetics and claim that studies to falsify these claims are doomed because it is simply impossible to measure the health effects of "Blackness," as this cannot be controlled for.[30] Others, however, urge the scientific community to measure genetic differences among racial groups in more detail, by funding, for instance, the Genomic Research in African-American Pedigree (G-RAP) at Howard University, which sets as its goal "to improve the health status of African-Americans through research on DNA variability and the application of knowledge gained from research to better understand the bio-medical significance of gene-based differences already known to exist."[31] Cooper and Dunston respectively, at least in

this context, are not disagreeing about politics, ethics, or utility. They just see race differently. Cooper thinks there is no detectable way to discern contributions of genetics to racial differences in disease, while Dunston urges that if the HGP's medical potential is good enough for those seeking to benefit from the CEPH reference panel (North American and north European men), then it is also a project relevant to African Americans. Underlying the utility issue is a more or less apparently factual disagreement as to whether genes can be isolated by racial subgroups in a manner that would lead to causal observations about diseases.

Political Power

Almost by definition, the inquiry here—whether a taxonomy is legitimate—produces and manifests political concerns that may be more latent in other scientific disputes. In the name of a particular community (rather than truth), those advocating on behalf of a particular racial group may produce radically different arguments for why or why not to use "race" in genetic research. Whereas Cooper and Dunston disagree on what is feasible, others dispute the effect of racial taxonomies on the political status of those groups already weak or otherwise marginal (such as the "aboriginal" people studied by the HGDP). The objection is not primarily that genetically discrete groups do not exist or cannot be studied with current techniques, but that if they are (or are not) studied, disadvantaged groups qua groups will benefit (or suffer).

For instance, Fatimah Jackson opens her thoughtful and devastating critique of the selection of European cell lines for HGP research by stating that it is unclear how the HGP "will directly benefit African-Americans."[32] Here, the method of cell line selection, symptomatic of other oversights,[33] manifests the political context of this research. Jackson describes the principles laid out in the 1994 *African American Manifesto on Genomic Studies*, among which is the proposal to create a national review panel that will "issue certification of projects that are consistent with the research aims and objectives of the African-American community."[34] Interestingly, although one of the chief catalysts of this manifesto was the "misrepresentation of African-American perspectives and priorities articulated by a representative of the Human Genome Diversity Project (HGDP) at the World Council of Indigenous Peoples Conference,"[35] the manifesto's call for separate genetic studies of "Africans of the various diasporas" and Jackson's previous claims of the potential irrelevance of a "European" genome to "African" disease draw explicitly on the work of Cavalli-Sforza and others who study population genetics. Jackson thinks it

politically useful to study the African genome (and its diversity), but only so long as this is done under the direction of a group looking out for the interests of the African American community.

Others dispute the political usefulness of racial taxonomies based on genetic research, worrying that such classifications inevitably perpetuate conditions of stigmatization that hurt those who occupy the lower rungs of the racial hierarchy. On these grounds, researchers may decide it is better to compare groups by, say, zip code or neighborhood characteristics rather than race. Closer to the HGP, critics of racial typologies say that such research should be precluded because any "difference" will immediately stigmatize certain groups as "inferior" to the European reference sample.[36]

Ethics

A third set of criteria underlying claims about knowledge are those rooted in ethical concerns. On the Platonic assumption that the true and the good coincide, some researchers may divide along lines of whether a set of inquiries will result in the human society to which they aspire. Although all sorts of other arguments may also come into play, ethicists may offer guidance on genetic research not based strictly on available scientific idioms or on behalf of particular groups but instead couch their views in appeals to what is putatively the "good" decision. Due to the character of race—that the classification refers to group difference—few ethical arguments do not immediately have the appearance of political ones. Of course, arguments against setting off certain groups by their genetic differences can take a more universal form, when the position is generalized to the harm for human beings and not simply for this or that particular group. Therefore, ethicists are most prominent in discussions of individual-level genomic research, for instance, in matters of whether it is good for an individual to know about genetic defects if there are no cures for the disease being studied or whether insurance companies should have access to individual disease propensities.[37]

Use

The fourth major type of assumption about knowledge is that it exists when it does things, when it can be used for something. This is perhaps the most influential framework for debates about genetic racial taxonomies and scientific knowledge more generally. On this account, we know some-

thing is real when that knowledge can be applied to change ourselves or our environment. In a general sense, there need be no beneficent outcome associated with these pragmatic findings or interventions. Regardless of whether one finds the atom bomb a help or hindrance to society, its explosion verified certain principles of theoretical physics, principles that some might have believed simply because they were "objectively right," but that others would not count as knowledge until they knew the bomb displayed a chain reaction.[38] In the realm of genetics, some use pragmatic arguments to justify racial taxonomies. There are two routes. One is the apparent existence of statistically significant differences in genetic disease rates among idiomatic racial groups. For disease probability, if nothing else, racial knowledge appears to do something when it allows one to predict the chances of individual susceptibility to a particular genetic illness based on one's racial identification. More substantively, if blood antigens have differences that vary by populations, then such knowledge may reduce harmful immune response to blood transfusions.[39]

Of course, others stress that the vast majority of even those diseases with a genetic component have etiologies that follow a complicated course of nongenetic interactions at the level of the cell, the person, and the environment. Emphasizing genetic discoveries alone as a source of knowledge about diseases has, on this view, the pernicious effect of diverting attention from more important causes. For these reasons, Sarkar questions whether most research currently understood as "genetic" is really yielding knowledge about genes. After pointing out that "most of the chemicals that act as cues for the genome are environmental in the sense that they are not alleles or immediate products of the incipient organism's own genome,"[40] he proposes a far more limited definition of "genetic" than currently in use. To be defined as "genetic" a trait must: (1) be under the control of a few chromosomal loci; (2) show high expressivity in all populations; and (3) reveal a connection between the products of the alleles and the "biochemical characterization of the trait."[41] This definition of genetic knowledge "would cure the habit of calling some trait 'genetic' when all that is known is that some unspecified locus has some slight influence in its occurrence—a habit that would lead one to call every trait of every organism 'genetic.' Moreover, it would emphasize, as most geneticists explicitly do—that the successful modification of these traits through genetic intervention may well be far less plausible than through intervention at environmental levels."[42] In short, if knowledge of DNA does not lead to chromosomal interventions, then by Sarkar's definition, this is not genetic knowledge.

Those in SSK seem to have as a primary goal the driving of a wedge between science as truth and science as use. SSK practitioners criticize the possibility that scientific discoveries might occur independent of politics, ethics, religion, and so forth. Descriptions of the scientific method being challenged can be found in works by everyone from Francis Bacon to Newton to Hans-Georg Gadamer, who writes: "The experience that can be validated as certain by the scientific method has the distinction of being in principle absolutely independent of every integration into the context of action. This 'objectivity' conversely implies that it is able to serve every such possible context."[43] Gadamer sees scientific knowledge as distinct from what is learned in *practice*. Practice is dependent on context: "Practice always has a relationship to a person's 'being.' . . . From this point of view an irreducible opposition between science and practice becomes clear."[44] Practice depends on what we humans decide to do to order our lives (and how the decisions of others affect us), while scientific experiences as such are simply in pursuit of the truth, a knowledge that one might "enjoy for its own sake out of . . . a primary curiosity about the world."[45] Although Gadamer preserves an association of "science" with truth and distinguishes this from "modern natural science," which is concerned with "know-how," and while other sociologists of science refuse to recognize any scientific pursuits as following from a "purely theoretical interest" that Gadamer locates in real science,[46] both critiques find science or knowledge (modern science for Gadamer) enmeshed in the same quagmire of human contingency—including ethics and politics—that we normally associate with technology.

Those in SSK can demonstrate that a myriad of discursive forces shapes scientific inquiry. This convinces them that the scientific experience inevitably lacks objectivity. In this section, I will be reviewing some of these claims, with an eye to showing why in their current form they have not been persuasive. I elaborate on some of these arguments to point a way toward rendering them as useful as the experiments they critique.

Sticks and Stones

Richard Rorty argues that science is not really about getting reality right; rather, it consists of gaining knowledge that helps people solve particular problems.[47] However, pointing this out is not the intellectual comeuppance Rorty seems to desire. Rather than diminish the authority and objectivity associated with the natural sciences, Rorty's definition easily

accommodates the apparent transparency of scientific claims and their obvious superiority over self-avowed heuristic studies in the humanities. Sarah Franklin notes that the "power of science, of scientific objectivity, of the experimental method, of rational empiricism, is that *it can do things*."[48] Hence, rather than delegitimate scientific inquiry, the observation that science helps us cope with reality is one of the chief cornerstones of scientific truth. Genetic experiments can do things visible to us, while critiques of genetic concepts seem so much fancy window dressing.

Why should anyone believe that scientific insights are anything but what makes things happen in accordance with principles that allow for generalization and reproducibility? One answer has been a new positioning of marginal viewpoints to redirect scientific inquiry so that it will be more truthful. Consider Sandra Harding's concept of "super-objectivity," or the "Golem Science" of Harry Collins and Trevor Pinch.[49] Similarly, Sarkar concedes the possibility of more scientifically defensible claims about genetics when he writes that "whether reductions are going to be successful or not . . . is an empirical issue."[50] Here the problem with current genetic research is overstating its promise in light of available evidence. And Dorothy Nelkin and M. Susan Lee write that "[b]iological differences in themselves have no intrinsic meaning. Skin color is genetic—it is a real biological property—but it became a sign of political and economic difference for specific historical reasons, including the European colonization and exploitation of Africa."[51]

For Harding, Collins and Pinch, and Sarkar, objective empirical truths exist and science has failed by misunderstanding them.[52] For Nelkin and Lee, science gets the facts right—the geneticists know that race is not real—but political circumstances result in a problematic invocation. That science itself "does" things on these accounts only reinforces its underlying epistemic authority as objective. If it did not have the potential to get things right, then how can we criticize mistakes that may harm us? On the natural scientific account, empirical truths automatically liberate us as part of a forward march of progress, while for those doing SSK, facts are subject to distortion, but it is to be hoped diligent neutral investigators will set the record straight.

A related reason that positivists seem so persuasive is that they flatly reject the SSK position that because scientific knowledge is verified by uses, therefore science is enmeshed in the more expansive habitus of politics, ethics, and other discourses. Natural scientists rebut this assertion by simply restating the accuracy of facts discovered under these conditions, how the results can be reproduced and hold true across cultures. Regardless of creationist studies cited by the Kansas Board of Education in 1999, evolution is a fact, for them and for the rest of us as well. At a certain

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point, when science seems tainted by an agenda, then, according to Gadamer, science becomes a practice. Yet insight into science as technology—science as a way to do things and not as a realm of pure observation—does not require the conclusion that scientific discoveries are "merely" political or social ones, much less that habitus affects the underlying "truth" of the resulting scientific statements.[53] There is no logical reason to view technology—the study of how to *do things*—as any less neutral and disinterested than science—the study of how to *know things* (by doing).

One example of the inference that scientific findings are instrumental and therefore not factual occurs in the sociology of racial knowledge. Knowing that various racist projects underlay the first, and subsequent, forays into population studies—technologies of population management—from Francis Galton to Edward Jensen to Charles Murray and Richard Herrnstein leads the antiracialist scientist to write: "We need to recognize that race is not a thing; race is a social idea."[54] Good, pure scientists such as Cooper can tell us how ideology has misled his prejudiced counterparts. And yet despite much lip service, still race remains—in ordinary practices of racial profiling or reports on racial health differences—as a demonstrable thing easily detected. Blacks stopped by the New Jersey police did not protest the unfairness of this action on the grounds that race is not a thing but rather resented the use of that thing, their thing, their race, against them.

The reason that race remains a thing is that, like other things in science, we can see and grasp what it does, whereas, we believe, we cannot see what truly fictional ideas do. Of course, the dichotomy between ideas and things is an artifice, but one that speaks to idiomatic distinctions we regularly formulate. Sarah Franklin states the basis of the rhetorical success of scientists quite clearly: "The point at which science studies scholars and traditionalists part company is in the matter of what difference it makes to construct knowledge as relational. No amount of rational argumentation, historical documentation, or cultural interpretation is capable of dislodging their view *because it is ultimately one that positions knowers as less powerful than the reality they describe*."[55] When race just *is*, then those looking at it are not making a partial, subjective claim, but noticing the truth. Those who would suggest otherwise are the ones with the biases. The social science studies scholars are viewed as toying with sober-minded investigators interested in just the facts.

A good example of Franklin's point is SSK debunker Richard Dawkins's bellicose challenge: "Show me a cultural relativist at 30,000 feet and I will show you a hypocrite. Airplanes built according to scientific principles work."[56] Dawkins's point, present in the use of racial typologies

in the *Vox Sanguinis* article, is that as long as a theory works, it cannot be said to depend on the influences of cultural concepts but rather must be true independent of what any individual or a community thinks about it. Words do not cause planes to fly or gravity to down them, therefore critiques of science focusing on discourse are off base.

There are two problems with this juxtaposition of things and words. One is Dawkins's contrast. The other is the dichotomy in most SSK and anti-SSK articles between words and things. The difficulty with Dawkins's inferences from planes flying to the wrongheadedness of cultural relativism is that he too quickly assumes that this particular example of material activity (a plane flying) could have its significance generalized to materiality in general.[57] Likewise, he assumes that the triviality of this potential particular discursive intervention—someone questioning objectivity in a plane—characterizes all discursive acts. Before turning to the problematic dichotomy of words and things, it is important to understand that the linchpin of its phenomenology, one that privileges the objectivity of activities involving thingness and diminishes the objectivity of words, is the transparency and necessity of certain cause-effect relations between things, compared to the apparent opacity, subjectivity, and contingency in discursive events, a contrast highlighted in the plane example. If Dawkins uses his words to tell me, "Jump out the plane and fly alongside it!" that will not prompt me to do so. Mastering the materially embedded principles of plane technology and working with the right materials, however, allows one to produce something that, regardless of what anyone else says, will fly at 30,000 feet.

Dawkins's error is that he does not consider competing examples of material/discursive contrasts. Indeed, many critiques of postfoundationalist views on language use life-threatening situations for their examples: "There is an objective reality out there too, and it applies to social relations as well as to natural science. External reality is crucial when it comes to the ultimate resource, violence: when you shoot someone, that person dies regardless of whether he or she believes in ballistics or bullets." [58] But what about a Hitler rally, or Martin Luther King Jr.'s "I Have a Dream" speech, not in contrast to the technological changes that made possible rapid industrialization and unemployment in Europe or the migrations of Blacks to the North, but in contrast to the metal on the microphones? Or consider the means of abortion clinic protests, where it is "mere words" being chanted and "mere photos" being displayed for purposes of changing life-and-death decisions at that moment. Is "Baby killer!"—made present in the world by the compression of air in a particular way—less potent than the dust on a heckler's shoe? What about the fear of Osama bin Laden's mere words being broadcast on Arabic television: "This isn't

playing with fire," said Middle East expert James Morris at the University of Exeter, "this is using a flamethrower in terms of the political impact on the governments in the Islamic world."[59] Indeed, a sense of life-and-death urgency prompted Defense Secretary Donald Rumsfeld to chastise reporters for dangerous representations: "The fact that some members of the press knew enough about those operations to ask the questions and to print the stories was clearly because someone in the Pentagon had provided them with that information. And clearly it put at risk the individuals involved in that operation."[60] And just as Rumsfeld worried that operational information would risk American lives, National Security Adviser Condoleeza Rice implored television networks not to air bin Laden's speeches because they would prompt Muslims to take his side. The White House was worried that the speech by bin Laden immediately after the United States initiated its bombing of Afghanistan would turn more people to his cause than the U.S. military action might dissuade. White House Press Secretary Ari Fleischer was not worried about bullets or even box cutters when he defended Rice: "At best Osama bin Laden's message is propaganda, calling on people to kill Americans. At worst, he could be issuing orders to his followers to initiate such attacks."[61] In response, the White House prevailed on the Arabic network to interview Rice.

Just as "traditionalists" can list words that do not matter, postfoundationalists can list things that do not matter, things that produce no significant effects, or at least effects situationally no more interesting than the cultural relativist in an airplane. As these extreme examples of airplanes and political speeches show, it is impossible to decide, knowing only that an experience is of a thing or a concept, that one is more consequential.

Indeed, given the Humean problem of cause-effect relations, even the claim that "bullets kill" requires elaboration. Not all bullets kill, even those that hit the body. And if a bullet does precede death, is it really "the bullet" that has caused the death, or is it that this bullet entering the body caused blood to disburse and stop reaching the brain? But was this the point of death, or was it when the heart stopped beating? And if a "bullet" is this far away from being an immediate cause of death, then why be content to say that "the bullet killed" the person, and not the one who fired the gun? But why stop here, and not, as some state prosecutors have done, observe that the gun manufacturer caused the death?[62] Or the bullet maker? All this is to say a cause-effect framework does not logically enhance the status of "things" or diminish the relevance of "words" as catalysts.

Just as Dawkins sees the fact of the airplane flying as proof of the law of gravity as well as the various equations that predict, say, jet propulsion, geneticists reasonably see the predictable frequency of alleles in enzyme

production of antigens as proof of the existence of racial classifications. As opposed to M. W. Feldman and Richard Lewontin who, in 1970, wrote that "variance analyses as summarized by heritability is irrelevant to attempts to cure and eliminate such disease and is rarely applied in genetic counseling,"[63] Michael Specter now writes of the Icelandic genetic studies: "after examining five hundred and seventy-five Icelandic breast-cancer patients, including thirty-four women who had been found to have the disease since the Second World War, researchers discovered only one BRCA2 mutation in Iceland: Einar's. That means scientists don't have to guess what caused cancer in those patients; they know. And knowing the root of a disease is the first step along the difficult road toward curing it."[64] If (the taxonomy of) "Icelandic breast-cancer patients" allows for knowledge of disease, it seems futile to claim this taxonomy a mere heuristic invention, a discursive reflection of cultural values, a "social idea," and not an objective basis of knowledge, a "thing," the very solid knowledge the authors of the *Vox Sanguinis* article have at hand in their racial taxonomies.

Before attempting to reconcile the inferences wrought by "words" as opposed to "things," I want to review a crucial text that sets them apart. Karl Popper's *Logic of Scientific Discovery*[65] is the touchstone, for defenders and foes alike, for what is conventionally referred to as the "scientific method." For instance, Hilary Rose refers to her "enemy" as those "shaped by the Popperian mold" and refers to "mentor Popper" for the disciples Adolf Grünbaum and Ernest Gellner whose work she associates with "Science" (her capitalization), an endeavor that is relentlessly "positivist" in that it insists on the possibility of making metaphysical claims that do not depend for their verification on analyzing language but on following a particular experimental method.[66] There are numerous places one might point to in this text to demonstrate how Popper has been misread by those who invoke and denigrate his work. Most glaring are those who do not heed his repeated caveats about the inability of scientists to discover the truth.

Popper clearly and repeatedly argues against the possibility that hypothesis testing provides scientists with the truth. What one learns in this manner is always provisional, never foundational or predictive: "I never assume that we can argue from the truth of singular statements to the truth of theories. I never assume that by force of 'verified' conclusions, theories can be established as 'true,' *or even as merely 'probable*.' "[67]

Moreover, although Popper insists that theories need empirical testing for purposes of possible falsification, he commits himself to a strong view on the importance of preliminary concepts to the formation of theories. He sees the role of the scientist not as passively observing information but

as creating concepts that direct scientific inquiries. In challenging language philosophers who would reduce reality to words, he is not advocating a banal form of Anglo inductivism: his theory "stands directly opposed to all attempts to operate with the ideas of inductive logic. It might be described as the theory of the *deductive method of testing*, or as the view that a hypothesis can only be empirically *tested*—and only after it has been advanced."[68] This is familiar, but the weight of the hypothesis in this formulation has not been fully grasped.

Popper continues, describing how he "shall distinguish sharply between the process of conceiving a new idea, and the methods and results of examining it."[69] Now, this turns out to be important. While Popper has told us that half of a scientific investigation is coming up with an idea, he spends no time at all explaining either where these ideas come from or how they might have quantum effects on the world. Since Popper refutes the notion that the world is static—the absence of falsification in one context does not mean a theory will hold in the future—his emphasis on concept formation raises two important possibilities that do not receive enough attention from positivists. First, how do scientists arrive at their ideas? And second, what are the effects of these ideas on the objects of their analyses? While the answers to these questions are acknowledged to be relevant to fields such as quantum physics, they are even more central to investigations of the social world, where the objects under the microscope actively participate in their own reproduction through the reiteration of scientific concepts. If you instruct an apple on the importance of gravity, behavior will not alter, but if you tell humans they are racial creatures, they will change their behaviors.

One reason that the mechanism by which humans can be shown to react to symbolic cues has been insufficiently integrated into an appreciation of the importance of concept formation is that we inhabit a culture that privileges obvious cause-effect relations of what is material, for example, the theory of gravity embodied in a falling apple. As we have seen, one of the main impediments to fostering understanding between geneticists and those who study scientific knowledge is the mischaracterization of the word as immaterial. Popper, for instance, begins his exodus toward scientific knowledge by quoting with approval Kant's dictum that scientific disputes are not a "'problem about mere words, but always a genuine problem about things.'"[70] Popper expands on this: "Admittedly, understanding the function of our language is an important part [of cosmology]; but explaining away our problems as merely linguistic 'puzzles' is not."[71] Or, as a political scientist wrote in response to a claim I made elsewhere, that racial categories should be seen as risk factors analogous to guns or cigarettes, "I can touch a gun but I cannot touch a racial category." So

while Popper concedes language is important, it retains its quality in his thought as a nonmaterial set of labels that plays an instrumental role in grasping the true nature of things in themselves, things that are by definition separate from the words that describe them. Similarly, we have seen how those in the field of SSK perpetuate the division by diminishing the weight of those linguistic characterizations that they believe inaccurately represent race as a "thing" as opposed to an "idea."

Postfoundationalists have brilliantly charted the ways that things are also discursive, as when Judith Butler defines "matter" "not as site or surface, but as *a process of materialization that stabilizes over time to produce the effect of boundary, fixity, and surface we call matter.* That matter is always materialized has, I think, to be thought in relation to the productive and, indeed, materializing effects of regulatory power in the Foucaultian sense. . . . To claim that discourse is formative is not to claim that it originates, causes, or exhaustively composes that which it concedes; rather, it is to claim that there is no reference to a pure body which is not at the same time a further formation of that body."[72] While Butler claims that matter is materialized, I want to stress that *discourse is itself material* and not simply that which makes possible materialization. Words, all words, like all signs or symbols, exist only as things. If natural scientists want to study the world, to pursue the Popperian "problem of cosmology: *the problem of understanding the world including ourselves and our knowledge, as part of the world*,"[73] then they must study language as an object.

The Möbius Strip: The Missing Link

One of the metaphorical centerpieces of work such as Butler's is the Saussurian sign, which Saussure analogizes to a piece of paper.[74] It is as impossible to detach the word (or signifier) from the (concept of the) thing it evokes (the signified) as it is to find a one-sided piece of paper. This is the observation that has proved so motivational and fruitful to a variety of postfoundationalists and so confounding to positivists.[75] However, as compelling and useful as this metaphor has been, it still reinforces the intuition of the metaphysical separateness of words and things that it is used to resist: words remain on one side and (the meaning of) things on the other.

Perhaps a more apt metaphor for characterizing the relation between words and things is to abandon the notion of their mediation by concepts altogether. Instead of seeing the sign as the word/concept that evokes the thing, it may be more useful to view the piece of paper as a Möbius strip, one that, curiously, has only one side, even though at any given point it

has an interior and an exterior. Such a strip is formed when a rectangular piece of paper has its ends joined after a half twist is made. If, prior to joining the ends, one painted each side a different color, one would observe that the colors that are interior and exterior change, with a contrast of proportion at any particular point that depends on the evenness of the twist. A mathematics textbook describes the Möbius strip thus: "An ordinary surface has two sides. If the surface is closed, the two colors never meet. . . . A bug crawling along such a surface and prevented from crossing the boundary curves [straying from that side of the surface] . . . would always remain on the same side. Moebius made the surprising discovery that there are surfaces with only *one* side. . . . A bug crawling along this surface, keeping always to the middle of the strip, will return to its original position upside down."[76] One might say that the Möbius strip, if we imagine words on one side and things on the other—at any particular point this holds—is the missing link that helps us conceptualize the simultaneous relationship that, say, Linnaeus's taxonomies have to the order of things. His words formally can be seen to be labels for things that the words are not, labels for the species he identifies. But at the same time we know that these words are coincident with things, that they too are material, are part of that same cosmology they ostensibly merely name.

In this way we may grasp that the political and ethical approaches to scientific research confront objects that also are material, ineluctably part of the social organism. This is close to the point Evelyn Fox Keller makes when she observes that scientific formulations are always speech acts in the sense of Austinean performatives, where words such as "I promise" or "I do" do not describe reality but constitute it.[77] The Möbius strip analogy prompts us to bridge the chasm between words and things—between the scientific article and the experiment itself—that seems so intuitively infinite. The metaphor allows us to visualize words as force, the materiality of their structural status, and the contingency of the order to which they are bound. At the same time, the metaphor accommodates resistances to such observations. Just as it is the case that in the vast majority of circumstances Euclidean geometry, Newtonian physics, and the theorems of Maxwell and Lorentz work just fine—despite the accuracy of Einstein's incommensurate theory of relativity[78]—it is the case that in most instances seeing words and things as separate allows useful observations to be made.

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The baseline for what counts as an obvious perception changes as conceptual conceits become widely used and begin to feel intuitive. The average six-year-old in the United States in the early twenty-first century does not see the use of the decimal system or the alphabet as challenging or strange, though both would strike a visiting Mycenean adult from the

seveneenth century B.C. as incomprehensible. One might envision the Möbius strip of everyday life as one that has the "internal" portions resembling those of a nontwisted strip with the ends pasted together, except for a sharp twist in a narrow section. This would be the view of the separateness of words and things held by most people in most situations, including today's scientists. This would be the perspective of those who are vaguely aware that their concepts may not directly represent what they appear to name, but who nonetheless rely on the dichotomy because it seems to work at the level of sense certainty—how we experience most of our daily lives. However, we might also postulate that this is an extremely partial view, that the surface of word-things twists evenly, so evenly that at any particular point the coincidence of the interior with the exterior is hard to fathom.

It is precisely the subtlety of the relation between words and things that commends its exploration by scientists, especially those pursuing research on genetics. When molecular biologists observe that morphology plays a role in cell development, that the relative position of cells plays a role in their growth, this is not dismissed as philosophical doublespeak but is an incentive to further research: "In vitro, many animal cells can only metabolize and divide if they are spread out; and to spread out they must first attach to a surface. . . . Understanding how attachment and shape can regulate a cell's ability to receive growth signals may be of great importance in understanding cancer, where such control is frequently lost."[79] The effects of the political and ethical environments of research might be said to be equally difficult to ascertain, just as the documents scientists produce may change their environments according to patterns that may be hard if not impossible to discern. Indeed, such patterns as such may not even exist. But that does not mean that these articles do not produce effects. For instance, a leading molecular genetics textbook acknowledges that some viruses may cause cancer, even though a widely used technology for detecting carcinogenic activity does not reveal this: "We also realize now that not all viruses spread horizontally as highly contagious agents and also that viruses that are widespread in the population may contribute to cancer in only a small percent of infected individuals, so that epidemiological evidence alone cannot easily rule out viral involvement in many cancers. Furthermore, the latent period between infection and the appearance of the cancer is often far greater with virus-induced cancer than with many other infectious diseases, so that the connection may be very obscure."[80] This is one of numerous examples where, like the effects of words, researchers acknowledge cause-effect relations even when present methods for detecting and representing mechanisms of that relation may render it "obscure."

Up to this point I have been emphasizing the reasons to regard words

as things, but it is also the case that things are words. That is, we might easily represent our cosmology as one in which things exhibit patterns that function as a language, so that their effects can be surmised not by studying the serial accumulation of cause and effect but through observing their structural grammar. Although this insight has been used most frequently in writings by humanist structuralists and poststructuralists, it is also prominent in genetics. From its inception, DNA has been regarded as a "code," as an array of amino acids that appear through the "transcription" of strings of U (Uracil), G (Guanine), C (Cytocine), and A (Adenine). The strings of these are nucleotides that cluster in "codons" whose particular order and relation to other codons provide messenger RNA (mRNA) that regulates amino acid production. The entire lexicon of DNA research is a grammatical one. DNA is analyzed as "fragments," "sentences," "libraries." They control their replication through "editing," "translation," and even "proofreading." For instance, "a constant need for proof-reading may be the reason that no enzyme has evolved that adds deoxyribonucleotides onto the 5' end of a DNA chain."[81] Ironically, although language is denigrated by some natural scientists as "mere words," when those words are power, when "codes" appear through the medium of DNA in cell cultures, they are regarded as substantial, primordial, or, as the genome project has been dubbed, the Book of Life.

The insight into this relation between language and genetics has been taken up in the molecular biological literature, with some researchers claiming that "language is more than just a metaphor and provides a fundamental principle underlying cell biology."[82] Ji's work on this topic parallels the efforts of Edward O. Wilson to reduce all activity to that of the smallest detectable physical level, on the premise that larger life processes are best understood as being controlled by and functioning in a manner parallel to these microscopic and submicroscopic interactions. What Ji terms "cellese" is not a metaphor for (the language of) transcription but part of a hypothesis that there is a unifying principle of language through which humans and cells communicate.[83] This coincidence of the word with or as the thing need not take a determinist direction, however. Language is something humans have the capacity to decide to use in particular ways. To recognize the materiality of language does not mean we are genetically or otherwise programmed but can be the basis for motivating thoughtful deliberative discussions about how we might speak and write.

The "consilience" thesis—the existence of a parallel between the human organism and the larger natural world—is not original with Wilson or even earlier Darwinians. The view was held by a number of pre-Socratic philosophers. Rather than think that humans are regularly behaving, predictable entities in the natural world, Heraclitus imputed to *physis*

the chaos and uncertainty of humans. But our choices do not stop at reducing human complexity to that of amoeba or leaving people perilously navigating an animate, willful cosmos. Another choice is to understand the dual character of language as simultaneously representational and material, the diffuse but concrete nebula of conversation and exchange that makes us who we are.

To extend or operationalize these insights about language as material to genetics research —to see how genes, like language, are malleable and subject to political organization—we need to recognize that the codes of DNA are no more or less metaphorical than the codes outside DNA. Both are part of the environment that shapes various events, ranging from the political and economic forces of "environmental racism" that lead to higher incidences of asthma among African Americans than European Americans to the legal struggles against this disparity to the possibility that some genetic factors may contribute to disease disparities (though so far these have not been isolated as the source of this difference).[84] Indeed, if we take seriously Cavalli-Sforza's claims that cultural differences among people influence genetic ones,[85] then it seems a gross oversight to preclude studies of geneticists' own culture, especially their articles, as a part of the genetic cosmos. Cavalli-Sforza is pointing out that practices of endogamy may decrease genetic heterogeneity, an obvious observation that shows that haphazardly or deliberately our social conventions have eugenic implications for a variety of inherited diseases as well as adaptive mutations.

The Voice of Blood

If we now consider the *Vox Sanguinis* article not as an objective statement of facts about population genetics but as itself a series of codes that instruct the social organism of human (and other) life, we might think about its own functions and effects as well as how we might intervene to change these.[86] Just as DNA replication sometimes results in mutations that scientists seek to change, we might ask about the ways that articles such as this might also include mistakes that we might seek to fix. When scientists observe genetic mistakes, they do not say the code exists as such and should not be altered but that when the organisms' own processes do not detect or eliminate the error, problems may ensue, the kinds of problems we believe call for medical intervention.

In the case of this article, its reference to races and its use of population genetics have the effect of harming those whose membership in stigmatized and disadvantaged groups is made more determinate at the level

of the individual and a stronger basis for discrimination at the level of society. That is, each individual thought "Black" has his or her Blackness objectified, while those making discriminations based on race have their prejudices legitimized—as group membership is experienced not as a concept but a thing. Second, the information directs attention to genetic components of disease at a point when known environmental contributions still go unaddressed. For population geneticists in particular to stress medical applications of their research is for them to potentially violate the Hippocratic Oath, "first do no harm," since the harms of racial typologies are known while their potential benefits remain remote for all but a few highly privileged elites in a very few countries. By extension, this genetic emphasis draws attention away from the environmental sources of disease made possible by the manipulation of group differences that allow those with power to concentrate toxic chemicals and emissions in places populated by those who are "not us." The differences allow groups to treat "strangers" in ways they would not treat members of their own family or "kind." Finally, this study and those like it, by not calling their terms into question, obscure their roles as agents in social change, making it difficult to subject their pronouncements to the political processes of responsible evaluation. If science is legitimated by what it does, then it can be called to account for doing something badly. Attempting to justify current harms of research by a gesture toward some possible future when the benefits might outweigh the harms is far more idealistic than pointing to the present dangers of certain heuristics. Such a view requires the faith of utopians. Why should we believe that scientific research per se is always beneficent?—a question prompted not because scientists are evil or otherwise antisocial but because at any particular point there is no reason to cede them authority to go beyond the usefulness allowed by the parameters of their own research.

What Is to Be Done

To address the foregoing defects of such articles the following steps might be taken.

1. There need to be more stringent review criteria that would take into account discussions of the consequences of an article's "observations." Large amounts of federal money are spent on these studies, and there is no reason to avoid explicit discussion of the political consequences of publishing certain findings. This is not to say that some findings should not be published, but that they should display their own warning signs, so

that producers and consumers of these codes might have on hand some material to aid in their own "editing" or "proofreading" of this information. Such a notion of knowledge counters that of Popper, who has described theories as "nets cast to catch what we call 'the world'; to rationalize, to explain, and to master it. We endeavor to make the mesh even finer."[87] Scientists use this type of thinking to exclaim that they are merely revealing "the world" in more detail, and there is nothing to be done about what that may do. But the metaphor is a poor one. The finest possible "net" would be a solid surface that would capture everything and hence be useless. Instead of seeking ever-tighter meshes, scientists actually use different nets for different purposes. Expecting that scientists anticipate and repair their nets when they catch the "wrong" thing seems reasonable and even productive.

For instance, although the pernicious effects of racial taxonomies are widely known and the relevance of DNA differences to racial taxonomies has been widely questioned, including by geneticists themselves, the *Vox Sanguinis* article reveals no cognizance of this. Distributing an article in this form is just as harmful as dispensing pharmaceuticals that have known side effects without providing the appropriate label.

2. The theoretical and historical context of particular experiments should be made transparent. The narrowness of laboratory research programs induces and rewards a certain practical myopia that not only blinds investigators to the harms of their "discoveries" but, moreover, limits the rate of useful paradigm shifts and new insights. Rather than simply assuming that it was important to distinguish the allele differences among certain subpopulations, the authors of the *Vox Sanguinis* article would have produced a more interesting piece of research had they situated their question in the context of prevailing questions about racial typologies, including the pressing political and medical questions that make their research interesting. In the social sciences, and even the humanities, the norms governing the presentation of scholarly research press authors to highlight the importance of the problem they are pursuing, indeed, to show that there is a question that is of significance. In this case, the authors might have introduced their research by stating competing claims about the existence of genetically differentiated races, and then justified their compilation of data that seemingly is at odds with those critiques. Even better, they would have acknowledged the importance of environmental influences on health and explained why research on possible immune differences based on genetic diversity was a productive research agenda. The apparent virtue of research programs that are narrowly conceived—one arrives at discrete discoveries at a rapid pace—entails costs as well. Among these is the limit of real insight such studies provide. To be clear, this is not an objection to "pure research" but a suggestion to enlarge the scope of such studies.
3. The economic and political agendas of those who fund the research

should be made explicit and discussed in the context of the laboratory's research agenda. This should be done in as much detail as possible. For instance, the authors of the *Vox Sanguinis* article state in their acknowledgements: "This work was partly supported by CNPq and PADCT (Brazil)."[88] I imagine that among a certain research community these acronyms are not cryptic, but the authors should nonetheless state not only the full names of the institutions or corporations providing their grants but also explain the priorities of the fund providers and how these shape the research program.[89] Obviously, scientists are not craven profit seekers, but they are nonetheless constrained, in ways both obvious and subtle, by the kinds of priorities defined by those who provide them with the resources necessary to maintain their laboratories. While the effect of this is blatant in the case of pharmaceutical companies, even apparently neutral parties such as university boards and government agencies shape research in a manner that is not driven by simple concerns about finding the truth. For instance, in the case of genetic research, pharmaceutical companies and defense interests rooted in the Department of Energy's effort to manage genetic mutations that result from radiation, influence the priorities of NIH so that it is increasingly difficult to garner funds that do not address genetics. One could write a long essay on the sociology of knowledge that would explain the intricate ways that biological research has been governed by such a political-economic nexus, and that explains why funding for genetic research is much more available than resources for research on the interaction between environmental toxins and the human body, but much better would be local acknowledgments of this in the articles published by particular investigators. Perhaps making these influences explicit would encourage scientists to challenge the priorities that are set by factors other than a putatively obvious question about genetics. In any case, publishing such discussions might contribute to inoculating research communities and the general public from the effects of apparently unadulterated truths.

Notes

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1. SPSX refers to the Statistical Package for the Social Sciences, a widely used set of computer data-processing programs.

2. For articles on the relation between media images and public opinion, see Vincent Price, "Social Identification and Public Opinion: Effects of Communicating Group Conflict," *Public Opinion Quarterly* 53 (1989): 197–224; Joseph Wagner, "Media Do Make a Difference: The Differential Impact of Mass Media in the 1976 Presidential Race," *American Journal of Political Science* 27 (1983): 407–30; Fay Lomax Cook, et al., "Media and Agenda Setting: Effects on the

Public, Interest Group Leaders, Policy Makers, and Policy," *Public Opinion Quarterly* 47 (1983): 16–35; Michael J. Robinson and Andrew Kohut, "Believability and the Press," *Public Opinion Quarterly* 52 (1988): 174–89; Roy L. Behr and Shanto Iyengar, "Television News, Real-World Cues, and Changes in the Public Agenda," *Public Opinion Quarterly* 49 (1985): 38–57; Jon A. Krosnick and Donald R. Kinder, "Altering the Foundations of Support for the President through Priming," *American Political Science Review* 84 (1990): 497–512; Benjamin I. Page, Robert Y. Shapiro, and Glenn R. Dempsey, "What Moves Public Opinion?" *American Political Science Review* 81 (1987): 23–44; John G. Geer, "Critical Realignments and the Public Opinion Poll," *Journal of Politics* 53 (1991): 434–53.

3. There is a lengthy list of books on this topic. Some especially good ones are Troy Duster, *Backdoor to Eugenics* (New York: Routledge, 1990); Richard Lewontin, *Biology as Ideology: The Doctrine of DNA* (New York: Harper, 1993); Sohatra Sarkar, *Genetics and Reductionism* (Cambridge: Cambridge University Press, 1996).

4. For a sociology of bioethical genetic knowledge, see John H. Evans, *Playing God? Human Genetic Engineering and the Rationalization of Public Bioethical Debate* (University of Chicago Press, 2002).

5. D. T. Covas, et al., "Gene Frequencies of the HPA-1 AND HPA-2 Platelet Antigen Alleles among the Amerindians," *Vox Sanguinis* 73 (1997): 182–84.

6. Richard Herrnstein, *The Bell Curve: Intelligence and Class Structure in American Life* (New York: Free Press, 1994).

7. Hilary Rose, "My Enemy's Enemy Is—Only Perhaps—My Friend," *Social Text*, no. 46/47 (1996): 62.

8. Martin Heidegger, *On the Way to Language*, trans. Peter Hertz (San Francisco: Harper, 1982).

9. In molecular biology, a *gene* refers to a set of DNA codons associated with particular functions of the organism. An *allele* refers to the particular form of that gene. There is some slippage in the uses of "gene" and "allele" that reflects the developments in observation techniques since Mendel's early work, when genes were hypothesized before DNA fragments could be more directly represented. For instance, eye color is genetic, but whether that eye color is blue or brown reflects the alleles, or form, of the gene. When Mendel described alleles for eye colors, the form of the variations was not understood. Now geneticists use "allele" to describe the differences among the strings of DNA fragments that make up similar genes. Rather than infer alleles from observation of hereditary phenotypes, as Mendel did, researchers can now directly examine the variations in DNA. The ease in identifying variations in DNA codons that have unknown physiological significance has led to an explosion in largely inductivist research on "allele frequencies," that is, the codon variation among populations for a particular gene. Whether many of these variations have any truly genetic meaning at all, that is, whether they relate to the function of the organism, is a point of contention. Philosopher of science Sohotra Sarkar rejects the notion that all DNA manifest phenotypic differences, claiming that a better way to understand phenotype is "any feature of an organism that is nontrivially involved in its interactions with its environment." This means that DNA variation alone is not the equivalent of genetic variation, since codons may differ but the organism's functions remain the same. In Sarkar, *Genetics and Reductionism*, 7.

10. An annotated overview of some of these articles provides a schematic sense of what I am referring to: L. Renee Bailey et al., "Breast Cancer and CYPIa1, GSTM1, and GSTT1 Polymorphisms: Evidence of a Lack of Association in Caucasians and African Americans," *Cancer Research* 58 (1998): 65–70, contradicts earlier reports that find correlations between these DNA codons and breast cancer and finds lower prevalence of one allele for an enzyme (no otherwise known function) in African Americans, though this too is not associated with breast cancer; Zhenjun Chen et al., "Platelet Antigen Allele Frequencies in Australian Aboriginal and Caucasian Populations," *Pathology* 29 (1997): 392–98, finds differences in the frequency of six DNA fragments associated with antigen production; John M. Hartmann et al., "The Effect of Ethnic and Racial Population Substructuring on the Estimation of Multi-Locus Fixed-Bin VNTR RFLP Genotype Probabilities," *Journal of Forensic Sciences* 42 (1997): 232–40, verifies usefulness of racial and ethnic stratified subpopulation analysis of Chinese, Japanese, Korean, Vietnamese, Black, White, and Hispanic DNA loci for identification purposes; L. A. Malcolm, P. B. Booth, and L. L. Cavalli-Sforza, "Intermarriage Patterns and Blood Group Frequencies in the Bundi People of the New Guinea Highlands," *Human Biology Oceania* 43 (1971): 187–99. Of course, many more studies that do not take population or racial differences as the object of analysis nonetheless insert these terms into their genetic findings. An excellent example of this was a 1996 *Science* article that studied a particular DNA fragment in HIV positive and negative men; in passing, the article observes a difference in its frequency between Caucasians and African Americans, a weak finding that became a chief object of media attention when the experiments were reported in the popular press. *Science*, no. 273 (1996): 1859–61.

11. "Junk DNA" refers to large sections of DNA between chromosomes that have no obvious or even nonobvious function. Though some scientists speculate an eventual discovery of significance among these nucleotides, virtually all research is devoted to chromosomal DNA. My discussion above pertains as well to much chromosomal DNA: when it has no known significant biological function, then it should not be thought genetic. I make this point not to preclude research into their potential biological importance, but to preserve a space between DNA and genes.

12. Covas et al., "Gene Frequencies," 183.

13. Ibid., 182–83.

14. A telling example of internal inconsistency: although the studies cited in the tables are for allele frequencies among "several European and North American white populations and for American blacks," and the "Amerindians" studied are all in Brazil, the authors inexplicably extrapolate their findings to refer much more broadly to "Whites," "Blacks," and "Amerindian populations of South America." Ibid.

15. Unlike Anthony Appiah, who refers to "race" in quotation marks to denote its specifically ideological (as opposed to real) existence, "race" here means simply the word race. His convention is both awkward and confusing. To follow such a convention would mean first assuming that our ideas and reality are separate—a point I reject—and second, that we would be placing all words in quotation marks. "Identity, Authenticity, Survival: Multicultural Societies and Social Reproduction," in *Multiculturalism: Examining the Politics of Recognition*, ed. Amy Gutmann (Princeton, N.J.: Princeton University Press, 1992), 149–64.

16. Luigi Luca Cavalli-Sforza, "Race Differences: Genetic Evidence," in *Plain Talk about the Human Genome Conference*, ed. Edward Smith and Walter Sapp, 52 (Tuskegee, Ala.: Tuskegee University Press, 1997). The article frequently cited for this point, especially among social scientists, is R. L. Cann, M. Stoneking, and A. C. Wilson, "Mitochondrial DNA and Human Evolution," *Nature*, no. 325 (1982): 31–36. Cavalli-Sforza cites G. Barbujani, "An Apportionment of Human DNA Diversity," *Proceedings of the National Academy of Science USA*, 94 (1997): 516–19.

17. Cavalli-Sforza, "Race Differences," 52–53.

18. Ibid., 55.

19. Cavalli-Sforza, Paolo Monozzi, and Alberto Piazza, *The History and Geography of Human Genes*, abr. ed. (Princeton, N.J.: Princeton University Press, 1994), 16–20; and see more recently Cavalli-Sforza, *Genes, Peoples and Languages* (New York: Northpoint, 2000).

20. Cavalli-Sforza, "Race Differences," 54, 55. The book performs the same anxiety about and ultimate use of "race": "The classification into races has proved to be a futile exercise for reasons that were already clear to Darwin." But racial classifications are used throughout, including in an adjacent table representing the "first use of genetic markers to study racial differences," 19, 20, fig. 1.5.1.

21. Covas et al., "Gene Frequencies," 183. Again, so as not to wrestle straw figures, I am not discussing any of the numerous similar projects that cheerfully report their findings on specifically "racial" groups, not "populations."

22. Cavalli-Sforza, Monozzi, and Piazza, *History and Geography*, 121–25.

23. Ibid., 17, 73.

24. For an overview of various programs, see Raymond Zilinskas, "Global Perspectives on the Human Genome Project," in Smith and Sapp, *Plain Talk*, 59–74. The DOE and NIH Web site on the Human Genome Project, with links to many others, is www.ornl.gov/hgmis.

25. For a critique of the selection criteria, see Fatimah Jackson, "Assessing the Human Genome Project: An African American and Bioanthropological Critique," in Smith and Sapp, *Plain Talk*, 95–104.

26. For a critique of genetic research from a public health perspective, see Sarkar, *Genetics and Reductionism* , 175–90; and Duster, *Backdoor to Eugenics*.

27. Some participants in ELSI programs have expressed to me private concerns that ELSI research recommendations are not taken seriously and that the NHGRI shops around for bioethicists whose views endorse in-house priorities.

28. Evans, *Playing God?*

29. Yipang Yang and James M. Wilson, "CD40 Ligand-Dependant T-Cell Activation: Requirement of B7-CD28 Signaling through CD40," *Science*, no. 273 (1996): 1859–61.

30. Richard Cooper, "Hypertension in the African Diaspora: Genes and the Environment," in Smith and Sapp, *Plain Talk*, 42.

31. Georgia M. Dunston, "G-RAP: A Model HBCU Genomic Research and Training Program," in Smith and Sapp, *Plain Talk*, 105.

32. Jackson, "Assessing the Human Genome Project," in Smith and Sapp, *Plain Talk*, 96.

33. Jackson points out four alternative methods—ranging from selecting the oldest cell line to selecting the most prevalent one—that have more sophisticated

rationales than collecting whatever DNA happens to be in the laboratory. Ibid., 97.

34. Ibid., 101.

35. Ibid.

36. Duster, *Backdoor to Eugenics*, 37–38.

37. Sarkar, *Genetics and Reductionism*, 146.

38. Karl Popper writes: "Indeed the scientifically significant *physical effect* may be defined as that which can be regularly reproduced by anyone who carries out the appropriate experiments in the way prescribed. No serious physicist would offer for publication, as a scientific discovery, any such 'occult effect,' as I propose to describe it—one for whose reproduction he could give no instructions. The 'discovery' would be only too soon rejected as chimerical, simply because attempts to test it would lead to negative results." *The Logic of Scientific Discovery* [1934] (New York: Harper and Row, 1965), 45–46. Popper is claiming that without the "testing of the theory by way of empirical applications of the conclusions which can be derived from it," a theory cannot produce specifically scientific knowledge, a kind of knowledge he believes is the apex of all knowledge. Ibid., 33, 15.

39. Covas et al., "Gene Frequencies," 183.

40. Sarkar, *Genetics and Reductionism*, 176–77.

41. Ibid., 182.

42. Ibid., 187.

43. *The Enigma of Health: The Art of Healing in a Scientific Age*, trans. Jason Geiger and Nicholas Walker (Stanford, Calif.: Stanford University Press, 1996), 2. The conceptual contrasts here are somewhat elusive due to language differences. *Wissenschaft* is usually translated as *science*, even though the former (with the root *wissen* used similarly to how English-speakers use *to know*) has far broader connotations than the person-in-lab-coat images associated with *science*.

44. Ibid., 6.

45. Ibid., 5.

46. Ibid., 5–6.

47. Richard Rorty, *Philosophy and the Mirror of Nature* (Princeton, N.J.: Princeton University Press, 1979).

48. Sarah Franklin, "Making Transparencies: Seeing through the Science Wars," *Social Text*, no. 46/47 (1996): 143.

49. Harding, *Whose Science, Whose Knowledge?* (Ithaca, N.Y.: Cornell University Press, 1991); Collins and Pinch, *The Golem: What Everyone Should Know about Science* (Cambridge: Cambridge University Press, 1993).

50. Sarkar, *Genetics and Reductionism*, 169.

51. *The DNA Mystique: The Gene as Cultural Icon* (New York: W. H. Freeman, 1995), 124.

52. For a similar critique, see Rose, "My Enemy's Enemy," 68–73.

53. Gadamer, *Enigma of Health*, 6.

54. Cooper, "Hypertension in the African Diaspora," 42.

55. Franklin, "Making Transparencies," 145.

56. Richard Dawkins, *River out of Eden* (London: Weidenfeld, 1995), 32.

57. "Materiality" is an adjective that I am using to mean "thingness." I use "materiality" here because "thing" has no cognate that is an adjective.

58. Ronald Inglehart, *Modernization and Postmodernization: Cultural, Eco-*

nomic, and Political Change in 43 Societies (Princeton, N.J.: Princeton University Press, 1997), 12.

59. Quoted in Warren Richey, "Arab TV Network Plays Key Disputed Role in Afghan War," *Christian Science Monitor*, 15 October 2001.

60. Quoted in Bryan Bender, "Rumsfeld Chides Press for Reporting on Raid," *Boston Globe*, 23 October 2001.

61. Quoted in Mark Jarkowitz, "Networks Yield to White House," *Boston Globe*, 11 October 2001.

62. Pam Bellucke, "Chicago Gun Suit Fails, but California's Proceeds," *New York Times*, 16 September 2000; Richard Pérez-Peña, "State Court Sides with Gun Makers in Liability Case," *New York Times*, 27 April 2001.

63. "The Heritability Hang-Up," *Science* 190 (1970): 1165. To be clear, the heritability referred to here is based on family genetics and not population genetics—though population genetics underlie most discoveries of, say, a certain breast cancer gene among Ashkenazi Jews.

64. Michael Specter, "Decoding Iceland," *New Yorker*, 18 January 1999, 40.

65. *Forschung* is usually translated as *inquiry*, not *discovery*, and again, *Wissenschaft* has very different connotations than *science*, meaning something like *knowledge-craft*. The translation implies Popper has a far stronger positivist agenda than does his original. In the translation title we imagine antiseptic approaches to discovery, implying objects already in existence, whereas Popper addresses a far broader research community, anyone who is inquiring into or investigating knowledge.

66. Rose, "My Enemy's Enemy," 62, 63.

67. Popper's scientific method allows only for the provisional verification of statements at a given point. The distinction between Popper's provisional and Kantian understanding of the gulf between categories of perception and things in themselves is a topic that speaks directly to the use of probability theory in work on population genetics. *Logic*, 33; emphasis added.

68. Ibid., 30.

69. Ibid., 31.

70. Kant (1786), quoted in Popper, *Logic*, 13.

71. Popper, *Logic*, 15.

72. Judith Butler, *Bodies That Matter: On the Discursive Limits of "Sex"* (New York: Routledge, 1993), 9–10.

73. Popper, *Logic*,15; emphasis in original.

74. Ferdinand Saussure, *Course on General Linguistics* [1911], trans. Wade Baskin (London: P. Owen, 1960), 113.

75. To be clear, Popper's primary foils were actually language philosophers who wrote under the influence of Wittgenstein and Carnap, as well as Russell and to a lesser extent Austin. Their German and English writings and engagements reveal no direct influence of the French Saussure. Some of these philosophers, especially Carnap and Russell, believed that language analysis could yield the sort of metaphysical truths that subsequent antagonists of Popper—such as those SSK authors influenced by Foucault or Derrida—thought equally utopian.

76. Richard Courant and Herbert Robbins, *What Is Mathematics? An Elementary Approach to Ideas and Methods*, 2d ed. (Oxford: Oxford University Press, 1996), 259.

77. Evelyn Fox Keller, *Refiguring Life: Metaphors of Twentieth Century Biology* (New York: Columbia University Press, 1995), x–xi.

78. Albert Einstein, *Relativity* (Amherst, Mass.: Prometheus Books, 1995), 50, 71–73, 84–86.

79. James Watson et al., *Molecular Biology of the Gene* (Menlo Park, Calif.: Benjamin/Cummings, 1988), 990.

80. Ibid., 1010.

81. Ibid., 290.

82. Sungchul Ji, "The Linguistics of DNA: Words, Sentences, Grammar, and Semantics" (paper presented at the New York Academy of Sciences Conference on Molecular Strategies in Biological Evolution, Rockefeller University, New York, 27–29 June 1998), 1.

83. See also M. I. Sereno, "Four Analogies between Biological and Cultural/Linguistic Evolution," *Journal of Theoretical Biology* 151 (August 1991): 467–507.

84. Green et al., "Differences in the Prevalance of a TaqI RFLP in the 3' Flanking Region of the α_1-Proteinase Inhibitor Gene between Asthmatic and Non-Asthmatic Black and White South Africans," *Clinical Genetics* 52 (1997): 162–66. The researchers found allele differences between the groups of White and Black subjects, but no correlation between the allele and the incidence of asthma within each group.

85. Cavalli-Sforza writes: "The differences that we have found show that culture (including language) has influenced genes in the sense that different languages and different cultures generate barriers between people and reduce (but only slightly) genetic interchange between them." "Race Differences," 56. Cavalli-Sforza's qualification on the limited role culture plays in genetic variation refers to the percentage of DNA differences among groups, an observation required by the political climate of this moment, which demands that he appease worries about the racist implications of his research. At the same time, Cavalli-Sforza obviously regards these differences as important or he would not distinguish groups by virtue of them nor think such distinctions worthy of a research agenda in the tens of millions of dollars.

86. Marx's famous "Eleventh Thesis on Feuerbach" holds, "Philosophers have only *interpreted* the world, in various ways; the point, however, is to *change* it." In *The Marx-Engels Reader*, 2d ed., ed. Robert C. Tucker (New York: W. W. Norton, 1978), 145. However, this might be recast in a more consistently materialist light to say, "Philosophers have only thought they interpreted the world, while they were also changing it." And so too for scientists.

87. Popper, *Logic*, 59.

88. Covas et al., "Gene Frequencies,"183.

89. This is now the practice at the journal *Nature*. The result is sometimes half-page lists of corporate sponsors.