SCIENCE AND SOCIETY

How geneticists can help reporters to get their story right

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Abstract | Many geneticists are disgruntled with the coverage of genetics in the mass media, yet geneticists themselves have a part to play in improving that coverage. This article aims to help geneticists to do so by explaining the forces that shape science news. It provides some specific options for reducing hype, countering genetic determinism and preventing the use of genetics to reinforce discriminatory messages, slants that many reporters are inclined to give to their articles.

Geneticists and critics of genetics might agree on little else than that the coverage of genetics by the news media is lamentably poor. However, scientists bear some responsibility, both in their own writing and in their discussions with journalists, for the content of the news about genetics. This idea has recently received clear evidential support by the research of Bubela & Caulfield[1]. Their comparisons of original scientific sources and news reports about those sources in Canadian and US newspapers showed that the 'hype' and much of the key content in the articles was in parity with the original scientific articles. Although scientists cannot ensure that journalists get the story right, they can certainly enable journalists to do so.

Scientists have a social responsibility to talk knowledgeably with reporters, and to do so is in the interest of science in an era when public funding and control over science is significant. However, some scientists avoid this task because it is onerous. At a minimum, it requires the same level of preparation that one would give to a platform presentation at a scientific conference. Such time and care are warranted, because the reach of the reporter is larger than that of the academic conference (at least in the short term). To become more skilful at guiding journalists, it might be helpful to understand the nature of journalistic articles, and this Perspective seeks to help in this by examining potential solutions to a few important and common problems, including hype, genetic determinism and discrimination.

What drives science journalism?

Science journalists, for the most part, are people who find science interesting and at least potentially valuable. However, many news pieces about scientific topics are not written by reporters who specialize in science news, and journalists are paid primarily to attract demographically valuable audiences so that advertisers will pay high rates. This creates a problem for science journalists, which has been described as the 'hype–space conflict'[2]. That is, science reporters experience a conflict over whether to use their space to present hyped content or more dispassionate and thorough descriptions.

On the one hand, science journalists must create articles that attract the interest and attention of many people, and they are competing against more titillating information about sports and celebrities, more frightening information about rapes and murders, and more immediately momentous information about war and global economics. This leads to the need to hype the article. As Dorothy Nelkin observed long ago, journalists most often do so by designing stories that frame science as offering wonders and miracles, and occasionally do so through frameworks that present scientific discoveries as frightening threats[3]. Frequently, journalists combine these two elements to present scientific results as embroiled in controversy, especially important political controversies such as gay rights, racial justice, patent rights and so on[4].

On the other hand, science journalists also feel compelled both by journalistic norms, and by the canons of the science they are covering, to give much of their space to 'objective' representations of the subject matter that they are covering. There has been substantial debate about the possibility, desirability and meaning of objectivity in news coverage and in general[5–7]. However, research into reporters' norms has indicated that they attend to what they perceive as objectivity, and that they operationalize it largely by the inclusion of statements from 'both sides' of a subject[8]. This means that two sides are presented, regardless of how many sides might actually warrant attention. As a result of this conflict between the need to hype and the need to give space to detailed, objective treatments, science news articles often feature a combination of dramatic overstatements and colourful descriptions mixed with statements that ostensibly balance these claims with opposing or moderating views and a limited level of technical detail. Science news therefore usually has a slant, or frame[9], that plays up the wonders (or occasionally the potential threats) of a scientific breakthrough, but also includes a more-or-less detailed nod at 'the other side'.

The slant or frame is not merely a subtle shading of a story. It can determine the meaning that a story communicates. Horowitz's[10] recent analysis of press coverage of research into gene–environment interactions is illustrative. He showed that news stories about a high-impact article by Caspi *et al.*, published in *Science* in 2003, were generally framed by the idea that mental illness was genetic, rather than by the idea that the cases of depression that were studied were the result of a gene–environment interaction[11]. The original scientific article was distinctive because it showed that depression in humans could result from a particular gene–environment interaction; specifically, from the co-presence of an allele of the 5-HTT gene (also known as *SLC6A4*) and major life stressors. It specifically indicated

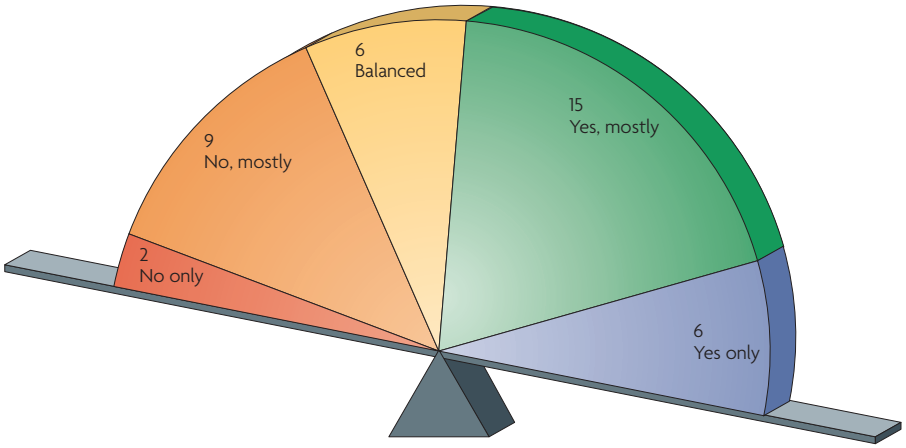

Figure 1 | **Slant on the issue of whether race is genetic in a sample of news articles about human genetic variation.** The figure shows an analysis of all news articles from 1990 to 1992 and from 2001 to 2003 in LexisNexis academic, in which there was co-occurrence of 'genetics' and 'race', or co-occurrence of 'human', genetic' and 'variation', within ten words. Articles were coded for the degree of slant by a paid independent coder, after establishing inter-coder reliability using two coders trained on the five fixed categories plus an 'ambiguous' category (which was empty). Data from REF. 2.

that the presence of the allele alone was not associated with variation in levels of depression; nonetheless, the 'genetic discoveries!' frame that was used in the news articles left the impression that this was a 'gene for depression', rather than conveying the more interesting and complicated portrait of the pair of interacting variables.

There are often strong trends among journalists' choices of frames for particular topics. For example, coverage of genetics for human medical interventions is usually more favourable than coverage of genetics for genetically modified crops (GMO)[12]. However, there are also differences among reporters. In Europe, substantially more reporters have chosen a negative slant on GMO than in the United States[12]. Similarly, as FIG. 1 indicates, journalists in the United States came to the issue of whether race is genetically grounded with a range of slants, but leaned mostly towards the frame that 'race is genetic'. Knowing the type of slant that is typically used by a reporter enhances the likelihood that one can provide effective balance or, occasionally, correction.

Finally, science journalists face the problem of communicating with non-experts about highly technical material. The difficulty of this task can be seen by taking a paragraph of your own scientific prose and evaluating it with the Flesch–Kincaid 'readability' tool in your word-processing program. Try to rewrite your paragraph at the tenth-grade level, which is fairly typical of local newspapers (the tool maxes out at twelfth-grade). Lay people — even lay people with advanced degrees in other fields — cannot be expected to have the technical vocabulary that is required to understand details of specialties such as genetics. For this reason, science journalists must be expert at simplification. Figures of speech such as metaphors constitute a fundamental resource of language[13–15], so they are often used to provide comparisons that can be easily grasped. For example, in a single article about cancer genetics by Gina Kolata[16], scientists are quoted or directly attributed as using seven rhetorical figures, including snowball, chain reaction, Achilles heel, looking 'mean', bomb, molecular razor and black box. Such simplifications inevitably contain misrepresentations. To take common examples, a gene is neither precisely a 'blueprint' nor a 'recipe' because it is not consciously drawn up by a designer or a chef. Because such simplifications are nonetheless necessary for communicating with non-experts, the pertinent question is whether the simplifications that are chosen encourage people to make judgments that are likely to lead them towards faulty choices. The three most widely written about pitfalls that geneticists might want to steer journalists away from include hyping of scientific potential, genetic determinism and genetic discrimination.

Reducing hype

In a research report with the tongue-in-cheek title, "Has the gene for alcoholism been discovered 3 times since 1980?"[17], Conrad and Weinberg showed how the journalistic norms discussed above led to news stories announcing the discovery of alcoholism as a genetic disease at three widely separated time points. The first major period reported heritability studies, the second reported genetic association studies and the third focused on women. In each wave, Conrad and Weinberg's analysis showed that the news articles presented undue optimism about a cure based on the research, and/or an overemphasis on the genetic component of the condition.

The enthusiasm of scientists for their work can feed such hype (as can the demands for grant funding). For example, in 1993, medical geneticist W. French Anderson predicted that soon, "…any physician can take a vial off a shelf and inject an appropriate gene into a patient."[18] The enthusiasm for the prospects of gene therapy among some members of the scientific community drove a tidal wave of optimistic reporting that suggested a 10-year time frame for gene therapy as practically a cure-all[19]. The optimism was immensely overstated, at least for the time period for which it was predicted.

Scientific findings can be enormously distant from social applications for both technical and social reasons. Although the implications of this distance might seem obvious, in practice they have been repeatedly overlooked. To provide an accurate picture of the implications of a scientific discovery and to avoid a sense of betrayal by the public, when speaking with journalists about their work, geneticists might consider curbing their own hopefulness. Instead, they might enumerate the scientific roadblocks, and perhaps the social ones, that stand in the way of the desired applications. In most cases, it also would be appropriate to remind the reporter of the ever-present potential for results to be overturned by further research.

Avoiding determinism

In the narrow sense, genetic determinism can be defined as the belief that genes are the only major contributor to the form, behaviour and life course of an organism. Given that genes evolve that produce reproductively effective responses to ranges of particular environmental stimuli, genetic determinism is generally understood among scientists to be false. Two organisms with the same genes will manifest different forms, behaviours and life courses in different environments. It is the interaction of different factors that determine outcomes. Unfortunately, some influential science journalists tend to write as if a genetically deterministic view is the only possible

scientific view, whereas taking account of environments is non-scientific (especially with regard to human behaviours). Such perspectives can be encouraged by scientists, even those who are not absolute determinists, when they over-emphasize the role of genes or neglect the influence of environments (which are easily controlled in laboratories and can therefore be considered as background from the geneticist's perspective). With such encouragement, journalists are likely to use the 'genes win!' frame, which portrays a genetic discovery as a triumph of genetics (and science) over behaviour, culture or environment. For example, articles by such journalists tend to misrepresent heritability studies in humans as though they are a measure of the extent to which genes trump environments, rather than understanding them as a measure of the relative influence of hereditary factors of multiple kinds within a limited range of environments[20,21]. Owing to the biases of the journalists and the complexities of the concepts and operationalizations of heritability, it is probably useless to try to use this word with most journalists. However, there are other ways to communicate about the important role of genes in biological outcomes.

One option is to insist on replacing the 'gene versus environment' frame with the 'gene–environment interaction' frame. As Horowitz's analysis indicates, this is not easy to achieve[10]. Although medical genetics is rapidly outgrowing the 'one gene, one disease' (OGOD) model, journalists and lay individuals are still rehearsing their high school biology lectures, which taught eye colour, for example, as a single-gene model of the causation of human characteristics. A society-wide shift to the more complex understanding that is currently being pieced together in studies of obesity, heart disease, diabetes and other diseases will not come immediately, but awareness of reporters' tendency to collapse the gene–environment frame back into the genes win frame can help one to generate a clear, consistent counter to this outdated story. With regard to the Caspi *et al.*[11] article described above, for example, a consistent statement that a gene–environment pairing has been found that is more likely to produce depression than other environmental or genetic factors on their own is more likely to enable a story in which the news was not the discovery of a gene, but the discovery of a gene–environment pair. The recent trend to try to transfer the term 'epigenetic' to the public realm only enhances the adoption of the genes win frame, because it centralizes the term genetic and adds a prefix with a meaning that is surely unclear to the general public. Using a lay vocabulary such as 'pairs' or 'pairings' provides an easy-to-grasp noun that gives relatively equal emphasis to different components.

Another source of genetic determinism is the unwillingness of journalists to try to teach the lay public the word allele. Consequently, they are reduced to writing that a discovery is a 'gene for' a disease or, more recently, a 'variant gene'. What does a 'gene for' mean to lay people? Bates *et al.* asked people in 13 focus groups in the United States, "What does 'a gene for heart disease' mean?"[22] They coded their comments and found that more than one-quarter of them indicated a belief that the affected person would absolutely get heart disease (FIG. 2). Opinion polls have consistently shown that about one-quarter to one-third of the US public endorse genetic determinism, although this varies substantially by the particular characteristic or disease[23]. More detailed parsing of lay attitudes in ongoing research by our group shows that the interaction of two different discourse tracks produces the following results[24]. Most people interpret statements of genetic causation in a highly deterministic fashion. However, they have two separate, non-integrated tracks for explaining health causation. In addition to a genetic explanation, they have a behavioural account, which most of them prefer to use whenever possible. Thus, the poll results show that modest levels of net determinism result from people's shifting between the two tracks. To avoid the conclusions of the determinism they find implicit in genetic accounts, they either deny the role of genes altogether (15% did so in Bates's study), or they simply shift their attention over to a behavioural explanatory system. In more than 100 in-depth interviews of lay people, we've found that extremely few people have an explicit integration of genetic and behavioural accounts as a gene–environment interaction. Avoiding deterministic implications is consequently challenging.

The phrase 'variant gene' is likely to be even more problematic, because it suggests to many readers that the gene (rather than the allele) is something that only some people have. It does not effectively translate the idea that all humans have a shared stretch of DNA that codes for a particular protein, but that there are single base pair modifications among people's DNA in that stretch that produce proteins with modified forms. Additionally, journalists and the public will most often lack the context shared by geneticists, that everyone has some rare alleles at some loci, so that this phrase can also be stigmatizing (a tendency that is probably enhanced by the similar sound qualities of 'mutant' and 'variant').

Our work with community advisory boards and focus groups has shown that the term 'version of a gene' is a better lay translation. To communicate that a particular version of a gene is associated with higher chances of particular unwanted outcomes, the Multiplex Genetic Susceptibility Testing Study initiated by the Social and Behavioural Sciences Branch of the US National Human Genome Research Institute, under the direction of Colleen McBride, is using the short-hand, 'risk version of a gene'.

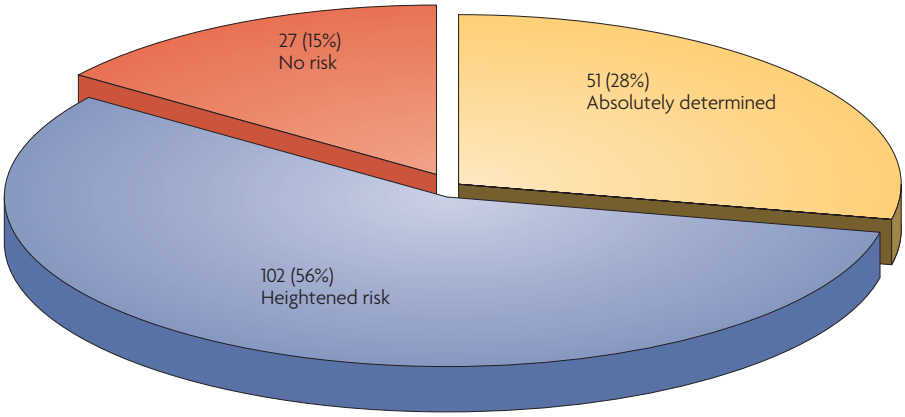

Figure 2 | **Numbers and percentages of statements indicating perceived risk level in 13 focus groups asked "What does 'a gene for heart disease' mean?"** Focus-group participants were recruited through nomination by multiracial community advisory boards. Statements were placed into categories by a paid independent coder, after establishing inter-coder reliability using two coders trained in the category system. Only comments reporting a risk level are tallied here. Percentages are rounded. Data from REF. 22.

Table 1 | **Variations among labels used to describe human groups by lay people, scientists and journalists**

Apparent organizing principle	Lay people asked to "list some races" in 15 focus groups*	Labels used in 50 published articles in scientific journals‡	Labels used in 57 newspaper articles describing the debate about whether race is genetic§
Skin colour	Black, white	White‖	White, black, people of colour, colored, brown, red, mulatto, dark-skinned, non-black, lighter-skinned
Continent	Asian, Australian, Native American (?)	North American	Europeans, Native Americans (?), Asians, Africans, American Indian (?)
Nationality	Mexican, Cuban, Chinese, Korean, Japanese	New Guinea, Swiss, Brazilian, Belgium, Portuguese, Chinese	Chinese, Swedes, Indians, Fiji, Saudia Arabia, Greece, Japanese, Nigerians, Mexican, Portuguese, Americans and 23 others
Tribal	Aboriginal		Pygmy people, Cherokee Indian, Blackfoot Indian, Kung
Continent X Nationality	African American, Asian American	African American, Mexican American	African American, Afro-American, Mexican Americans, Chinese Americans, American-Europeans,
Linguistic Group	Hispanic		Hispanic, Bantu-speakers, Gullah-speaking African Americans
Region (sub-continental)	Latino, West African, Latin American, South Asian	Latin American	Latino, Northern Europeans, sub-Saharan Africans, Indian sub-continent, Middle East, Siberia and 10 others
Religion		Jews	Jews, Amish, Ashkanazi Jews, Eastern European Jews, Siddhi
Other	Caucasian, 'other'	Anglo Saxon, Swiss Caucasian, Caucasian Mestizos from Columbia, African American and Caucasian populations from Marion County, Indiana, USA	Caucasian, Caucasian Americans, white Americans, African pygmies, Western hemisphere blacks, non-Latino whites, Oriental, Gypsies, Melungeon, Roanoke, Phonecians, Eurasian, multiracial, Indo-Europeans, Basque, Negro, white Finland and 8 others

*From REF. 41. There was a total of 53 mentions of these terms. ‡Search on Medline (accessed 27 October 2003) for 'race' and 'genetics'. The first 50 rank relevancy out of 306 are given. §Purposive sample of newspaper articles on 'race' and 'genetics' together, as described in FIG. 1 (J. A. Lynch & C.M.C., unpublished data). ‖The exclusive use of 'white' in this category might be due to the limited sample size. However, it might also be a product of the widely documented bias in Western nations toward centralizing 'whiteness', that is, whiteness becomes the norm against which all other groups are compared[40]. For the scientists, white remains the normative term, but because skin colour is not the primary focus, non-skin-colour-based terms are used for the comparison groups. On this account, the black–white dialectic that has historically dominated race relations in the United States might explain the selection of these two terms in the focus groups.

Countering discrimination

The issue of human genetic variation is inevitably a sensitive one, because people's lives are shaped and constrained by the labels that are used to describe them. Members of both the disability rights and racial equalities movements have complained that at least some ways of talking about particular instances or patterns of human genetic variation encourage discriminatory attitudes, and some empirical evidence suggests these concerns are well founded[25]. Although it is not possible to rehearse all of the data on this complicated and loaded topic here, the evidence is strong enough to suggest that one should not use the term 'race' or classify humans into groups casually. Human genetic variation is clinal across the globe (reflecting the flow of immigrants out from Africa), with strong regional variations resulting from climatic and geographical factors. Variation is also locally brecciated. These crosscutting patterns of variation do not match up well with the social groupings that people assign to race, which are constantly changing through recorded history[26,27]. We have shown that the intuitive categories for racial grouping that scientists use today tend to be similar to the imprecise and changeable categories that the contemporary society uses for race[28] (TABLE 1). This means that no scientist (or anyone else) should trust their intuition about race labels.

An example of the constant slippage of race terms is provided by Nicholas Wade, who was a strong journalistic propagator of Neil Risch's claim that there are five major human races that are defined by genetic clusters, specifically, Africans, Caucasians, Asians, Pacific Islanders, and Native Americans. However, when reporting on recent diabetes research, Wade includes as his list of races, "African-Americans, Latinos, American Indians, and Asian-Americans."[29] The social grouping we call Hispanics is not one of Risch *et al.*'s categories, and it does not share a stable, historically deep genetic cluster. In the South-Western United States, most Hispanics have a mixture of ancestors who were indigenous to the Americas and who came from Spain and Portugal whereas, in the South-Eastern United States, Hispanic ancestry includes many people who came from the Caribbean and, previously, from sub-Saharan Africa. Of course, in US popular culture, people who speak Spanish or related languages, Hispanics, are coming to be understood as parallel to other traditional minority groups in the United States that have been defined as races, such as African Americans and Native Americans. So, Hispanics are now being identified as a race in common parlance. This is just the most recent shift-point in the historical variability of the groupings that scientists and lay people alike have classified as races through time[26]. Thus, one should use the term race only after familiarizing oneself with the general issues involved[30–32], and with all of the details of the specific case of population variation. Adopting newer frames such as ecotypes, populations or ancestry might be more promising for specific instances, but using these alternatives will still require rigour and caution that can be overridden by the power of folk concepts of race.

The issue of labelling individuals who have particular genetic variations is equally sensitive and consequential. Few people today would use the term 'mutant' in public to describe someone with such a variation

Table 2 | **Crib sheet for talking genetics with reporters**

Issue	Avoid?	Consider
Process	Just picking up the phone and chatting	Know the slant the reporter is likely to take; write out your key points in lay language; test it out on 'readability' ratings and lay people
Hype	Effusive enthusiasm; predictions of 10–15 years to applications	Describe technical and social roadblocks; highlight the potential for findings to be overturned
Determinism	The 'genes win!' frame; the terms 'heritability', 'gene for' and 'variant gene'	The 'gene–environment interaction' frame; the terms 'gene–environment pairs', 'version of a gene', 'risk version of a gene' or 'risk-increasing version of a gene'
Discrimination	Race labels drawn from lay-based intuitions; terms such as 'mutant', 'mutation', 'sickle-cell victim', 'sickle-cell carrier', "dwarf," etc.	Carefully and precisely delineated 'populations', 'ecotypes' or 'ancestries'; terms such as 'change in a gene', 'genetic change', 'people with the (…) genotype' or 'people with (…)'

but, as we have shown, the term 'mutation' carries a similar negative resonance for lay people[33]. There is simply no reason for this scientific term to be used in communicating with the public, for whom it connotes the monsters of science fiction. Medical geneticists have defended the use of the term on the grounds that it is the accurate term; however, there are many terms that are accurate to scientists that are not used in the parlance of the general public (for example, 'allele' or 'linkage analysis') because they do not communicate effectively. Medical geneticists resist the use of alternative terms such as 'genetic change', 'version of a gene' or 'genetic variation' because they allege that these terms do not carry the negative connotation of an undesired change. However, it is exactly the desirability of the change that is in dispute in many cases, especially with hereditary deafness and small stature, where at least some people with these genetic variations maintain that they are not undesirable genotypes. Moreover, outside of and before the dominance of medical genetics in the genetics community, 'mutation' among scientists did not mean a deleterious change in DNA; it simply meant a change in DNA[34].

The particular impacts of the use of the phrase 'genetic change' instead of 'mutation' in any given case is, of course, only an example of the larger framework to be sought, which is to think and speak about all human beings as people with a range of genotypes that manifest themselves in an even greater range of phenotypes, rather than reducing individuals to a disease or physical condition such as 'sickle-cell victims' and 'dwarfs', or further reducing them to their DNA: 'sickle-cell carriers' or 'BRCA1 positives'.

Procedural recommendations

Translating technical vocabularies into lay parlance is not an easy task, nor will it ever be perfectly achieved. Given the difficulties, writing out exactly the message one wants to convey to a journalist in four or five sentences might be the most effective preparation. Part of the writing task will include choosing figures of speech that quickly and clearly convey the core ideas. To ensure that one's metaphorical and other choices do not convey unintended meanings, it is desirable to try out one's paragraph on a couple of non-scientists to see what they make of it. Sometimes this can be usefully done through the internet for a broad response but, unless one knows the background of one's internet interactants well, it should also be done with local individuals whom one knows are likely to be members of the target audience. After trying out one's set-piece and ensuring that it communicates effectively, there are some things one can do to increase the chance that the journalist's frame won't simply swamp what you believe needs to be said.

Journalists prefer phone interviews because they are fluid and interactive, and give the journalist substantial control over the record of what is said. Wherever possible, insisting on written questions and responses helps the interviewee to focus the interview on what they want to communicate. Occasionally, as a condition of being interviewed, one can also gain an agreement to see the copy before it is submitted, so that one has a chance to correct any faulty interpretations. Finally, even after publication, if a reporter makes an error or uses an inappropriate frame, the reporter should be told that. In some cases, the reporter's editor might also benefit from being informed of serious or systematic errors, especially when more than one interviewee agrees that there are problems in the reporting.

Conclusion

The challenges involved in talking to reporters cannot be reduced to a simple formula (this Perspective has provided only brief pointers; see TABLE 2). Ongoing research is delineating what information about genetics consumers want and need[35,36]. Furthermore, a large body of research is developing in domains such as health, risk, science communication, health marketing, epidemiology and elsewhere that can provide useful additional guidance towards effective communication about genetics. For example, a variety of research suggests that using proportions instead of percentages, or small denominators instead of large denominators, can help people to understand frequency relations[37], and systematic biases in gauging or responding to risks are increasingly well understood[38,39].

The challenges that are faced in communicating about genetics with lay people are constantly changing as geneticists invent new methodologies and new findings. Notably missing from our current understandings are research-based recommendations about what lay people make of complex visual data, such as those produced by gene expression studies using microarrays. Perhaps more immediately important will be research that generates recommendations on how to communicate the meaning of personal genetic tests that involve multiple contributing alleles for common diseases. Given the difficulties involved in explaining the implications of a single genetic test, communicating the implications of having, for example, two risk-conferring alleles and two non-risk conferring alleles for hypertension or skin cancer or osteoporosis will certainly be challenging. Grounds for hope arise from the willingness of many journalists to improve their ability to communicate about genetics in an effective fashion. Should geneticists themselves do any less?

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Competing interests statement
The author declares no competing financial interests.

DATABASES

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FURTHER INFORMATION

The Southern Center: http://southerncenter.uga.edu/
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