

Neuroethics as a Science Engagement Strategy for Excellence in Global Neuroscience.

I. INTRODUCTION

Neuroscience has a timely opportunity to lead across the scientific enterprise in a thoughtful, intentional, and proactive union with ethics and engagement. Neuroscience is providing insights into the human condition and promises transformative applications to life that are unprecedented.¹ Furthering our understanding of the brain and its functions is showing us how humans think, behave, and decide while surfacing important questions about how to carry out research ethically and responsibly. Yet, this endeavor is embedded in the cultures and respective values of the societies we live in, many of which may be in conflict. In turn, this embeddedness raises a distinct set of questions about how neuroscience innovation will be understood and interpreted by different publics, the social benefit it confers, and how appropriate regulation will be balanced with equitable access. We propose that neuroethics and public engagement methodologies should be integrated at the frontiers of neuroscience in order to ensure that the resulting research has positive impacts and is attuned to diverse societal and cultural values. **For the purposes of this article and in agreeance with the UNESCO definition, we use the term culture to refer to:** “the set of distinctive spiritual, material, intellectual and emotional features of society or a social group, and that it encompasses, in addition to art and literature, lifestyles, ways of living together, value systems, traditions and beliefs”.² The approach described in this paper is the work of the Global Neuroethics Working Group (GNWG), an endeavor of the International Brain Initiative, which has gathered annually since 2017 to identify and discuss common ethical concerns and promote opportunities for systematic ethical reflection and analysis of the issues raised by neuroscience.

Neuroethics is a field that evolved to explore the ethical, social, philosophical, and regulatory issues raised by neuroscientific research and emerging neurotechnologies using both conceptual analysis and empirical methodologies. Despite the numerous ways in which neuroethics is understood and operationalized,³ there is growing consensus that neuroethics is not limited to the now familiar discussions of responsible conduct of research, compliance mechanisms, and practical management of ethical issues. In addition to examining how empirical knowledge of the brain can increase the understanding of human beings and human behaviour, neuroethics has a conceptual and normative component⁴⁻⁸ and contributes to the discussion of how neuroscience knowledge is constructed and why it might have explanatory or normative relevance.⁹ This entails identifying, interrogating, and challenging underlying assumptions and unspoken value commitments within neuroscience, as well as exploring value commitments associated with neuroethical issues within broader publics and diverse cultures. Through the IBI network, the existing brain initiatives from across the globe (Figure 1) have already collectively agreed that neuroethics can empower scientists to do their most impactful work, rather than being mainly a reactive policing mechanism. The IBI provides a unique platform to change the sociology of neuroscience—acting as a starting point in the global ecosystem to test new ideas that could potentially translate beyond the large-scale brain initiatives.¹⁰

Public engagement with science requires meaningful bi- and multi-directional dialogue between science experts and public audiences, with all groups listening and learning together. This strategy leaps beyond

what is traditionally known as the “knowledge deficit model,” which views interactions with the public as unidirectional communication from scientists to a public that has low scientific literacy. It uses more effective methods focused on engagement in order to build support, trust, and understanding of science.¹¹

Public engagement in science is not new, but is often deprioritized for two reasons. First, the need for public engagement is frequently invoked, but often it does not go further in implementation or may not use evidence-based or rigorous methods to do so. In surveys on attitudes towards public engagement, scientist respondents express their personal interest in bidirectional engagement objectives, such as learning what public audiences think about a specific issue,¹² building trust,¹³ or contributing to public policy. However, this individual interest and commitment is challenged by a lack of institutional support, in terms of both concrete resources and perceived professional value. Among barriers to high-quality, impactful public engagement, scientists often cite the lack of time and career incentives, the need for investment in training and evaluation, and the expectation of differing priorities among scientific colleagues and institutions.¹²⁻¹⁵

Second, public engagement is most often been implemented in response to moments of pivotal change or public crisis—as is the case with sudden advancements in genetic technologies or global climate change. The same can be said for ethical and societal considerations that are usually brought up to address a specific issue facing the scientific community or following negative media attention (as we are now seeing with anti-vaccination sentiment and Covid vaccines). **Neuroscience has a timely opportunity to be a leader in the scientific enterprise with a thoughtful, intentional, and proactive union of ethics and engagement.** Given the rapid evolution and development of neuroscience across the globe, neuroethics inquiry and public engagement together must be employed in a proactive, rather than a reactive way to facilitate the most impactful and societal benefits of neuroscience. When used proactively, public engagement can strengthen science by aligning research with community values and working toward minimizing and possibly avoiding potential crises. Public dialogue ensures neuroscience is respectful of, and positively impacts, diverse publics. Similarly, when addressed proactively, socioethical considerations can strengthen the neuroscience agenda by becoming internal to the scientific enterprise rather than viewed as constraints imposed from the outside. How neuroethical considerations are addressed can potentially make or break public trust and ultimately affect progress and funding in neuroscience research.¹⁶ In turn, a lack of engagement with public audiences can lead to public misunderstanding of emerging knowledge in neuroscience and potential misuse of developments and applications.

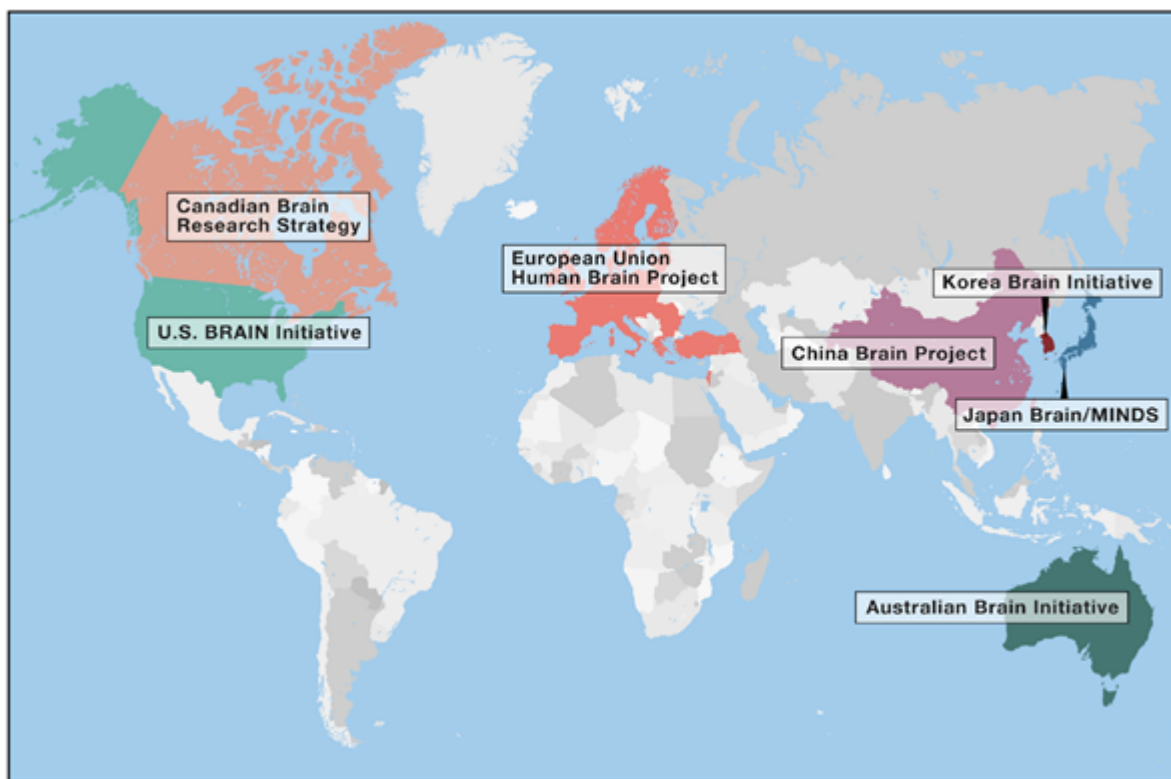
As public audiences learn about science, they want to know what the practice and findings of science mean for them and how the findings might change daily life, as well as their potential effects on society’s health, policy, and culture.¹⁷⁻¹⁹ Having scientists engage with diverse groups to seek perspectives about science related to societal and individual issues can both help to ensure that science is useful to and benefits society and helps to build and foster collective confidence in scientific practices. Engaging public audiences in science includes exploring the underlying values, questions, the processes, results and potential applications. Such an approach is critical in order for the scientific enterprise to promote meaningful discoveries, be responsive to people’s needs and priorities, reflect societal values and, develop to benefit a diverse society especially, and to be an enterprise that can be trusted and supported by many. Ethical issues are low-hanging fruit for developing a model/precedent for multidirectional dialogue between public and science, because (a) the public may have more interest and ability to engage with ethical questions than ‘pure’ science, and (b) scientists might value lay

perspectives more and have weaker deficit model biases when the question is self-evidently one of values rather than evidence.

II. BACKGROUND

At present, there are seven existing and emerging large-scale nationally and regionally sponsored brain research initiatives around the globe.^{10, 20} These include the Australian Brain Alliance, Canadian Brain Research Strategy, the China Brain Project, the EU Human Brain Project, the Korea Brain Initiative, Japan Brain/MINDS, and the US BRAIN Initiative. Together they represent an investment of over 7 Billion USD. There are more national and regional brain programs in development. The International Brain Initiative (IBI) was the result of widespread recognition that these brain initiatives could maximize the impact of their science, reduce potential redundancies, and tackle common challenges and high priority areas.²¹ Neuroethics and public engagement were identified as high priority areas from the earliest discussions among IBI participants ([IBI Declaration of Intent](#)).

Figure 1. The Global Brain Projects



Neuroscience is at a crossroads: high levels of public interest and the increasing global scale of research do not match the level of public engagement. A high-level concerted effort amongst global brain initiatives recognizes the importance of unifying and intensifying efforts in both neuroethics and public engagement in order to facilitate advancements in research and treatment relating to neuroscience. The IBI provides a unique platform to change the practices within neuroscience by acting as an anchor point in an ecosystem which can be used to test new ideas at the intersection of ethics and public engagement that could potentially translate beyond these large-scale brain initiatives.¹⁰

Through the IBI network, the brain initiatives have already collectively agreed that neuroethics can empower scientists to do their most impactful work, rather than being just a reactive policing mechanism. This consensus aligned with the goals of the Global Neuroethics Working Group which has gathered annually since 2017 to identify and discuss common ethical concerns and promote opportunities for systematic ethical reflection and analysis of the issues raised by neuroscience. The Global Neuroethics Working Group (GNWG) is characterized by the international nature of the collaboration it proposes, which seeks to consider the underlying values and ethical concerns that drive brain research across cultures and continents. Cultural values influence not only how science is done, but also how science itself might be adopted and integrated in societal practice.²⁰ The GNWG is particularly interested in using and promoting an anticipatory strategic approach instead of a reactive approach to ethical and societal issues with a foundational value of integrating cultural awareness into its research activities. The group’s work in foresight and engagement is largely inspired by the Human’s Brain Project’s strategy for implementing Responsible Research Innovation described below.²² The proactive approach to engagement combined with the intention to integrate cultural awareness represents a novel shift in the practice of neuroscience.

A first, significant result of the GNWG’s work was the formulation and publication of a list of neuroethics questions for neuroscientists²⁰ intended to assist them in identifying potential neuroethics issues in their work. Themes underlying these five neuroethics questions can motivate a diverse set of stakeholders to reflect on near-term to far-reaching—often unexpected—implications of new neurotechnologies, findings about the brain that may result from neuroscience research, and the implementation of emerging innovations.²⁰ A second output was a number of publications in a later special issue devoted to neuroethics which outlined the broad scope of the field and its applications for guiding research and innovation, including fundamental questions relating to philosophy, the integration of diverse cultural perspectives, and the importance of dialogue among ethicists, scientists, and diverse publics ([Neuroethics special issue](#)).

Table 1. Neuroethics Questions to Guide Ethical Research (NeQNs)
<p>Q1. WHAT IS THE POTENTIAL IMPACT OF A MODEL OR NEUROSCIENTIFIC ACCOUNT OF DISEASE ON INDIVIDUALS, COMMUNITIES, AND SOCIETY?</p> <p>1a. What are the possible unintended consequences of neuroscience research on social stigma and self-stigma?</p> <p>1b. Is it possible that social or cultural bias has been introduced in research design or in the interpretation of scientific results?</p>
<p>Q2. WHAT ARE THE ETHICAL STANDARDS OF BIOLOGICAL MATERIAL AND DATA COLLECTION AND HOW DO LOCAL STANDARDS COMPARE TO THOSE OF GLOBAL COLLABORATORS?</p> <p>2a. How can human brain data (e.g. images, neural recordings, etc.), and the privacy of participants from whom data is acquired, be protected in case of immediate or legacy use beyond the experiment?</p> <p>2b. Should special regard be given to the brain tissue and its donors due to the origin of the tissue and its past?</p>
<p>Q3. WHAT IS THE MORAL SIGNIFICANCE OF NEURAL SYSTEMS THAT ARE UNDER DEVELOPMENT IN NEUROSCIENCE RESEARCH LABORATORIES?</p> <p>3a. What are the requisite or minimum features of engineered neural circuitry required to generate a concern about moral significance?</p> <p>3b. Are the ethical standards for research conduct adequate and appropriate for the evolving methodologies and brain models?</p>
<p>Q4. HOW COULD BRAIN INTERVENTIONS IMPACT OR REDUCE AUTONOMY?</p> <p>4a. What measures can be in place to ensure optimal autonomy and agency for participants/users?</p> <p>4b. Who will have responsibility for effects (where responsibility has broad meaning encompassing legal,</p>

economic, and social contexts)?

Q5. IN WHICH CONTEXTS MIGHT A NEUROSCIENTIFIC TECHNOLOGY/INNOVATION BE USED OR DEPLOYED?

5a. Which applications might be considered misuse or best uses beyond the laboratory?

5b. Does this research raise different and unique equity concerns and, if so, have equitable access and benefit of stakeholders been considered?

The next task for the GNWG was the implementation of these neuroethics questions and a culturally-aware approach into a variety of relevant contexts. For this, a natural step was a systematic reflection on public engagement. Integrating a public engagement component into the exploration of neuroethical issues can contribute to increased public relevance of research questions and agendas, to greater insight into lived experiences of disease challenges to various potential solutions that take into account the unique context of individuals and communities, and to provide inspiration and ideas for how to approach an ethically complex research questions or projects.

Publics within international brain initiatives

The emphasis on a richer understanding of public engagement as mutual, interactive dialogue between stakeholders in some neuroscience projects in IBI entities also is supported by approaches related to the Responsible Research Innovation (RRI) framework.^{23, 24} Since its inception, the European Human Brain Project has had a dedicated public engagement strategy including components focused on citizen empowerment and participatory decision-making in research governance under the auspices of the Danish Board of Technology Foundation.²² Similar to the dialogue-driven approach to the Human Brain Project, the Australian Brain Alliance (ABA) and the Australian National Centre for Public Awareness of Science (CPAS) has focused on stakeholder engagement to garner government and citizen support for neuroscience and for the Australian Brain Initiative. The ABA recognizes and promotes the field of neuroethics through public forums, influencing policy, and increasing patient empowerment to encourage early conversations around neurotechnologies and their potential users.²⁵

The recently-initiated Canadian Brain Research Strategy (CBRS) includes a commitment to neuroethics and public engagement through community-based participation including clinical populations in research and through frequent presence by Canadian researchers in the public news media discussions of the policy implications of neuroscience and technology. An important part of the CBRS public engagement landscape are the special rules under Canadian codes of research ethics for research involving the Indigenous community, where engagement is mandatory and there is a preference for collaborative and participatory research where appropriate.²⁶

Other brain initiatives interact with public audiences using different approaches. For example, the NIH BRAIN Initiative communicates through websites, social media, printed pamphlets, press releases and interviews; organizes symposia and exhibits for science conferences; builds awareness with programs for younger audiences (e.g. Brains are Us, Brain Awareness Week), supporting women in STEM, and investigators (e.g. the Annual US BRAIN Initiative Investigators Meeting) and funds research into lived experiences of participants in research and in the clinic. The Korea Brain Initiative conducts neuroscience outreach activities, primarily focused on engaging trainees and students out of the Korea Brain Research Institute (KBRI). The Japan Brain/MINDS Beyond initiative aims to promote programs and collaboration between initiative partners. The China Brain Project's outreach efforts aim to reduce stigma surrounding

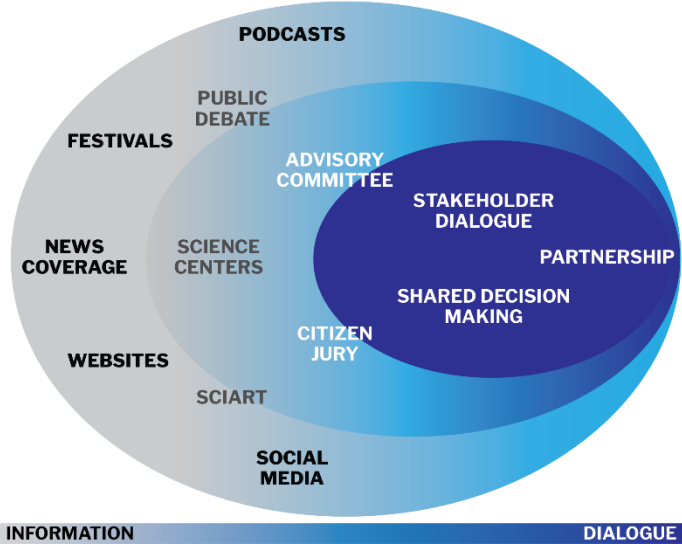
neuropsychiatric disease and mental health—with a particular focus on social media to address the cultural challenges in establishing brain banks. The Australian Brain Alliance (ABA) holds public events on neuroethics, and science and society. Their annual “Brains on the Hill” event at Parliament House provides an opportunity to engage political leaders in science and their “Brain Champions” campaign provides a mechanism for members of the public to support brain science research and translation. The ABA works with the Australian Neuroethics Network and the Australian Research Council Centre of Excellence for Integrative Brain Function (through its public engagement platform, the Brain Dialogue), to run public engagement and education events focusing on the legal, ethical and societal implications of neuroscience research.

These efforts might more accurately be called “public understanding of science” activities, which we discuss below.

Public understanding of science and public engagement with science

In each one of the above interactions between experts and public audiences, the various brain initiatives considered multiple dimensions that lead to different programmatic choices. The goal of the

Figure 2: The Spectrum of Activities from Public Understanding of Science to Public Engagement with Science



interactions; the specific topic and focus; the attitudes, behaviors, and expectations of public participants; and the attitudes, behaviors, and expectations of experts all influence the nature of this work. These factors combine to create a spectrum within various types of models that frame how scientists, educators, humanity scholars, health care professionals, artists, policymakers, and diverse public audiences interact with science, as well as its societal impacts. This spectrum, shown in **Figure 2**, stretches from unidirectional communication of information (in gray) to a mutually-informing dialogue model based on participation in the public engagement of science (in blues).^{27, 28}

Many current neuroscience outreach efforts fall under the umbrella of *public understanding of science*, where the goal may be to demonstrate a phenomenon, build excitement about science and its benefits, or inform about an issue—often a one-way dissemination of information with experts in control.²⁹

Information about science alone, however, cannot guide the choices that are made about science and technology at the individual, community, or societal level. Ethics, cultural values, and impacts on future generations are among the factors that must influence our understanding and applications of science, and are often best explored using engagement methodologies. Although there are multiple definitions of public engagement with science, a common thread is a focus on dialogue between stakeholders that creates opportunities for an exchange of perspectives and mutual learning.

With agreement amongst members of the different IBI brain initiatives that public engagement is important and that doing more to increase understanding of the priorities and concerns of different publics will engender trust and support for neuroscience, we embarked on community-building, planning a roadmap forward, identifying key tensions and opportunities, and began discussing a series of critical topical areas that would benefit the most from strategies combining neuroethics and public engagement, or what we term **neuroethics engagement**. Such a collaboration can be transformative and engender growth of the fields of engagement, neuroethics, and neuroscience, and it is especially timely given the momentum of the IBI and its growing influence as a venue for convening critical ideas and activities for the broader neuroscience community. It also can provide a model for other scientific fields at similar stages of development seeking to engage publics in contentious issues in a preventive manner.

III. DEVELOPING A LANDSCAPE AND KEY FINDINGS

Our year-long investigation began with a global landscaping report on neuroscience public engagement through neuroethics including and beyond the centralized efforts of IBI projects.³⁰ Then we hosted a preliminary workshop with representatives from all brain initiatives where trends and public engagement strategies from the landscaping study were used to unveil significant—and sometimes unexpected—neuroscience research topics ripe for neuroethics engagement. The examination of these topics with the larger interdisciplinary audience of the Global Neuroethics Summit revealed potential tension points alongside opportunities for future public engagement efforts.

1. Current Landscape of Public Engagement through Neuroethics

Representatives of the (U.S.) National Informal STEM Education (NISE) Network joined the Global Neuroethics Working Group (GNWG) in early 2019 to help characterize neuroscience and neuroethics oriented public engagement efforts around the globe connected to the NeQNs.³⁰ Using a working definition of public engagement as activities with the potential for two-way interaction between experts and public audiences, we reached out to neuroscientists, neuroethicists, patient advocates, and educators involved in public engagement for a series of expert interviews. Participants were recruited through GNWG connections, professional societies, and literature searches—without filtering for interaction formats or program goals. Some contacted public engagement programs were meant to spark public awareness of and interest in ethical issues, with minimal direct interaction between experts and the public audiences, while others were intended to shape the direction of research or policy through close collaboration between stakeholders. After almost 50 expert interviews, five categories of public engagement styles (see Table 2 below) emerged that are broadly representative of the current state of neuroscience and neuroethics-oriented public engagement.

Characteristic activities of each category shared similar implementation strategies, key features, and outcomes. **Expert discussions for public audiences** were the most common public engagement example found, with many flexible formats and diverse venues, occasionally featuring individuals with relevant lived experiences. **Structured assessment of public opinions and attitudes** included interviews and surveys (when used in conjunction with a dialogical component), and online comment analysis with the goal of identifying community- or population-level attitudes. **Deliberative approaches** were used to enable stakeholders to come together to find points of consensus or to surface clearly defined differences. **Interactive exhibits, public programs, and other informal STEM learning experiences** stressed active, responsive, and social experiences, often leveraging free-choice learning and specialized physical environments. **Inspirational media through partnerships with artists** resulted in popular and

sometimes evocative experiences particularly when accompanied by extended dialogue opportunities. **Partnerships for clinical applications** sought to shape treatment priorities, improve outcomes, or change attitudes often to reduce stigma or increase research participation through dialogue and discussion.

Table 2. Overview of Public Engagement Styles, Goals, Advantages, and Disadvantages

Public Engagement Style	Goals	Advantages	Disadvantages
Structured assessment of public opinions & attitudes Interviews and surveys/online comment analysis (preceded by facilitated dialogue)	To obtain a systematic understanding of community- or population-level attitudes that can help define cultural context and societal values about a particular issue	Useful for shaping research priorities, public policy, or communication strategies Can be administered at scale to reach large numbers of people (i.e. surveys) Can allow comparisons of trends in public opinion at different periods of time	Kind of information obtained, and its accuracy, is highly dependent on design and sampling methodology Finding the right level of background context to elicit meaningful answers can be challenging
Deliberative Approaches Facilitated dialogue Deliberative dialogue	To bring to the surface public and scientific assumptions To allow multiple forms of argument and evidence to be brought to bear on an issue To create forums for mutual understanding and discussion	Useful for exploring issues, values and multiple points of view Possibilities for synthesizing new arguments and forms of evidence Can enable people to come together and find points of consensus and clearly defined differences	Can introduce explosive disagreements Can force consensus or harden differences
Interactive exhibits, public programs & informal STEM learning Exhibitions, often employing multisensory interactivity, new technologies, social engagement, physicality, and flow Public programs such as summer camps, after-school programs, science festivals, or other facilitated learning programs outside of school	To create fun, social learning experiences that spark interest and motivation in participants, while contributing to a personal identity of knowing about and using STEM	Lasting cognitive and emotional connections to physical environments with immersive and interactive components Free-choice experiences that allow formative conversations with peers and facilitators Supported by a professional community of practitioners, especially in museums, with expertise in evaluation and research	Often based on experiences with phenomena and materials rather than dialogue about societal impacts Minimal interaction between museums and other types of venues limits opportunities for peer learning in creating high-quality experiences Depth of impact can be dependent on opportunities for dialogue and debate in association with the programs

Inspirational media through partnerships with artists Artistic interpretations of science, shared in a public forum Narrative performance, e.g. theatre, film, or radio, bringing together artists and scientists	To channel imagination into expression, visualize the unseen in science, or verbalize unspoken emotions, through creative work	Builds bridges between disparate communities by creating a common point of connection Sparks introspection and curiosity about neuroscience by adding context, emotions, and aesthetics Provides relatable characters or situations with which to consider theoretical concepts and ethical quandaries	Art installations or media platforms are often ephemeral, limiting long-term reach Depth of impact can be dependent on opportunities for in-person dialogue
Expert discussions for public audiences Professional conference events Moderated session mixing professional expertise and lived experiences Forums for extended discussion	To bring together experts, representing different perspectives of multiple disciplines, to discuss a particular topic in front of a public audience	Relative ease of implementation Provides opportunities to build professional connections across disciplines Potential opportunities for public stakeholders to provide real-world perspectives to complement and challenge academic experts	The inherent one-to-many style of interaction limits the potential for meaningful dialogue Possibility of perpetuating the deficit model of science communication
Partnerships to guide research or applications Research collaborations between researchers, clinicians, and patients Public participation in research governance Focus groups with patients and end users Online communication and engagement	To bring researchers, medical professionals, patients, and advocates together to shape research priorities, improve participation and health outcomes, improve research and care, and change public attitudes	Outcome-driven engagement can allow patients to shape research priorities Diversity and broader inclusion in biomedical research accelerate progress and improves health Opportunities to grow network-level partnerships of professional and advocacy groups for public engagement	Cultural divides between biomedical research and patient groups can impede collaboration Traditional cultural stigmas, especially with respect to mental illness, can be hard to overcome

As with IBI projects, the breadth of examples of public engagement included in this study reflect the breadth of cognitive and affective goals of science communication and public engagement in general—stretching from sharing the excitement of science to gathering perspectives on societal issues in science from diverse groups.^{31, 32} The interviews revealed public engagement practices incorporating neuroethics concepts, but the strategy of incorporating neuroethics was not consistent across geographic regions or institution types. The absence of neuroethics in public engagement can be due to many factors including lack of in-house expertise to carry out more dialogue-centric programming, regional preferences in STEM education and discourse or simply insufficient levels of funding. Many program representatives who were interviewed expressed enthusiasm for collaboration with ethicists, and other interdisciplinary expertise (e.g. survey methodology, the arts, and evaluation and learning research) but did not have the funding or the right connections to develop and sustain such a partnerships. As with other STEM public engagement efforts, interviews also suggested that changes are needed to academic culture for the continued growth of public engagement in neuroscience, including more institutional recognition for participating faculty and students.

We found some public engagement efforts focusing on these topics explicitly leveraged participants’ lived experiences and emotional connections towards greater mutual learning between experts and public audiences. A majority of the scientists who we consulted reflected that although their research was intended to benefit patients or end users, often public engagement programs were their only opportunity for personal interaction with those they aim to help. On the basis of these consultations and previous work pointing to gaps in neuroethics engagement,^{33, 34} there is an opportunity: dialogical forms

of public engagement about neuroethics can result in meaningful conversations that can have tremendous impact on all participants. Incorporation of neuroethics topics into engagement strategies on neuroscience can facilitate deeper exchange of ideas on the possible value conflicts, expectations for societal outcomes of the science-core issues that often matter the most for publics (and often scientists alike).³⁵

2. Topical considerations for public engagement

Another trend that emerged in the landscaping report was that the five NeQNs are not perceived to have equal status by the neuroscience public engagement community. Our interviews suggest preferences and priorities among the NeQNs that may be based on institutional and regional characteristics, and also differences in key focal topics, with those around neurotechnologies, data privacy, and mental illness more frequently discussed as relevant than others.³⁰ This trend was the basis of further discussions within the working group to have deeper exploration of how priorities in neuroethics mapped to public perceptions and potential engagement strategies.

The GNWG brought neuroscientists, neuroethicists, and engagement experts together in a large international and interdisciplinary forum at the Global Neuroethics Summit in 2019 at Daegu, South Korea, to explore opportunities for public engagement strategies around five “hot topics” reflecting current key thorny ethical issues (Table 3). The topics represent the extremely sharp leading edge of neuroscience, and hence elicited strong professional and personal reactions from neuroscientists, neuroethicists, and public engagement specialists.

From these discussions we arrived at a number of tentative conclusions. First, different topics call for different engagement goals and corresponding strategies. Second, some topics tend to be more polarizing than others, and engagement strategies must be sensitive to these likely reactions in order to engage productively with the different publics. This sensitivity can be particularly evident when addressing contested issues around organoids, human tissue donation, and nonhuman primate research in neuroscience where there may be tension and disagreement amongst different researchers as well as publics and for which these sensitivities can vary across cultures and geographies. Third and perhaps most importantly, for engagement to be most robustly employed, engagement specialists and scientists must align around how to best define the goals of engagement for any specific issue in neuroscience, along with the most appropriate methods that result from these considerations.

Table 3. Topical Neuroscience Issues for Neuroethics Engagement

<i>Topic</i>	<i>Ethical Challenge</i>	<i>Considerations for Neuroethics Engagement</i>
Data sharing & neuroprivacy. From brain imaging to artificial intelligence, neuroscience research and emerging neurotechnologies rely on “big data” and sharing of neural data that can be linked to	How to reap the benefits of sharing neuroscience data while ensuring a truly informed consent of participants and protecting participants’ interests?	As applications of big data become prevalent in everyday life, accompanying ethical concerns have gained widespread awareness. Efforts are underway to consider public reaction and views,

individual identity.		and assist with grounding public dialogue and debate in the current realities of neurotechnology development, sensitivity to neural data, and to generate recommendations for action.
Modeling human attributes. What does it mean to be human? This question is merging tools of neuroscience with philosophy, especially as researchers develop experimental models of human brains including neural organoids and chimeras.	How to develop a deeper and more nuanced definition of consciousness and the human ‘mind’ that synthesizes diverse cultural and disciplinary perspectives?	The question of consciousness has long been brought to public awareness through the arts and humanities. Integrating these efforts with scientific research and philosophical inquiry may help generate a collective conceptualization of consciousness that may help clarify arguments in current debates and drive new hypotheses.
Neuroscience-based policy. Neuroscience informs many areas of public policy, from law to product regulations. In particular, issues in education, healthcare, and welfare services have a unique connection to our understanding of the developing brain and the brain’s susceptibility to neuromodulation technologies.	How to ensure appropriate, fair and equitable application of neuroscience knowledge in the public sphere, especially for vulnerable populations?	On policy issues affecting specific communities, intentional and targeted engagement may be a better strategy than outreach to broad publics. Opportunities for collaboration between scientists, policymakers, and affected community groups could lead to more beneficial policy outcomes.
Human brain banking. Brain tissue samples from diverse populations are essential for advancing neuroscience, but brain banking has been historically limited outside of Western countries and likely influenced by a range of ethical and sociocultural factors.	How can concepts and procedures of consent align with cultural beliefs about autonomy and respect after death?	Science communications around human brain banking has primarily been pursued with the explicit goal of increasing tissue donation. Current efforts focus on raising awareness of the importance of donation, framing it within a relevant cultural context, and simplifying the donor registration process. A multi-directional dialogue could support more fruitful relationships between scientists and the publics a shared understanding of underlying individual and cultural value conflicts.
Nonhuman primate research. ³⁶ Studies of higher brain function and human brain disorders may be accelerated by studying nonhuman	How to balance trust and transparency to facilitate nuanced dialogue about specific use cases, rather than generic discussions of	Government regulation, often moved by public opinion, has shifted the global and geographic trajectory of science with

<p>primates (NHPs) due to the presence of analogous brain structures, behavioral assays underpinned by theoretical neuroscience approaches, and emerging tools for genetic modification. However, both experts and members of the general public have wide-ranging views on using nonhuman animals in research aimed at improving human health.</p>	<p>NHP experimentation related to the implications of utilizing proxies for human brains in research?</p>	<p>nonhuman animal research. The legacy of conversations around the use of nonhuman animals in research has frequently struggled to balance trust and transparency across scientists and the public, and foreclosed opportunities for a nuanced conversation about the ethical implications of brain research. A careful dialogue between neuroscientists, ethicists and publics to frame specific use cases rather than pursuing generic discussions of NHP experimentation may be a helpful precursor to productive public engagement.</p>
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3. Tensions in collaboration

The first step to any type of neuroethics engagement strategies must be open and mutual dialogue between neuroscientists and neuroethicists. Neuroethicists must keep up with science; they must have their concerns grounded in the current state of the science to identify and analyze current and near-future topics of interest for various publics. Neuroscientists often have a narrow view of ethics as a compliance and policing mechanism, and the prevalence of mandatory, click-based research ethics training that has led to reduced trust and lack of understanding of the potential value of partnerships between scientists and ethicists. In addition, partnerships with public engagement specialists can help neuroscientists, and ethicists alike develop the aims and methodologies for their engagement activities, and assist in the translation between the research priorities, ethical issues, needs, values and concerns of different societal groups^{1, 37, 38}. Neuroscience, neuroethics, and engagement with the public could benefit if both groups shifted from *telling/informing* to *listening* to the public. While daunting, the GNWG believes existing tensions such as these associated with public engagement can be productively explored and lead to new methodologies for solving problems. We identified typical impediments relating to interdisciplinary collaborations, particularly between neuroscientists, neuroethicists, and public engagement experts, and list them below (Table 4).

Table 4. Hurdles and Opportunities for Further Exploration

<p>Hurdles in Community Building</p>	<p>Opportunities for exploration</p>
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¹ Public engagement is a specialist field in its own right with a diverse set of practices and methods for engagement. Examples of inventories of engagement methods include: <http://actioncatalogue.eu/>
<https://rri-tools.eu/search-engine>

<p>1. Multidisciplinary partnerships are not incentivized</p>	<p>Academic culture does not always view public engagement specialists and programs as equal partners in the scientific enterprise, leading to fewer incentives and less funding for partnerships across disciplines. Incentive structures can be developed to support the integration of public engagement in neuroscience training and practice to the mutual benefit of all involved.</p>
<p>2. Time is not set aside for establishing foundations of trust</p>	<p>With more attention to different methodologies, definitions, and professional goals of their own respective fields, neuroscientists, neuroethicists, and public engagement specialists need resources and opportunities to create protected time and space to build trust among each other. New forums and venues created to support interdisciplinary trust building with these groups could enhance and normalize such collaborations.</p>
<p>3. Global and cultural awareness is low and not prioritized</p>	<p>Public engagement efforts and even neuroethics have largely been dominated by geographically and ideologically western practices. Global communities working in public engagement could help promote international collaboration and cultural awareness and perspective within neuroscientists and neuroethics communities.</p>
<p>Hurdles in Communication Conceptualization and Practice</p>	<p>Opportunities for exploration</p>
<p>1. Deficit model orientation tends to be default</p>	<p>The bi-directional communication that defines public engagement may not always be desired especially when unidirectional communication or broadcast style communication may be viewed as easier to do. The scientific community are often not oriented to the benefits of also learning from the public. Raising awareness of the state of the art in engagement, particularly in the goals and possible outcomes of specific engagement methodologies could help scientists appreciate the added value of public engagement.</p>
<p>2. Engagement goals are not defined</p>	<p>Neuroscientists, and related academic and industrial organizations may not be ready for the outcomes of public engagement (e.g., if public audiences and neuroscientists simply disagree), especially if uninformed of the latest state of the art with science engagement and stuck in a deficit model orientation. They may also struggle with appropriate ways to act on public input. Training, awareness, and toolkits developed on science engagement could enhance existing efforts, particularly those efforts led in absence of a science engagement specialist, to connect with public communities around scientific and ethical issues.</p>
<p>3. Best practices and assessment are unclear</p>	<p>Engagement practices with neuroscience are more advanced than in issues of neuroethics. Even so, empirical assessment can sometimes be a challenge for all disciplines</p>

	involved in neuroscience public engagement. Rubrics and metrics are needed that highlight the effectiveness of high-quality public engagement could make the value proposition for neuroscientists and neuroethicists easier to appreciate.
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Challenges of community building

There are a number of challenges to community building an interdisciplinary community focused on public engagement. First, it seems the value of multidisciplinary partnership (not just across scientific disciplines but across fields of ethics, biomedical science, and social science) has historically been unclear and often goes unrewarded with many institutions: disciplines tend to exist in silos without natural points of intersection through which collaborations might be sparked, let alone contacts with various publics which do not typically arise naturally. Related, trust³⁹ can be slow to build and comes with the premium of time. To be clear, trust is not just between scientists and the public, but also across ethicists, scientists, and engagement specialists. The concept of trust is used in many disciplines and with different undertones. Directly relevant to science is what is known as epistemic trust, which refers to people’s belief that the knowledge and information provided by science is accurate and reliable and thus can ground decisions at the micro and macro level. Information provided by science is thus trustworthy if indeed reliable and accurate.^{40, 41} Epistemic trust needs to be complimented by transparency on uncertainties or scientific disagreements. It must be clear that society is often facing the need to make decisions in situations where the available scientific knowledge is not free from uncertainty – that fact should not exclude public engagement exercises, but rather should in fact incentivize them. Social trust, that is trust that the individuals/institutions who produce this evidence are motivated by values one shares another critical dimension. is also Studies have shown that the public’s trust in scientists does not necessarily follow confidence in scientific evidence, because trust is primarily determined by shared identities and values.

With different methodologies, definitions, and professional goals of their own respective fields, neuroscientists, neuroethicists, and public engagement specialists need space to build trust in science. Likewise, neuroscientists need to build trust in ethics and engagement processes. In our expert consultations and in our year of collaborative work, we noted that our events offered for a new experience and surfaced many unspoken assumptions about how the respective disciplines should interact. For many, it was the first time neuroethicists, neuroscientists, and public engagement specialists had come together and had the opportunity to articulate the scope of their fields and their methodologies. Academic culture especially does not always view public engagement specialists and programs as equal partners in the scientific enterprise and there are few incentives to participate in public engagement or neuroethical inquiry.

Finally, public engagement efforts and even neuroethics have largely been dominated by geographically and ideologically western practices. Even engagement strategies and design have been modeled primarily by Western expertise and orientation.³⁰ Although it must be noted that methods of public engagement have found wide application across the world, including approaches such as consensus conferences, citizen assemblies and deliberative polling exercises. It would be useful to look to other fields that have used non-Western methods and integrated culturally diverse approaches to public engagement, for instance in participatory action research (PAR) particularly in relation to environmental

and climate change research, as well as public health engagement processes for instance with infectious diseases, vaccines, and other issues.⁴²

We see these tensions as an opportunity to explore models of meaningful partnerships and to develop strategies to align value and incentive structures.

Conceptualization and practice of communication

The science and practice of science communication is a vibrant field. The state of the art in laboratory researchers would be enriched by meeting the state of the art in science communication and engagement. Despite interest and intentions toward public dialogue, deficit models have persisted. Everyone is a member of multiple publics and has a wealth of perspectives to offer. To be clear, taking a deficit model approach likewise will not work to engage scientists in neuroethics discussions either. Just as the public has important views on science, so too do scientists have valuable insights into ethics. The type of multi-directional interactions that define genuine public engagement are not the norm for many scientists, particularly as they have not been trained in such methods and inadequate resourcing is often available to pursue such approaches. Hence unidirectional communication or broadcast style communication seems to be preferred and the method of choice in the broader community and across many, but not all brain projects. The complexity of the brain and the difficulty in understanding neuroscience also impose great challenges to neuroscientists in their dissemination of neuroscience advances intelligibly as well as accurately, without invoking misunderstanding and unwarranted mistrust and fear. To be sure, there may be times when broadcasting information can help to provide opportunities for publics to stay informed. But such efforts should not be considered to be public engagement, and should only be utilized when simple communication of information or public relations is the goal, which brings us to the next point.

An issue related to the deficit model is that communication methodologies are often chosen without articulation of a clear goal. Is the goal to garner public favor and increase enthusiasm? Or, to encourage critical encounters with science for better decision-making? If goals are not made explicit, it is impossible to choose the most appropriate methods to interact with the public. Furthermore, careful consideration of goals requires careful consideration of the potential outcomes that can result from public engagement. Another aspect to consider, is how to translate public input into change, action, or policy. Lack of widespread collaborative partnerships between neuroscientists, neuroethicists and public engagement specialists, can mean that engagement is seen as an exercise to convince one part (often the public) of the viewpoint and benefit of the activity of the other (often science). Bi-directional public engagement activities are not designed to convince, but rather to build understanding and trust, or to co-develop ideas and priorities. A closer collaboration of engagement specialists with neuroethicists, scientists, and policy makers, with a clear match between the goals of the exercise and the method of engagement that is applied, may lead to more fruitful adoption and engagement into scientific practice.

The final tension in communication styles is identifying best practices and assessment: empirical assessment of the effectiveness of public engagement can sometimes be a challenge and is not the norm in public engagement nor in neuroethics.⁴³⁴⁴ However, the value may be difficult to ascertain for particular stakeholders without clear measures and indicators of beneficial outcome. This evaluation is further complicated because specific and formal goal setting is rarely identified before a communication method has been chosen. This is where in collaborations with sociologists, psychologists, and

communication scholars who have skillsets in such empirical work could be invaluable in systematically developing and assessing best practices in neuroethics engagement.

To be clear, the above topics require yet more significant discussion and continued community building across the relevant disciplines before goals can be set and strategies for neuroethics engagement can move forward in effective and productive ways. For neuroscience engagement activities to advance with neuroethics discourse, the state of the science and the voices of scientists will be a critical foundation for surfacing and articulating important ethical issues particularly those that face them in their research practices and their potential applications. Neuroethicists provide important tools and concepts for helping to organize questions to think through in the context of engagement with publics. Public engagement specialists can provide guidance in setting goals and recommending methods in order to lead to robust dialogue and outcomes.

Gaps and Opportunities

Interdisciplinary approaches to public engagement can be the spark for a new, international network of practice that can more effectively convene researchers and diverse publics in order to generate both public and professional impacts. Our work to date has revealed several cross-cutting challenges, impediments, and opportunities. The landscaping report³⁰ demonstrates examples of neuroscience public engagement efforts connected with neuroethics, but also shows that these efforts are not consistently offered across geographic regions or institution types. International brain research projects, localized research centers, and individual scientists have different goals around public engagement and different levels of access to or partnerships with neuroethicists and public engagement experts. There is a need for more collaboration among neuroscientists, neuroethicists, and experts in other fields such as communications, public engagement, social sciences, the arts, and evaluation and learning research.

As we consider the varied approaches and stakeholders that must be involved in any public engagement effort, clear articulation of goals, along with intentional design of strategies to meet those goals, is critical for success. By responding to the challenges and opportunities for exploration, our discussions have identified two broad sets of strategies for neuroscience researchers from various fields to coalesce around shared goals to maximize the impact of public engagement in neuroscience and ethics (Table 5). With respect to *community building*, defining engagement in partnership with public stakeholders will allow clearer articulation of the goals and expected outcomes of potential engagement activities. Collaboration and dialogue during planning facilitates mutual learning during practice. In addition, the global work of the IBI has prioritized the importance of integrating cultural awareness and we need to continue to find collaborative ways to do so, drawing on successes in other fields. Societal values influence both perceptions of science and norms of engagement, and it is essential for scientists to recognize, embrace, and learn from diverse perspectives and traditions. Cultivating these relationships is a necessary foundation for then *conceptualizing communication and practice*. There likely is no one-size-fits-all approach to public engagement with neuroscience and neuroethics; in order to map neuroethics questions first it is necessary to characterize the relevant issues. Once focused, developing tools for researchers to create, evaluate, and disseminate effective engagement strategies will lower barriers to participation and help diminish reliance on deficit models. Thoughtful approaches to engagement—especially when broadly applied within subdisciplines—can lead not only to shared learnings with

greater impact, but to sustainable interdisciplinary relationships that can inform future neuroscience research and relevant ethical questions.

In **Table 5**, we outline these opportunities with recommended questions and activities to facilitate strategic development of public engagement in neuroethical and neuroscientific issues. These opportunities can be explored at multiple levels—whether by an individual researcher, a collective group within a subdiscipline, or decision makers shaping the underlying systems of scientific research such as funding or research priorities.

Table 5. Proposed strategies for development of neuroscience and neuroethics engagement.

Strategies for Community Building	
<p>Key questions</p> <p>Can we develop a framework for bringing interdisciplinary communities together?</p> <p>What are the shared goals of public engagement?</p> <p>How does culture intersect with goals and strategies for public engagement in neuroethics?</p>	<ul style="list-style-type: none"> ● Create shared definitions: Set expectations and define common ground between functional collaborative groups of scientists, ethicists, and public engagement experts. ● Work locally to build trust: Start with local collaborators to build working relationships, establish shared values, and engage diverse publics. ● Work globally to broaden reach: Leverage connections to existing international networks in each field to build momentum, draw in broader expertise, and advance mutual learning across disciplines ● Explore cultural context of scientific research and neuroethics topics: Build on the design of the NeQN to articulate a framework of how cultural awareness can shape discussions of neuroethics questions across global scientific, ethical, and public stakeholders. ● Explore the cultural context of public engagement. Strive for cultural competence in public interactions by building partnerships, distributing power, and working toward shared goals. ● Track emerging neuroethics issues: Within subdisciplines, researchers can capture and share relevant questions emerging in real-time across different countries (prospective/retrospective).
Strategies for Communication Conceptualization and Practice	
<p>Key questions</p> <p>What are the ethical issues relevant to an area of research?</p> <p>How do different stakeholder groups view these issues?</p> <p>What do scientists and ethicists hope to learn from public engagement activities and how will they act on public input?</p>	<ul style="list-style-type: none"> ● Identify specific ethical concerns: Across subdisciplines of neuroscience, the intersection of research and ethics can include questions of safety, privacy, confidentiality, autonomy and agency, unintended uses of research, and equity. Researchers should prioritize specific questions for public engagement in their work. ● Assess public viewpoints: Transdisciplinary connections in the arts, law, social sciences, or policy can inform researchers’ understanding of our current

<p>How can researchers operationalize public engagement?</p>	<p>knowledge of the range of views amongst publics on scientific questions about human identity and the brain or concepts like consciousness, decision-making, and privacy.</p> <ul style="list-style-type: none"> ● Catalog the landscape: As public engagement activities proliferate, build on the IBI’s initial landscaping report (https://www.nisenet.org/brain) to document and share learnings across the field. ● Develop an open-source toolkit for neuroethics engagement: As different methodologies are implemented and evaluated, consolidate a toolkit specific to neuroethics, identifying goals, strategies, audience, and cultural context, and mapping out a guide to best practices. ● Catalog the landscape: As public engagement activities proliferate, build on the IBI’s initial landscaping report (https://www.nisenet.org/brain) to document and share learnings across the field. ● Build systemic support for engagement: In the long term, align public engagement as an integral component of innovative, responsible research and transform scientific culture to support training and incentives amongst neuroscientists for participating in public engagement research and practice.
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IV. CONCLUDING REMARKS

Scientific excellence should not be seen as a concept independent of ethics or public engagement.

Neuroethics and public engagement methodologies, when integrated, can ensure that the emerging frontiers of neuroscience are their most positively impactful and attuned to societal needs and cultural values. Neuroscience, as a field, is committed to interdisciplinary approaches to explore and understand our brains and nervous systems with ultimate goals of understanding behavior and cognitive life. By addressing the ethical, philosophical, societal and regulatory issues raised by neuroscience, neuroethics aims to be of service to both science and society. Something similar can be said of public engagement which empowers people to be part of science. Together, neuroethics and public engagement can lead to science that is better because it is guided by informed decision-making and supported by the public.

In the context of our Global Neuroethics Working Group, we have explored current neuroethics and neuroscience engagement efforts, developed prototypes and tools facilitating neuroethics engagement activities, and also considered some critical issues that could undermine or facilitate neuroethics engagement efforts. Ethics can be a useful entry point for public engagement with science. Neuroethics can be a useful entry point for public engagement with neuroscience, because of global awareness of the importance of brain science and brain-inspired artificial intelligence, as well as the societal urgency in treating brain disorders. With neuroscience, we have a unique opportunity to be strategic versus opportunistic in considering priority areas, goals, and best strategies for engagement. Given the rapid

pace in advancing neuroscience, society will face increasingly complex ethical issues that will warrant community participation and dialogue, ideally before such issues become high profile or controversial via social or other forms of popular media. The public can play an integral role early and throughout technology development and research prioritization in actively engaging with neuroethical issues so that they can be jointly considered proactively and not reactively. The IBI has given us a unique opportunity to facilitate such public engagement by allowing deeper intercultural examination of neuroscience and neuroethics, and creating a space for co-construction of strategies and solutions that will be aligned with public benefits.

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