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fMRI in the public eye

Eric Racine
The Stanford Center for Biomedical Ethics, 701 Welch Road, Building A, Suite 1105, Palo Alto, California 94304-5748, USA.

Ofek Bar-Ilan
The Stanford Center for Biomedical Ethics, 701 Welch Road, Building A, Suite 1105, Palo Alto, California 94304-5748, USA.; The Dominican University of California, 50 Acacia Avenue, San Rafael, California 94901, USA.

Judy Illes
The Stanford Center for Biomedical Ethics, 701 Welch Road, Building A, Suite 1105, Palo Alto, California 94304-5748, USA.; the Department of Radiology, Stanford University School of Medicine, 300 Pasteur Drive, Stanford, California 94305-5105, USA.

Abstract

The wide dissemination and expanding applications of functional MRI have not escaped the attention of the media or discussion in the wider public arena. From the bench to the bedside, this technology has introduced substantial ethical challenges. Are the boundaries of what it can and cannot achieve being communicated to the public? Are its limitations understood? And given the complexities that are inherent to neuroscience, are current avenues for communication adequate?

Functional neuroimaging techniques, such as functional MRI (fMRI) and positron emission tomography (PET), have evolved as key research approaches to studying both disease processes and the basic physiology of cognitive phenomena in contemporary neuroscience. In the clinical domain, they carry hope for guiding neurosurgical mapping, monitoring drug development and providing new approaches to disease diagnosis and management at early, possibly even presymptomatic stages. However, issues relating to these capabilities, such as technical readiness and the possibility of disease screening in advance of effective therapeutic intervention, raise substantial ethical challenges for investigators, health care providers and patients alike. In basic neuroscience, increasing numbers of non-health-related fMRI studies that touch on our personal values and beliefs have also forced us to expand our ethical perspectives[1].The wide dissemination of this research, growing applications of the technology and continuously improving resolution have not escaped the attention of the neuroscience and neuroethics communities, the media or the broader public[2-6]. However, are the boundaries of what this technology can and cannot achieve being effectively communicated to the public? Are its limitations understood? Are the applications of the technology viewed as useful and meaningful? Are some studies more conducive to misinterpretation than others? What are the associated risks to society? From a scientific perspective, important methodological and technical assumptions guide fMRI research. However, from the public's point of view, once research results are publicized, especially when they concern personality, self-identity and other social constructs, they are bound to interact with lay conceptions of these phenomena.

To understand this complex interaction between neuroscience and society, we focused on the coverage of fMRI — as one model of frontier neurotechnology — in the print press. We

Correspondence to J.I. e-mail: illes@stanford.edu.

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investigated how both neuroscience and the media shape the social understanding of fundamental aspects of our reality and how this, in turn, points to issues of scientific communication and public involvement in neuroscience. To this end, we frame our arguments according to three trends that we have observed in press coverage of fMRI — 'neuro-realism', 'neuro-essentialism' and 'neuro-policy'— and explore how neuroethics can attend to the related ethical, legal and social issues by promoting multidirectional communication in neuroscience.

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The increasing investigation of cognitive and social phenomena using fMRI[1] represents a relatively new venture for neuroscience. Neuroscientists who pursue such research hope for new insights into behaviour, culture and personality. However, they face new challenges in trying to convey this knowledge meaningfully to the public. Journalists, from their purview, must report these results in an adapted communication style that differs from scientific communication and adheres to a separate set of standards[7].This creates a context in which the wider significance of research results and efforts for public out-reach intermingle with the reporting of neuroscientific findings.

To understand this context specifically in relation to neuroimaging, and to launch a discussion of these issues, we carried out a press content analysis[8] of samples of print media coverage of fMRI. Using this method, we were able to capture salient messages about the research as they are conveyed to readers. We did not study content from the point of view of scientific accuracy, but rather as a phenomenon of communication that could affect public perceptions. In this respect, the dynamics of news production, including the original interaction between journalists and scientists, are not directly addressed, but this information is also unavailable to readers.

We conducted a key-word search on fMRI using the LexisNexis Academic database of General News (major newspapers), General News (magazines and journals), Medical News (medical and health news), University News and Legal News. We retrieved 132 non-redundant articles for our sample, returned from a search beginning in January 1991 and ending in June 2004 (FIG. 1). Seventy-nine articles were from general sources such as *The New York Times* and the *Washington Post*, and 53 were from specialized sources such as *Pain & Central Nervous System Week* and *New Scientist*.After an initial pilot of a coding scheme and testing for reproducibility, two of us (E.R. and O.B.-I.) coded the articles for tone, presence of ethical issues and type of research reported. Further methodological details are available as online supplementary information.

Among our findings, we observed that press coverage of fMRI featured adults (84%) and, to a lesser extent, school-aged children and adolescents (14%), and infants (2%). It largely provided no explanation of the capabilities and limitations of fMRI (67%). The coverage had a mostly optimistic tone (79%), compared with 16% that was considered balanced and 5% that was critical. Scientific issues, such as validity, were raised more frequently (18%) than ethical issues, such as confidentiality (7%). The ethical issues were found in general source articles only.

We found descriptions of clinical research in 35% of the articles, of non-clinical research (in particular, studies of higher- order cognition and emotions) in 44% and both in 20%. We also found discussion of clinical benefits (for example, early or improved diagnosis, therapy and monitoring of health interventions such as drug effects and neurosurgery) in 65% of the articles, but non-clinical benefits (such as technical improvements of fMRI, non-health related early childhood interventions and improved techniques for lie detection) in only 17%.

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To put these findings in perspective, we draw on three concepts that we have termed neuro-realism, neuro-essentialism and neuro-policy, and use examples from the articles themselves for illustration. The interaction of these concepts, which encompasses lay perceptions of reality, subjectivity and policy making, combined with both hope and leaps of faith about the meaning of the data across the lifespan, contribute to public appreciation of the benefits and risks of functional neuroimaging. These interactions undoubtedly also influence the evolution of the science itself, as researchers are not isolated from wider social and cultural beliefs about the brain.

Neuro-realism

Our concept of 'neuro-realism' describes how coverage of fMRI investigations can make a phenomenon uncritically real, objective or effective in the eyes of the public. This occurs most notably when qualifications about results are not brought to the reader's attention. For example, commenting on an fMRI study of fear, one article[9] states,"Now scientists say the feeling is not only real, but they can show what happens in the brain to cause it." Many occurrences of neuro-realism deal with the effectiveness of health-related procedures such as acupuncture. For example,"Patients have long reported that acupuncture helps relieve their pain, but scientists don't know why. Could it be an illusion? Now brain imaging technology has indicated that the perception of pain relief is accurate."[10] Another headline: "A relatively new form of brain imaging provides visual proof that acupuncture alleviates pain."[11] Furthermore, because fMRI investigation shows activation in reward centres when subjects ingest high-fat foods, one reads,"Fat really does bring pleasure."[12] So, neuro-realism reflects the uncritical way in which an fMRI investigation can be taken as validation or invalidation of our ordinary view of the world. Neuro-realism is, therefore, grounded in the belief that fMRI enables us to capture a 'visual proof ' of brain activity, despite the enormous complexities of data acquisition and image processing.

Neuro-essentialism

The concept of 'neuro-essentialism' reflects how fMRI research can be depicted as equating subjectivity and personal identity to the brain. In this sense, the brain is used implicitly as a shortcut for more global concepts such as the person, the individual or the self. This is the case in many expressions where the brain is used as a grammatical subject. Headline examples of this phenomenon are: "Brain can banish unwanted memories"[13],"How brain stores languages"[14] and "'Brain stores perceptions into small meaningful chunks"[15].

Other statements imply that fMRI is scrutinizing our minds. For example,"The better fMRI systems become, and the more adept scientists get at extracting information from them, the more they will be able to piece together the neural circuits that make us who we are,"[16] and "The brain can't lie: brain scans reveal how you think and feel and even how you might behave. No wonder the CIA and big businesses are interested." Other claims insinuate that individual differences can be reduced to brain differences[17] — "Odds are that gambling addict's brain is built differently" — or that neuroscience provides ultimate explanations[18] — "How it all starts inside your brain."Although studies of the mind and brain are a cornerstone of cognitive neuro-science, neuro-essentialism represents a hasty reduction of identity to the brain.

Neuro-policy

'Neuro-policy' describes attempts to use fMRI results to promote political and personal agendas, as in the case of interest groups that uphold the investigation of social problems using fMRI. For example, the Lighted Candle Society, a Utah-based non-profit organization that is dedicated to the enhancement of moral values, advocates the use of fMRI to prove that pornography is addictive[19]. Another example of neuro-policy has been reported by a

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neuroscientist who has received queries from "both sides of the current California debate on bilingual education."[20]

These examples represent press coverage that shows how neuroscience is extending to new areas of social concern and, accordingly, how neuroscientists are being tapped for advice in policy development. Undoubtedly, an element of neuro-policy can imply neuro-realism and neuro-essentialism, as the regulatory appeal of neuroscience might be increased by the beliefs that brain research shows reality and that the brain is the core of our identity.

Neuro-policy also creates practical challenges for the neuroscientist. What happens when neuroimagers receive calls from journalists to explain their (or others') provocative findings? How can the early state of certain findings be communicated, especially before peer review? What is the proper reaction to 'social demand' for brain findings? Brain-machine neuroengineering research has shown that military demand for neuroscience research can certainly be controversial[21-24]. These are some of the challenges faced by neuroscientists when participating in research efforts that are framed in terms of real-world policy.

Leaps of faith

Some of the interest in fMRI stems from the hope for and pursuit of a deeper understanding of fundamental human phenomena such as emotion and cognition. However, as we have seen, the way in which some results are presented in the media can be loaded, and whether portrayal of the results is entirely consistent with the intentions of interviewed scientists is an open question. Often we find staggering leaps. Although these can inadvertently lead to 'neurofallacies', as is shown by previous examples, we still find them in the headlines of widely read newspapers such as *The New York Times*, *The Financial Times* or the *Washington Post* and in magazines such as *Newsweek*.It is not a leap of faith to believe that headlines such as "fMRI knows your secrets"[25] can have a powerful impact on readers.

The debate about the influence of the written press on public perception of science is still wide open. Some argue that this influence is considerable[26] whereas others believe that it is more moderate[27,28].To take a closer look specifically at neuroscientific research in the press, a survey on public neuroscience literacy conducted on more than 2,000 people in Rio de Janeiro showed that newspaper reading is associated with both positive and negative effects on neuroscience literacy[29]. In an analysis of lobotomy coverage in the popular press, Diffenbach *et al.* provided evidence that initial optimistic news coverage might have been a factor in the rapid and widespread adoption of this psychiatric treatment[30].At the very least, therefore, print journalism provides some source of information for public discourse.

Press content analysis also indicates ways in which public representations of neuro-science could inform controversial uses of neurotechnology[31]. Consider, for example, the possibility of marketing neuroimaging and other brain products directly to consumers for clinical or non-clinical uses[32].This is likely to increase if consumers believe in fMRI's power to reveal 'the reality' or 'our essence'.

Others have shown that the reporting of what we could call 'critical-period mythology' can narrow childcare and nurturing to certain aspects of brain development, largely leaving out the importance of nutrition or ongoing plasticity[33]. Flawed understanding and leaps of faith can conspire to reinforce parents' searches for new types of child-rearing approaches or interventions, however unscientific those interventions might be[20].At stake are both the meaning of parenthood and the well-being of the child. One newspaper article critically highlights this phenomenon as follows:"The results of experiments, undeniably exciting but nonetheless limited and preliminary, are being used by non-experts to inform everything from the style of a mother's nurturing to the organization of day-care centers to public policy on

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child rearing, with precious little scientific data to support ambitious, even aggressive leaps into future education policy. In some cases, neuroscience is being used to usurp the common sense of mothering."[20] Also on this theme, the medicalization of attention deficit hyperactivity disorder (ADHD) might also have been reinforced by press coverage of related neuroimaging findings[34].Although the debate about appropriate intervention strategies remains fierce[35,36],media emphasis has focused first on the biological and genetic causes of the disorder, and second on environmental and cultural causes[34].

In a final example of the public adoption of new scientific knowledge for practical benefit, we draw on coverage of pharmaceutical developments that have 'smart drug'[37] potential. As for fMRI, depending on how the benefits and risks of these products are framed in the press, and the extent to which personal identity and social context are involved, it is not unreasonable to expect keen interest in the competitive neurocognitive edge that such products might engender. An entrepreneurial response to those interests is equally predictable and is now being realized[38].

Genomics and biotechnology

To the best of our knowledge, this is the first consideration of fMRI press coverage. It is of interest, therefore, to bring other perspectives to this discussion. The framing of genomics and biotechnology has been studied extensively in the past and also raises many ethical and social issues.

Among our observations about fMRI coverage in the popular and specialized press, we noted an overwhelming optimism for the technology. This finding is consistent with a genomics study in which 91% of 749 genomics articles were rated as entirely positive in tone[39],with optimistic reporting of other genomics and biotechnology advances[26,39-42], and with commentaries such as: "Media coverage as a whole is predominantly positive in tone, contrary to some industry claims, and emphasizes benefits and economic trade-offs rather than ethical issues, public awareness questions or the sufficiency of available information to fully predict outcomes."[43] Accompanying the general sense of optimism about genomics, studies in the popular press have also considered ethical issues, which were found in about 40% of articles[26,39,44,45]. By contrast, in our review of press coverage of fMRI (general sources only, as these are directly comparable to the genomics studies), ethical issues such as confidentiality and human nature were discussed in only 11% of the articles. In a commentary on studies that used brain scans to inform marketing strategies, for example, *The Guardian* reported: "... that using brain scans to predict behaviour is a long way off, the progress is such that we should think about the implications ... It raises serious philosophical questions, because it reduces us to a machine, but there's also a huge moral issue: who should be allowed to access our brain scans, if they can reveal so much about us?"[16] However, scientific challenges, such as interpretation, limitations of fMRI or its validity, were about twice as prevalent, appearing in 23% of the general source articles. For example, "Modern cognitive scientists have thoroughly discounted 'bumpology', and they no longer discuss faculties such as 'marvelousness'. But they have divided the mind into equally suspect categories ... it is probably impossible to dissect cognition into mental modules ... imaging studies that purport to find localization of mental abilities in the brain suffer from a number of flaws that invalidate such discoveries."[46] (TABLES 1 AND 2).

Issues such as commercialization, discrimination and fear of unregulated and unbridled research are often associated with genomics in the press[39,47]. Concerns for the transformation of human nature in the reports of controversial neuromarketing studies[2] resemble concerns of hubris in genetic manipulation of humans. We would expect traditional ethical norms and issues to cross over from genomics to neuroscience, but many genomics-related issues are absent from fMRI reporting. Issues relating to fMRI seem to be more tightly linked to scientific

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concerns, and the content of the limited ethical discussion is only loosely constrained by traditional ethical categories. This might be due to the early state of neuroethical discussions, to the fact that fMRI presents new issues, or to both of these. Nonetheless, even as genomics and neuroscience increasingly cross-fertilize, they will always have different histories. In terms of public concern, eugenics and discrimination have a considerable impact on the public framing of genomics[47].

Implications for neuroscience

The unhappy legacy[48] of psychosurgery can serve as a dramatic reminder of the responsibilities of researchers when their results are presented in the press:"Indeed, perhaps a cautionary lesson can be learned from the history of lobotomy. The hallmark of scientific discovery is objective and controlled experiments with replication that creates a dynamic process evolving through time. However ... this does not occur in a vacuum. For example, medical research is propelled in part by public desperation."[30] When the expectations of the public collide with scientific standards, it can lead to news reporting that uncritically reports benefits and understates risks. Greater attention needs to be paid to the interface between neuroscience and society, of which the press is one conduit."As policymakers, the courts, and the public become aware of imaging techniques and become intrigued by this window on the living brain, researchers must avoid inadvertently fueling misconceptions about the power and promise of neuroimaging. This task is complicated by media accounts that portray brain imaging technology as the functional equivalent of a polygraph, a Rorshach test, or a Ouiji board."[49]

The scope of the issues raised by fMRI will be at least as far-reaching as those of genomics[50].We might even face them sooner. It is therefore necessary to promote global and proactive analysis of fMRI. Reflecting on an editorial reaction in the *Lancet Neurology*[51] to an article published in *The Economist* on the ethics of neuroscience[52], Fins wrote[53]:"It is the promotion of responsible and scientifically-informed debate which accurately depicts the risks and benefits of new interventions and the emerging regulatory framework with stringent protection of human beings. If the media errs in its depiction of the complexities of emerging neurotechnologies, civic discourse about its meaning will be impoverished."

Although it might seem surprising, we found that general news sources presented more critical discussions of fMRI studies than did specialized scientific and medical sources. The absence of ethical issues in the sample from the specialized press indicates that there is much work to be done in launching discussions within the research community. It further underscores the need for increased participation of the neuroscience community in sustained public dialogue efforts and for intensification of collaborations between neuroscientists and bioethicists. A 1998 *Nature Neuroscience* editorial about the relationship between neuroscientists and emerging public concerns that neuroscience could threaten human values[6] concluded that neuroscientists "should recognize that their work may be construed as having deep and possibly disturbing implications, and that if they do not discuss these implications, others will do so on their behalf."

This is a particularly important observation given that cognitive neuroscience is increasingly integrating social science domains traditionally not involved in neuroscience[54,55],and nonneuroscientists are directly summoned by studies dealing, for example, with consumer preferences, emotions or decision-making. Accordingly, intensified collaborations between neuroscientists and social scientists are taking place. In this exciting but complex context, specific educational challenges need to be addressed. For example, understanding interests and limitations in the integration of levels of analysis is a primary concern. It will be necessary to provide neuroscientists with more background on the epistemological challenges of studying social phenomena to ensure the validity of their research and to promote qualified, responsible

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and sensitive interpretation of the results[50].So, an educated media and general public are important aims, but a more broadly-educated scientific community is also an emerging endeavour.

Multidirectional relationships

If we use the proactive approach that is inherent to neuroethics as a constructive starting point for advancing better communication, exchanges between neuroscientists and the lay public will be promoted not only to increase public understanding of neuroscience, but also to heighten neuroscientists'awareness of issues of public concern[56]. In this sense, continued one-way communication, where neuroscientists rely on traditional media sources to disseminate results[7], is limited (FIG. 2) and, as a model for the transfer of knowledge to the public and for public input to neuroscience, has significant inadequacies.

The complexity of the issues at stake and the potential benefits afforded by open debate invite a more elaborate, multidirectional communication scheme (FIG. 3). Such a scheme recognizes both that science is part of culture and that societies are increasingly multicultural[57]. The distinction between expert and lay conceptions becomes a continuum, in which each interacts with the other. Given calls for increased public dialogue, sustained relationships with the media and growing interdisciplinary dialogue with colleagues in the humanities and social science are also needed. This scheme will also enable public advocacy for neuroscience (see the Society for Neuroscience Guide to Public Advocacy), and will firmly situate science communication within a robust framework.

Two-way and multi-way communication has been advocated in ethical discussions of genetics and genomics[58-61].Regulatory agencies are now promoting public consultation and meaningful dialogue. The International Bioethics Committee of UNESCO (Article 6) promotes the expression of different viewpoints. A Canadian genetic research network has published innovative guidelines requiring that research on a given population be based on dialogue between the population and the research team (see Quebec Network of Applied Genetic Medicine). These recommendations, albeit from a different research domain, express fresh thinking on the relationships between science and society and point towards new challenges to, and ways of, communicating neuroimaging science in a democratic framework. Indeed, open debate is a central tenet of both science and democracy[62] because both are based on critical thinking and freedom of expression. New forms of public debate such as citizen's conferences have been used successfully by the Danish Board of Technology and are now a worldwide phenomenon[63]. Public and community events that showcase neuroscience, such as fairs, museum exhibits and educational forums (see online links for an example), represent other ways in which neuroscientists and the public can meet in a dynamic fashion[64].

In an effort to improve public outreach, pressures on journalists must also be put in context[65]. As part of any democracy, the media strives to serve the immediate interests of the population but finds itself in a paradoxical relationship with its audience. In addition to the increasing demand for speed that has been made possible by technologies such as electronic filing, the media also,"tries to give readers and viewers what they want;... it feels responsible for telling them what they should know even when that information is neither easy to assimilate nor popular. And as newspaper and broadcast conglomerates have become publicly owned financial operations responsive to escalating shareholder expectations, the tendency has been to compete for the audience's attention by providing the news that is easiest to assimilate."[65]

Given this broader context, relationships between journalists and scientists need to be retooled to be more sustainable[33]. A more informed, critical press — one that can evaluate the claims of benefits in relation to research and that can also pinpoint risks and concerns — is needed. Rose argues that science reporters rely too much on press releases put out by universities and

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scientific journals[56].This tendency is indeed disquieting: press releases, in particular from scientific meetings, often involve results that will not be published[66].

To further manage the consequences of our three original concepts of neuro-realism, neuro-essentialism and neuro-policy, media reporters also need to reflect on how they select and frame fMRI studies to ensure balanced and sensitive communication. In parallel, and despite the time and career pressures of interfacing with the media, the neuroscience community must respond by reflecting on its own ways of conveying the complexities of fMRI and other neurotechnologies to the press, and ensure proper interpretation of the results. Communication of the limitations of fMRI technology and critical appraisal of claims of health benefits are immediate challenges. New collaborations with bioethics and humanities scholars in the design of investigations into the lay perception of neurotechnologies, on medical, scientific and public perceptions of neurological and psychiatric diseases, and on patient narratives, will also be instrumental in broadening the reflection and bringing new elements to the discussion. To fully realize and appreciate the transition, we will need increasingly elaborate and diverse research perspectives.

Resistance to some of these suggestions is not unexpected, but this does not dispirit the endeavour. In the end, debate among neuro-scientists, life science colleagues, the media and the public represents an exercise in critical thinking and self-reflection. It brings into focus and strengthens the pillars of science, medicine and our pluralist society.

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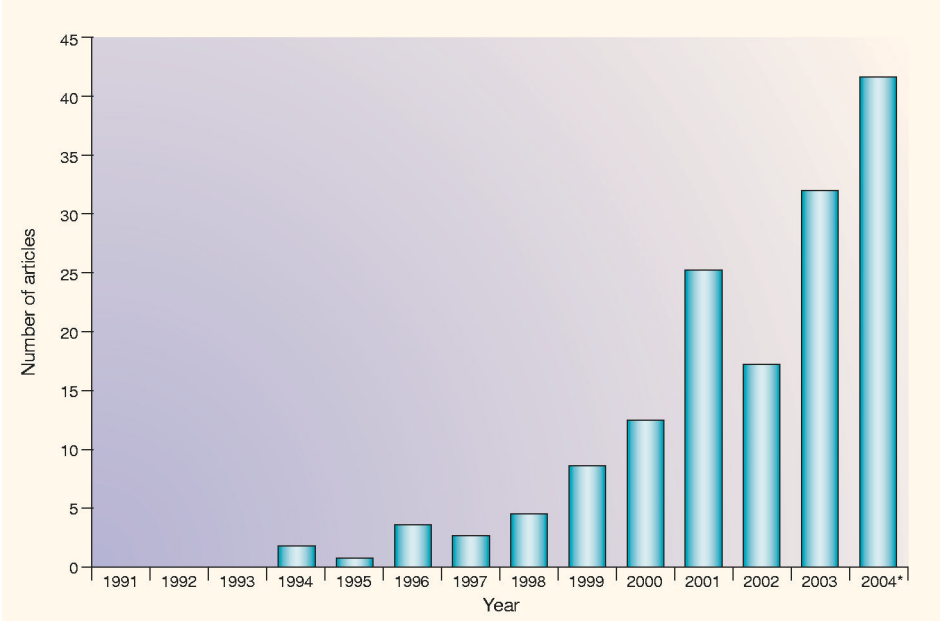

Figure 1.

Composition of the sample of articles returned to a search of print media coverage (general and specialized sources combined) of fMRI from January 1991 to June 2004. *Projected value for 2004.

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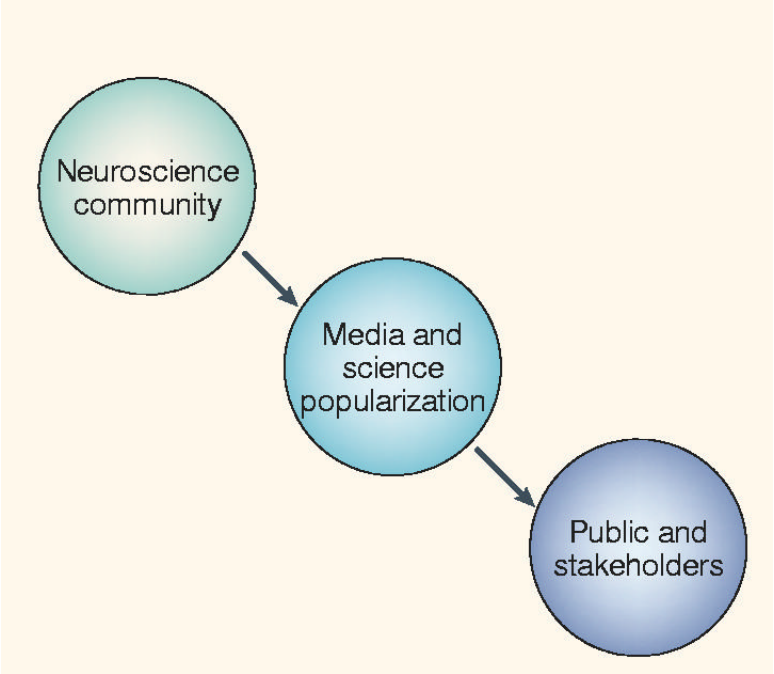

Figure 2.

Unidirectional communication in neuroscience. Unidirectional communication is based on an expertise model of knowledge. Conveying accurate information to the public is the primary goal of science communication.

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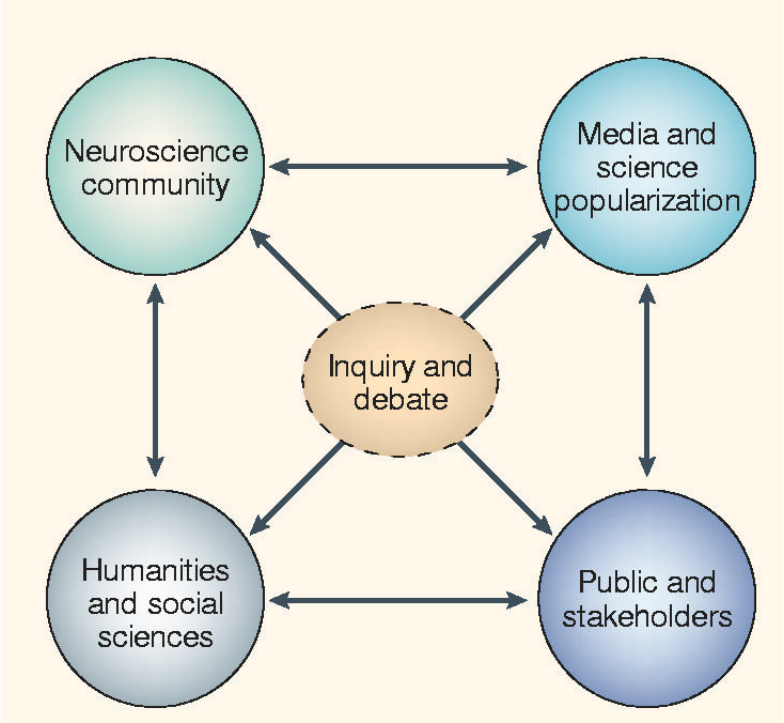

Figure 3.

Multidirectional communication in neuroscience. Multidirectional communication encourages open dialogue and the mutual enrichment of all parties. Accuracy of scientific information is a key goal and differences in interpretation promote reflection. Ensuring dynamic inquiry and debate is integral to science and a pluralist democratic society.

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Table 1

Definition of functional MRI issues identified in press coverage

Issue	Definition
Ethical	
Human nature	Risks and concerns that relate to the transformation of human nature; manipulation of people conducive to a view of humans as mere means; misuses.
Confidentiality	Risks and concerns that relate to the potential harm that could result from sharing confidential information.
Troubling findings	Risks and concerns that relate to the potential harm to individuals or society of findings,of actions based on fMRI findings or of incidental findings.
Recruitment	Risks and concerns that relate to the recruitment of research subjects and protection of subjects enrolled in protocols.
Scientific	
Limitations	Risks and concerns that relate to the limitations of knowledge gained by fMRI and its scope of application.
Interpretation	Risks and concerns that relate to interpretation/meaning of findings by the public and researchers.
Validity	Risks and concerns that relate to scientific research design.

fMRI, functional MRI.

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Table 2

Divergent issues identified in functional MRI and genomics press

fMRI (General sources)	%	Genomics*	%
Limitations	19	Commercial and economic	22
Interpretation	10	Meaning and regulation	18
Validity	6	Autonomy and responsibility	14
Human nature	8	Human dignity and integrity	12
Confidentiality	4	Discrimination and stigmatization	8
Troubling findings	4	Eugenics and artificial selection	7
Recruitment	1		

*Genomics data from REF. 39. fMRI, functional MRI.