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Science and the Sources of Hype

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Abstract
It has been suggested that genomic research is frequently inappropriately hyped, in both the popular press and the scientific literature, and that this hype has the potential to create a range of social concerns. This paper maps the complex array of social forces that contribute to the phenomenon of hype, including the pressure to publish, the increasingly intense commercialization agenda, the messaging emanating from research institutions, the news media and, even, the public itself. These numerous and interrelated factors create a 'hype pipeline' that will be difficult to counter without the utilization of a wide range of policy strategies.

Introduction

There has been substantial concern articulated about 'science hype' [1] – that is, the worry that messages about science exaggerate the benefits of research and underplay the costs and risks of science and its technological products. Diverse scholars have suggested that this phenomenon is currently occurring in a wide range of fields, including stem cells [2], neuroscanning [3], nanotechnology [4], and genetics [5]. Such hype has been criticized by academics and a variety of policy entities [6], and even scientists view it as a problematic trend [1, 7].

Lines of research relevant to public health genomics have not been immune to hype, if we understand public health genomics within the scope prescribed by this journal's statement of 'Aims and Scope', and thus including 'the very pressing need for the development of effective personalized healthcare which is complementary to health protection and health promotion,' and which is taken to include the territory of 'public health, health policies, and healthcare as a whole.' Fitting within this definition, components of hype have been identified in advertisements for direct-to-consumer genetic testing [8], in research agendas for genomics related to hypertension [9] and pharmocogenomics [10] in news coverage of genomics [11], in stock and venture capital associated with genomics-based research programs [12] as well as in national-level initiatives such as Iceland's DeCode initiative [13, 14]. Indeed, Boddington [15] identifies hype as a characteristic feature of the genomics enterprise, naming as 'one of its characteristic faults: a pervasive tendency to hype itself up, or to be hyped up by others, such as politicians and the media' (p. 93).

Hype in genomics has been widely recognized and discussed, but we believe it valuable to attend to 2 areas that

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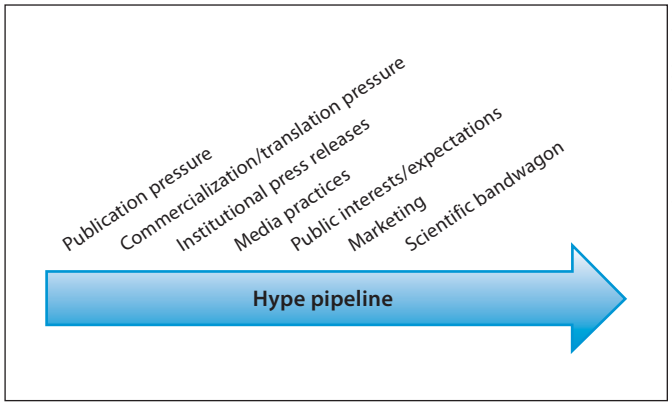

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Fig. 1. The cumulative forces of hype.

might still be underappreciated. The first issue is the question of the source of hype, and the second is the importance of attending to the specific contents within genomics that are being hyped. In drawing attention to these 2 aspects of hype, we will be arguing that no one entity (including the mass media) is singularly responsible for the hype phenomenon and that more attention needs to be paid to exactly which dimensions of genomics get hyped, rather than focusing solely on issues of degree.

With regard to the issue of responsibility, the mass media receives much of the blame for science hype. This is probably because news reports are the most readily accessible locations in which hype gets articulated. But substantial evidence now demonstrates that hype does not originate solely or primarily with the press, but rather is a product of the input and incentives of a diverse array of entities, including scientists, funding agencies, business interests, and the public itself. In this commentary, we will try to draw together the evidence that shows that most of the major entities involved in public communication about genomics – including researchers, commercial forces, research institutions, the media, and the public – all participate in the 'hyping' of genomics, although their motives for doing so vary. We will represent this circulation as a 'pipeline' which starts with the researchers and is accelerated via pressure to publish, commercialize and translate work (fig. 1). The popular press and the interests and expectations of the public then reinforce and amplify the pressure on the research community to provide overly optimistic portrayals.

The second issue we will broach is the need to attend more carefully to the specific contents that are hyped by different agents. This essay assumes the proposition that some 'hype' exists in the field of genomics, and that this can in some ways and instances have undesirable consequences. With regard to science in general, it has been suggested, for example, that hype can lead to inter alia: expectations and a concomitant loss in public trust [5], the premature implementation of technologies and interventions [16], a harmful diversion of research resources [5, 17, 18], inaccurate perceptions of disease risk [19], and misinformed policy debates about the benefits and harms of a particular area of science. With regard to public health genomics particularly, the relatively low levels of involvement in genomics by public health officials outside maternal and child health programs [20, 21] and the relatively slow acquisition of genetic expertise by primary care doctors [22, 23] might be due in some part to feelings, rightly or not, that genetics is more hype than substance.

To be fair, the empirical data on many of these issues is far from robust and what is available is not always consistent with the hype-is-bad perspective. For example, recent research suggests that the public is not always taken in by hype [24, 25].

Most importantly, perhaps, several sources have indicated that hype is undoubtedly a natural part of the scientific process and can help to stimulate needed public and political interest [26]. Indeed, 'hype' has been described by Brown [14] as part of the process of projecting competing futures. In his words: 'anticipation is constitutive of value' (p. 17). On this view, our shared construction of social futures requires multiple parties to offer up possible futures, and not all of them will be right. Losers will, by historical hindsight, turn out to have been 'hype.' Losers, however, not only cannot be known in advance, but are necessary to the debate and discussion that constitute the robust and creative processes for constructing social futures.

There is an important consequence of this view that the articulations we identify as hype are part of the process of constructing social futures. On this view, it is not merely the question of whether genomics receives an appropriate *degree* of attention that is important, it is also what specifically about genomics receives attention that matters for the futures we are projecting. This means that while we will endorse calls for scale-backs in overly rosy predictions by all contributing parties (such as that offered by Nature Genetics [1]), the concerns raised by 'hype' are not resolved merely by attention to the degree of 'over' and 'under' statement. Instead, attentiveness to what precisely is being over- and understated is important. Therefore, as we describe different sources of hype,

we will also begin to draw attention to the forces that lead different contributors to the hype pipeline to hype specific views or dimensions of genomics.

The Academic Publication Process

Academic scientists are under considerable pressure to publish in top journals. And the top journals want to publish the most cutting-edge and groundbreaking work, as this raises the profile and prestige of the journal. It has been shown, however, that this combination has a tendency to result in the publication of research that exaggerates the conclusiveness and value of the results [27]. In other words, the current academic publication process contributes to hype. In fact, recent research has shown that pressure to publish, and the competitive nature of the academic environment, can lead to a publication bias against negative results [28]. Additional research has shown that scientists who perceive that media coverage has favorable outcomes for their work are, in fact, the persons who are most likely to appear in media coverage [29].

Others have suggested that the focus on publication as a measure of academic productivity encourages scientists to concentrate on publication strategies, including how best to position and represent research in a manner that is attractive to both top journals and the popular press, at the expense of creative and worthwhile scientific inquiry. As noted by Lawrence [30], 'Skilled career scientists are learning how to package up their work in parcels of the right size so that they can be fed first to the journals and then into the maws of the granting agencies' (p. 2).

This careerist motivational set may also tend to encourage hyping up older visions of genomics rather than shifting research trajectories in the face of accumulating findings. This tendency can be seen at work, for example, in the tensions elucidated in an editorial in the *American Journal of Respiratory Cell and Molecular Biology*. The editorial acknowledges that 'It is undeniable that our expanding knowledge has not significantly influenced patient care. So, while basic scientists revel in the "scientific revolution," clinicians question whether this "movement" is pure hype' [31]. In the face of this challenge, the journal affirms the criteria of clinical success on the grounds that 'it is a noble endeavor that brings even greater meaning to our careers.' But the problem of clinical failure is addressed not by suggestions of new trajectories for research, but rather by suggestions that what is needed is even more of the same. The essay lists the goals of increasing the journal's already high impact factor, seeking outside funding so more papers can be published, and using web-based supplements to 'manage resources better' so that more papers can be published. This is an agenda for hypeing what the research field is already doing. It is not an agenda for modifying the trajectory to better target public health. Public health here is not what is getting 'hyped' – it is not a focus of one's activities, but rather a penumbra providing a noble glow to activities that have more pressing and proximate career goals.

Our purpose in citing this example is to show how mundane forces exhibit themselves in evident ways in scientific publications, not to indict anyone or group of people for attending to the mundane components of careers. And some scientists have indeed precisely raised the difficult questions relating to changing research trajectories in the face of negative findings [32]. Our point is merely that such careerist factors almost inevitably influence what it is that researchers choose to hype – and therefore it requires attention by both internal and external agents to identify, challenge and correct for the necessary careerism of researchers. This example suggests the appropriateness of exploring the hypothesis that careerist forces may tend to lead researchers to hype what they have been doing (primarily because they have been doing it) rather than to make difficult changes to reorient toward the substantial new – and surprising – findings that genomics research has already bequeathed. As we indicated in the introduction, the social challenge related to hype is not merely to attend to whether something is getting adequate versus excessive attention, but rather to explore exactly what is being hyped, by whom, and why. Attention should be directed not merely to whether genomics is getting 'too much' or 'too positive' attention, but also what kinds of research trajectories in genomics are getting positive attention.

Commercialization and Translation Pressure

As the previous instance hints, over the past decade, there has been increasing pressure on academic researchers to portray their work in terms of economic and near-future clinical benefits [33]. Economic growth has emerged as one of the dominant justifications for the government funding of research. This reality was highlighted in President Obama's 2011 State of the Union address where he justified his plan to 'invest in biomedical research', among other technologies, not on the need to cure diseases or create knowledge, but on the basis of eco-

nomic competition and the potential to 'create countless new jobs' [34].

Commercialization pressures most obviously may result in hyped representations of genomic products by companies to consumers. The existence of such tendencies was indicated by a review by Gollust et al. [8], of advertisements for direct-to-consumer genetic tests. They concluded that '[t]hese advertisements downplay the uncertainties of genetic testing, obscure the phenotypic variability expected with positive results and distort disease risk information for the consumer. Advertisements draw on hyperbole to describe the utility of their genetic tests' (p. 1764). Company websites have also been found to be far from ideal [35]. In fact, some commentators have gone so far as to suggest that the '[m]arketers of genetic tests often openly or implicitly misrepresent the utility of genetic information' [36] (p. 459).

Commercialization pressures also may impact what researchers themselves say about their research programs and results. The idea that research needs to be tied to economic growth has led to a funding environment that encourages academic researchers to build specific kinds of relationships with the private sector. There can be, of course, benefits to this practice. For many areas of research, particularly in the sphere of biomedicine, industry is an essential partner and is often needed in order to obtain effective knowledge translation. However, substantial research has shown that funding from private sources can have an impact on research results. It can lead to an overemphasis on benefits and a deemphasis of negative results [37, 38].

In addition, commercialization pressure seems likely to intensify the tendency to report work in an overly optimistic manner. Research must be portrayed in a manner that makes it seem that it may result in a commercial product [39, 40]. In a world where biomedical research is expected to help build the economy, researchers and research institutions must position their work in a manner that makes this appear possible. This strongly encourages a degree of hype about benefits and overly optimistic guesses about the speed of clinical translation. To do otherwise may result in a loss of funding support to other researchers or to other areas of research.

Institutions and Their Press Releases

Another, more direct, way in which the institutions involved in research, such as universities, journals and funding entities, can play a role in creating hype is the institutional press release. These publicity tools, which are often issued by public relations offices, are used to garner news coverage in order to profile researchers and increase the public awareness of the institution (which can increase the prestige of a journal or institution or assist in the institution's fund raising efforts and help to highlight to those who provide funds, be they government or the private sector, progress toward translation or commercialization).

While journalists do not necessarily rely on press releases as the only source of information, the press release seems to both stimulate and shape news coverage. For example, there is some research that indicates that a large portion of news reports do not go beyond the information provided in the release [41]. In addition, press releases are associated with subsequent news coverage [42, 43], highlighting that they remain an effective promotional strategy.

However, emerging research also confirms the notion that press releases are a significant source of hype [44, 45]. Brechman et al. [46] did an analysis of the nature and impact of press releases in the context of news reports about cancer genetics. The results indicated that the press releases presented the research in a 'biologically deterministic and simplified manner' and that, as a result, 'the intermediary press release may serve as a source of distortion in the dissemination of science to the lay public' (p. 453). A study by Woloshin et al. [44] of a random sample of press releases from research universities came to a similar conclusion. They found press releases from academic centers 'frequently promoted preliminary research or inherently limited human studies without providing basic details or cautions needed to judge the meaning, relevance, or validity of the science' (p. 616). As a result, the authors conclude that press releases 'contribute to poor media coverage' (p. 617).

The particular locality and goals of an institutionally-generated press release indicate why news releases generate hype with these particular qualities within genomics as well as other sciences. Because most news releases are inherently designed to draw attention to institutional agents via reports of single studies or publications (rather than via trajectories of research), they will achieve substantial attractiveness only if they over-state the role of a single study or publication. Genomic science, however, generally moves forward not by single, nonreplicated, 'critical' experiments, but rather by series of research studies that build on each other, replicate each other and constrain the breadth of each other's conclusions. Therefore, any press release that focuses on a single study or a

small set of studies by a single research team in genomics necessarily 'hypes' that study – regardless of the release's particular wording or contents. Precisely because the progress of genomic science rests not in the single experimental study, but rather in the process by which multiple studies check and contour our understandings of the complex patterns of distribution, interaction and outcomes of suites of genes (in interaction with other elements), the press release that draws attention to a singular research result will, inevitably, 'hype' something disproportionately. The hype produced by such press releases therefore not only has the quality of excess optimism and inadequate sense of limits, costs or risks, it also contributes to a faulty impression of how genomic science works. It hypes the view of science as a set of isolated flashes-in-the-pan rather than as a slow process involving many agents. Of course, the characteristics of press releases are related to the characteristics of the media agents that the releases target as their immediate audience.

Media

Studies of print news coverage of genetics have shown that for some areas of biomedical research, the media is surprisingly accurate [47]. Still, a degree of hype and inaccuracies remain. Indeed, recent work by Brechman et al. [48] found that the distortion between the press release and the subsequent media report is, in general, greater than the distortion between original research article and the press release. There seems little doubt that the media remains an important component of the hype phenomenon.

In general, studies of the content in news articles have found that they include balancing material (that is, elements that provide a variety of perspectives), but they still tend to be slanted toward an optimistic view of medical genetics [14]. The particular qualities of this optimistic hype include a simplification that produces an emphasis on the strength of influence of genes on human characteristics and relatively little discussion of roadblocks, risks, and environmental and behavioral inputs [49–53]. Not surprisingly, the headlines for stories about genetic research are even more hyped than the news stories [54].

Different motivating factors account for particular elements of this content. The presence of balancing content is accounted for both by the economic advantages of including content that affirms the perspectives of multiple audiences (see below) and by journalistic norms that define objectivity in terms of the representation of 'both sides' of a controversy [55]. The positive slant can be accounted for by several journalism-specific factors. First, many science reporters have scientific backgrounds and are drawn to scientific reporting because of their appreciation of science. Second, science reporters must compete for space and attention with other news, in an industry where the motto is 'if it bleeds, it leads.' Research on the attitudes of editors (who select content for inclusion and exert influence on reporters' careers) indicates a pro-sensationalism bias [56]. This bias is further exacerbated by the tendency of journalism to use a personal, narrative format that includes ethical judgments: it 'relishes the personal, the particular and the subjective; it thrives on anecdote; it looks for simple, un-nuanced explanations, for judgments of right and wrong, safe or unsafe' [57]. There are many examples of the popular press taking this approach with science stories, highlighting personal stories of success and downplaying risks and limitations [58].

Media coverage is also influenced by a tendency of the journalist community to turn to a narrowly defined core of experts and to politicians as their primary sources of information for news coverage in general [59]. In addition to the issues raised above, experts in genetics have a vested interest in articulating support for genetics as an enterprise and may experience some peer pressure that dissuades them from offering strong critiques in the mass media of their colleagues' work. Politicians have been some of the biggest 'hypers' of genetics, so the use of politicians as a source further pushes coverage toward overly optimistic representations [53]. Presumably this is because politicians perceive public support for these kinds of hype.

The Public

Both scientists and critics of science are quick to portray the public as passive dupes of these media contents and processes. That model of a passive public was discarded by audience research decades ago [60, 61], and recent research continues to show that such models do not sufficiently account for audience responses to press contents, including those in the area of biotechnology [62]. Current press models indicate that the public plays a major role in determining the contents of both mass media and technological products [63]. Because news is substantially a consumer product, if there is a potential large audience that prefers a particular type of coverage (whether hype or condemnation), then there are likely to be news

media outlets that provide coverage with that slant. However, this also explains why much media is polysemic – prone to include some coverage of both sides of an issue. Coverage that gives voice to many potential audience's preferences is likely to attract the largest possible audience [64].

This model indicates that instead of the media stamping a view on an audience that is a blank slate, the media respond to audience preferences. Hence, if there is an audience for media contents that contain hopeful coverage of near-at-hand medical cures from genomics, then that type of coverage will prosper. Opinions of members of the general public about genetics have tended to be generally favorable with regard to medical applications and more mixed with regard to agricultural applications [65]. As sophisticated research by Bauer [66] has shown, these opinions are not a simple product of press coverage that favors medical applications and criticizes agricultural applications (though press exposure increases these tendencies through time, so that the press and the predisposed public may mutually contribute to a spiral through time).

There are a variety of motivating factors that predispose specific groups of people to prefer favorable coverage of medical genetics. Many people who have genetically-based predispositions for specific diseases in their family have been highly active in support groups, and some of these support groups have been active in promoting funding for research in genetics (see e.g. Genetic Alliance [67]). Other people are simply fans of science in general (and these people made up a substantial portion of the readership of science sections of traditional newspapers and popular science magazines). In general, people who are more highly educated tend to be more favorable toward science, and the more highly educated are more likely to be news readers, and this confluence is clearly visible with regard to biotechnology [68].

Of equal importance is a general consonance of worldview between some sectors of the public and what might be called a technological mindset or 'pill culture' [69]. This worldview assumes that most of the physical and even mental ills of life are avoidable and can be prevented or cured on a medical model that applies quick or simple 'fixes' (surgery or pills). Since this is what commercialized technology seeks to offer (including medical genetics), then there is a fit between the expectations of some substantial number of the public and the vision being offered by medical genetics [70]. This worldview creates a public-driven incentive for optimism or hype with the particular quality of emphasis on simple 'cures' for common diseases, rather than prevention or health maintenance. Indeed, in one interview-based study, members of the public who read headlines about genetics most often indicated an expectation that the article would talk about a 'cure' (though the headline did not mention a cure; unpublished data, analysis by Gooding and colleagues [24]). An interesting research project would be to compare the extent to which 'hype' in various venues is associated with a 'cure for common disease' content as opposed to being associated with contents that are less close fits for this public model (e.g. articles about mass screening or gene-environment interaction based articles).

The preference for the 'cure'-based perspective among some members of the public is evident when members of the public author their own opinions. On the worldwide web, where members of the public have the opportunity to generate their own content about medical genetics, a substantial set of that discourse fits our definition of hype (see e.g. Revolution Health Forums [71]). Although other participants articulate counter-views, the members of the public for whom a hype-like discourse about total, rapid cures is a good fit for their own views provides an audience for that kind of hype-like coverage from the news media. The convergence of the predispositions of the media toward optimistic hype coupled with an active section of the reading public who find 'the cure' perspective attractive has thus led to hype focused on optimism about this kind of future application of genomics as a visible component of some press coverage. As the news media have become less centralized with the decline of newspapers and the rise of the Internet, it may be that this convergence will change, but this remains to be seen. This is certainly an underresearched area.

Other Sources

Of course, there are other sources of hype. One worth considering is, simply, momentum. Fujimura [72] first described the concept of a scientific bandwagon – the commitment of a large number of people, laboratories, organizations, and funds to 1 particular approach to research – in 1988. Her analysis explored the development of a scientific bandwagon in the context of the molecular biology approach to cancer research. Recent commentators have suggested that the development of a bandwagon, which is likely facilitated by vested interests that benefit from the scientific concepts necessary to sustain the bandwagon, has also contributed to exaggerated claims of scientific significance in the context of genomics [73, 74]. A scientific bandwagon needs to be sustained. As

such, findings that do not accord with the bandwagon's implicit agenda, such as the value of genomic research to addressing disease, are deemphasized and results that support the agenda are emphasized. Some support for the possibility that such a bandwagon has been a historically significant factor in genomics hype is provided by the historical maintenance of high levels of optimism across the half century movement of genetics research from the vision of a simple 'central dogma' (gene→RNA→protein) focused on single gene disorders to complex family-based candidate-gene studies for hereditary cancer, to genome-wide association studies focused on the genomics of common complex diseases, to the present call for studies of unprecedented size in medical research. As each type of study failed to produce clinically useable results (especially on the 'cure' model), the new type of study was hailed as the 'promising approach' that will deliver the (commercially viable) medical goods from genetics/genomics.

Discussion

Given the numerous forces that contribute to hype, developing effective strategies that can counter such trends will be a challenge. This is particularly so given that the entities and individuals behind the exaggerated representations – such as the researchers, the research institutions, the media, and relevant private companies – all benefit from the hype, at least in the short term [75]. Also, for many of the forces, there may be no overt intent. Scientists do not, necessarily, intend to exaggerate claims of benefit. And research institutions and science journalists do not, necessarily, intend to misrepresent results. The pressures that create these distortions are systemic and often an understandable response to existing incentive structures, such as the pressure to publish and commercialize research. A further challenge relates to fragmentation of the news media [76]. With so many different avenues of dissemination – and, for that matter, so many diverse audiences – the opportunity to inform a broadly applicable communication policy has become more difficult.

Nevertheless, numerous commentators have provided suggestions on how to encourage a more balanced approach to science communication [6]. Example strategies include, inter alia: placing a greater emphasis on the publication of negative results, encouraging granting agencies and faculty evaluation committees to place less weight on journal impact factor as a way of measuring publication quality [30], insulating researchers from industry and commercialization pressures, the formation of independent science media organizations (e.g. Science Media Centre of Canada [77]), encouraging media to seek independent sources of information about implications of research results [48], educating science graduate students on the issues associated with science communication [6], and considering and utilizing the full breadth of communication media (e.g. museums, documentaries, blogs, movies, etc.) [78]. Continued education of the public to be savvy media consumers might also contribute to dampening the spiral. But, as we have suggested, this education needs to focus not merely on an attempt to calibrate 'the right level' of optimism and pessimism, but also attunement to the question of which particular contents are getting hyped and what that might mean with regard to our reasonable projection of hopeful futures. Scholars doing assessments of the media might also provide additional service to the field by shifting some of their attention from questions of 'degree' of hype to studies identifying the specific types of genomic contents that get hyped. From the perspective of the advancement of public health genomics, comparing such content patterns to priorities for public health genomics (such as those offered by Khoury et al. [79]) might be an interesting and fruitful place to begin such investigations.

This commentary is not the place to assess the effectiveness or desirability of these various suggestions, not only due to space constraints, but also because the literatures in these areas are not yet robust. Nonetheless, it is worth noting that each approach addresses a different source of hype. They are aimed not at the entire hype pipeline, but at particular actors and outputs in the pipeline. Given the complex nature and multiple causes of the phenomenon, it is likely that many of these strategies will need to be utilized in concert. A comprehensive science communication strategy is required. This strategy does not need to be 'anti-science.' Maintaining support for science does not require that science claim inflated pay-offs; a recent survey found that most support the government funding of science, 76% of participants in a British survey supported the statement that 'even if it brings no immediate benefits, research which advances knowledge should be funded by the Government' [80]. In the US, 85% of respondents supported government funding of basic research [81]. With regard to genetics particularly, support for personal health-based applications has been strong in both North America and Europe [65].

This broad and general support for science per se may point to the opportunity to consider changes in underly-

ing incentives. To the degree that hype is an inevitable outcome of the ways in which research is both funded (i.e. via lobbying politicians, competitive grants and the private sector) and disseminated (i.e. via a profit motivated news media), decreasing hype would seem to require changing those structures. For example, to what degree should academic researchers be asked to view themselves as part of an engine of economic growth? At the least, one might consider the development of more robust countervailing incentives.

It is true that, eventually, the scientific process – such as the practice of replication and confirmatory studies – will usually correct hype; a more complete and balanced view of the benefits, risks and limits of a particular area of research usually surfaces. Indeed, hints of this corrective process can be seen in the area of genetics [17, 74]. However, there seems little doubt that some degrees and foci of hype delay this correction and create inefficiencies that make the correction more difficult. As we noted in the introduction, hype is not without consequences. At the very least, it misallocates resources to inappropriate projects and creates a model of the future that may be not only unattainable, but undesirable. In the long run, then, too much hype focused on the wrong dimensions of genomics can't be a good thing – not for researchers or for the public who fund and hope to benefit from research results.

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