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Science and Society: To Indicate, to Motivate or to Persuade?

Clélia Maria Nascimento-Schulze

Throughout the 20th century, social psychologists have been concerned with the structural context of persuasive messages and they have studied the phenomenon of persuasion largely using the experimental method (e.g. Hovland et al., 1953). More recently, however, in parallel with the paradigmatic changes in the world of science, they have highlighted the importance of examining persuasion by means of narratives, focusing on the power of language and rhetoric (Billig, 1989). This has empowered a concentration on communicative events, socially shared thoughts, social representations and reciprocity of actors in dialogues.

Considering that the transmission of an understanding of science to the public has become a central issue in general education, it is reasonable to ask whether they should receive information about scientific news and discoveries obliquely, by indication, in one way or other, or by being directly informed, or whether members of various communities should be invited to participate in programs of science diffusion. These are relevant questions if we consider that many citizens in developing countries are still excluded from the language of science and have no access to science, new technologies and the virtual world.

The subject of persuasion connects with many topics studied by social psychologists, such as communication, social influence, convergence and deviance, compliance with group norms, attitude change and propaganda. Despite these relations with other social psychological topics, persuasion has been studied largely in association with attitude change, while the study of social influence and communication has been neglected. I would suggest that the study of communication in highly complex societies is worthy of further visits to the subject of persuasion, not only in order to understand subtle strategies of control and domination, but above all to guide the pursuit of general policies concerned with education and the provision of information to citizens in modern societies.

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During and after the Second World War, social psychologists were mobilized by the topic of propaganda and persuasion, partly driven by the need to comprehend the Holocaust and to answer the question of how a society as culturally advanced as Germany could create conditions that permitted open discrimination, segregation and the final extermination of millions of lives to occur. In addition, social psychology as a practical science investigated the effect of propaganda on American soldiers during and after the Second World War, and their motivations for enrolling in the army (Hovland et al., 1953; Hovland, 1954).

Scholars like Lewin, Lasswell and Hovland were concerned to explain and describe the conditions under which persuasion took place and why the persuasive message succeeds or fails in its designated purpose. The outcomes of experimental studies have allowed social psychologists to arrive at a set of variables describing the occurrence of persuasion and to look for universal laws explaining its impact. They searched to answer the question: *Who says what, to whom, and with what effect*?

Although this approach may contribute to the visualization and unveiling of the variables involved in a persuasive situation, the conclusions of these studies should be taken as provisional. Communicative settings in which persuasive messages take place are multifaceted and messages can be presented in an infinite variety of ways, and they are certainly more complex than those studied during the Second World War.

In this article we focus on some central elements that characterize more complex contemporary societies, and which must be taken into consideration as the background to any discussion of the role of persuasion in the context of public participation in programs of science popularization. Specifically, we discuss:

- changes that have occurred in the general public's experience and perception of time
- current attitudes towards science
- and the fact that our present-day societies are permanently connected by the network of information technologies.

Since the end of the 19th century, innovations in transport and communication have radically altered the established relationships between time and space. As suggested by Adam (1992), considering that contemporary technologies emphasize a plurality of time, the actual changes that have occurred in the perception of time should be made more explicit. Technological artifacts facilitate the introduction of new concepts in our daily lives such as 'networks', 'feedback', 'non-causal connections', 'instantaneity' and 'simultaneity'. It appears that at present the public is experiencing a certain disenchantment with science and scientific endeavors, particularly those concerned with the effect of science on the domain of nature and the impact of its technological discoveries. As Beck (1992) reminds us, science is being conceived simultaneously as one of the causes, as an instrument of analysis, and as the source of solutions for the risks that pervade modern life. Thus one of the characteristics of this stage of modernity is the individual and institutional awareness regarding risks and the need for reflexion in relation to science and its limitations. Another factor that distinguishes our present world and makes it different from other historical periods, including the post-Second World War era, is the revolution in the technolo-

gies of information. This revolution began in the last century and continues to remodel the material basis of our societies at a vertiginous speed. In addition, the economies of the entire world have adopted a model of global interdependence. Such global changes bring important phenomena into the social scenario. These include the redefinition of relationships between men and women, the environmental awareness now present at all societal levels, and a tendency for ethnic, religious and political communities to re-group themselves around primary identities. These issues all have implications for discussions in social theory regarding the human mind, social actors and cultural systems and their autonomies. In other words, as put forward by Castells, what needs to be taken into account is the existence of an *active audience*, in which the receptor is active in the interpretation of messages and codes, and of an *interactive society*, represented by virtual communities, which organize themselves around common interests and goals. Concerning the place of science in contemporary societies, it has also become apparent that science has undergone a metamorphosis. Stengers and Prigogine recognize that 'to know' has been identified with 'to know how to manipulate'. Instead, the authors argue, the sciences should involve a dialogue between the science producers and society (Stengers and Prigogine, 1997).

Science, technology and society

Within such a wide framework of structural change, we find that various groups of scientists and educators have become concerned with the scientific education of populations. In fact it is argued that citizens should be more and more prepared to face global change, and that an educated population in a democratic society could contribute positively to the formation of scientific policy. Thus, the teaching of science and technology is seen as being central to modern industrial societies. It is assumed that knowledge will help citizens form a deeper understanding of their circumstances, and that society can provide them with autonomy in the use and choice of new technologies in their daily lives (Kumar and Chubin, 2000).

Looking specifically at the Brazilian reality, Moreira and Massarani have pointed out that since the 19th century there have been various attempts to call the public's attention to science (Massarani et al., 2002). Such initiatives have involved conferences and publications and, later, radio and television programs. However, it was only towards the end of the 20th century that the science museums began to grow in number and popularity. It is important to mention that since then, and particularly so at present, a society and forum for all Brazilian scientists, the SBPC (Sociedade Brasileira para o Progresso da Ciência), has been taking important steps in the organization of a program for the popularization of science in Brazil.

Since 2001, when the Ministry of Science and Technology proposed an open forum to debate the issue, the government has become directly involved with increasing the scientific knowledge of its population. A document called *O Livro Verde* (the Green Book) was published as a synthesis of discussions and proposals made by several regional and national commissions, which included members of the civil society and the government (see Silva and Mello, 2001). These commissions

have been concerned with the role of scientific knowledge and innovation as accelerators of the economic development of the country. The Green Book has inspired future public policies on science and technology and stressed the importance of helping the present students and future generations to master the current scientific and technological advances, aiming to develop a scientific culture. Particular emphasis has been placed on the transmission of scientific understanding to the general public in order that scientific education might extend beyond the classroom into the realm of leisure and other activities. Furthermore, educators dedicated to the analysis of Brazilian children's performance levels in tests and measurement of their mathematical and scientific skills concluded that Brazil needed to invest more resources in the scientific and technological development of its citizens, in order to maintain its cultural identity and to survive in the globalized world (Ivanissevich, 2003).

Scientific literacy

Those concerned with science, technology and society often refer to Jon Miller and his longitudinal work on scientific literacy in the United States. He points out that citizens of modern industrial societies live in the age of science and technology and that most adults live surrounded by a wide array of technologies unknown to their parents' generation. Furthermore, children of the next generation will live in a culture that is significantly more scientific and technological than the previous one. Consequently, in the future our societies will value, more than they do now, a scientifically literate population capable of absorbing the challenges of a technically sophisticated market, not only as consumers but also as practitioners of a highly specialized technology. In addition, a scientific literacy with respect to environmental topics could be of great importance for the future of the planet. Recently, a program of research was devised and developed in the south of Brazil, in the state of Santa Catarina, for the purpose of diagnosing this problem and to thereby provide data about the scientific literacy of the students and their attitudes at secondary-school level to the scientific issues considered relevant to modern societies in general, and to Santa Catarina specifically.

A translated version of a test developed by R. C. Laugksch and P. E. Spargo was used with secondary students from Florianópolis and Criciúma, in the south of Brazil. This test, called the 'Test of Basic Scientific Literacy' (Laugksch and Spargo, 1996), had been developed by its two South African authors on the foundations of more complex instruments originally devised by the American Association for the Advancement of Science. It is a scale of scientific literacy, inspired by the three dimensions suggested by Miller (1983): the nature of science, cognitive knowledge of science, and the impact of science and technology on society. It was found that among 754 students who had provided answers to this version of the Test of Basic Scientific Literacy, only 36.5% could be considered scientifically literate (Nascimento-Schulze, 2006). The results have also shown that students from private schools obtained a better index of scientific literacy (69%) in comparison to students from public schools (29.3%). These results could be taken to indicate that formal edu-

cation programs should pay special attention to the teaching of sciences, but they also suggest a need for implementing informal ways to complement the curriculum through different sorts of initiatives, such as travelling exhibitions, updating existing themes in school-science exhibitions, and the inclusion of scientific activities within leisure programs. Another initiative consisted of consulting science teachers about themes to be included in programs of informal education for science (Santos et al., 2005). Their choices coincided with the themes which were, and still are, sources of inspiration for exhibitions in science centers and science museums in Europe, such as environmental issues, new discoveries in genetics, and recent discoveries about the universe. On this basis, a set of research projects was implemented that was mainly concerned with social studies of science.

Contribution of social psychology to the popularization of science

Social theory makes a relevant contribution to the discussion concerning the popularization of science. In the specific case of social psychology, the value of its contribution seems to be concerned with psychosocial conditions, under which the diffusion of scientific content takes place. A series of studies conducted in Santa Catarina examined the impact of scientific exhibitions on public representations, and employed several types of presentation media to do so.

Three versions of traveling exhibitions, known as 'Environmental Paradigms' and related to environmental issues, were devised to inform the general public, and secondary school students in particular, about scientific facts related to the discovery of DNA, the planet's water sources, and the manipulation and cultivation of transgenic crops. The media presentations consisted of a set of graphs based on the environmental problems of the region, images of unspoiled local landscapes captured by well-known local photographers, and films and documentaries related to these same issues. All of these media stimulated group discussions. In addition a website, specially devised for students and other visitors, offered relevant information in addition to a series of related links, such as the DNA page organized by *Nature* magazine. The DNA page was dedicated to the 50th anniversary of the discovery of DNA in 2003, the UN Millennium Goals' page was dedicated to sustainable development, and the United Nations Development Programme (UNDP) site addressed the problem of sustainability and water management contributing to the UN International Year of Freshwater in 2003. These touring exhibitions provided the settings for socio-psychological research, exploring their impact on social-representation formations and visitor attitudes.

A brief summary of the results highlights the following outcomes. The DNA exhibition, introducing new concepts and promoting a more integrated and systemic view of the environment, seemed to have influenced visitors' representations (Mezzomo and Nascimento-Schulze, 2004; Santos et al., 2005). Visitors' attitudes, after they had viewed the exhibition on the planet's resources, were detected as having changed from a naturalistic to a more globalized representation (Carboni, 2005). The introduction of music to the exhibition was seen as facilitating the reception of messages (Nunes, 2005). Despite the volume of information that had already

appeared in the media over the years, studies tracking the popularization of scientific knowledge in relation to the use of transgenic crops showed that citizens were poorly informed about the current state of affairs and the measures already adopted with respect to the planting of transgenic crops and the commercialization of food based on such crops. However, a specific examination of the effect of scientific exhibits on social representations of transgenics has shown the emergence of new elements in the cognitive structure of visitors' representations, indicating that scientific exhibits can be an effective source of information. Finally, a study based on the same stimulus material (photographs, film and site) as the two first exhibitions examined the influence of the different media on the representations of the environment. Participants were asked to evaluate their preferences from among the three media. It was found that the interactive site proved to be the favorite, and the most efficient of the media for informing subjects about environmental issues (Martinelli, 2006).

If we compare more traditional survey studies of scientific literacy with those above that were based on social representations, we find the following. The former entail the idea of students' knowledge deficits, whereas the latter seek to unveil knowledge about particular issues as shared by the group. Both approaches can contribute to the discussion of 'scientific citizenship' because both sets of results suggest steps that educators responsible for formal education in the sciences can take. However, the results based on social representations can identify different lay theories and may point to factors that could make the task of science popularization difficult, e.g. resistance to change. Social representations of scientific themes cover a variety of aspects, from the shared representations of different groups concerning a particular object or phenomenon to the means of scientific communication itself. It could even involve the acceptance or rejection of the scientific content being communicated. Moscovici (1993) points out that during the process of science diffusion concepts acquire a certain autonomy. For him, those who popularize science, and its mediators in general, are participating in the formation of social representations in relation to scientific issues. New discoveries and scientific ideas must be named and classified by the different social groups before they can be related to already known theories, giving rise to social representations. If new ideas are too far from the already known objects and too unfamiliar to the people involved, they might be rejected or ignored. Thus, the initiatives taken towards the popularization of science demand from the mediator the appropriation and transformation of the new scientific ideas in a way that allows them to be adopted by the public sphere.

When communities are exposed to new discoveries or scientific theories that threaten their view of reality or their identity, their reactions may take the form of absolute denial. Or, alternatively, they may oppose them with different phenomena or ideas. Moreover, during the process of transmission of scientific knowledge to the public, the mediator attempts to make the content more familiar to the receivers. Two processes are involved: on the one hand, unknown ideas are anchored in the universe of familiar concepts; and second the newly acquired knowledge is objectified and turned into a concrete-seeming object in the world of familiar objects. As a result, these new concepts can be interpreted and addressed through a common language and can also be compared to other familiar objects. Schiele, analyzing the

phenomenon of the popularization of science in museums and science centers, concludes that although the implicit intention of the science popularizers is to raise the level of information among the public as much as it is to promote the sharing of scientific knowledge, this task cannot be fully accomplished because of educational and other inequalities among the members of the public (Schiele and Koster, 2000; Schiele, 2001a; 2001b). He considers that the scientific exhibit contributes more to the reorganization of existing social representations of members of the public regarding a particular scientific issue than to a real transformation of cognitive processes. In fact, some of the results of the above-mentioned studies confirmed Schiele's claims when visitors, having just viewed a scientific exhibition, display peripheral changes in the structural elements of their social representations (Mezzomo and Nascimento-Schulze, 2004; Allain and Nascimento-Schulze, 2006).

The theory of social representations and its research results can be considered in this context of science popularization as a type of 'social technology'. It is able to contribute to the designing of strategies for science popularization programs which aim to predict the impact of a particular scientific content upon the daily practices of members of a community and at clarifying the functions of such representations in relation to such practices. Furthermore, the research on social representations within a science popularization context can bring a positive contribution, mediating the debate among the different trends in science education. It could, for example, rehabilitate the theories of common sense, bringing them closer to the approach of modern science in such a way as to harmonize science and society. The contribution of the social representations approach could also be instrumental in the development of touring exhibitions for local communities, empowering and giving voice to their members while they are interviewed on the very issues that inspire the exhibits. Such interest in the public's ideas seems to be compatible with Bradburne's (2000) analysis of tracing routes to new strategies for science museums in this century. He emphasizes the importance of creating informal environments for the public, encouraging citizens from all backgrounds to participate in informal learning settings within the science centers. In addition, he makes explicit the 'bottom-up' approach in which the public is seen as not only sufficiently competent to receive knowledge but also to generate and suggest information and new approaches.

Popular education programs in the sciences are nowadays seen as a priority in most democratic societies. In Brazil touring exhibitions seem to be a workable option for complementing formal institutional initiatives. Identifying the social representations of members of local communities in advance of the arrival of a touring exhibition could be instrumental in articulating ideas shared by the communities and determining policies to be implemented on a national and global scale, by the likes of the World Health Organization or UNESCO.

Global and local policies for science popularization

Within such a context it seems that bringing together local and global policies in the construction of scientific education programs is a good way to think about the popularization of science. This approach can involve the use of computers in touring

exhibitions so that participants are brought into the digital world, or making use of arts and science orientated materials and methods, and also by varying the levels of knowledge associated with scientific content. The touring exhibition could be seen as a prototype medium for the popularization of scientific information, and a setting to which a broad spectrum of the public could respond. Here they would, with equal ease, consult the internet or focus on the specially devised sites for each particular theme. This particular kind of setting would minimize any existing social, racial, sex-linked and age-related inequalities among the public. As Castells (2002) remarks, in Latin America 90% of internet users come from groups with higher incomes. Exclusion from, or inequalities in access to, information technologies and the lack of operational knowledge in the use of computers all contribute an impediment to the status of scientific citizenship. Digital exclusion prevents citizens from gaining knowledge of new scientific policies and discoveries and bars them from communicating with other virtual communities.

Internet sites often bring together art and science, both as a creative and an informative medium. For example, we could again refer to the site created by *Nature*, in 2003, to commemorate the 50th anniversary of the discovery of DNA. Citizens worldwide could access information about the discovery and the history of events related to the double helix, which was treated as the *Mona Lisa of modern science.* Images featured on the site have brought the public closer to scientific discoveries and debates. In addition, the visual stimulus of modern art as a source of rich images in relation to the topic further motivates learning. From this point, one can imagine creating new associations between scientific discoveries and motivating members of the public to search for further information, as well as applying newly acquired knowledge to their daily practices.

Knowledge in the design of touring exhibitions can be articulated at several levels:

1. the *personal knowledge* of visitors who interact with the communicative skills of the designer and the personal knowledge of the community representative;
2. the *local knowledge* of members of social groups and communities, representing the shared resources of local community thinking, and
3. scientific *global knowledge* conveyed and organized by specialists.

In order to promote communication among these three levels of knowledge, the organizer has to consult community leaders and bring their contributions to the exhibit. In addition, he/she must understand the shared social representations of the relevant groups and harmonize them with the different dimensions of scientific knowledge.

If we consider persuasion to be the art of winning over the minds of others, we can suggest that it is inappropriate to adopt the policy of persuading the public. Being mindful of the nature of contemporary democratic societies, it seems more appropriate to think about the installation of an open forum in matters of scientific knowledge and technology that would enable citizens to have their say in such matters. The touring exhibition could be one of the instruments to contribute to the success of the open forum. One example of such an articulation was the touring exhibition that covered the development and diffusion of transgenic plants in Brazil

and the rest of the world. It took place in Florianópolis in 2005 during Science and Technology week. The public was informed not only about the scientific procedures for creating transgenic crops but also about the various and opposing political standpoints on the issue. It included information about the precautionary principle and the steps to be taken by the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST). The Commission clarifies the precautionary principle and considers that science cannot be expected to offer the one and only version of the truth regarding environmental issues. Society must play its part in taking decisions on such matters. A Commission document suggests that alternative sources of wisdom, such as local knowledge, folk wisdom and the like, should be taken into account alongside the more scientific knowledge.

The contributions offered by social scientists, and specifically by social psychologists, seem to be valuable at the stage where social sciences are called on to offer pragmatic contributions to the popularization of science. Taking into account the structural changes to society which have occurred in the last few decades, as well as the accompanying narrative changes in social theory, we may notice yet more changes to come. They concern the status attributed to human beings in the context of the popularization of science; while previously they were seen as responsive subjects, they are now regarded as actors and agents in their social contexts. To coin a metaphor, social reality in democratic societies could be taken as a joint musical improvisation in which different lifestyles and versions of reality come together and play their part. It cannot be expected that the public will accept new scientific discoveries immediately and without question. Rather, we must assume that in the process of science diffusion the public will resist some new scientific ideas, and that such ideas will create cognitive inconsistencies between the public viewpoint and the scientific content. It is important that the popularizer should hold two issues in mind. He/she should motivate the public to consider arguments, policies or programs seen as important by global and local institutions. And, again, he or she must be clear about how these policies and programs will contribute to the personal and collective growth of the citizenry. Keeping good principles such as these to the fore would counteract manipulation and persuasion, even if the art of argumentation is seen as being significant to the process.

Clélia Maria Nascimento-Schulze
Universidade Federal de Santa Catarina

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