

## Neuroethics Engagement

In recent years, the field of neuroscience has increasingly recognized the need for new strategies to increase public understanding of current research and explore areas of public concern (Global Neuroethics Summit Delegates et al., 2018; NASEM, 2021). In response to this need, the Changing Brains project aimed to create opportunities for multidirectional learning among members of the public, scientists, educators, policymakers, and others through the development of evidence-based, scalable, and inclusive new approaches to neuroscience public engagement. Specifically, our work focused on expanding the new field of **neuroethics engagement**, combining best practices of STEM public engagement with the principles of neuroethics.

*Neuroethics engagement explores the ethical and societal implications of neuroscience research and neurotechnology through best practices to engage diverse audiences with scientific issues for mutual learning and dialogue.*

As described in the model proposed by Das et al. (2022), neuroethics engagement also involves the cultivation of personal and interpersonal attributes among participants, such as reflexivity and creativity, and ultimately results in beneficial societal outcomes:

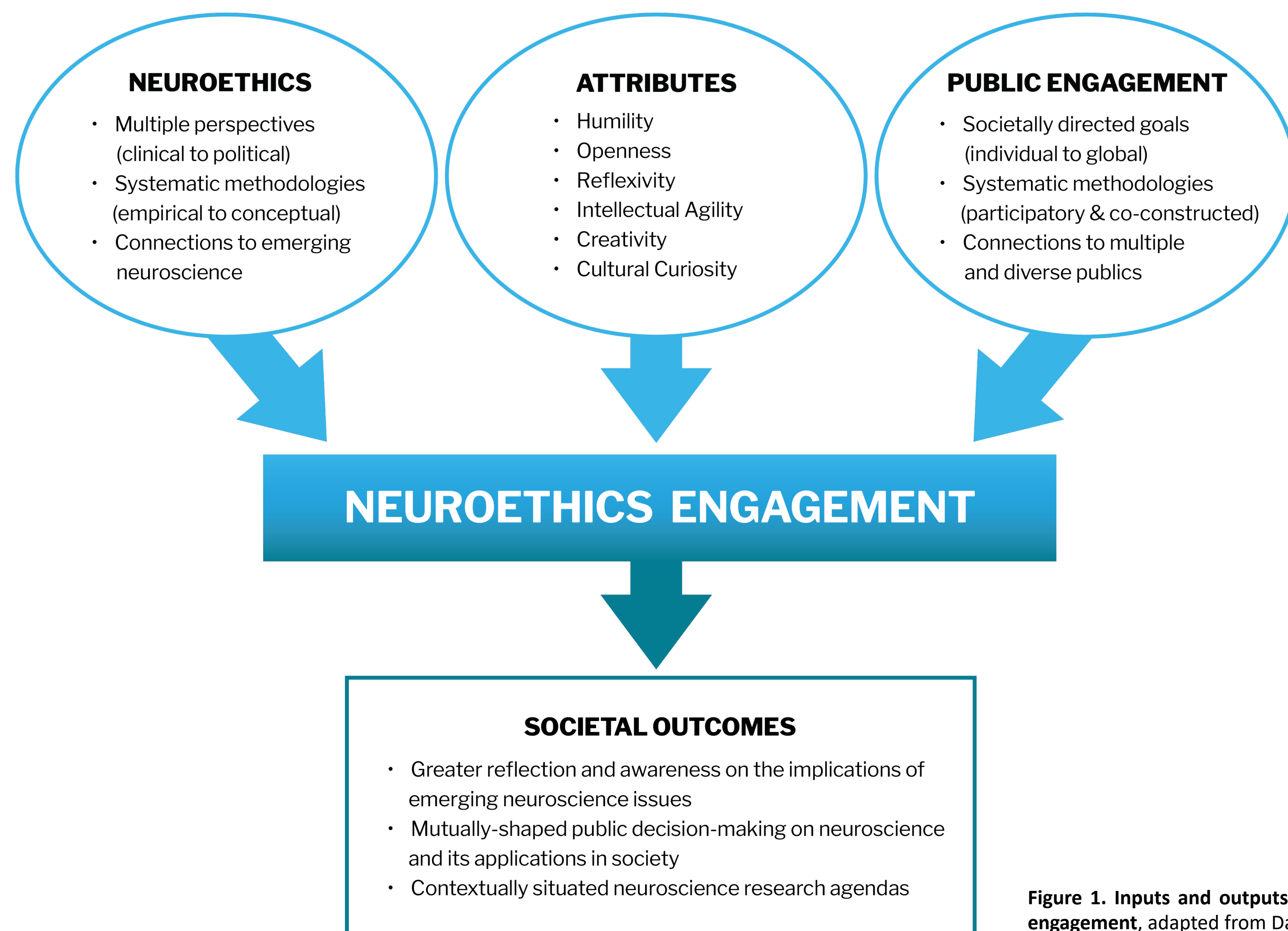


Figure 1. Inputs and outputs of neuroethics engagement, adapted from Das et al. (2022).

## Identifying Key Neuroethics Issues

Neuroethics engagement should address issues that *require* input from all parties, focused on relevant and accessible questions that are “easy to understand but hard to answer” in which each participant has insights to contribute and opportunities to learn from others. Through conversations with **over 40 expert stakeholders** including neuroscientists, ethicists, policy and law professionals, and educators, we identified two key areas ripe for neuroethics engagement:

- Development of new neurotechnologies** such as brain-machine interfaces, deep brain stimulation, and others
- Modeling human attributes** through artificial intelligence, brain organoids, and other approaches

Additional insights gained from these stakeholder interviews include the need to **prioritize cross-cutting themes** (e.g. privacy, agency, identity, diversity & inclusion, equity & access), **support multidirectional learning** (“science doesn’t belong to scientists”), **make neuroethics relevant** (connect to values, morality, and/or religious beliefs as well as topics of interest such as mental health and neurodiversity), and **support productive reflection and discussion** (consider terminology and framing, such as different interpretations of the word “ethics”).

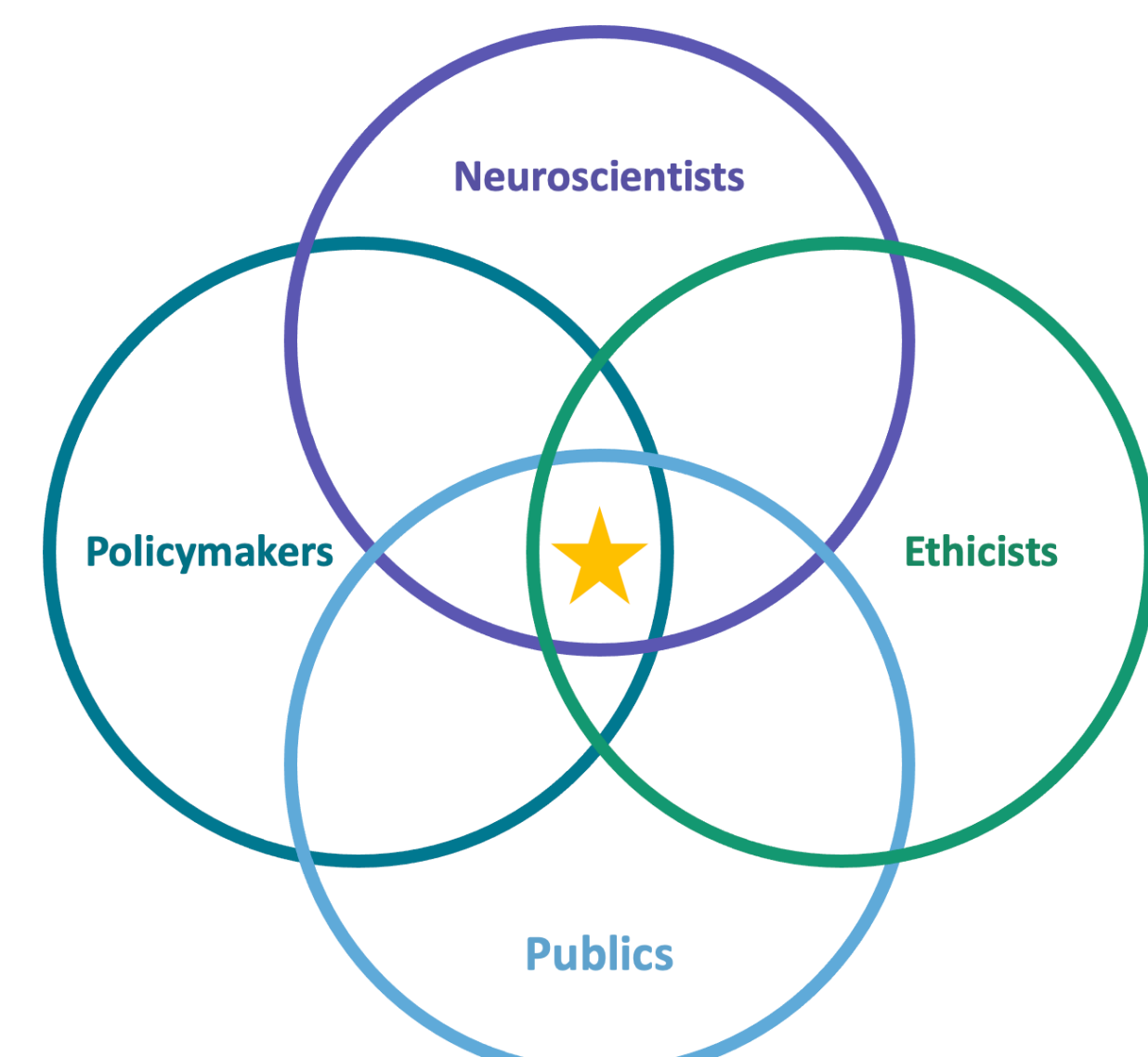


Figure 2. Neuroethics engagement occurs at the intersection of stakeholder interests, including those of scientists, ethicists, policymakers, and publics.

## Developing New Tools

Drawing on prior NISE Network projects at the intersection of science and society, we developed prototype engagement activities to be tested in the context of informal learning spaces such as science museums. We sought a mix of formats: **broad engagement** activities that cover a range of topics in relatively short amount of time, suitable for diverse groups and settings; **deep engagement** activities designed for more in-depth conversation about specific topics, typically designed for teens and adults; and **experimental approaches** to neuroethics engagement, integrating science with arts.

The logic model below describes key inputs and resources; project activities and outputs; learning goals for individual activities; and outcomes and broader impacts for a program of neuroethics engagement over time. Each activity aims to provide participants with opportunities to practice **personal attributes** and **interpersonal skills** that have been suggested as critical for productive neuroethics engagement (Das et al., 2022). Intended outcomes of neuroethics engagement activities over time include **strengthened self-efficacy** in discussing neuroscience topics and personal values and **increased awareness of neuroethics** issues and questions. Ultimately, this could lead to opportunities for wider stakeholder input in neuroscience research and policy.

### Logic Model for Neuroethics Engagement

**Purpose:** Support mutual learning about neuroscience topics and their ethical implications for society among scientists, ethicists, policy makers, educators, and members of the public.

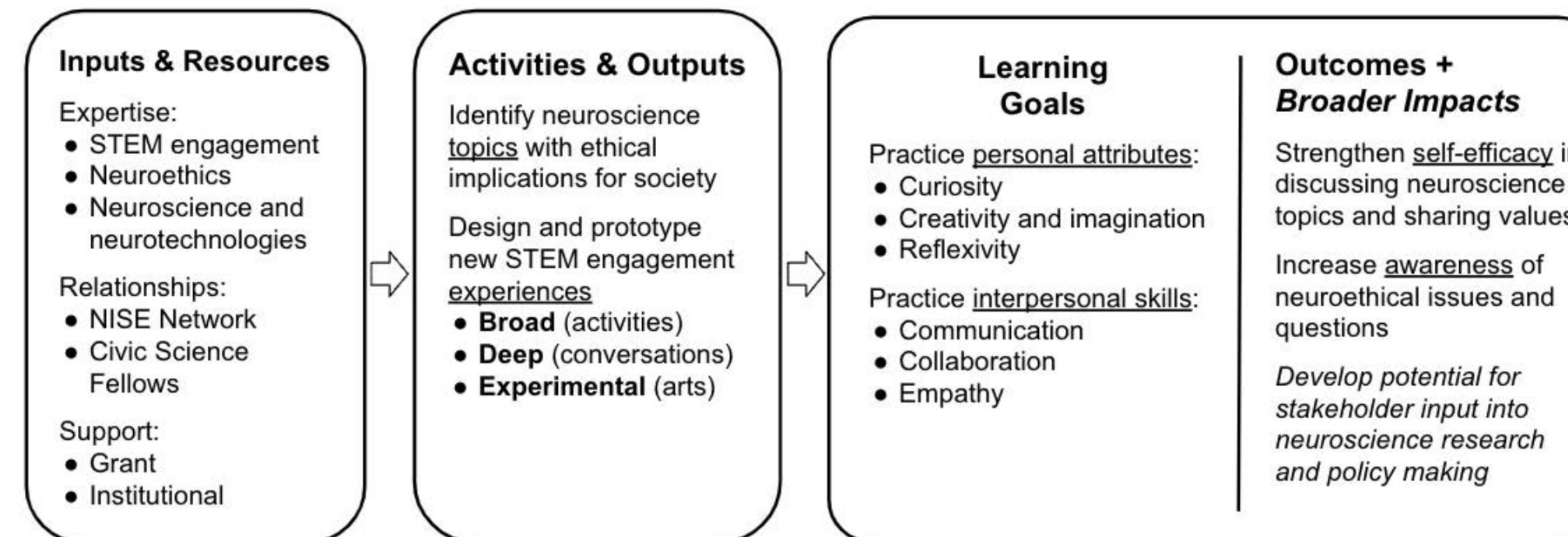


Figure 3. The Changing Brains logic model for neuroethics engagement.

After prototyping, three broad engagement activities were developed into completed neuroethics engagement resources. (For more information about the deep and experimental approaches, visit [nisenet.org/brain](http://nisenet.org/brain)). Each of these hands-on activities is designed to promote reflection and dialogue among adults, teens, and families.

### Neuro Futures Card Game

*How might future brain technologies change our society? How can we include diverse perspectives and priorities in the development of brain technologies?*

- Participants prioritize emerging neurotechnologies from their own perspective, then from a fictional character’s perspective
- Card decks, facilitator guide, and training materials available online



### What Makes Us Human Card Game

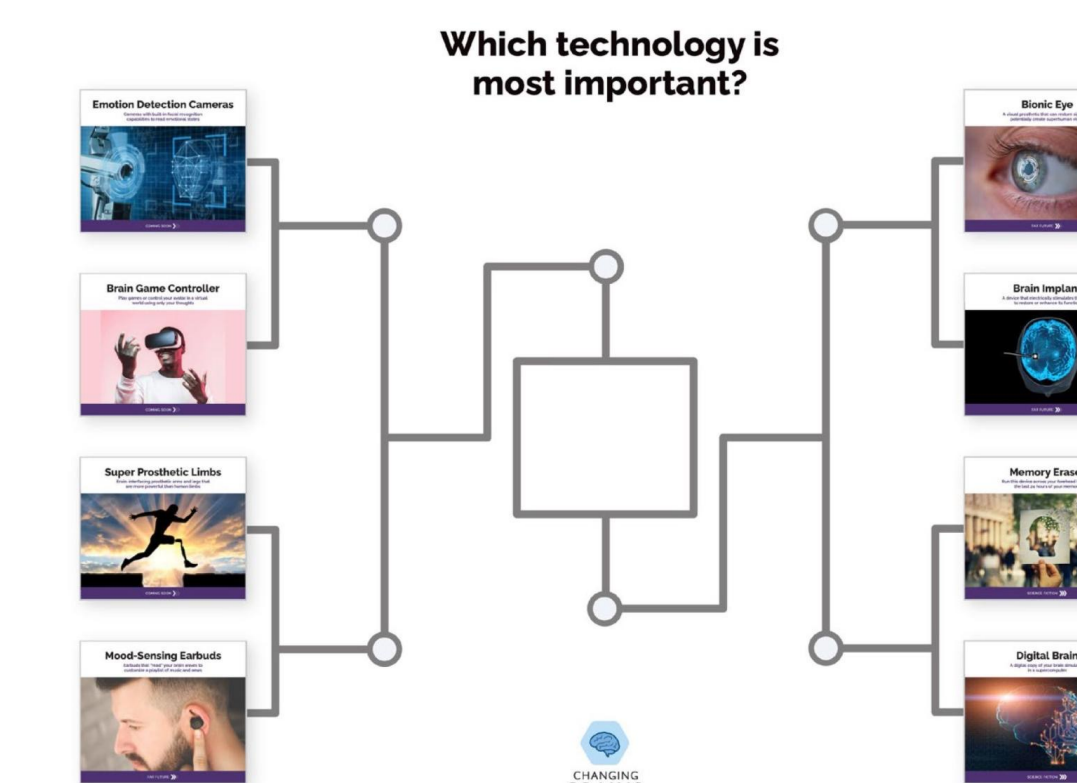
*What does it mean to be human? What is unique about the human brain? How human-like could machines become? What would be the risks/benefits?*

- Participants consider which abilities are most uniquely human, then design a fictional robot incorporating some of those abilities
- Card decks, facilitator guide, and training materials available online

### Neuro Futures Championship Game

*How might future brain technologies change our society? How can we include diverse perspectives and priorities in the development of brain technologies?*

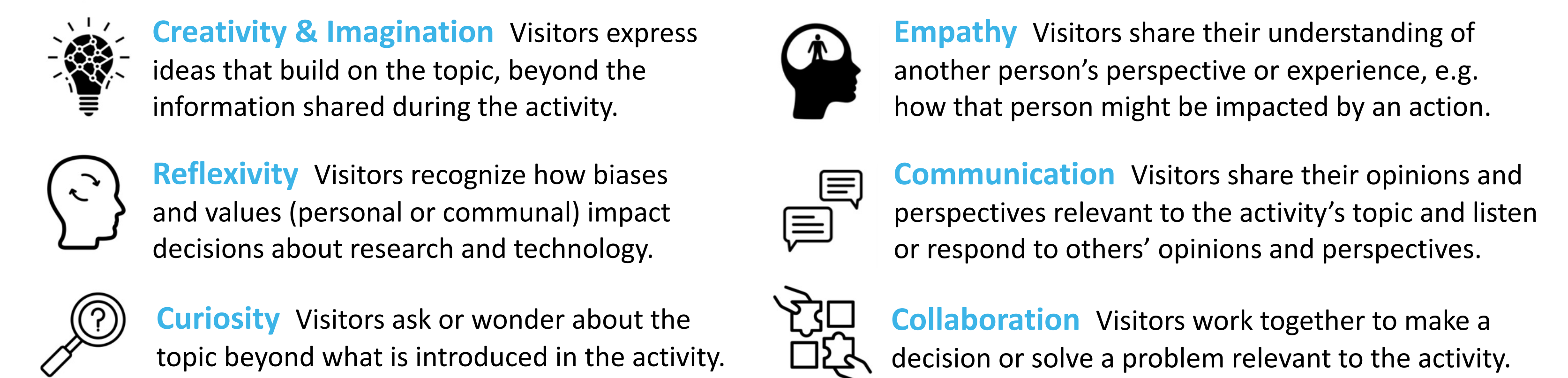
- Participants discuss the implications of neurotechnologies using a sports-style bracket, working together to pick their top technology
- Bracket board, cards, facilitator guide, and training materials online



## Evaluation & Participant Reflections

A **formative evaluation** was conducted to understand how participants interact with the activities for the purpose of future improvements, exploring to what extent the activities promote our learning goals. Visitors at the Arizona Science Center were observed during the activities and invited to participate in a short interview afterwards. The study was exempted by the Arizona State University institutional review board.

Eligible visitors included **adult-only and family groups** with at least one participant over 8 years old. Verbal consent was obtained from adults for themselves and/or their children, and additional verbal assent obtained from participants under 18. Each activity was tested with two facilitators between December 2022 and January 2023. Across all three activities, **137 visitors** participated in **47 groups**. Observations and interviews were coded based on the personal attributes and interpersonal skills for neuroethics engagement:



The three activities were found to promote each of the attributes and skills to varying degrees (Figure 4), and specific design strategies of the games were identified as potentially facilitating these experiences (Figure 5). Additionally, **96% of interviewed participants** found the game they played interesting, with a majority stating they would play again. Sample quotations below reflect some themes raised by participants in interviews.

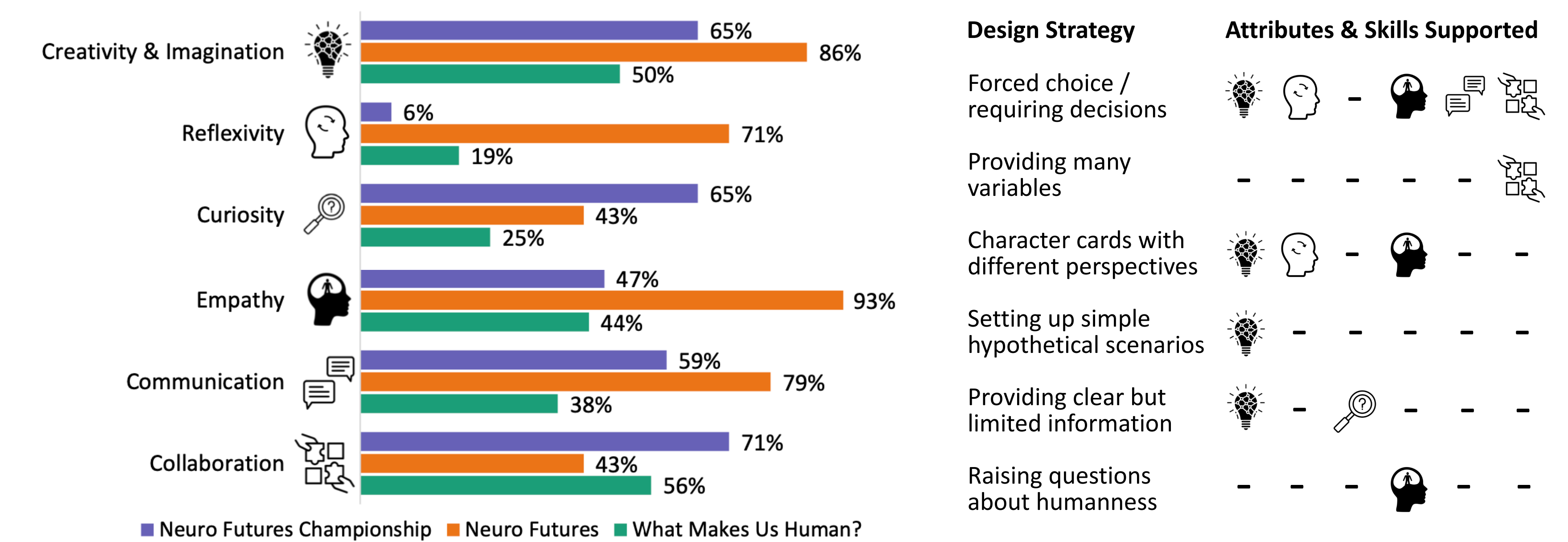


Figure 4. Prevalence of observed personal attributes and interpersonal skills at the group level (N=47 groups) as a percentage of total groups participating in each activity.

Figure 5. Design strategies hypothesized to support personal attributes and interpersonal skills; see icon key above.

### I think this activity is about...

*“Where we’re going as a society, where our values are.”* (52-year-old)

*“More ethical [issues] than straight facts.”* (31-year-old)

*“Reflecting on what we want to see ... thinking about ourselves and others.”* (28-year-old)

*“Very philosophical ... So often we think science is objective, but all [museum] exhibits have a perspective ... this brings it more to the surface.”* (36-year-old)

### What would you want to tell or ask a neuroscientist after playing this game?

*“How accessible the tech would be – is it only the rich who get access to it?”* (19-year-old)

*“Try to create things that will help the most [people].”* (11-year-old)

*“Remember Oppenheimer!”* (52-year-old)

*“Don’t mess with our brains – the brain is you!”* (20-year-old)

*“I’d tell them to get more input from a variety of different people, because not everyone thinks the same way ... before making something that affects everyone.”* (36-year-old)

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### References

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