January 2010

From Viruses to Russian Roulette to Dance: A Rhetorical Critique and Creation of Genetic Metaphors

Marita Gronnvoll
Eastern Illinois University, mgronnvoll@eiu.edu

Published in final edited form as:
Rhetor Soc Q. 2010 January 1; 40(1): 46–70. doi:10.1080/02773940903413415.

From Viruses to Russian Roulette to Dance: A Rhetorical Critique and Creation of Genetic Metaphors

Marita Gronnvoll [Assistant Professor] and
Department of Communication Studies at Eastern Illinois University

Jamie Landau, Ph.D. [Candidate]
Department of Speech Communication at the University of Georgia

Abstract

This essay critiques and creates metaphoric genetic rhetoric by examining metaphors for genes used by representatives of the lay American public. We assess these metaphors with a new rhetorical orientation that we developed by building onto work by Robert Ivie and social scientific qualitative studies of audiences. Specifically, our analysis reveals three themes of genetic metaphors, with the first two appearing most frequently: 1) genes as a disease or problem 2) genes as fire or bomb, and 3) genes as gambling. We not only discuss the problems and untapped potential of these metaphors, but also we suggest metaphorically understanding genes interacting with the environment as a dance or a band. This essay has implications for rhetorical criticism, science studies, and public health.

Metaphors are modes of perception. As Kenneth Burke notes, "Metaphor is a device for seeing something *in terms* of something else. It brings out the thisness of a that, or the thatness of a this" (503). George Lakoff and Mark Johnson further emphasize this function of metaphors:

> Metaphors may create realties for us, especially social realities. A metaphor may thus be a guide for future action. Such actions will, of course, fit the metaphor. This will, in turn, reinforce the power of the metaphor to make experience coherent. In this sense, metaphors can be self-fulfilling prophecies. (156)

Lakoff and Johnson remind us that metaphors depend upon "a coherent network of entailments that highlight some features of reality and hide others" (157). The implications of metaphoric entailments are significant not because the metaphor may be true or false, but rather because of "the perceptions and inferences that follow from it and the actions that are sanctioned by it" (158). Thus, metaphors that circulate have material consequences.

The sub-discipline of the rhetoric of science has unique implications for research on metaphors. Historically, metaphors abound in discourses of science even as science has often been regarded as non-metaphorical (Nate 496). Interdisciplinary research on genetic metaphors in rhetorical studies and other fields such as philosophy, sociology, and the biological sciences offers exceptional case studies in the "reality" function of metaphors given what Elizabeth Shea describes as the "material-abstract ambiguity" of the literal gene (508), or how the human genome is invisible to the naked eye, enormously complex, and a still-developing discovery of modern science. For the most part this scholarship critiques the use and socio-political implications of genetic metaphors that come from scientists and media professionals, such as the commonly articulated code and blueprint metaphors for genes. In this essay we share what we believe is an exciting possibility to add another dimension to this work by broadening both

Contact Marita Gronnvoll at Eastern Illinois University - Communication Studies, 600 Lincoln Ave., Charleston, Illinois 61920. mgronnvoll@eiu.edu.

theoretical and methodological attitudes about rhetorical criticism. Specifically, we argue that metaphoric rhetorical analysis, in addition to providing valuable critique, may also assist in creating productive metaphors. We propose that one way rhetorical scholars can become creators is to develop replacement metaphors by advancing the positive potential of metaphorical rhetoric (about genetics, in our case) used by "real" audiences. Creating metaphors and assessing lay audiences are imperative for rhetorical scholars of science who hope to offer pragmatic solutions to preventable public health problems.

Put simply, metaphoric criticism is generally taken to be a descriptive and evaluative analysis of a text,[1] an approach that may encourage the critic to focus solely on the genius or the inadequacies of texts. With this approach, especially when the critique is negative, the critic's metaphorical solutions to the problematic rhetoric may remain undeveloped, the incorporation of possible solutions from the metaphorical rhetoric of lay audiences tends to be overlooked, and a pessimistic temperament may underlie much of the critique as a whole. We argue that this theoretical and methodological limitation is not distinctive to metaphoric rhetorical scholarship, but rather is based in the traditions of the discipline and therefore is functioning across many research streams in rhetoric today.

Therefore, we offer our proposal for a new orientation of rhetorical criticism—that rhetorical scholars could be critics *and* creators. We acknowledge that all discourses are incapable of representing truth and, thus, all discourses fail. Instead of aligning ourselves with Platonic philosophers, positivist scientists, and even some contemporary rhetoricians who aspire to what Edward Schiappa labels "the impossible dream of representational correctness" (6), we wish to push beyond the failure of discourses. Acknowledging discourse as always already a failure of representation? means, for instance, that there are always already opportunities for change. In particular, our proposed orientation for metaphoric rhetorical criticism builds directly on Robert Ivie's previous call to identify the limits and "untapped potential" of dysfunctional metaphors and to find replacements. Creating metaphors, along with providing critique, combines constructive and deconstructive practices, and may encourage an optimistic attitude for rhetorical scholarship. We argue that such an approach is needed to advance the field of rhetoric and the academy as a whole, plus provide an avenue for social change. This new approach is especially needed now as we confront unprecedented challenges in the 21st century, such as degenerating public health and the destruction of the planet. In turn, analyzing the metaphorical rhetoric of "real" audiences is one way for rhetorical critics to create a richer archive of metaphors. For example, it is to be expected that rhetorical studies of genomic science up to this point have predominantly identified and judged the "code" and "blueprint" metaphors to have limited public utility since the discourses from geneticists and other scientists may be narrowly shaped to represent scientific goals. As we will argue, these goals may be quite different from those of the lay public. Rhetorically studying lay audience metaphors for genes is a reasonable step toward filling a gap in research.

Corresponding with our proposal for a new orientation of rhetorical criticism is the secondary purpose of our essay—to identify metaphoric rhetoric about genetics that may decrease fatalism and encourage public motivations to form environments that are health protecting, while avoiding environments that are health destroying. Our essay is one outcome of two large, multi-phase, federally funded research studies that had the general goal of exploring lay conceptions of the "interactions" of genes with non-genetic factors in the context of the contraction and prevention of disease. This research purposely centered on three common chronic diseases—heart disease, lung cancer, and diabetes—since they are widespread, have substantial public health consequences, and for the most part are understood as such by the lay public. At the

[1]In fact, Carl R. Burgchardt summarizes metaphoric rhetorical criticism in exactly this manner in *Readings in Rhetorical Criticism*: "The metaphoric critic focuses on describing, evaluating, and understanding such metaphors as vital rhetorical phenomena" (337).

same time, according to the U.S. Centers for Disease Control and Prevention (CDC), these diseases are among the leading causes of preventable death in the U.S. (National Center for Health Statistics). The research also involved depression because, while not as common as the other three diseases, rates of depression are increasing globally (Kessler, Zhao, Blazer, and Swartz). Given the public health implications of this research, the CDC and NIH provided funding for our studies.

It is significant that our case study involves genetic metaphors by the lay public. We turn our lens toward the metaphoric discourses of laypeople for several methodological and theoretical reasons. At its simplest, we attend to a lay audience to value public discourses about science as much as those from medical and media professionals, since to date most rhetorical studies of science on genomic metaphors focus on the discourses of scientists, public figures, and/or mass mediated messages (Ceccarelli; Condit; Kay; Keller). While these studies are valuable, we believe it is important to acknowledge that metaphors used by scientists may serve a different epistemological function than do metaphors deployed by the lay public. Research suggests that, historically, metaphors have been used in scientific discourses to explain the global workings of genes as a part of scientific discovery (Condit; Keller; Ceccarelli; Nerlich and Hellsten; Nordgren). In contrast, members of the lay public may use genetic metaphors to grapple personally with a nearly incomprehensible concept and its connection to diseases. Given the divergent goals of these two communities, it is unsurprising that the participants in our studies did not spontaneously deploy metaphors that are common among scientists, such as blueprints and codes. Instead, the participants of our studies tended to offer very different metaphors.

We found that members of the lay public who participated in our studies offered metaphors unprompted when discussing the role of genetics in the contraction and prevention of disease. They articulated the following three metaphoric themes, with the first two appearing most frequently: (1) genes as a disease or problem, (2) genes as fire or bomb, and (3) genes as gambling. With the first theme, genes are negatively represented as a pre-existing or dormant disease, virus, or general problem that comes on or worsens with an unhealthy environment. The second metaphor of genes as a fire or bomb relates to the first theme in the sense that genes are designated as an already exploding, or potentially explosive, device that is activated by an unhealthy environment. The final theme of gambling understands genes and their relation to the environment as games of chance, such as Russian roulette.

Our intention is not to assail members of the lay public for their lack of understanding of the workings of genes and environment. Indeed, with so much competing information available on the relatively new and increasingly complex issue of human genetics, it is not surprising that members of the public have been selective in gathering explanatory information (Sanders et al.). Rather, Ivie writes, “the value of locating underlying metaphors is in revealing their limits or untapped potential as sources of invention” (167). In analyzing metaphors that are already in use by laypeople, then, we hope to illuminate the “untapped potential” for educational public health programs in this impending age of personalized predictive genetic testing. However, if the metaphors that are circulating are overly simplistic or even dangerously deterministic, in contrast to what we will argue is a more useful understanding of genes as interacting with the environment, then an option for a public health campaign would be to undermine a dysfunctional metaphor with a replacement metaphor (Ivie 180).

In the remainder of this essay, we first justify and explain our argument for metaphorically understanding the “interaction” of genes and the environment. Next we describe our methodology. We then turn to an analysis of the three most frequent genetic metaphors that came from members of the lay public who participated in our studies. Finally, we close by offering suggestions for replacement metaphors that could aid educational public health

campaigns about genetics in the U.S. In particular, we propose metaphorically understanding the interaction between genes and environment as a dance or a musical performance by a band. We also suggest implications of our project for rhetorical studies.

The Human Genome Project and the Interaction between Genes and the Environment

In 2003, the Human Genome Project (HGP), a 13-year project spearheaded by the U.S. Department of Energy and the National Institutes of Health (NIH), was completed. Although the HGP has technically ended, its findings and implications are only now entering the public realm. For instance, Dorothy Nelkin and M. Susan Lindee write in the preface to their book, *The DNA Mystique: The Gene as Cultural Icon*, that when they published the first edition of this book in 1995, they expected changes but did not foresee that "DNA would grow in public importance […]. Far from disappearing from the limelight, genes remain widely discussed and parodied entities, the focus of ethical debates, press coverage, and public policy negotiations" (xii). This increasing public attention to genetics is related to one of the major goals of the HGP—transferring genetic technologies to the private sector. According to Francis Collins, the director of the National Human Genome Research Institute, personalized genetic testing for diagnostics and prognostics of common disease is expected within the decade of the HGP's completion. Another goal of the project was to "address the ethical, legal, and social issues that may arise from the project" (Human Genome Project Information). Given this development of new medical technology and its imminent impact on the public, scholarship about the rhetoric of genomic science in the 21st century is justified and urgent.

But communication about genetic testing, especially with regard to the contraction and prevention of disease, faces unique challenges. Perhaps chief among these is the possibility that public health messages about genetics may increase fatalism. Many studies suggest that belief in genetic causation can create a barrier to adopting healthy practices as people may be less likely to perceive that condition as modifiable by behavior and changes in physical environment (Marteau and Senior; Marteau and Lerman; Hunt et al.; Senior et al.). Because genes are understood by the majority of Americans through discourses that originate in scientific communities and are subsequently disseminated through mass media, the increasing media coverage of genetic discoveries surrounding diseases could influence fatalistic beliefs as well. That is, the possibility exists for people to equate having a genetic predisposition for a disease with actually having the disease.

Such a public understanding of genes is not only reductive, but also, we argue, inhibits improving public health. Understanding genes as the sole or even primary cause of some common complex diseases misses the important role of environment[2] as a contributing or "interacting" factor. Indeed, much recent genetic research shows that genes interact with environments to create a multiplicative outcome in causation and prevention of some common complex diseases (Talmud; Sing, Stengârd and Kardia; Tiret). Put differently, it is the *relationship* between genes and environment that may provide a key determinant of whether a person contracts certain diseases. Significantly, this relationship is an "interaction," and it is multiplicative in the sense that, over time, an unhealthy environment, combined with a genetic predisposition, can create conditions that are increasingly amenable for the contraction of certain diseases. On a positive note, healthy environments can counteract some genetic predispositions in ways that are also multiplicative. In other words, the longer a person engages in healthy behaviors, the less likely it is that certain diseases will occur. Importantly, the

[2]Unless otherwise stated, we use the word "environment" to refer to behavior, as in lifestyle choices, as well as the physical environment, such as exposure to toxins or living in a high stress environment.

outcome of this interaction between genes and environment is not instantaneous but rather progressive over time. Understanding this interactive relationship could give a person with a family history of disease some sense of personal control. This increased sense of personal control could then potentially help laypeople resist dominant media discourses that suggest genetic determinism in the context of the contraction and prevention of common diseases.

Rhetorically Studying "Real" Lay Audiences

In 1970, Samuel L. Becker wrote that one of the greatest needs in rhetorical studies was a broader view of what counted as data. He urged rhetoricians to take account of the total communication environment by, for example, stretching beyond the "concentrated" and "internal" messages and looking at the heterogeneity of audiences (41). Although concern with the audience has been a central principle of rhetoric since classical times, Becker's perspective differs by highlighting the diversity of "real" audiences that exists outside of the audience personae crafted within discourses. "Audience studies," as broadly categorized, are legitimated and regularly practiced in the social sciences. However, for the most part rhetoricians have been slow to deploy this methodological and theoretical lens as a primary, or even a secondary, approach. Instead, we continue to favor text-based analysis.[3] Text-based rhetorical studies are warranted and illuminating. But if we take seriously Danette Paul, Davida Charney, and Aimee Kendall's reminder that "the limitations of one method may be overcome with other methods" (394), then audience studies have much to offer even traditional text-based rhetorical analyses. We see at least three major benefits to assessing audiences for rhetorical studies of (genetic) metaphors, benefits that should help resolve the limitations in the literature referenced earlier: 1) discovering lay metaphorical rhetoric that critics, scientists, and other professionals have difficulty seeing from their own perspectives; 2) providing evidence for the force of metaphorical rhetoric on the public, such as what it does or how it is received; and 3) improving the position of metaphoric rhetorical criticism in science proper and social science studies.

We are not the first rhetoricians to suggest that audience reception studies may help rhetorical scholars of science discover alternative discourses. In 1993, Steve Fuller called for more attention to audience reception to demonstrate how scientists read texts in contrast to rhetorical analyses of science. To justify their use of an audience reception study to explore *The Bell Curve's* impact on racism, E. Michele Ramsey, Paul Achter, and Celeste M. Condit noted that researchers can learn new meanings that, as professional critics, they might not be aware of:

> Audience studies assume that critics are not always able to guess accurately the full range and distribution of meanings a text will have for its readers. Because audiences are active, researchers can learn something about texts and their uses by asking viewers, readers, or listeners for their responses to texts or by observing directly the uses of a text. (5)

Most recently, Randy A. Harris encouraged the increased attention to reception in rhetoric of science. As examples of this turn to the reception of scientific discourse, Harris offered up Leah Ceccarelli's book, *Shaping Science with Rhetoric*, and his edited collection, *Rhetoric and Incommensurability*. Harris summed up well this need for reception studies when concluding that "the production of science is born of its reception" (254).

Related to the first benefit is that audience reception studies also support arguments about the forces of rhetoric, such as how metaphoric rhetoric is received. A decade ago Jennifer Stormer-Galley and Schiappa traced a pattern of rhetorical critics making claims about audience effects

[3]Of course "text-based analysis" is not a cohesive category. We agree with Edward Schiappa and others who recognize that traditional textual rhetorical criticism is actually a form of reception analysis, and thus our concern is *which* audience reception should be the focus of rhetorical scholarship (88).

of popular culture without supporting these claims with audience research. They posited that, although such research is not deeply flawed, "audience conjectures would be more interesting as arguments, important for theory development, and more sound as scholarship if they were supported with evidence generated through audience research" (34). When Paul, Charney, and Kendall argued for rhetorical studies of science to "move beyond the moment" in 2001, they similarly contended that qualitative and quantitative social scientific research methods for testing reception by scientists and other communities was essential for critiquing the effects of textual rhetorical strategies and situations. They wrote,

> "[textual] analyses can tell us what rhetorical strategies have been employed but not why scientists use them or what effects they have on readers … Without independent means to measure either success or effectiveness, discourse analyses of historical texts may devolve into a form of relativism that endorses whatever choices a scientist makes as appropriate to the unique situation. (375)

Lastly, we suggest that audience studies are beneficial for rhetorical studies of science because they are one means for improving our stance in the academy. For some time now rhetoricians of science have been concerned about their inferior status in the interdisciplinary study of science (Gaonkar; Gross; Ceccarelli). At its simplest, then, studying the rhetoric of science with methodology influenced by and therefore familiar to the social sciences would improve translation of our research. In addition, improved translation often leads to clearer justification. We wish to stress that our goal is not to equate rhetoricians with social scientists. Rather, by entering their methodological conversation we have the chance to contribute the methods and theories that are distinctive to rhetorical criticism. In the end, what rhetorical audience studies of science might really have to offer is an orientation that operates at the intersection of disciplines, successfully in tension between the humanities and sciences.

To access current lay public metaphors of genes, we deployed semi-structured interview methodology. After human subjects approval, recruitment of participants and interviews took place in three southern U.S. cities. We selected these locations because they are representative of the urban, small city, and rural southern region. We were interested in these areas since the large metropolitan hub and rural community have a disproportionate number of African American and white families who are poor or near poor, while the small city has a multicultural population that is socioeconomically varied, thereby providing us with a diverse population. We conducted two studies with a total of 96 participants. The first study was funded by the CDC and the second study by the NIH.

For the first study, we conducted a total of 50 individual in-depth interviews in the spring of 2006. All of the participants in this study self-identified as poor or near poor, using the categories developed by the CDC, which we operationalized as having a family household income below $33,625 annually. Half of the participants self-identified as "black" or "African American," and the other half as "white." The participants were also equally split along gender lines. Furthermore, educational levels ranged from seventh grade to a complete 4-year college degree.

For the second study, we conducted a total of 46 individual in-depth interviews in the fall of 2006 through the spring of 2007 These participants in the second study had annual family household income levels that ranged from poor or near poor to upper-level income (more than $100K). Eleven participants self-identified as "black" or "African American," 9 participants as "white," 14 as "Mexican American," and 12 as "Chinese American." In addition, their educational levels ranged from high school to graduate degrees. At the time of the interviews, all 96 participants gave informed written consent to participate in their respective studies. We also gave each participant a $75 honorarium to reimburse them for their time and costs incurred for transportation and childcare.

We conducted the interviews by using two interview guides developed by the principal investigator of the CDC and NIH grants that funded our studies. Generally the interview guides sought to gain in-depth responses to relatively complex questions about the relationship between genes and environment in the contraction and prevention of certain diseases. The interview guide for the first study focused on heart disease, lung cancer, and diabetes, while the interview guide for the second study added depression. Each interview guide was divided into sections by disease. It is noteworthy that neither interview guide included a specific section on metaphors. Interviewers were encouraged to include follow-ups or to revise the wording of the question set to enable participants to explore the issues. Open-ended questions, follow-ups, and reworded questions allowed for the widest possible range of responses from participants, thus avoiding limitations in measurement.

At the end of each disease section, the interview guide included a question about what the word "gene" meant to the participant. It was common for participants to respond to this question by using metaphors. At this time, a hypothetical scenario was introduced to probe for more understandings of the relationship between genes and environment. Interviewers posited a version of the following scenario: "Imagine two people from different families. Gene has a gene that increases his risk for [heart disease, lung cancer, diabetes, depression]. Doug does not. If Gene and Doug both stop smoking, both increase their exercise, and both improve their diet, which one will benefit his health the most, and why?" Interviewers also asked specific follow-up questions, such as "Which one will end up with the highest risk of [disease under discussion], and why?" The name "Gene" was chosen for one of the hypothetical people as a memory aid. This hypothetical section featured the highest occurrence of metaphorical discourse used by the participants. Given that the overarching goal of the federal grants that funded our studies was to research lay public understandings of genes in the context of disease, we intentionally designed the interview guides so that the moderator introduced genetic discourse. But with full cognizance of the danger of leading our participants into a perceived correct response, moderators kept their questions as open and neutral as possible, asking, for example, "what does the word 'gene' mean to you?" rather than "how are genes connected to diseases?"

The analysis that we present in this essay was conducted through four phases, with the first three phases based in qualitative social scientific methodology and the last phase based in our proposed new orientation for metaphoric rhetorical criticism. Because participants offered their metaphorical understandings of genetics in response to the hypothetical scenario and the question about what the word "gene" meant to them, we analyzed only those two portions of the data. First, we performed an inductive thematic analysis adapted from Barney G. Glaser's and Anselm L. Strauss' "grounded theory" approach. This qualitative methodology consists of three phases: open coding, axial coding, and selective coding (Ezzy; Glaser and Strauss, Lindlof and Taylor). Coding was performed by the authors of this essay who are credentialed rhetoricians with training in social scientific research methods. When open coding, we conducted a careful, unrestricted, line-by-line reading of the data in order to identify emergent patterns of meaning or themes. When axial coding, we refined the relationship between themes formulated during the first phase. Finally, we re-read the data when selective coding, which also involved comparing and contrasting the emergent themes to existent literature about genetics. The outcome of this inductive coding process was the following three genetic metaphors: 1) genes as a disease or problem, 2) genes as a fire or bomb, and 3) genes as gambling. For the final phase of our analysis we used and extended Ivie's approach to metaphoric rhetorical criticism. Thus, we critiqued the limits and untapped potential of the three metaphors that resulted from our qualitative analysis and created the following possible replacement metaphors for genes: Genes as a dance and genes as a band.

Genes as a Disease or Problem

We begin with two themes that were so closely related to each other that they were often articulated together, namely, genes as a disease and/or virus, and genes as a problem and/or trouble. Our methodology intentionally allowed participants to grapple with their understandings of genetics. In so doing, they deployed metaphors epistemologically to create a genetic world as they spoke to the moderator. When deploying metaphors, it was common for participants to describe genes as something foreign and dangerous to the human body. The connotation, then, was a battle between a potentially healthy body and the invading force of the gene. The notion of genes as an already existing or dormant disease was the metaphor most commonly expressed by our participants, appearing in nearly a third of the transcripts. The second most commonly deployed metaphor was that of genes as a problem—which seemed to be used as a synonym for disease.

The idea that genes represent a pre-existing dormant disease presents a particular challenge to reducing deterministic attitudes about genetics and educating people about the interaction between genes and environment. Rather than seeing genes holistically as part of a complex and interacting system influenced by the physical environment and human behavioral choices, a significant number of our participants understood a genetic predisposition as equivalent to a person already having the disease in question. Often participants would even use the word "gene" and disease or virus interchangeably, as an excerpt from transcript #57 demonstrates:

> M: [follow-up to interviewee's response regarding who would have the higher risk of contracting heart disease, hypothetical Gene or hypothetical Doug] Why Gene?
>
> **I:** Because he already had the virus?
>
> M: The virus?
>
> **I:** The gene.

Our participants rarely described genes as being *similar to* a disease or virus. Rather, genes were conceptualized as themselves *being* diseases or viruses. This is aptly demonstrated by participant #59 who, when asked to define the word "gene," responded: "Gene means disease." Others understood genes as being something one would have "a high chance of catching" (#55); as something that "runs through your bloodstream" (#57); as something that "when you're at that point, it will transfer to you automatically, without you doing anything" (#1085). These definitions all equate genes to something that is separate from the human body, but may occupy space within it, waiting for the opportune moment (e.g., "when you're at that point") to afflict the host. These equations demonstrate what I.A. Richards refers to as the metaphor becoming so closely related to the thing it is meant to describe that it "is imagined to be that very thing which it only resembles" (100). The understanding that having a gene for a disease is literally having the disease allows for little social utility since, for instance, it tends to ignore the possibility of personal intervention, and the process of gene and environment interaction.

Although a large number of our study participants understood genes metaphorically as a dormant disease or virus, their further discussion, when prompted, revealed their belief that even if a person carried this "defect" in the body, choosing healthy behaviors could play an ameliorating role. Our findings therefore suggest that when participants were probed about their own metaphor use, they would expand their understanding of genes as an irreversible, chronic, disease to one in which genes were described as more plastic, and influenced by behavioral choices. The inclusion of behavior in the equation is promising for improving human health, since it illustrates less determinism about genetics and promotes the possibility of behavioral factors. Still, the notion of genes as a *dormant* disease, at times even waiting like a time bomb (a metaphor we discuss later), creates a genetic world in which a person with a predisposition would go through life on shaky ground. This belief is demonstrated by

participant #1531 who responded to the hypothetical Gene and Doug scenario regarding lung cancer:

> **I**: No, they can improve their health. The gene itself, when it's dormant, you can improve your health. 'Cause it's not affecting you. But once it's awakened, that's where the tragedy comes in. You have to prepare [pause] basically preparation itself, or a good defense, when it happens. That's one of the most important things of all, prepare.

Here, although the participant believes one's behavior impacts health positively, the overall feel of the metaphor of the "dormant" gene is that healthy behavior only helps you prepare to face the inevitable. Participant #102 similarly grapples with her response about "Gene" who has a family history of heart disease and is likely to have a heart attack "because he has the gene:"

> **I**: I mean, that's just how I would see it, analyze it, think about it; because he has the genes. It's kind of the same thing, you know, with AIDS and just, you know, they carry certain kind of genes, I mean, I know I'm not saying that right, but [pause] like sickle cell, and people with that. They have that gene in 'em, and it's like threatening, and if someone else doesn't have that gene, they are not going to come down with it, and it's more than likely not going to happen to them.

This participant's explanation suggests that she equates genes to a viral condition. The more she talked, the more she constructed a vision of genetic predisposition to heart disease as viruses, like AIDS, or chronic genetic blood diseases, like sickle cell anemia. Had the moderator not probed her to expand on her initial views, she would not have had the opportunity to think through her initially unarticulated understandings of gene mechanisms. She begins with using AIDS as a metaphor then substitutes sickle cell as a more apt comparison. Although this participant does reject the AIDS virus as a means of explaining the functions of genes, her use of the morphology of sickle cell anemia to explain the heritability of a common chronic disease, such as heart disease, suggests a flawed one-size-fits-all understanding of the genetic functioning. If one inherits the sickle cell gene from both parents, only a bone marrow transplant can affect a cure, and in only a small number of cases (NIH). Common chronic heart disease, however, is dissimilar to such genetic defects and, according to medical research, largely preventable.

The specter of AIDS was raised by yet another participant. During a discussion of heart disease, participant #0531 struggled to find a fitting metaphor to understand genes:

> **I**: It's like a [pause] it's like a disease [pause] it's like an egg [pause] like a virus that is not spread at the moment because it knows, it's like, he's taking care of himself, and it just [pause] it's going to be there. Between AIDS and HIV, there's a gene. And then it turns into a virus. The virus turns into a deadly thing.

Here, the participant rejects first the disease analogy, then the egg analogy, but then goes to an analogy that has more sinister connotations, seeing the gene as a thing that turns into something deadly and dangerous, in this case a virus—likened to AIDS and HIV. There is little to applaud in this understanding. Although the participant suggests that "taking care of himself" may prevent the gene from turning "into a deadly thing," a definite lack of personal control is implied. As the participant expands on his understandings, the picture does not appear to get brighter. He sees unhealthful behavior as "putting a firecracker in gasoline." The gene is envisioned as dangerously flammable, and is "ignited" by one's behavior. A few moments later, this participant articulates unhealthy behaviors as colliding and exploding with the gene. Both give the feel of something extremely dangerous that can ignite or explode quickly. This theme of genes as a fire or bomb was common and will be discussed later.

A strong sense of lacking personal control is further suggested by the large number of participants who see genes as an inherent "problem" or "trouble." Here, participants would articulate a family history for a particular disease as one having a problem, such as "trouble with his heart" (#56), a "gene problem" (#153, #1023), or simply the "problem" (#6, #7). This understanding of genes as some vague problem or trouble presents another challenge to educational efforts toward gene and environment interaction. Genes are again viewed as inherently negative, this time coiled within the human body awaiting release of their deadly potential. This notion of one's genes is likewise deterministic and fatalistic. Even if, as some of our participants suggested, one could delay the onset of the problem or disease through behavior, it would be unlikely that healthful behavior could forever prevent one from contracting a chronic disease in the event of a family history of that disease. Participant #65 illustrates this last point in his equating genes to open wounds. When asked if healthful behaviors would help to promote health if one had a genetic predisposition for a disease, he provided a hesitant response:

> **I**: I think it would help a lot, you know. Once again, it's…it's…I mean, if you imagine a sore, if you do nothing to it, guess over a period, it will heal itself, but if you apply certain [pause] certain medicines to it, it'll heal a lot quicker. So if you continue to just ignore it, yeah, maybe they'll go away, but it's still there. But if you do things that are [pause] so go ahead and get it back to the way it was before it was there. You know, then possibly…

This participant struggled to explain his understandings of genetics, and used the metaphor of a sore to help him articulate his view to the moderator. His response suggests that people with a genetic predisposition for a chronic illness could "heal" themselves by applying healthful behaviors, and even by doing nothing. However, the "sore"—the "problem" gene as a potential disease—would still be there. Similar to the view of genes as a disease or virus, healthful behavior is envisioned as providing only a palliative measure, like preventing a dangerous enemy from gaining further ground.

Genes as Fire or Bomb

Another theme of genetic metaphors is "fire." This theme was less often articulated by participants than the majority of conceptualizations of genes as a disease/virus and problem/trouble. Nonetheless, this finding is significant for exploring the problems and possibilities of lay genetic discourse. We argue that this metaphorical theme, while still disturbing to us, contains components that, upon careful scrutiny, may reveal some untapped potential for constructing alternative metaphors. From this thematic perspective, genes are metaphorically understood as a smoldering fire. Specifically, the fire gets bigger when unhealthy behavior, articulated as "gas" or other lighting materials, is added to the combustion. In a comparable act of ignition, an unhealthy behavior or environment is frequently talked about as an action that activates a person's genes, leading to the contraction of a certain disease. Participant #95 offered this fire metaphor in the context of someone who has a gene for heart disease and also has a poor diet:

> **I**: Because it's like, anything that you do, if you have a gene, something that runs in your family, anything that you do negatively to your body is just adding. It's like adding fuel to the fire. It's like pouring gasoline on a fire.

Later when discussing someone who has a gene for lung cancer and also smokes cigarettes, the same participant repeats this fire metaphor, albeit with a more catastrophic ending, "They just adding. They're pouring gasoline on a forest fire. It's eventually going to burn down."

Like the negative valence of the "disease" and "problem" genetic metaphors, seeing genes as a fire or some other type of combustible material is pessimistic. For the participants of our

study, the consequence of combustion was often catastrophic, with such descriptions as "burning down a forest" or ending in a person's death. Additionally, like the metaphor of disease or virus, the gene is seen as something separated from and antagonistic to the human body. In other words, having a fire smoldering within one's body puts a person in the position of forever playing the role of genetic firefighter.

With this metaphor, rhetoricians and public health educators hoping to improve human health, and in particular encourage people's sense of control over their own bodies, face a major challenge. It is somewhat promising that with the fire metaphor our participants began to create a genetic world in which genes and environment exist in a kind of relation to each other. Nonetheless, the view of environmental factors providing some kind of instantaneous activation of an already deficient gene is not what genetic research suggests, nor is it necessarily helpful in bettering one's health. Such an instantaneous or "trigger" notion of the relation between the environment and genetics might lead to behavioral change if triggers were readily avoidable. But if triggers were difficult to avoid it could lead to fatalism, in the sense that nothing could be done if, for example, a person had a gene for depression and was unable reduce stress. In addition to confusing the nature of disease risk, then, this metaphor can be fatalistic either because nothing could ever be done to avoid a disease, or because just one more unhealthy behavior or environmental influence could suddenly bring on the disease or end in death. The immediacy of the fire metaphor comes across very clearly when a few participants go so far as to envision the gene as a "bomb" (#653, #192) ready to explode. As participant #653 continues to articulate a "ticking genetic time bomb" metaphor,

> **I**: But I don't think – I know earlier, I said, genes were a ticking [genetic] time bomb, and we were going to get [depression] at some point, but I guess I meant that if you have a higher likelihood of it, that you're going to get it at some point and there's nothing you can do to change it."

Even with a metaphor that portrays such devastating consequences as a bomb, some participants saw the potential for some personal human control over this explosive genetic device. This view is demonstrated by participant #1092.

> **I**: Because you have a risk inside your body, it's just like a bomb, on a bus or something. It just [pause] has that problem. But maybe a bus also have a safe journey, just because you carefully treated it. So for the heart disease, it's the same thing, like [pause] you care enough about your mood and health, and the food, I think heart disease will not happen.

In this example, although the participant's understanding of genes is rather negative, she does not describe the devastating consequences as inevitable. One could completely avoid contracting heart disease through lifestyle choices. The "bomb" need not explode, since one could "have a safe journey." The genetic predisposition for heart disease, understood metaphorically as a bomb, is mitigated as the participant sees the bomb under the control of the driver.

Hinted at in the above rhetorical metaphoric themes of genes as fire and bombs *may be* some untapped productivity. Put metaphorically, the fire does not always have to get bigger and the bomb does not have to explode if nothing jump starts the combustion. In other words, even if someone is genetically predisposed to a disease, the person might not get the disease if the genes are not kicked off by an environmental, temporal, or even a supernatural factor. What is more, a handful of participants expressed within this metaphoric theme that there was a way to prepare or even prevent the activation. Some sense of personal control like this is essential for health promotion messages to have any kind of positive impact on lay audiences. In response to a question about how someone's health will be affected if he or she has a gene for depression

and is stressed from a relationship break-up, participant #554 deploys both fire and trigger metaphors while simultaneously recognizing that the disease could be ameliorated:

> **I**: The risk for triggering depression would be greater. Uh, like I said, it kind of goes back to uh, feeding the fire, so to speak. You've got that gene. It needs something to trigger the body to say 'hey, let's have depression. Let's turn it on.' And, um, if they're not, if it's going to be something that's unexpected, then um, yeah – definitely it will trigger it greater than something that say, 'it's coming.' I can kind of see this coming, so I can at least get myself ready for it.

Unfortunately what exactly the participant meant by "getting ready" went unspecified here and elsewhere in similarly themed responses, like when participant #1092 did not specify, and the moderator neglected to probe about, what entails "being careful" in an answer to what the word "gene" means: "It's something you inherited, a problem from your parents. So that's another – that's a risk that you find in your body. It's just – be careful not to trigger it." On a couple of occasions, though, interviewees did expand on this promising belief that something can be done to prevent "fueling the fire." As participant #29 said with regard to how poor diet affects whether a person with a gene for heart disease will get heart disease,

> **I:** If you add the gene and you eat fatty foods, foods that are high in fatness, you're just adding fuel to the fire IF you don't exercise. I feel like exercise is like a counterbalance to everything. So you could be eating unhealthy and you can get up and run a mile and a half [pause] try to be doing something to help your body instead of always doing damage to it. And that might counterbalance everything.

The preventive fire metaphor still does not account for the cumulative effect of the interaction between genes and environment (Talmud; Sing, Stengârd, and Kardia; Tiret). But it does suggest a view of genes in relation to other factors in human health and may make allowance for an understanding of personal control over one's well being, all of which reduces genetic fatalism. Ideally, a person could even completely extinguish a fire.

Genes as Gambling

Another smaller theme of metaphors that generally provided little individual control from the perspective of our participants, but components of which might be refashioned for health promotion purposes, is gambling. Here, genes are viewed again as potential diseases, but the risks of contracting those diseases seem to be perceived as entirely a game of chance. Unlike the virus metaphors, the gambling metaphors do imply some specific human control in that one's behavior was generally equated to the act of gambling. But like most poor gambling results in real life, our participants created a genetic world in which the person with a genetic predisposition loses and "the house always wins." Participants metaphorically expressed combining unhealthful behaviors with a genetic predisposition as "roll[ing] the dice" (#67), a "crapshoot" (#0554), and "Russian roulette" (#102, #0554). None of these metaphors implies the presence of a skilled and experienced gambler who might be engaging in risky behavior, but at least has demonstrated some expertise at beating the house. Instead, the presence of a genetic predisposition is described as so precarious a position that, like Russian roulette, engaging in a risky behavior could bring immediate and devastating consequences. It does not imply a progressive risk increasing slowly over time. The use of this metaphor suggests that the health of a person with a family history of a chronic illness is extremely unstable. In fact, one participant suggested that a person with a family history of diabetes could avoid contracting the disease by not "eat[ing] any sugar" (#102). To do anything otherwise was understood by this participant as playing "Russian roulette."

This metaphor has several problematic aspects besides the chance-like fatalism it implies. First, it simplistically suggests that one's behavior, not outside environmental influences, completely

determines health. Second, it has the feel of sudden and devastating change (much like the instantaneous effect of the fire and bomb metaphors), as opposed to slow, progressive degeneration of health. And finally, it suggests that the only way to avoid illness is to engage in an almost monastic life as any lapse of healthful behavior can bring immediate consequences. None of these implications is supported by scientific research. But perhaps equally important, these implications do not contain much social utility. Even though many of our participants concede that human behavior plays a large role in activating the genetic virus, such as by starting the genetic fire or throwing dice in a genetic casino, the workings of genes are consistently viewed as dangerously unstable and prone to instantaneous activation. This view renders nearly moot any human agency as genes are viewed as something invading the body that is dangerous, immediate once engaged, and irreversible.

The material consequences of a worldview in which genes are dormant diseases or smoldering fires, and behavior is likened to risky gambling, are significant. A person could develop a deterministic or even fatalistic belief that if one had, say, a family history of diabetes then no amount of healthful behavior, such as proper diet and exercise, could prevent the disease. The best outcome of a diet and exercise program would be to delay the inevitable. Viewing one's health as so precarious in the case of a family history of disease could also lead to a discouraging perception of one's health being irrevocably damaged even by infrequent lapses of healthful behavior. Such a view is overly deterministic, rather than seeing a complex relationship and interplay of genes, human behavior, and physical environment. Contrary to these consequences, one could also develop a view that is overly optimistic. For example, the perception that, absent family history, a person is immune to certain diseases—a view we did hear expressed by some of our participants.

Despite our findings and their untapped potential for promoting better health, given our above arguments, we must limit our enthusiasm about these views demonstrating a lack of determinism with regard to genetic predispositions. Even though our analysis shows that some laypeople may have a complex understanding of genes, including sometimes even their relation to the environment, their metaphoric rhetoric suggests genes are still predominantly viewed as "diseased" invaders in an otherwise healthy body. Rather than seeing the human body as an integrated system where genes interact complexly with environments, laypeople tend to see a battle with two sides drawn: genes, and their always damaging influence on one side, and behavior, good or bad, on the other. In this genetic worldview, one must always be vigilant in the fight against genes. There is little metaphoric discourse among our participants to suggest that genes in combination with, much less *interaction* with, healthy behavior and positive environmental influences contribute to overall good health. It will be difficult to sustain a successful health promotion campaign if genes are consistently equated to inherent weaknesses, such as dormant diseases, viruses, or bombs about to explode.

New Genetic Metaphors and Implications for Rhetoric and Public Health

Ivie argues that metaphoric rhetorical criticism can "reveal the sources both of failure and opportunity" of rhetorical invention (166). Similarly, our case study shows how metaphoric rhetoric from a sample of lay Americans challenges scientific understandings of genes in problematic *and* productive ways. The metaphors for genes that are currently in common parlance are not useful for our purposes for the many reasons noted in our analysis and later in this concluding section. This fact notwithstanding, Ivie's call presses us onward to identify some ways in which the metaphorical worlds created by the lay public still might promote better human life. And our proposed new orientation for metaphoric rhetorical criticism pushes this "untapped potential" even further. In particular, here we offer two potential replacement metaphors for understanding the interaction between genes and environment—a dance and a band. We recognize that there is no unified scientific (or rhetorical) theory about genetics, nor

do we think there should ever be. Therefore our conclusions and metaphorical creations are provisional and partial, aptly leaving, as Fox Keller says, "the project of 'making sense of life' with an essentially—and perhaps necessarily—mosaic structure" (3).

It is promising that, evidenced by their metaphors, not all laypeople are wholly deterministic about genes. For example, even when conceptualizing genes as an inherent problem or fire, some of our participants included in their metaphors other factors as additional contributors to human health. Unlike widespread concern from scientists that genetic discourse entails genetic determinism (Marteau and Lerman; Hunt, et al.), the metaphoric worldviews created by the lay public are apparently more complicated and frequently less fatalistic than this. First, it is important that genes are at least sometimes seen in relation to environment rather than seen *only* as isolated (or worse, diseased and inflamed) determinants of a person's health. Indeed, most of these metaphoric relations are limited in comparison to the latest genetic research, which finds that genes and environment have an "interactive" relationship (Talmud; Sing, Stengârd, and Kardia; Tiret). Such a multiplicative relationship was never articulated metaphorically by our participants. Nonetheless, some laypeople are apparently open to viewing genes as just one cause in a larger health system made up of several human and nonhuman factors working together. Second, laypeople are already envisioning what this combination might look like. The ability to "see" and "know" something like the human genome that is invisible to the naked eye and not accessible to the average person—and especially the ability to conceptualize the complex relation of one's genes to one's self and other things in the world—is a central benefit of metaphoric rhetoric. This phenomenon has led scholars like Shea to describe the gene as first and foremost a rhetorical figure.

Our participants often struggled to make sense of this unseen and truly complicated element of the human body, and as noted in our analysis, it was common for them to perceive genes as a nonhuman invader, such as viruses, fire, or ticking bombs. Genetic metaphors that are seen as nonhuman objects are not entirely problematic, but to decrease fatalistic attitudes about genes, we argue that these metaphors must also entail a human agent who has behavioral control and/or can influence other causal factors such as environmental change. For instance, it is promising that the gambling metaphor for genes includes a human agent, but it unfortunately involves games of chance rather than strategy. Finally, because a handful of people we interviewed deployed multiple metaphors, we have hope that these complex metaphoric discourses aid them in understanding their genetic world in a way that acknowledges its complexity rather than relying on simplistic, possibly deterministic, understandings of genes.

In Ivie's study of the metaphors in the rhetoric of three Cold War opponents, he critiques these "idealist" rhetors as largely self-defeating because they proposed metaphoric "reversals" of the conventional image of the Soviet Union as savage. Ivie concludes that there would have been a different persuasive outcome for the war had they used metaphors that "transcended" the older image. He follows up this claim by offering "replacement" metaphors which integrate mixed images of both superpowers (180). A central purpose of our essay is also theorizing new metaphors, though it should be noted that metaphor replacement is not always persuasive. Evidently, the transference to common parlance of the preferred metaphors of scientific professionals, such as blueprints or codes, has been largely unsuccessful. Therefore, even as we suggest alternates to the genetic metaphors that are in use in both expert and lay discourses, we recognize that a U.S. health promotion campaign might face persuasive problems in application. At the very least, our goal here is to question foundational metaphors since questioning foundations opens them up to a re-usage that may prove to be productive.

The theme of our replacement genetic metaphors is "gene and environment interaction." The theme of gene and environment interaction reflects recent research in genetics and incorporates lay knowledge about the relationship between genes, lifestyle choices, and the physical

environment in the context of some common chronic diseases. It is important to note that the interaction between genes and environment is a multiplicative relationship rather than an additive one that would only reflect the sum of multiple health factors. This interaction is also progressive over time rather than immediate. Crucially, understanding gene and environment interaction is non-deterministic because it recognizes that a person's health may be promoted or impaired over time by multiple factors.

We term two potential metaphors for gene and environment interaction "dance" and "a band." Most Americans can positively relate to dancing and bands due to enjoyable everyday life experiences or representations in mainstream U.S. mass media. With dance between two people as a genetic metaphor, one dancer would represent the gene while the other would stand in for the environment. As the two people danced together, they would not just improve their individual dancing skills, but also their *unified* performance would show steady improvement. What is more, the longer they practiced or danced together then the better the individual dancers and the dance as a whole would become. We believe this metaphor demonstrates the issues of time and multiplicative outcome of gene and environment interaction.

In the metaphor of a band, different musicians could represent genetic, behavioral, and physical environment factors of human health. All musicians would play an instrument, but it is only by working with others and over time *as a collective* that they could produce a masterful musical performance. We suggest that our genetic metaphor of an active band is more apt for understanding the interaction between genes and environment than the passive metaphor of genes as musical instruments without musicians, which has been noted by some scientists and scholars of science (Hamer and Copland; Nordgren).

There are a number of key characteristics to our metaphors that we should highlight. First, besides the majority of people being able to identify with a dance and a band, generally there are positive associations with dances and musical performances that might increase identification with the metaphors. Second, both metaphors are fundamentally corporeal, with both involving human agents that actively contribute to improving their overall performance. Embodying genetics as a dance or musical performance would, we suggest, prevent conceptually separating genes from the self or body, which our analysis suggests is necessary. Third, the dance and band metaphors portray not only a physically collaborative and beneficial relationship, but also an interactive relationship that multiplies its outcome over time. For example, more time and practice dancing or playing music in a group significantly enhances a dance or musical performance.

Ideally, we intend for U.S. public service announcements, private health campaigns, and other media messages about genes to incorporate our replacement metaphors. We believe that the genetic metaphors of a dance and a band will help the American public envision a world of interacting genes and environment. In turn, more people might be motivated to create environments that are health protecting, avoid environments that are health destroying, and work in other ways on a daily basis to improve their health. Quantitative results from a pretest of the impact of the genetic metaphor of a dance on a nationally representative sample of 87 people provide preliminary support for our recommendation even as questions remain.

Specifically, in the winter of 2008, members of our grant teams worked with Knowledge Networks, a company that collects scientifically valid consumer information, to develop and pretest two different online videos that portrayed the interaction between genes and environment, with one of the videos featuring the genetic metaphor of a dance. The pretest found that, on average, participants were not fatalistic about genetics after watching the video with the dance metaphor. On average participants fell between "neutral" and "mostly agree" when it came to understanding that genes and environment interact after watching the video

with the dance metaphor. In addition, on average participants "mostly agree" that the video with the dance metaphor was easy to understand. These initial results are promising. Evidently metaphoric discourse about the interaction between genes and environment is comprehensible, and better yet, does not increase genetic fatalism. Still, the dance metaphor only slightly educated people about gene and environment interaction since it did not commonly elicit "strongly agree" responses. Given that this was most likely people's first exposure to a health message about the complex process of gene and environment interaction, we are optimistic about this result even as we recognize room for growth. Whether participants were not as educated about the interaction between genes and environment as they could have been because of the particulars of the dance metaphor, because of the medium of online video, and/or because of other factors, remains an unknown. Given the limited scope of this pretest, it would be worthwhile to run additional pretests that use other methods and include the alternative genetic metaphor of a musical performance for comparison. Pretests are necessary for assessing the effectiveness of any new genetic metaphor prior to its circulation in official public health messages.

While the new metaphors that we created have a great deal of potential as evidenced by the pretest, they are limited even in their conception. Ivie writes, "Regardless of how compelling any metaphor may be, however, its limitations eventually are encountered in its application" (179). This holds true for the genetic metaphors of a dance or band. As we saw repeatedly demonstrated by our participants, there is a tendency among laypeople to see genes as separate from the body. A metaphor such as a dance performance, with one dancer representing genes and another representing the environment, may further encourage the notion of genes as foreign to the body, as if one could walk away from one's genes as from an inadequate dance partner. Thus, we acknowledge that our proposed replacement metaphors are not perfect even prior to testing their reception, but neither is any metaphor able to represent another thing exactly. Metaphors will always face limitations, and may potentially further muddy the waters of comprehension, for as Jacques Derrida writes, "metaphor is never innocent" (17). A major barrier facing any attempt to integrate the body in public understandings is the Cartesian tendency of Western culture to separate the "self" from the body. As many of our interviews illustrate, people tend to distinguish the body from genes, and often see both as something recalcitrant and untrustworthy. A surprising number of our participants created images of bodies over which one needs to stand vigil lest their genetic weaknesses are unleashed. This detachment of genes from the body, and the body from the self, has far reaching implications for public health campaigns concerned with educating the public about the interactions between genes, human behavior, and the physical environment. In order for metaphoric discourses to be successful in educating the public, people must begin to see the body as an integrated, collaborative whole and connected to the world rather than a series of parts at war with each other. This is no easy task as public health educators in Western modern societies like the U.S. find themselves confronted with hundreds of years of Cartesian dualism.

Proposing new metaphors for genetics was just one purpose of our essay. As rhetoricians, another goal for us was to expand rhetorical theory and criticism of metaphors by examining "texts" that are too often overlooked by scholars of rhetoric. Our case study demonstrates how metaphors are used in situations that are not intentionally persuasive to dynamically construct worldviews, and how those worldviews differ from those of elites. During the course of the interviews, our participants struggled with and enlarged their explanations without obvious attempts to persuade the moderator. A close examination of these texts allows a glimpse into the process of knowledge construction. Put differently, people appeared to be engaged more in an intrapersonal journey than they were in an interpersonal, intentional act to shift the moderator's opinion. Our interviews provided opportunities for the demonstration of the epistemic aspect of metaphoric rhetoric as our participants often created their genetic views in

the process of the interview, without overt collaboration with the moderator. In contrast to much rhetorical scholarship that tends to focus on traditional suasive efforts of professional rhetors, our participants showed that their use of metaphors was an inseparable part of their coming to an understanding of their own worldviews, and that these views are quite different from those we find in scientific discourses. Metaphors may well "travel," as Journet and others argue (383), but our analysis suggests that those in professional communities, such as viewing genes as a code, are not traveling to lay communities today.

This disconnect between scientific professionals and lay communities presents a daunting problem for scholars like us who genuinely wish to improve society with the knowledge obtained through genetic research such as the HGP. Metaphors may be the only way to translate so complex a topic to nonscientists. However, as our analysis shows, the metaphors in current use by scientists may not resonate outside of their own communities. Therefore we suggest that scientists must work in cooperation with mainstream U.S. mass media outlets to disseminate genetic discoveries that focus on predispositions for genetic *strengths*, not just genetic weaknesses. It is our belief that when so much news attention in this country is given to diseases that may have genetic components, it is to be expected that nonscientists will begin to equate genes only with diseases. It is significant that so many of the people we talked to equated genes to sleeping diseases and smoldering fires, both of which are extremely negative and suggest limited personal control. This is a finding that should concern scientists, scholars, and activists interested in improving public health.

Despite the difficulty facing educators, we do not mean to suggest that such efforts would be fruitless. On the contrary, with common preventable diseases decimating public health and personalized genetic testing entering the public realm, research and educational efforts must be increased, and must find ways to be more effective. We believe that any effort to share important genetic discoveries with the lay public must take into account existing metaphoric discourses as well as strive to replace dysfunctional metaphors with new metaphors that conceptualize an interaction between genes and environment. In fact, evolutionary biologist John C. Avise wrote in an article in *Science* that this exact moment— the years following the completion of the HGP— is perhaps "the right [time] for new panoramic images of the genomic landscape that capture proper notions of complexity and evolutionary dynamism." He continues, "Although no one metaphor is likely to be informative in all respects, some new perspective that views the genome as an interactive community of evolving loci may be especially useful and stimulating at this time" (87). We hope that our efforts to assess metaphoric rhetoric by lay audiences and create new genetic metaphors, captures some of this evolving genetic landscape and inspires others to look in similar directions.

Acknowledgments

For the purposes of this essay, the authors are listed alphabetically, but would like to note that we both contributed equally to its creation and production. We would like to thank Celeste Condit, the editor, and the anonymous reviewers for their invaluable assistance in the preparation of this manuscript. We also extend our gratitude to the CDC and NIH grant teams at the University of Georgia for their help in data collection.

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