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NeuroTalk: Improving the Communication of Neuroscience

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Abstract

There is increasing pressure for neuroscientists to communicate their research and the societal implications of their findings to the public. Communicating science is challenging and the transformation of communication by digital and interactive media makes the challenge even greater. To successfully facilitate dialogue with the public in this new media landscape we suggest three courses of action for the neuroscience community: a cultural shift that explicitly recognizes and rewards public outreach, the identification and development of neuroscience communication experts, and ongoing empirical research on public communication of neuroscience.

> "That science has become more difficult for nonspecialists to understand is a truth universally acknowledged."[1]

Neuroscientists are in a tough spot. With the development of powerful new tools, neuroscientists are gaining a better understanding of the biology of the brain every day. At the same time, this progress is prompting many questions about the personal, social, moral and spiritual choices that humans make. These factors conspire to place increasing pressure on neuroscientists to discuss both their scientific research and the ethical implications of their findings. It is the interactions between neuroscience and society, and the debates triggered by the social implications of neuroscience findings after all, that ultimately inform public policy[2, 3].

While translating and disseminating new knowledge is a fundamental responsibility for all scientists, neuroscience is among several scientific disciplines that are particularly prone to misinformation and inaccurate reporting. Sensational media headlines that evoke mind reading, a neurogenetic basis for fidelity or voting patterns, memory boosters for the healthy, and miracle cures for sensory and movement disorders are but a few examples. Without accurate and sufficient context, the public – who are naturally interested in diseases and cures, especially with regard to common and devastating brain disorders – may accept these simplistic messages uncritically[4]. The power of brain imaging techniques such as functional Magnetic Resonance Imaging further feeds into this problem, with the potential for brain scan images to create beliefs and biases in the laboratory, the clinic, and courtroom[5-7].

The interest in the neurological basis of individual and social behavior has also spawned a staggering number of *neurologisms* – new terms for the complex and varied phenomena arising at the intersection of brain science and society – including neuroethics, neuromyths, neurorealism, neuromarketing and, of course, neurotalk. Some, like neurotalk and neuroethics, bring ideas for a dedicated new practical and scholarly effort to the foreground; while others, like neurorealism[8] and neuromyths[9] highlight how the seductive allure of neuroscience explanations can confer an unwarranted sense of objectivity based on the general hype that surrounds contemporary science and technology[10].

Not all science in the public sphere is treated equally. Like the science behind genetically modified foods and nanotechnology, neuroscience combines high public relevance with rapidly advancing technologies. Everyone has a stake in understanding how the brain works. Neuroscientists, as members of the academy and professional societies, recipients of public

funds, and as beneficiaries of scientific advances themselves, have a stake in public outreach. Many are already actively engaged in furthering public understanding of the brain. However, the growing emphasis on social accountability in science along with the interest of the public in the brain create a clear need for not only more efficient and accessible approaches for the communication of neuroscience by neuroscientists themselves, but also scientist participation in the public debates about societal norms and social policy.

As outlined in Table 1, the communication of neuroscience creates substantial challenges[11, 12]. How can neuroscientists successfully tackle these challenges along with their research program goals? Over the past decade, science communication has expanded beyond unidirectional efforts that aim to convey accurate messages about new scientific findings to the public, although this remains an important goal. The expectation of the public for meaningful engagement and dialogue on ethical and social issues generated by science has introduced more interactive and multidirectional communication approaches[13]. The public expects to provide input on the direction of scientific research and neuroscientists themselves are uncomfortable in presuming society's response to the potential of new knowledge and tools. In this regard, there has been a recent wave of calls to increase direct interaction of scientists with journalists and the public[14-17]. However, for individual scientists, the time required for such successful science communication efforts is considerable. This is especially the case if, as in this paper, communication is considered to include both the dissemination of accurate accounts of neuroscience to the layperson and public engagement activities that tend to be two-way fora for debate and dialogue.

We suggest advances on several fronts to initiate a sustainable change over the long term for individual scientists and the research community more broadly. Our recommendations aim to support the goals of both neuroscience literacy (understanding the science) and public engagement in discussions about what this science can tell us about ourselves (ethical and societal issues). These recommendations can facilitate public engagement with knowledge from neuroscience that is used in everyday life: from how we make decisions, to how we understand common diseases such as depression and Alzheimer's, to how we deal with addictions, and how we imagine concepts of mind, body, and soul. The science and the ethics cannot be teased apart because the science itself presents new ethical questions. As neuroscientists better understand brain activity, definitions of normal behavior will be newly debated, our understanding of how humans think and learn will increase, and questions will be raised about personal identity, individual privacy, and privacy of thought.

The recommendations presented here envision three advances: a cultural shift within the scientific community, the creation of a cohort of neuroscience communication specialists, and empirically driven research on science communication. These recommendations take into account communication challenges specific to neuroscience in the new digital and interactive media landscape.

Communication Challenges

Trust, reciprocity, and transparency

A climate of trust, reciprocity, and transparency is essential for any science that is dependent on the public for funding and for public participation in research[18, 19]. Creating and maintaining such a climate raises several challenges with regard to neuroscience. First, a record of misrepresentative or sweeping claims can jeopardize trust and raise false expectations[20]. Neuroscience may be particularly vulnerable to exaggerated claims, such as “God spots in the brain”, because its findings can challenge widely held assumptions about sensitive social and behavioral phenomena.

There is also great potential for misunderstanding arising from the inherent complexity of neuroscience. As the number of neuroscience specializations grows including, for example, neuroeconomics that focuses on the neurobiology of decision-making, and neurolaw that seeks to discover how neuroscience can inform questions about justice on issues such as juvenile responsibility and moral agency, we achieve new levels of new knowledge. However, each additional specialization yields a new set of complex terms and concepts[1]. The challenge is to create a climate of trust and transparency while being aware of the considerable gap between the fine-grained nature of new knowledge and the need to distill it when presenting to the public. To narrow this gap, especially when scientific inquiry is directly related to deeply personal and intangible human phenomena such as identity or individuality, communication about the evolving science should optimally begin well before any findings are relayed. This will demystify the science by keeping the focus on progress and away, for example, from fear-provoking notions about forbidden knowledge or the reduction of people to neurons[21]. Even with many studies of this nature already published or underway [22], it is not too late to work toward narrowing the gap; now is better than never.

Openness about the potential and limitations of the research can also provide a framework in which to engage the public on ethical questions. While this may mean that neuroscientists could be constrained, having public input on research direction will likely lead to larger, long term gains. The research community needs to embrace the outcomes of scientifically informed debate, trusting that it will lead to sound policy decisions based on empirical evidence. To this end, multidirectional communication and mutual learning are critical objectives[8, 23].

Academic rewards for communication and outreach

Another challenge facing neuroscience communication is its emergent status within academic culture. Over the last 30 years, several successful strategies to improve the science-media relationship have been implemented. These include the development of guidelines for researchers on how to interact with the media and training workshops to prepare scientists for contact with journalists. One study of more than 1300 researchers in five different countries[24] reported a high rate of interaction between biomedical scientists and journalists and high satisfaction ratings of these interactions. These initiatives reflect an increased willingness within the scientific community to engage in public dialogue about research. However, there is room for improvement: academic recognition and merit systems provide little or no credit for communicating science to the public, such as writing opinion editorials and books for the general public, giving media interviews or public lectures, and volunteering in local classrooms. Sometimes efforts toward the popularization of science can stigmatize a researcher and even compromise professional credibility[25, 26]. Even where this effect is absent, many scientists may feel that their outreach and media work will never be considered an accomplishment like a publication or grant. Some neuroscientists still experience frustration when their results are reported in sound bites, and journalists are often frustrated by scientists' reluctance to speak candidly about their findings and lack of skills in doing so[27].

New social and interactive media

The new digital landscape is both a challenge and an opportunity for all science communication. New ways of communicating have flourished in recent years using social network platforms under the banner of Web 2.0 (for example Facebook or YouTube). People under the age of 21 receive and absorb the bulk of their information via television and the Internet. Indeed, 40 million Americans now rely on the Internet as their primary source for science news and information[28]. While most of these users are wealthy and educated, with 40% possessing college degrees and another 32% having at least some college coursework, the Internet is used as a source of information by individuals from many walks of life. Obtaining medical, health and current events information is the sixth most popular use of the Internet. Twitter, an almost

telegraphic tool that permits only the shallowest messaging, is one of the latest technologies to be embraced by young adults. The rapid changes introduced by interactive media are dramatically affecting traditional forms of journalism and means of communication. Although these digital tools open up new and creative ways of communicating the excitement of neuroscience directly and interactively to the public (Table 2), their advantages and limitations have been neither fully exploited nor explored. In particular, how neuroscientists are adjusting to the diverse new forms of media is unknown. Should neuroscientists be paying attention to these new tools? It would seem that, in order to reach today's generation and to do so on a global scale[14], the answer is yes.

Neurotalk recommendations

Against the backdrop of the communication challenges described above, and existing initiatives to leverage new ones (Table 3), we present three recommendations to improve communication of new neuroscience knowledge in a socially accountable way (Table 4). The aim of these recommendations is to equip a new generation of neuroscientists with the tools to communicate neuroscience findings in two interconnected ways. One advances neuroscience literacy – the science itself. The other genuinely engages the public – in lockstep with scientific research itself – in broader dialogues about neuroscience and society. These communication goals are connected because ethical issues often arise when new empirical data triggers the reconsideration of individual and social norms (Table 5).

A cultural shift

Due to the growing societal relevance of neuroscience, the importance of communication needs to be recognized explicitly and elevated as a priority in the community, akin to protecting the rights of human subjects and ensuring respectful animal care in research. Institutional support is required to advance this goal and that support begins with explicitly valuing the effort. Developing a process for valuing communication will surely be no less complex than the composite metrics used today, for example, for valuing productivity in peer-reviewed publications from a combination of raw numbers, journal impact factor, and individual publication impact. However, the latter two do not exist for science communication products. We propose that audience size, evaluations, and local national and international reach can serve as first proxy measures of impact. These measures must be ultimately factored into the evaluation of junior researchers for promotion and those more senior for advancement. Awards that recognize excellence, such as the Science Educator Award of the Society for Neuroscience and the Wellcome Trust Broadcast Development Awards are important signals of commitment and success. Other long-term rewards should take the form of time off from teaching, research or administration. Little in this shift will be cost-free either in real dollars or personal effort. Nevertheless, the already skilled must step forward to model these goals with mentorship and action.

Some actions toward the cultural shift can be immediately implemented, such as increasing the professional value of delivering public lectures, media work, and efforts to develop training activities tailored specifically for neuroscientists. Other actions, such as the full integration of communication training into neuroscience curricula and graduate training will require longer-range planning and a more fundamental culture shift to achieve equally full acceptance given already heavily-laden schedules. For neuroscientists, the overall continued development of specialized training sessions, online course modules, and boot camps at professional meetings or local institutions will help bring this culture shift to reality.

Indeed, some actions have been taken and investments already made toward this goal. For example, the American Association for the Advancement of Science (AAAS) sponsors a summer internship program that places graduate and post-graduate students in science,

engineering and mathematics at media organizations nationwide; participants "*come in knowing the importance of translating their work for the public, but they leave with the tools and the know-how to accomplish this important goal*" (http://www.aaas.org/programs/education/MassMedia). An intensive science communication program for scientists, journalists and communications professionals takes place each year at the Banff Centre in Alberta, Canada. This immersive residency program pushes mid-career professionals to initiate creative science communication projects, with the goal of fostering a broad, ethical, and more engaging role for science in public culture. Both of these programs cater to all scientific disciplines. We recommend that these initiatives be extended directly to neuroscience to create focused communication internships for trainees or mid-career researchers, and immersion opportunities for neuroscience communication experts. Organizations with already existing programs should customize new ones for neuroscience and provide guidance to others who wish to embark on new initiatives building on history and experience.

Some programs aimed specifically at neuroscience led, for example, by the International Brain Research Organization (IBRO), the Dana Alliance for Brain Initiatives (DABI), the Federation of European Neuroscience Societies (FENS) and the Society for Neuroscience (S*f*N), already have prominence. The S*f*N membership, for example, has endorsed public education as a key component of its strategic plan and published *Neuroscience Core Concepts*[29], a document with application to both K-12 educators and the general lay public that lays out fundamental principles about the brain and nervous system. The neuroscience research community can immediately support the further development, awareness of, and uptake of these resources by elevating the visibility of communication in the community and accountability of individuals to the task.

A commitment to culture shift will also urge funders of neuroscience research to encourage or even require information on plans for knowledge translation, public engagement, and outreach. The National Science Foundation (NSF), for example, which funds basic research across all disciplines including behavioral and neurobiological sciences, already has a societal impact review requirement. In Canada, many requests for applications and proposals have explicit knowledge translation (KT) requirements. Funding agencies that primarily target neuroscience research can follow suit by providing similar societal impact inclusion requirements in submitted proposals and funding opportunities for KT and public engagement. Even in a difficult economic climate, the prevailing view in science policy is that investment in the future of science and the R&D workforce through education is needed. The 2009 American Recovery and Reinvestment Act (2009) included portions for science, technology, engineering and math (STEM) education at all levels, as did the earlier American Competitiveness Act 2007.

Neuroscience trainees and neuroscience training curricula should be at the core of the culture shift in communication education and funding. It is important to train doctoral students not just to be experts of a specific field or subfield, but also to uphold the integrity of their discipline, to commit to generating new knowledge and critically evaluate that knowledge, to understand and appreciate how their work fits into the larger intellectual framework and social landscape, and to communicate ideas and information clearly and effectively to a broad range of audiences[30]. Communications internships can become required components of traditional training curricula. Accreditation and certification for participation are legitimate goals and measurables. Rigorous interdisciplinary master's level and PhD programs that span schools of journalism and faculties that house neuroscience programs can be developed, leveraging the expertise represented across domains. The leadership of those who are more senior in their careers is vital, but a new flexibility that promotes visible engagement in communication will be most effective if focused on the younger generation – the next stewards of the neuroscience discipline.

Support neuroscience communication specialists

Specialized training of journalists, editors and neuroscientists alike is needed to promote increasingly effective communication of newsworthy neuroscience findings and considerations of their ethical, social, and policy impact. We believe that specialists from both the academic and non-academic neuroscience community who can serve as specialists or ambassadors in neuroscience communication should be identified and should self-identify their interests to their supervisors, faculty heads and deans. Neuroscientists are not generally trained in communications or in emerging new media and, among those who are, skills are variable. It is not reasonable to assume that all scientists will be able to acquire the specialized skills required to communicate effectively in any medium despite the heightened level of exposure and activity we suggest. Although all neuroscientists need to be aware of the public discussions surrounding neuroscience and the increasingly diverse means by which it is circulated by online, print, television, and radio sources, a cohort of skilled neuroscience ambassadors who are embedded in neuroscience research programs could become experts in new communication tools. These individuals would work with each other, with other science communication experts at institutional press offices, journalists, and their own colleagues and students to foster the communication of accurate and contextualized information. They could become neuroscience 'knowledge brokers' by linking the creators of new knowledge with recipients, and could increase the quantity and calibre of communications activity by providing education about and access to new knowledge[31]. They could explore creative uses of new media tools and develop strategic communications for engaging the public using new media platforms. An investment in specialized programs, such as expert workshops in which neuroscientists and journalists exchange knowledge and know-how will be a further powerful tool in achieving this goal.

The need for such experts is further amplified by the rapid flow of information through continually emerging non-peer reviewed, non-curated publications and web postings. Organizations and researchers can disseminate their own information directly to the public via blogs and web sites. Filtering and discriminating high quality information in this new landscape is time consuming and will require dedicated and reliable specialists who can provide services for the larger community.

Enable research on neuroscience communication

More empirical data are needed from research on neuroscience communication. It is imperative to understand the receptivity, motivation, and barriers to communication of both neuroscience findings and their social impact. The complexities of commercialization and partnerships between academia and industry, including conflict of interest, intellectual property, and risks to the privacy of brain data, expand this imperative[17, 32]. In parallel, the opportunity also exists to gather data about neuroscience public engagement activities, make changes and improve these activities, and re-engage the communicators. These initiatives will require seed support from within institutions and funding from research sponsors both to support a communication component for projects that are not specifically focused on communication and others that are specifically earmarked to meet this objective.

To understand the willingness of scientists to engage in discussions about ethical and social issues in neuroscience, including science communication, one of us (JI) conducted a large-scale study of researchers whose work involves neuroimaging, neurodegenerative disease or both [33]. More than 800 neuroscientists reported significant interest in these topics, motivated both by personal factors (because *it is the right thing to do*), and external factors (to be *good citizens* and support the *public's right to know*). They further elucidated barriers to meeting fulfilling these including lack of time, lack of sufficient expertise and lack of opportunity for collaboration with ethicists. The communication opportunities that can be built from the

vantage point that these data offer, combined with past data on both the positive and negative effects of media reports on neuroscience literacy[34] are ripe for development.

Powerful methods from social science can be harnessed for this research. Although the neuroscience community may at present be unfamiliar with these methods, they provide ways to immediately start engaging the public in research processes. Appreciative inquiry[35] is a model program from the business community that has been used successfully to evaluate and re-shape practices. In contrast to standard evaluative models that recommend changes by focusing on failures, appreciative inquiry is a generative process that seeks to highlight successes of the past and bring members of a community into dialogue about what should be in the future. It relies on genuine engagement rather than on rigid principles. Consistent with the idea of framing science communication in the pursuit of a common understanding and set of goals[13] and a pragmatic approach to the task[36], such an approach respects that collective interests are unlikely to remain fixed in rapid technological change, and recognizes that deciding how to act, and what policies ought to be adopted, can best be achieved through a negotiated scientific-social decision process[37]. The input of neuroscientists is fully integrated into any future product in this way. Applied, for example, in interviews and focus groups, and to online professional user group discussions, rich perspectives from investigators on their experiences and priorities will emerge[38, 39].

It is also important to understand what the public knows, what is of interest, and how much science non-scientists can absorb, especially in this age when traditional journalistic reporting collides with the worlds of arts, electronic media, and entertainment. Whereas we do have detailed audience profiles for print, radio, television, and arts consumers, the same information is not yet available for the conflation of these forms on the web. For example, we can gather statistical data on the behaviour of visitors to a web site but at present need to infer intent. We can tell if someone uses a search engine to find an article on depression, but we do not have an understanding of the motivation or goal for that search. We do not understand how viewers are engaged with the data and how they take it up in everyday life. We do not understand how web-based information shapes public dialogue and participation in events. Empirical research in science communication that draws on quantitative and qualitative data in the Internet age can form the foundation of well-informed strategies. This can include appropriate and rigorous evaluations of current and emerging mechanisms designed to improve the public understanding of neuroscience, as well as the effectiveness of public dialogue and engagement activities.

Public deliberation is being used to explore public concerns and desires in the context of the development of biobanks[40] and the adoption of new health technologies[41]. Given both the need for scientists to listen to the public and the public's interest in learning about science, these approaches can be used to understand the depth of public knowledge, to create opportunities for expanded literacy about the brain, and to engage in meaningful exchanges on complex issues. These approaches reflect the values of trust, reciprocity, and transparency by engaging non-experts and acknowledging that they have a say in the conduct of science. These tools also provide richer data than snapshot views available through traditional methods such as opinion surveys. However, their use calls for enhanced training of neuroscientists and a willingness to engage in less conventional approaches. Empirical research throughout the process of public engagement is an integral part of this training, and measuring outcomes and impact will be an essential step in the new cycle of knowledge that feeds back in a dynamic to hone communication skills. It should not delay, however, the immediate and increasing encouragement of outreach and engagement through lectures, cafés scientifiques, and utilization of evolving media forms that enable the dissemination of scientifically accurate and scientifically proactive information.

Conclusions

Neuroscience communication requires scientists to explicitly articulate new scientific knowledge and the implications of that knowledge. The community of scientists and scholars with interests in neuroethics[22, 42-44] – a mixed composition of experts in brain science, social science, law and philosophy whose multidisciplinary interests lie at the intersection of neuroscience and its impact on people and society– offer a compelling starting point for advancing communication in neuroscience, and it is out of this community that this paper emerges.

We have recommended three areas of initial focus to advance public understanding of neuroscience and public engagement in the ethical issues it provokes in the rapidly changing world of science communication. First, although many neuroscientists are motivated to be responsive to the public, they need to be supported by the academic and research culture in which they work. Second, specialized communicators are needed to ensure that communication and outreach activities are of high quality and are well integrated with scientific research programs. The public is being exposed to new ways of thinking about neuroscience and society[45] and skill is needed to negotiate the promise and hype, the ties between the academy and industry, the occasional open sparring among neuroscientists themselves about the legitimacy of results,[46, 47] and routes for reporting them[48, 49]. This need for specialists also feeds into the third recommendation for ongoing research and empirical understanding of what works and what does not work in neuroscience communication. Research approaches from the social sciences can be used to shape public engagement. Given the different stakeholders involved and their respective challenges and expectations, specialized knowledge in this terrain will be required.

The climate for communicating neuroscience that can be created through initiatives such as those proposed here could have a significant influence on the way that the public is engaged both with the information and with emergent ethical and policy debates. With an even stronger commitment to communication, the neuroscience community and its partners could mitigate or avoid the public backlash and funding freezes that have taken other areas of science by surprise – including stem cells, genetic testing and population screening [50, 51]. From a long-term scientific and ethical standpoint, the future development of the relatively young field of neuroscience must occur with public debate, transparency, and trust. This in turn will empower neuroscience research, enhance understanding of brain health, and support the translation of fundamental knowledge into better care for individuals and societies.

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Table 1

Specific challenges for neuroscience communication.

Context	Challenges for Communicating
Complexity of the brain	Conveying intricate molecular pathways, their interactions, and their impact as understanding about the brain continues to emerge from varied neuroscience subspecialties.
Personal, philosophical and religious salience to mind and body	Advancing scientific inquiry about brain function and biologically-based causes of behavior that challenge the nature of “belief” leading to new definitions of normal behavior, increased understanding of how humans think and learn, and potentially socially charged attributions of moral responsibility.
Burden of central nervous system disease and impact on public health	Addressing the overwhelming personal and societal impact of diseases of the central nervous systems that engenders both high awareness and unfettered hope for and unsubstantiated hype of discoveries in neuroscience for diagnoses, treatments, and cures.
Stigma of neurological and mental health disorders	Navigating negative social perceptions that persist about the causes of, and reasons for, mental health disorders make meaningful public discussions about these conditions difficult, if not sometimes impossible.

Table 2

Advantages and disadvantages of interactive media for neuroscience communication.

Mode		Advantages	Disadvantages
Podcast	Audio or video broadcast that can be downloaded to computer, PDA, or mobile phone.	Can convey a great deal of information in a form that is brief and easily understood.	Requires some technical skill to produce.
		Room for creativity in explanations (graphics, sound effects, humor).	Short length is challenging for the complexity inherent to neuroscience information.
		Ubiquitous to the Web.	Requires some marketing and partnership for promotion.
		Likely to increase within the next five years.	
		Very easy technical distribution via iTunes, YouTube, Blip.tv and many more channels.	
Blog	Website used to log activities, thoughts, events, and other media such as pictures and videos; similar to an online daily column.	A contemporary mainstream format for news.	Current neuroscience blogs tend to be exclusive, written by and for experts using expert language that is inaccessible to the public.
		Can be updated easily, quickly and frequently.	Requires some technical knowledge of back-end interfaces.
		Can include all media (photos, illustrations, interactive graphics).	Requires good partnerships with known brands and excellent marketing to reach mainstream public.
		Current gap in the blogosphere for good, accessible neuroscience is a growth opportunity.	
Twitter	Text-based posts of up to 140 characters; updates are displayed by followers.	Extremely easy interface.	Launch of a Twitter feed requires some technical savvy.
		Can be easily and frequently updated.	Must be updated daily to keep audience engaged.
		Feeds can be updated by numerous people.	Brevity is a given, so communication of complex topics is limited.
		Feeds are public and do not require subscription or membership.	
		Dynamic through interactive messaging.	
		Growing audience base.	
		Few feeds are currently focused on neuroscience and represent another a growth opportunity.	
Online Discussion Forum	Public conversation through the World Wide Web (WWW).	Available to the global community.	Requires curator to ensure accurate and meaningful dissemination of information and prevent propagation of “neuromyths.”
		A topic thread can be ongoing.	

Mode		Advantages	Disadvantages
		Hyperlinks to brain images and other neuroscience sites augment text-based discussions.	
		Archived for future referencing.	
		Driven both by neuroscientists and non-experts who can suggest topics.	
Salon	Informal panel discussion in which a host presents topics for debate amongst panelists and audience.	Opportunities to meet neuroscientists.	Limited to local community.
		Moderator can facilitate communication between scientists and public.	Topics controlled by moderator.
		Can be webcasted live and videotaped for later use.	Often a one-time event.
		Clarifications can be made in real-time.	
Café Scientifique	Public lecture and discussion, usually in a coffee house or other informal public setting.	Opportunities for neuroscientists and the public to interact in casual setting.	Limited to local community.
		"Neuromyths" can be corrected in real-time.	Requires comfort and skill in speaking with public extemporaneously.

Table 3

Examples of professional programs for training and public engagement.

Organization	Programs and Resources
Society for Neuroscience (*Sf*N)	**Guide to Public Advocacy** Resource for individuals interested in communicating the importance of biomedical research to elected officials, the press, and the general public. The guide provides tools, information, and tips on how to be an effective advocate. http://sfn.org/index.aspx?pagename=GuideToPublicAdvocacy_main **Brain Facts** A comprehensive and accessible introduction to neuroscience designed for lay audiences and high school students. http://www.sfn.org/index.aspx?pagename=brainfacts **Neuroscience Wikipedia Initiative** A society initiative aimed at improving the accuracy, breadth, and accessibility of neuroscience content available for the public and at facilitating more members in public communication activities. SfN leadership encourages its members to review and update Wikipedia's neuroscience initiative and plans to engage trainees in the efforts as part of their coursework. http://www.sfn.org/index.aspx?pagename=wikipedia_main **Neuroscience Education Resources Virtual Encycloportal (NERVE)** A dynamic online gateway providing easy access to over 300 reliable educational resources in neuroscience. http://www.sfn.org/index.aspx?pagename=PublicEducation_nerve
Dana Alliance for Brain Initiatives (DABI)	**Brain Awareness Week (BAW)** Annual celebration of the brain coordinated by the Dana Alliance for Brain Initiatives, uniting the efforts of universities, hospitals, patient advocacy groups, professional associations, government agencies, service organizations and K-12 schools around the world. www.dana.org/brainweek **Brainy Kids** Online science resources for students, teachers, and parents. http://www.dana.org/resources/brainykids/ **Brain Expert Directory** Provides members of the media access to Dana Alliance for Brain Initiatives members, more than 280 leading experts in neuroscience who are willing to assist in reporting of neuroscience news. http://www.dana.org/media/resourcedirectory/
International Brain Research Organization (IBRO)	**The Brain Campaign** Small grants to assist groups organizing public education events to promote public understanding of the brain in IBRO's African, Latin American and Asian/Pacific regions.

Organization	Programs and Resources
	http://www.braincampaign.org/Pub/Pub_Front.asp? Supporting resources on how to design, organize and advertise events and interact with the press are also available online. http://www.braincampaign.org/Pub/Pub_Main_Display.asp?LC_Docs_ID=1889)
The Banff Centre	**Science Communications Program** Professional development summer residency for scientists, journalists, public and private sector communications professionals and educators responsible for communicating about science. http://www.banffcentre.ca/programs/program.aspx?id=344
AAAS Center for Public Engagement with Science and Technology	**Communicating Science: Tools for Scientists and Engineers** Science communication workshops and online resources including webinars, how-to tips for media interviews, strategies for identifying public outreach opportunities, and links to articles, books and other websites. http://www.aaas.org/communicatingscience
Wellcome Trust Fund	**Science Media Production Internships** Studentships offering financial support for practicing biomedical scientists to undertake a postgraduate qualification in science media production at Imperial College London and to then use these skills in a six-month internship working in the broadcast industry. http://www.wellcome.ac.uk/Funding/Public-engagement/Grants/Science-Media-Studentships/index.htm

Table 4

Recommendations and action for improving neuroscience communication.

Recommendation	Specific actions
Introduce and promote a shift in academic culture	
Individual neuroscientists	Give public lectures; participate in public discussions and debates.
	Support the efforts of trainees and junior faculty to lead interactive public events.
	Explore and become familiar with uses of new media.
	Organize local training opportunities, including interactions with experienced communicators and journalists.
	Participate in ongoing research, including the identification of needs, priorities, and qualities of good neuroscience communicators.
Academic institutions	Develop metrics for valuing neuroscience communication towards career advancement.
	Invest in opportunities for internships and attendance by trainees and faculty at communication programs.
	Provide financial and staff resources for faculty and trainee-led public events.
	Provide time off from teaching, research, and administration for neuroscience communication.
	Attribute awards for outstanding public communication accomplishments.
	Integrate neuroscience communication into graduate training curricula.
	Consider neuroscience communication accomplishments in the evaluation of faculty for promotion and advancement.
Professional organizations	Build on existing programs to create customized communication programs for neuroscience.
	Proactively encourage academic institutions to include neuroscience communication activities in faculty career advancement.
Research sponsors	Support neuroscience communication in requests for proposals and open competitions.
	Develop funding opportunities for public engagement activities, training, and collaboration.
Train and support communication specialists in neuroscience	
Individual neuroscientists	Self-identify to serve as neuroscience communicators and knowledge brokers.
	Pursue specialized training experiences for all aspects of neuroscience communication: basic, clinical and ethical-societal implications.

Recommendation	Specific actions
	Provide mentorship to junior faculty and develop relevant curricula.
	Master new forms of communication tools such as podcasts and webcasts.
	Actively attend to neuroscience in the news and be available to clarify and comment.
	Develop relationships with trusted journalists and disseminate potentially newsworthy results.
Academic institutions	Send trainees and faculty who self-identify and who exhibit potential excellence in neuroscience communication to specialized programs.
	Identify excellent communicators and nurture them with academic currency.
	Develop cross-disciplinary academic programs that will yield Master's and PhD level experts in neuroscience communication.
Professional organizations	Create new programs for neuroscience communication and public engagement.
	Enable journalists to acquire specialized training in neuroscience.
	Provide material and resources for quote and easy fact checking in press coverage.
Develop and carry out research in communication and public engagement	
Individual neuroscientists	Develop and participate in research on science communication and public engagement.
	Explore and embrace relevant new research approaches and methods to support evidence-based practices.
	Engage in the development, implementation, and testing of new initiatives on public neuroscience literacy.
	Encourage trainees showing interest in an alternative career in science to pursue research on communication and public and engagement.
Academic institutions	Seed in-house pilot research on neuroscience communication and public engagement.
	Create metrics for outcome and impact of communication and public engagement.
	Encourage the evaluation of public events and recognize excellence.
	Value interdisciplinary collaboration and grant funding in neuroscience communication.
	Encourage flexibility in training curricula to take into account new empirical data on neuroscience communication.
Professional organizations	Update existing tools and create new programs based on emerging empirical data.

Recommendation	Specific actions
Research sponsors	Develop dedicated research funding opportunities in the area of neuroscience communication and public engagement.

Table 5

Recommendations and impact on neuroscience communication.

Recommendation	Impact on Neuroscience Communication
Promote a cultural shift	Investment and professional incentives that promote communication and engagement with the public. Interaction of neuroscientists with the public at all career stages. Venues and opportunities for the public to learn directly from neuroscientists and to share views about advances in neuroscience.
Create communication specialists	Neuroscience communication specialists who are skilled in engaging and interacting with the public. Legitimized efforts of neuroscientists who enjoy and are eager for public engagement opportunities. New partnerships between science journalists and public relations professionals and the neuroscience community.
Enable research on neuroscience communication	New methods for communicating neuroscience to the public based on empirical data. Identified gaps in and barriers to neuroscience communication. New era of responsiveness to public desire and need for knowledge about neuroscience.
Cumulative Recommendation Significantly improve the essential conversations between the public and neuroscientists about the science and the ethical, social, and policy implications of ongoing research.	