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# Can genetics help us rethink communication? Public communication of science as a 'double helix'

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ABSTRACT *Public communication of science is still largely conceptualized within a 'transfer' paradigm that describes it as a displacement of results and ideas from the specialists to the lay public, problematizing the public, the media, (sometimes) science, but very rarely the notion of communication itself. This paper is a preliminary attempt to see if the discourse about genes and the genome can help us to problematize the concept of communication in relation to science, rethink our models of public communication of science and, more generally, the metaphors we employ to describe communication. It is suggested that the relationship between science and the public could be understood better by viewing communication through metaphors drawn from contemporary biology, e.g. as 'cross-talk' between the specialist and public discourse or as a 'double helix' coupling the two dimensions under certain conditions.*

## Introduction

*Information is not knowledge*

*Knowledge is not wisdom*

*Wisdom is not truth*

*Truth is not beauty*

*Beauty is not love*

(F. Zappa, "The Packard Goose")

Scientists and policy makers complain routinely about the difficulty in getting the message of science across to the public. Public hostility to applications of scientific research—like, for instance, those in the field of biotechnology—is attributed to scarce receptivity on the part of the public and to the inadequacy of mass media in channelling the information provided by the scientific community. Despite several initiatives, investments and research, scarce evidence is available of the impact of public communication of science on public opinion and attitudes, let alone behaviours. Indeed, recent studies, particularly on public perception of biotechnology, actually show that substantial exposure to science

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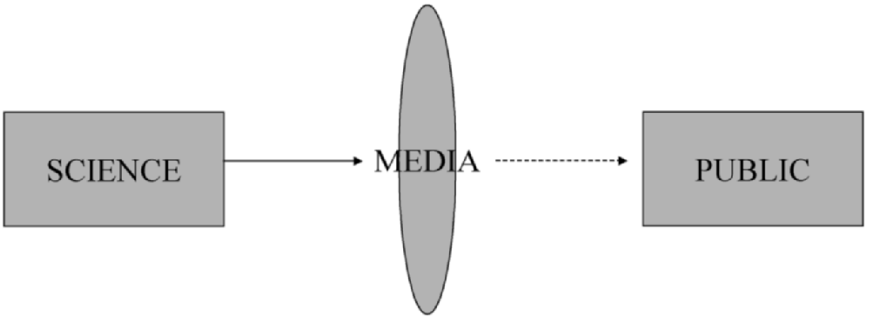


FIGURE 1. The transfer model of public communication of science.

communication does not reduce significantly the likelihood of being hostile to certain biotechnology applications, or at least that lack of information cannot be used as the only explanation for public scepticism (Gaskell & Bauer, 2001; Bucchi & Neresini, 2002).

It is very interesting that when discussing public communication of science, the public is often problematized, the media are often problematized, science is sometimes problematized (e.g. see Wynne, 1995; Michael, 2002), but communication itself, as a concept, is rarely problematized.

This paper is a preliminary attempt to see if the discourse about genes and the genome can help us to problematize our concept of communication in relation to science, rethink our models of public communication of science and, more generally, the metaphors we employ to describe communication.

## The 'transfer' paradigm

For at least sixty years the transfer model (Fig. 1) has been the dominant paradigm for describing communication—for scholars, practitioners and lay persons—as a process concerned with the transfer of knowledge from one subject or group of subjects to another subject or group of subjects. The widespread and unquestioned use of keywords, such as 'reception', 'flow', 'distortions' and 'target' when discussing communication, is in itself indicative of the power and pervasiveness of this 'transfer' metaphor. Within this paradigm, 'successful' communication is defined as the achieved transfer of information from one party to another; for instance, a public communication initiative in the area of genetics could be considered successful if one fraction of the knowledge available on this topic to the scientific community is acquired by a certain target public.

It is also interesting to notice that depending on the type of communication under examination, such successful transfer can be hoped for—as is the case of public communication of science—or regarded with apprehension—this is often the case in the area of political communication, where many actors may, indeed,

be worried that the transfer of ideas from one political faction to citizens actually takes place.

There are, of course, a number of implicit assumptions at the basis of such a paradigm. One assumption concerns the possibility of transferring knowledge without significant alteration from one context to another, so that we can simply take an idea from the scientific community and bring it to the general public. A second assumption is that the same knowledge in different contexts will result in the same attitudes and, eventually, in the same type of behaviour.

To explain how it has been possible for such assumptions—and, more generally, for the paradigm of communication as transfer—to prosper despite the scarce availability of empirical data and substantial research supporting it, is a matter for a rich and still largely unexplored study in the sociology of knowledge. It can be hypothesized, however, that this specific paradigm has been sustained by historical contingencies—e.g. the advent of mass media being almost simultaneous with the emergence in certain parts of Europe of totalitarian regimes relying heavily on propagandistic communication—as well as by its intuitive appeal, its simple quasi-physical structure: we are all familiar with the popular image that communication is sent through like a 'magic bullet' (for an overview, see DeFleur & Ball-Rokeach, 1989).

## Criticisms of the transfer paradigm and sociological models of science communication

Beginning in the 1950s, a great number of studies in the area of communication—in particular, mass communication—have challenged some of the core elements of the transfer paradigm. Studies have shown, among other things, that different types of filters can contribute to make the transfer a selective process. Filters include selective perception of media messages, previous motivations and attitudes of the audiences, communication intermediaries, such as opinion leaders.

In particular, in the area of science communication, several empirical and theoretical contributions have addressed the transfer paradigm critically during the past two decades. A necessarily selective list of the aspects which have been pointed out includes:

- the non-linearity of the communication process; science communication need not necessarily spring from specialized contexts but can originate also in popular, non-specialized arenas (Lewenstein, 1995a, 1995b; Bucchi, 1996, 1998);
- the reception of science communication is not a passive process but a complex set of active transformative processes which can, in turn, impact on the core scientific debate itself (Wynne, 1989, 1995; Epstein, 1996);
- specialist exposition of science theories and results (i.e. the source of 'transfer' in the traditional paradigm) cannot be separated sharply from popular exposition (the target of 'transfer') despite the fact that distinctions

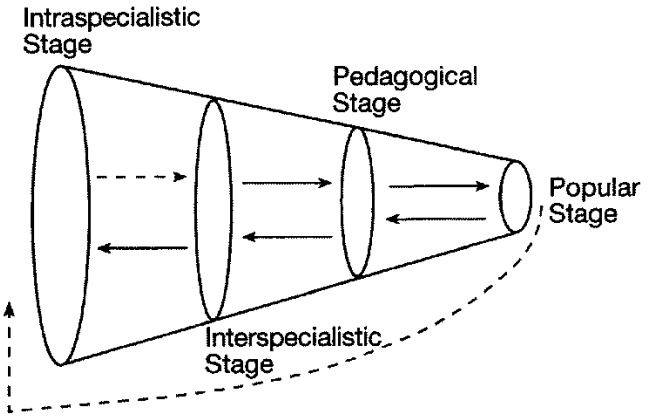


FIGURE 2. A model of science communication as a continuum.

between the two forms of exposition are often used by scientific actors as a rhetorical strategy (Hilgartner, 1990);

- the science communication process can be represented better as a continuous sequence of expository levels, gradually shifting one into another with differences in degree and not in kind, mutually influencing one another (Cloître & Shinn, 1985; Hilgartner, 1990; Lewenstein, 1995a; Bucchi, 1996, 1998).

One possible way of portraying this continuity is sketched in Figure 2. This more refined and certainly more 'sociological model' represents science communication as a *continuum* with several stages—the main four being the intraspecialistic stage, the interspecialistic stage, the pedagogical stage and the popular stage (Cloître & Shinn, 1985; Bucchi, 1996, 1998)—allowing for a more complex interaction between different levels as well as for feedback from the popular level to the 'above' levels.

The *continuum* is funnel-shaped to emphasize a property that several scholars attribute to the process, namely that the more one scientific result distances itself from the core specialist context ('the research front') and precipitates towards the public level, the more it becomes stylized, stabilized, apodictic and unquestionable (Whitley, 1985; Collins, 1987; Latour, 1987). At the popular level, doubts and disclaimers disappear: the distinctions and nuances of specialist knowledge condense into elementary and compact formulas: AIDS is HIV, psychoanalysis studies 'complexes', the neurological theory that hypothesizes a division of tasks between the two hemispheres of the brain is transformed into a sharp antithesis between 'right-dominated' and 'left-dominated' people. The communicative path from specialist to popular exposition removes subtleties and shades of meaning from the knowledge that passes through the funnel, reducing it to simple, certain and incontrovertible 'facts'.

Despite the several innovative elements that this model undoubtedly introduces, it largely remains within the limits of the transfer paradigm at least in two

senses. First, the whole process is still about transferring knowledge from one science communication level to another. The main difference lies in the model allowing the possibility that, during the transfer, knowledge becomes transformed; it does not assume that a scientific result can simply be 'transported' from one level to another. However, it is interesting to notice that the direction of the transformation is largely pre-established, with the touchstone of the transformation firmly remaining located at the specialized level. Eventually, what the continuity model describes seems to be a more complicated transfer process.

## The 'discourse of gene action': a case of public misunderstanding?

The proposal here is to try and see if we can use the case of genetics and genomics to step out of the 'transfer' paradigm of science communication in a more substantial fashion, and eventually to find a different metaphor to think about the very process of communication. To do this, I will consider for the sake of simplicity the two extreme levels of science communication as described by the continuity model, namely the specialist level and the public level. As several studies have illustrated in great detail, an analysis of these two discursive levels in relation to genetics reveal a sharp disjunction between them: while at the specialist level functional genomics is adding novel layers of complexity to the concept and role of gene, to the point that historians can go as far as to ask "what is gene talk for?"(Keller, 2000, pp. 67, 137), at the public level we are still largely witnessing an overwhelming success of genetic determinism, for instance in contexts such as the media or judicial courts (Nelkin & Lindee, 1995). This disjunction is exemplified vividly by frictions arising among actors operating at different levels, such as in the reported case of pressures by an officer of the US Department of Justice on a scientist to withdraw from publication a paper highlighting the limits and uncertainties of DNA fingerprinting tests (Roberts, 1991).

Obviously the transfer approach has a handy explanation for this disjunction: the different status of gene research and concepts at the specialist and at the public level is a result of imperfect transfer of specialist ideas and results, i.e. what is often referred to as 'public misunderstanding' or as 'deficit model' (Jordan [2000] gives an example of this approach with reference to genetics and genomics.) Left to itself, public discourse lags behind the specialist one just like a primitive culture yet to be civilized: past scientific notions, now superseded with the transition to genomics, float like wreckages at the public level (for a critical analysis of this view of science in public in terms of 'cultural lag' see Cooter & Pumfrey [1994]). Put more time, resources and efforts in communicating gene research to the public and, eventually, the gap will be covered: public discourse about genetics will match the specialist one. The 'continuity' variant will have an exactly opposite explanation; the distance between the two levels is exactly due to the fact that the transfer has worked: sliding through the funnel, specialist discourse has been dried and reduced to its intuitive and

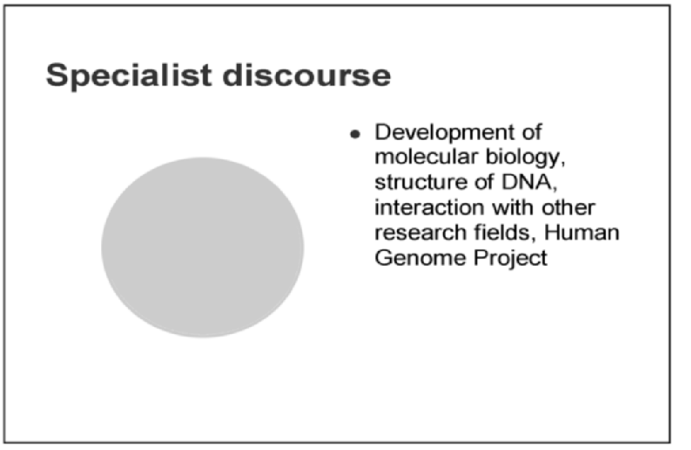


FIGURE 3. Specialist discourse about genetics.

apodictic core, namely, genetic determinism and the "discourse of gene action" (Keller, 1995, 2000).

However, there are several indications that public discourse about genetics has not arisen as a filtered or trickled down version of specialist discourse. In his study of genetics in popular culture, for instance, Jon Turney has shown that key achievements in terms of research agenda, including Watson and Crick's discovery of DNA structure, did not receive immediate attention by the general media; on the other hand, popular ideas on the transformation of species and modification of man had a much longer history (Turney, 1998) as documented, for example, by the famous claim by French novelist Emile Zola—thirty years before the rediscovery of Mendel's laws of heredity—that "heredity has its laws, just like gravitation" (Zola, 1871; cf. also Lewontin, 1996).

So, is another explanation of the above-described disjunction possible? Let us for a moment put aside the transfer metaphor with all its burden of assumptions and stereotypes of the public. Specialist and public dimensions can, thus, be considered not as layers of the same discourse, but as two different types of discourse which are developing in parallel (Figs 3, 4).

Specialist discourse about genetics is characterized, for example, by the development of molecular biology, the discovery of the structure of DNA, the interaction with other research fields such as physics or the information sciences, the Human Genome Project and the emergence of genomics (Keller, 1995, 2000). Within public discourse, we can observe, for example, on a long-term perspective the development of discourses about heredity, identity and difference, ideas of the transformation of species and man, shift of emphasis from community to the family and the individual; centralization of nature as the primary focus for understanding the development and management of life (Glasner, 1998). It seems quite reductive to assume that such ideas and concepts active within public discourse necessarily derive from either imperfect

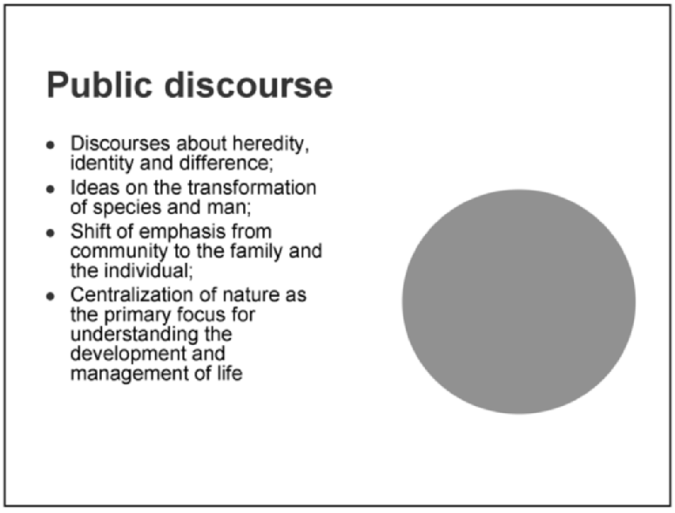


FIGURE 4. Public discourse about genetics.

or achieved transfer of ideas and concepts from specialist discourse. As has been mentioned, the study of public discourses about biology in the nineteenth and twentieth centuries offer several indications that such discourses were not simply an impoverished or diminished simulacrum of specialist discourses. If we take, for example, another case often cited as an example of miscommunication between scientists and the public—cloning—it can be documented easily that popular ideas about cloning individuals are much older than scientific research and techniques for cloning (Schwartz, 1996; Turney, 1998). In 1987, a singer submitted to Italy's most famous singing contest a song about cloning. After some discussion, the selection committee decided to accept the song, arguing that the term could reasonably be considered accessible to a large audience. On the other hand, a significant advance in human cloning announced by a team of scientists in 1993 received hardly any echo among the public; a few years later, the announcement of Dolly made a huge public impact by connecting to a debate which had developed over issues such as embryos, *in vitro* fertilization and abortion (Neresini, 2000).

## Public communication of science: from transfer to 'cross-talk'

An analysis that grants public discourse about science its own features and 'dignity'—without necessarily seeing it as a more or less opaque reflection of specialist discourse, as in the transfer approach—takes us probably not too far from what Ludwik Fleck, in presenting his theory of how a scientific fact results from the continuous exchanges between different "styles of thought", called "proto-ideas". These are blurred concepts circulating within public discourse that can be systematized eventually by specialist discourse. His detailed study of

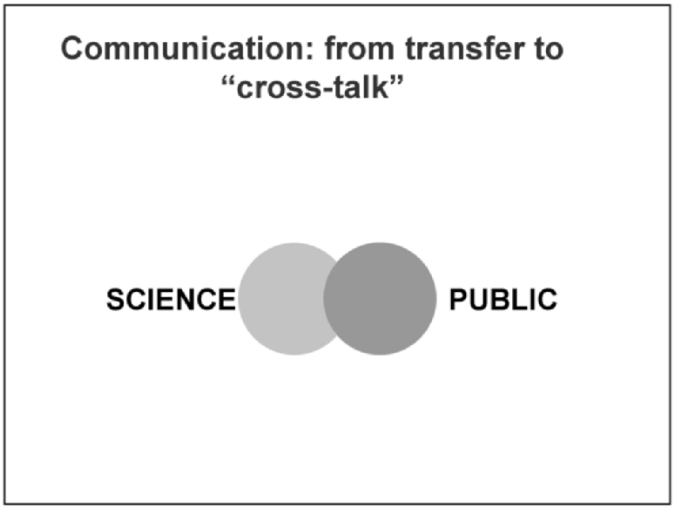


FIGURE 5. Public communication of science as cross-talk.

the tortuous history of the concept of syphilis, for example, revealed that "a hazy idea of syphilitic changes in the blood and shown that this idea existed centuries before scientific proof was available" (Fleck, 1935, English translation, 1979, p. 23).

The history of science is rich in other examples in this regard: to name one, the fact that infection in a mild form prevents a more serious attack of contagious diseases was known among farmers well before Pasteur began to struggle to persuade his colleagues that vaccination could be used to protect cattle from threats such as anthrax (Darmon, 1986; Bucchi, 1997).

Thus, one way to describe public communication of science that tries to avoid the mechanical strictures of the transfer paradigm could be to consider the possibility that ideas circulating within public discourse and within specialist discourse can, under certain conditions, 'cross-talk'.[1]

## What is gene talk for? The 'double helix' of science communication

We can now go back to Keller's question about what use can we make of the concept of the gene, largely superseded in its deterministic vision within specialist contexts, while so powerfully and straightforwardly employed in public discourse. What is gene talk for then? Within a model of public communication of science as 'cross-talk' (Fig. 5), it seems plausible to interpret the role of the gene in terms of notions familiar to sociologists of science. One such notion is that of boundary object. Boundary objects are

> both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. [...] They

> have different meanings in different social worlds but their structure is common enough to make them recognizable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds (Star & Griesemer, 1989, p. 393).

In local interaction situations, boundary objects may coincide with the concrete objects used and exchanged by different categories of actors: for example, in an institution like a science museum there may be files, specimens, paper forms or entire libraries which enable co-operation among different practitioners. In the communicative situations that concern us here, they may be thought of as the pivotal discursive elements that lie at the core of intersection between specialist and public discourse (Jacobi uses the expression 'termes-pivot' for those linguistic elements that are common both to specialist and to popular discourse—Jacobi & Schiele [1988]). Boundary objects make communication possible without necessarily requiring consensus, for an object may be interpreted and used in quite different ways within different types of discourse. 'Gene' could, thus, be seen as a boundary object, a label employed in both specialist and public contexts and thereby providing a common language, although translated in different ways in a laboratory conversation and in a car advertisement.[2]

Another notion which can be employed fruitfully here to clarify the meaning attributed to communication and the specific role played by concepts, such as gene, in the case of public communication of genetics, is that of 'trading zone'. A trading zone consists of objects shared between two cultures or subcultures "that carry radically different significance for donors and recipients" (Galison, 1999, p. 146). Just as the experimental and theoretical physicists studied by Galison could collaborate by exchanging experimental predictions with experimental results while diverging in the interpretation and perceived epistemic status of such objects, so the specialists and the public could communicate by sharing a trading zone, such as 'gene', despite their radically different use of it (Fig. 6). They did, however, 'communicate' in a quite different sense than that attributed to communication by the transfer paradigm. Research results and ideas were not plainly transferred from one context to another.

Without sharing boundary objects/trading zones such as gene, no interaction between the two types of discourse would have been possible. Perhaps, ironically, a decision like that of approving huge public investment to pursue the mapping of the genome—one of the key steps leading to supersede the same notion of a deterministic gene among the specialists—was made possible by the discourse on gene providing a common space of interaction.

A model of science communication as cross-talk implies seeing communication not simply as a *cause*—for instance, of changes in opinions and attitudes among the public, due to the transfer of certain results or ideas—but also as the *result* of developments in both discourses allowing the formation of an intersection zone. It is, of course, reasonable to hypothesize that once formed, this intersection would facilitate exchanges across different discourses, reinforcing

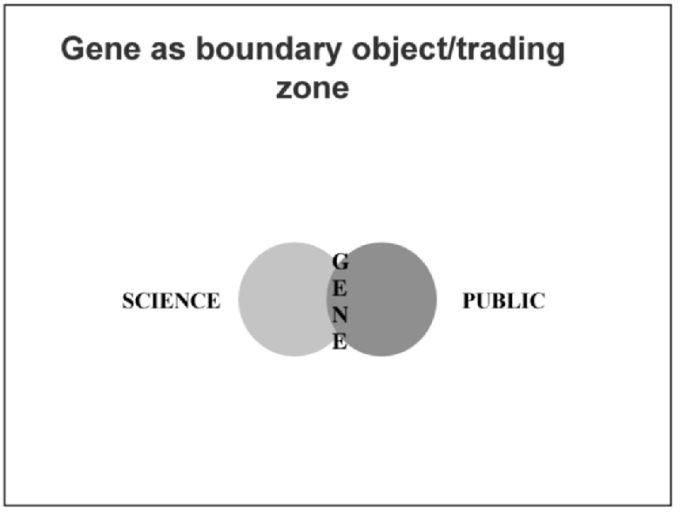


FIGURE 6. The concept of gene as boundary object/trading zone for genetics communication.

itself in a recursive fashion. Another advantage of the proposed model could, thus, be seen in its recapturing a view of communication as a *process*— which sustains (and has to be sustained by) actors' interaction—rather than as a taken-for-granted point of departure.[3] Actually, if we need another form of visualization to replace that of transfer, we could, indeed, take the biological metaphor one step further, representing interactions between specialist and public discourse as 'double helix'—one strand representing the specialist discourse, the other strand representing public discourse—with intersection be-

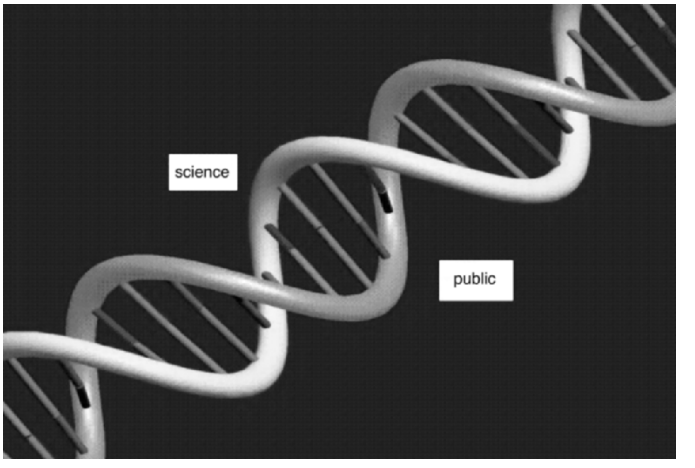


FIGURE 7. The 'double helix' of public communication of science.

tween strands taking place only at certain junctions rather than there being a transfer process (Fig.7).

If we apply this metaphor to the case of genetics, our surprise and disappointment for how imperfectly results, such as the discovery of DNA structure or the mapping of the human genome, have been channelled to the public may well disappear, replaced by an appreciation and wonder for how richly have such achievements intersected with popular discourses about heredity and identity. Just to clarify that the applicability of this model is not limited to the case of genetics, I will mention two other examples briefly. The first is the case of discourses on AIDS. Looking at communication in the AIDS case from the point of view of the double helix/cross-talk model means analysing the evolution of specialist discourse on themes such as retroviruses, the changes taking place in the public dimension in ideas about sexuality, morality and sin—particularly in American culture—and their powerful resonation and interaction at some point, which turned AIDS into one of the most publicly visible science issues in history (Grmek, 1989; Epstein, 1996). A second, perhaps less famous but no less instructive, case concerns the Big Bang model as an explanation of the origin of the universe. In the 1950s and early 1960s, when consensus on the Big Bang was still far from being reached within the scientific community, the public domain played an evident role in establishing it as the leading explanation in cosmology (McConnell, 1998). The idea of a "singularity", an instant creation burst, was far more appealing to common sense than any other model, such as Hoyle's steady-state theory. It was also reconciled more easily with religious beliefs. In 1951, Pope Pius XII proclaimed the Big Bang hypothesis in perfect accordance with the Christian idea of religious creation. Since then, the Big Bang model has settled as *the* explanation of the origin of the universe for the general public, despite doubts and distinctions expressed at different stages among specialists (Bucchi, 2000). As a boundary object, 'Big Bang' connects different discourses flexibly, being employed with quite different meanings by specialists and non-specialists; it may evoke a number of models addressing the problem of the origin of the universe to cosmologists, a single explanation to scientists not directly involved in this research area, a benevolent act of creation to lay readers. The inadequacy of the transfer model in describing a case such as Big Bang is also signalled by other elements. The very label of this boundary object, for example, originated in the public domain;[4] astronomer Fred Hoyle used it for the first time in 1950 during his BBC radio programme *The Nature of the Universe*, originally intended to ridicule the idea that the universe could originate from a primordial explosion—Hoyle being one of the scientists proposing an alternative explanation known as the 'steady-state' theory. Nevertheless, 'Big Bang' became the standard term to identify this model of the universe's origin and expansion, and met with increasing success in the following years.[5] The weakness of the transfer model here is also revealed by communication turning against the intentions of the supposed source of the transfer, namely, the scientist. The broader and more articulated meaning of communication implied in this case was emblematically restated decades later by the huge public success

of Steven Hawking's book, *A Brief History of Time*. Many commentators, including several scientists, were astonished by how many people bought the book and how few actually read it: a clear case of communication without transfer![6]

## Implications for public communication of science practice

Some, in particular science communication practitioners, could, perhaps, be tempted to draw, from the above discussion, the impression that public communication of science is a difficult, desperate or flatly impossible endeavour. I should emphasize that this impression is justified only if we keep the transfer paradigm as a term of reference. The 'double helix' model of public communication of science preliminary sketched here aims at describing communication—and science communication in particular—as a broader and, at the same time, more fragile phenomenon. Communication cannot be taken as a straightforward datum, but is, instead, the result of a complex and self-reinforcing process. Compared with the routine displacement of knowledge postulated by the transfer paradigm, this process is rarer but more articulated and richer in consequences. In a certain sense, it could be said that communication is not the rule but the exception in the relationships between science discourse and public discourse, with the two discourses routinely revolving each one within its own boundaries and only exceptionally short circuiting, cross-talking one with another. Alternation between the phases of 'apparent communication between science and the public' and 'actual communication between science and the public' (i.e. cross-talk) could be seen in analogy to the distinction introduced by Kuhn (1962) between normal science and revolutionary science—with the interesting hint offered by several cases, although still largely to be explored, that intense cross-talk between the public and the specialist discourses can be, to some extent, associated with revolutionary drifts in science (see Biezunski (1985) and Bucchi (1996, 1998) for some preliminary remarks).

Still, the model is not devoid of implications for science communication practice. One implication is that it is quite difficult for a single actor or category of actors to control the communication process. Communication as it is understood here requires the concurrence of several conditions; such conditions do not include only some of the factors traditionally analysed by science communication studies—e.g. the communicative strategies employed or the visibility of scientific actors and institutions undertaking them. A model of science communication as a double helix emphasizes the importance for a science communicator to map thoroughly the configurations of such conditions; it also emphasizes the importance of paying attention to conditions traditionally neglected within the transfer paradigm, namely the fine structure of public discourses directly or indirectly related to science issues.

It may certainly be objected that a model of communication as a double helix does not provide the science communicator with instructions as simple and appealing as those offered by the transfer paradigm; no easy 'switch'—to borrow

another term from new genetics research—to press (e.g. "more communication!", "focus the target!" "clarify the message!") in order to produce the desired outcome among the public. This could, on the one hand, contribute to explain the long-lasting popularity of the transfer paradigm, especially among actors directly involved in the field of science communication with the public. On the other hand, however, viewing science communication as a double helix does not only appear more suitable to understand it without cultivating expectations that can be disappointed easily. Through a notion of communication as cross-talk, the importance of paying attention to the mutual encounter and shaping of both public and specialist discourse is also underlined. This eventually makes the process of public communication of science—and thereby the activities in which science communication practitioners are routinely engaged—more relevant, not only as a means to achieve certain objectives but as a central space to understand (and participate in) the interacting transformations of both science and public discourse.

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## Notes

1. Here, I am deliberately borrowing a term which is employed frequently in genomics with regard to processes such as signal transduction pathways.
2. In this sense, boundary objects are not so different from what the actor-network theory identifies as 'obligatory passage points' in the translating of interests and enrolling supporters for a scientific claim (Latour, 1987), or what Moscovici locates at the heart of a social representation (its 'zero degree', see Moscovici, 1961).
3. An analogy may be traced here with Barnes' analysis of the relation between traditional accounts of agency and responsibility with the accounts emerging from genetics and genomics (Barnes, 2002). As the discourse of responsibility and choice makes it possible for individuals to align and regulate their conducts mutually, so the discourse on genes makes interaction possible between different discourse arenas and categories of actors.
4. Interestingly, a similar public shaping of the boundary concept connecting various discourses also took place in the AIDS case, as the acronym initially used to denote the disease—GRID (Gay Related Immunodeficiency Disease)—had to be discarded after protests by gay organizations (Grmek, 1989).
5. "Hoyle's idea of a static universe never caught on with the public. His name for it, the steady state universe, may have been too mundane. In any event, the 'big bang' stuck, with Hoyle opposing the very notion of it from the day he dreamed it up" (Boslough, 1992, p. 39).
6. See, for example, *The Daily Telegraph*, 27 February, 1992. It is interesting to notice that

Hawking was also often identified with Big Bang theory in the public domain (see Bucchi, 2000).

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