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ARTICLE

A comparative analysis of attitudes toward neuroscience and the application of information on the brain between the public and neuroscientists in Japan

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Abstract

Recent technological advancements have expanded our capacity to observe, decode, and modulate human brain activity. As these brain information (BI) technologies evolve, it becomes increasingly important to address relevant ethical, legal, and social issues and to communicate them effectively to the public. However, meaningful dialogue has been hindered by a limited understanding of how attitudes toward BI technologies differ between experts and the public. To address this gap, we examined the perspectives of both groups through surveys involving neuroscientists (N = 108) and non-expert citizens (N = 2000). Our findings indicate that, while both parties are concerned about data governance, non-expert citizens also expressed interest in threats to psychological continuity, whereas neuroscientists prioritize scientific content and the risks of stigmatization. These differences underscore the importance of framing discourse on BI applications to encompass both concerns raised by two prominent stakeholders, fostering constructive exchanges grounded in mutual understanding.

Keywords

Public perception of science and technology; Public understanding of science and technology; Science and media

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1 ▪ Introduction

Neuroscience has undergone unprecedented progress over the past decades, driven by advances in neuroimaging, neurophysiology, neurostimulation, computational modelling, and artificial intelligence (AI). Correctively referred to as brain information (BI) technologies hereafter, these developments have greatly expanded our capacity to observe, decode, and even modulate brain activity with remarkable precision and speed. For instance, brain-computer interfaces (BCIs) are increasingly progressing from laboratory experiments into clinical applications, offering new hope for restoring motor and communication abilities in individuals with neurological conditions such as stroke, spinal cord injury, and amyotrophic lateral sclerosis [Wolpaw et al., 2002; Chaudhary et al., 2016; Cervera et al., 2018; Levett et al., 2024]. Beyond clinical use, BCIs are also explored for a growing range of non-medical applications, including entertainment, mental wellness, and commercial activities [Nijholt et al., 2022; Alohaly, 2024].

Recognizing the transformative potential of data-intensive human neuroscience, many countries have prioritized research in this field by establishing dedicated policies and funding large-scale research initiatives, such as the BRAIN Initiative in the USA (2013–present) and the Human Brain Project in Europe (2013–2023). Notably, these programs also address the ethical, legal, and social issues (ELSI) arising from neuroscience research [Greely et al., 2016].

A broad range of neuroethical issues has been discussed in ELSI research in neuroscience. Some of these discussions directly address the data management schemes appropriate for recent data-intensive neuroscience research, exploring how to promote global collaboration while ensuring data protection [Wiener et al., 2016; Eke et al., 2022]. Others address various ethical questions unique to neuroscience, such as the acceptability of cognitive neuroenhancement [Jotterand & Dubljević, 2016] and the alleged psychological discontinuity after undergoing deep brain stimulation [Gilbert et al., 2021], whereas some focus on broader concerns, such as the protection of research participants, public engagement, and diversity in research communities [Feinsinger et al., 2022; Mendez et al., 2022; Taylor & Rommelfanger, 2022]. Both neuroethicists and neuroscientists engage with these topics, often highlighting different normative questions [Ishida et al., 2023]. Recently, ELSI discussions have been framed within Responsible Research and Innovation (RRI), a comprehensive approach to the entire ecosystem of knowledge production [Stilgoe et al., 2013; Stilgoe & Guston, 2017; Salles et al., 2019], as indicated (for instance) in the Organisation for Economic Co-operation and Development (OECD)'s 2019 *Recommendation on Responsible Innovation in Neurotechnology* [OECD, 2019]. These RRI-oriented debates have emphasized the potential effect of this cutting-edge scientific domain on our social values. This concern led to the concept of "neurorights" — human rights to safeguard brain function and neural data from misuse [Ienca & Andorno, 2017; Ienca, 2021b; Yuste et al., 2017, 2021] — though its practical relevance remains debated [Bublitz, 2022].

In Japan, the general treatment of biomedical and health data is governed by the "Act on the Protection of Personal Information". In addition, "Ethical Guidelines for Medical and Biological Research Involving Human Subjects" has influenced the conduct of research and development in biotechnology in Japan. The discussion on neuroethics grew significantly from the 2000s to the 2010s. Nakazawa et al. [2022] identified five major topics and challenges that have been actively debated: informed consent in psychiatric research and

public-patient engagement, global framework creation for neuroscience research using reliable samples and data, ethical support regarding the construction of brain banks and the research surrounding their use in Japan, the study of neuromodulation technologies that affect emotions, and a reexamination of neuroscience and neurotechnology from social perspectives [Nakazawa et al., 2022]. However, this discourse has recently subsided, deviating from global trends. With the rapid advancement of neuroscience research and the evolving situation surrounding the use of BI and brain-related information, the pressing need for active ELSI discussions is increasing.

In the development of Japan's science and technology policy, discussions and responses on ELSI are expected to play a key role in the advanced life sciences [Cabinet Office, 2016, 2019, 2020, 2021a, 2021b]. Moreover, the "Artificial Intelligence Strategy 2021" also highlights ELSI-oriented discussions concerning the use of BI [Cabinet Office, 2021a]. Researchers are now expected to play a more active role in addressing ELSI within society. Since the Second Science and Technology Basic Plan in 2001, researchers have been encouraged to engage in public communication and actively disseminate information [Cabinet Office, 2001]. The Fifth Science and Technology Basic Plan, approved by the Cabinet on January 22, 2016, emphasizes strengthening the relationship between science, technology innovation, and society, as well as promoting co-creation (or *kyoso* in Japanese), reemphasizing the need to promote broader science communication and collaborative shaping of research and policy agenda among relevant stakeholders [Cabinet Office, 2016]. This direction is sustained in the Sixth Science, Technology, and Innovation Basic Plan [Cabinet Office, 2021b].

While communication activities have been encouraged, the accumulation of sufficient information for effective communication remains limited. To build a communication infrastructure for emerging science and technology, such as BI, it is essential to understand public concerns and the factors influencing public acceptance. Simultaneously, the scientists' interests and attitudes, as well as the gaps in interest between the public and scientists, should be considered.

Similar surveys in Japan have been conducted in stem cell research and regenerative medicine [Shineha et al., 2018], and genome-edited food (GEF) [Kato-Nitta et al., 2019; Shineha et al., 2024]. In the case of stem cell research and regenerative medicine, findings revealed that while experts acknowledged the importance of topics and factors on the mechanism and scientific validation of regenerative medicine, the Japanese public was more concerned about governance issues after implementation, including cost, risk management, and clarification of responsibility and liability [Shineha et al., 2018]. For international comparison, these Japanese trends are similar to those observed in South Korea [Shineha et al., 2022]. For GEF, studies have shown that the Japanese public holds a "wait and watch" attitude, with high demand for basic information and concerns about effective risk governance systems. However, experts emphasized the adequacy of the mechanism, the necessity of technology, and trust in the scientific community [Shineha et al., 2024]. Interestingly, the Japanese public showed moderate attitudes toward GEF compared with genetically modified organisms [Kato-Nitta et al., 2019]. These findings indicate that differences in concerns may not necessarily extend to other topics. It is important to conduct detailed analyses and communicate on each emerging science and technology, including neuroscience. In addition, previous studies have shown that mass media discourse shapes public attitudes toward biotechnologies such as stem cell research and regenerative medicine [Shineha, 2016; Shineha et al., 2017]. Therefore, it is valuable to examine how

media coverage influences public understanding of neuroscience and the associated ethical and social concerns.

In previous literature on public attitudes toward ELSI in neuroscience — such as research by MacDuffie et al. [2022], an online survey conducted in the US — differences in attitudes regarding the prioritization of ethical guidelines for neuroscience were examined. They surveyed 1,088 members of the public and 66 industry professionals, finding differences in privacy, stigma, consent, and enhancement. Notably, industry professionals expressed confidence that their neural devices could address ethical concerns in their designs.

However, large-scale comparative surveys had not previously been conducted in Japan. Therefore, in this study, we aimed to identify the concerns of the Japanese public regarding neuroscience and the application of BI. We also sought to identify differences (or lack thereof) in concerns between experts and the general public to facilitate discussions on ELSI concerning neuroscience and improve communication between these two groups. Understanding these differences will provide fundamental data for improving the governance of human brain data and BI technologies.

2 ▪ Materials and methods

We conducted an online questionnaire survey, recruiting respondents from neuroscience-related academic societies via calls for participation posted on their websites or by emailing them [for similar studies using a comparable methodology, see Shineha et al., 2018, 2024]. The academic societies included science-oriented ones (e.g., Japan Neuroscience Society), clinical neurology-oriented ones (e.g., Japan Neurosurgical Society), and those at the intersection of neurology and psychiatry (e.g., Japanese Society of Psychiatry and Neurology). We also recruited participants from the Center for Information and Neural Networks Integration (CiNet), a major neuroscience research institution in Japan. The survey was conducted between July 9, 2022, and August 19, 2022, and included 108 respondents referred to as "neuroscientists" in the subsequent text. For the non-expert sample, we recruited 2,000 respondents through Rakuten Insight Co., Ltd. and collected 2,000 completed questionnaires, ensuring equal representation across different age groups and genders. The survey was conducted between July 4, 2022, and July 5, 2022. In the subsequent text, these respondents are referred to as "the general public".[1]

At the beginning of the questionnaire, we stated the purpose of the survey and how the data would be used. Respondents answered the questions after agreeing to this purpose and were given the option to opt out and delete their responses. The study was explained to respondents in the online questionnaire, including that participation would occur online and that all data would be de-identified and reported only in the aggregate. No sensitive questions were included in this survey (Supplementary material 1). All participants acknowledged an informed consent statement to participate in the study through Rakuten Insight Co.

Table 1 shows a summary of the basic structure of the survey, including examples of the actual questions (originally administered in Japanese and translated into English). The

1. This is not to assume there would be such a monolithic entity as "the public", either in Japan or elsewhere. We refer to the group of respondents — who we believe represent Japanese citizens in terms of age and gender — as "the general public" merely for the sake of brevity, following the terminological custom in similar survey studies.

questionnaire compared the perspectives of the general public and neuroscientists on what they wished to learn about and communicate regarding the use of BI technologies, the key factors influencing societal acceptance of BI applications, and the impact of mass media coverage on neuroscience and BI use.

We conducted a cross-table analysis to compare attitudes between experts and the public with chi-squared tests. We used SPSS 26.0 for our statistical analysis.

Table 1. The basic structure of the survey items.

Theme	*Focused themes*	*Sample questions*	*References on previous studies*
Recognition of BI	Recognition of keywords of BI Opinions on the promotion of neuroscience Opinions on the promotion of BI Opinions on social acceptance of BI Opinions and expected fields of application of BI	For experts/non-experts: "Do you approve or disapprove of the promotion of neuroscience research? Circle one from 5 (Approved) to 1 (Disapproved)." For experts/non-experts: "Do you think the use of brain information for the following purposes will become accepted in the future? Circle one for each item from 5 (Acceptable) to 1 (Unacceptable)."	[Shineha et al., 2018; Kato-Nitta et al., 2019]
Interest topics on BI	Interested topics for communication Important factors for social acceptance	For non-experts: "What would you like to know in relation to the use of BI? Please select up to five items from the list below." For experts: "What would you like to inform the general public in relation to the use of BI? Please select up to five items from the list below."	[Shineha et al., 2018, 2024; Hayashi & Morikawa, 1994; Kitada & Hayashi, 1999]
Interest/concern regarding ethical guidelines on BI	Prevailing interests/concerns to be addressed in the ethical guidelines on the use of BI	For experts/non-experts: "Which items should be included in ethical guidelines for the use of BI? Circle one for each item from 5 (Important) to 1 (Not important)."	[Presidential Commission for the Study of Bioethical Issues, 2014, 2015; Ienca, 2021a; MacDuffie et al., 2022]
Social influence of the media Media usage	Opinions on media effects on public attitudes and opinions	For experts/non-experts: "For each of the following items, please choose the degree to which you agree with the opinion about the influence of the mass media coverage of neuroscience. Circle one for each item from 5 (Agree) to 1 (Disagree)."	[Tsuchiya & Kosugi, 2011; Shineha et al., 2017]
Scientific literacy	Literacy about biology Self-evaluation of knowledge on neuroscience	For non-experts: "The oxygen we use to breathe comes from plants. (True / False)."	[Drummond & Fischhoff, 2017; Fernbach et al., 2019]
Demography	Age, Gender, Education, Income, Expertise, Occupation, and Religious Affiliation.		

3 ▪ Results

3.1 ▪ *Characteristics of general public respondents*

A general public sample was designed to achieve near-equal representation across gender (Figure 1a) and age groups, with 400 respondents per age category (29 or younger, 30–39, 40–49, 50–59, and 60 or older). Respondents had diverse educational backgrounds in terms of highest educational attainment (see demographic question F4 in Supplementary material 1), with "university" being the most common (865 respondents; 43.3%), followed by "high school" (506; 25.3%) (Figure 1b).

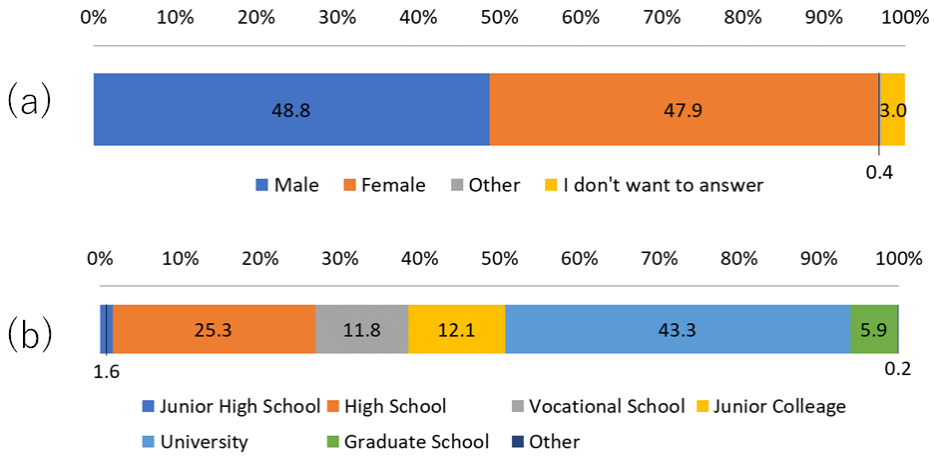

Figure 1. a. The distribution of general public respondents according to gender (N = 2,000). b. The distribution of general public respondents based on the level of education (N = 2,000).

In the general public, scientific literacy in biology was assessed using 14 biology-related questions — not directly related to neuroscience in particular — from two internationally recognized sets of literacy questions [Drummond & Fischhoff, 2017; Fernbach et al., 2019] (see Supplementary material 1). The mean score was 10.26 (SD ± 2.202).

3.2 ▪ *Respondent characteristics among neuroscientists*

Figures 2a and 2b present an overview of the respondent characteristics of expert neuroscientists recruited through academic societies mentioned above. Among them, 77 respondents (71.3%) were male, 24 (22.2%) were female, and 7 (6.5%) preferred not to disclose their gender (Figure 2a). Figure 2b shows the distribution of their research fields; 77 researchers (71.3%) were engaged in basic research, 14 (13.0%) in applied research (*oyo kenkyu*, a Japanese term referring to one of two domains of "applied research" in its broader sense, which involves applying the result of basic science to technological and pharmaceutical developments), and 17 (15.7%) in clinical research (*rinsho kenkyu*, the other domain of "applied research", where the clinical efficacy (e.g., safety) of *oyo kenkyu* outcomes is evaluated through trials involving human participants). The age of respondents ranged from 20 to 74 years, with the highest proportion (14.8%) in the group of 45–49. The respondents' degrees and employment status were not asked, not only because their membership of one or more neuroscientific societies can be understood as a proxy for their minimal expertise on the relevant field, but also because of the rough correlation between

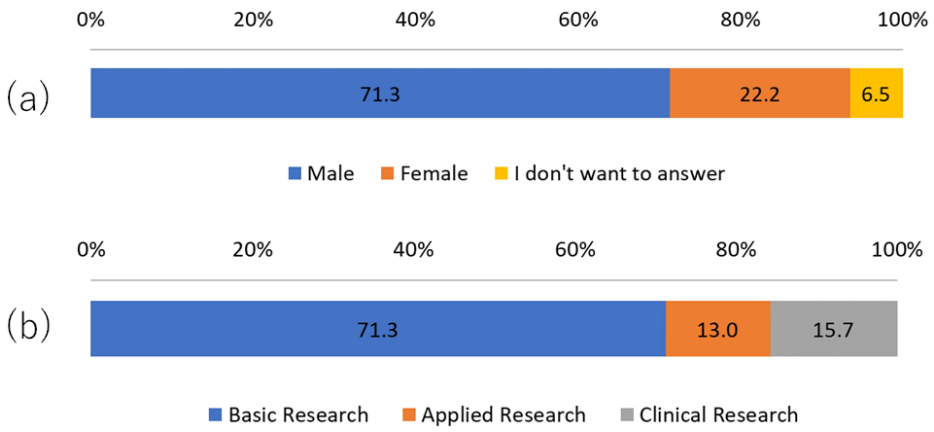

Figure 2. a. The distribution of expert respondents according to gender (N = 108). b. Research areas of expert respondents (N = 108).

academic degree status and age (asked in the demographic question F1, Supplementary material 2) in the Japanese context.

3.3 ▪ *Perceptions concerning neuroscience and BI use*

Figure 3a shows the attitudes of general public respondents towards promoting neuroscience research and the use of BI. Notably, 1,273 respondents (63.6%) either "approve" or "somewhat approve" of promoting neuroscience research, 664 (33.2%) "neither approve nor disapprove", and 63 (3.2%) either "somewhat disapprove" or "disapprove" of promoting this field. Figure 3b presents their views on the use of BI; 1,280 respondents (64.0%) viewed it positively, 634 (31.7%) neutrally or undecided, and 86 (4.3%) negatively.

Figure 3c shows that most non-expert respondents acknowledged their limited knowledge of neuroscience. As for their views on future social acceptance of BI use, presented in Figure 3d, 1,219 (61.0%) of the general public respondents deemed it either "acceptable" or "relatively acceptable", while 119 (6.0%) considered it either "relatively unacceptable" or "unacceptable", indicating that the proportion of respondents with a negative outlook on BI use and its societal acceptance was relatively small; however, at the same time, a substantial proportion of the respondents (662; 33.1%) were undecided. Overall, while most respondents held a positive view of neuroscience and BI use, many expressed a "wait-and-watch" stance owing to limited knowledge and a lack of understanding of these topics.

Previous research has established that a larger gap between self-assessed knowledge (standardized score) and scientific literacy (standardized score), known as the knowledge difference score, is linked to greater opposition to the societal acceptance of technology [Fernbach et al., 2019]. However, in this study, no correlation was observed between the knowledge difference score and approval inclinations.

Figure 4 shows a summary of the level of acceptance among the general public respondents for various applications of BI technology. "Medical application" received the highest combined percentage of "acceptable" and "relatively acceptable" responses, totaling 1,574 (78.7%). Other applications receiving broad acceptance include "provision for research" (1,338; 66.9%), "use for education" (1,221; 61.1%), and "use for societal benefits (e.g., crime

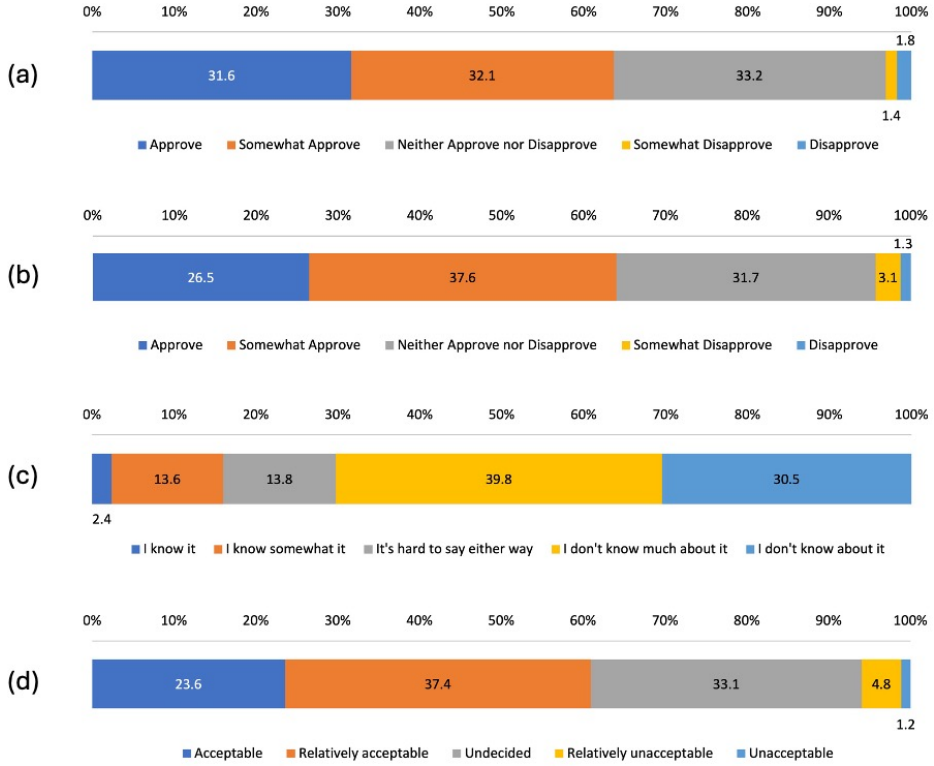

Figure 3. a. Public attitudes toward neuroscience (general public respondents, N = 2,000). b. Public attitudes toward promoting the use of BI technologies (general public respondents, N = 2,000). c. Self-assessed knowledge of neuroscience (general public respondents, N = 2,000). d. Public views on the future social acceptance of BI technologies in Japan (general public respondents, N = 2,000).

prevention and criminal investigation)" (1,263; 63.2%). Notably, while the use of neuroscience in criminal investigations and crime prevention is widely debated in neuroethics and related fields, only a small number of respondents in this survey (144; 7.2%) answered that such applications are "relatively unacceptable" or "unacceptable". In contrast, regarding commercial use of BI, the largest share of respondents (856; 42.8%) were undecided, while 598 (29.9%) deemed it unacceptable or relatively unacceptable. The strong wording of "commercial use" may have influenced these responses; however, this disparity indicates a notable divergence in opinions compared to other survey items.

3.4 ▪ *Different interests and concerns concerning BI use between the general public and neuroscientists*

Figure 5 highlights contrasting interests and concerns between the general public and experts regarding the use of BI technologies. General public respondents were asked what they would like to know, whereas experts were asked what they would like to communicate — that is, what they would want non-experts to know.

The general public's top interests were mechanisms (1,145 responses; 57.3%) and potential medical applications (1,071; 53.6%). These two topics clearly dominated; however, lower but notable levels of interest were observed for ethical and privacy-related issues, benefits and risks, and applications of BI technologies in communication, criminal justice, and robotics.

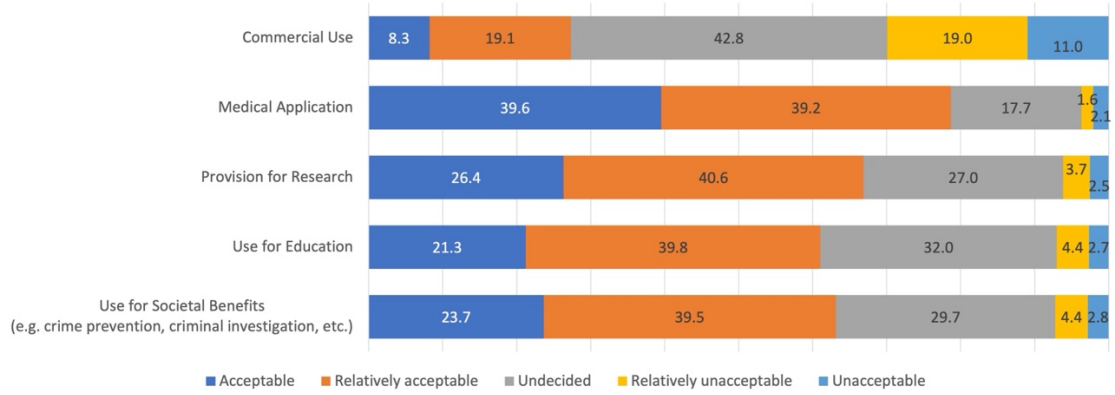

Figure 4. Responses regarding the possibility of future acceptance of BI use (general public respondents, N = 2,000).

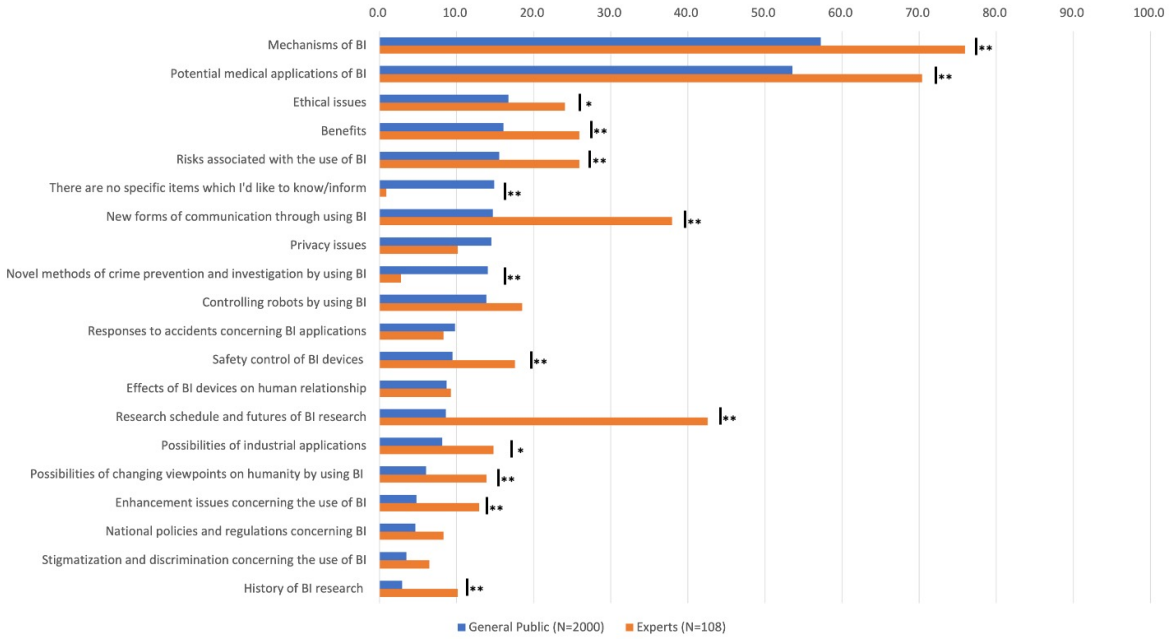

Figure 5. Comparison of what the general public respondents (N = 2,000) would like to know and what the experts (N = 108) would like to inform in relation to BI use (up to five items could be selected). χ^2 test: ** $p < 0.01$, * $p < 0.05$.

Among experts, the most selected items were mechanisms (82 responses; 75.9%) and potential medical applications (76; 70.4%), consistent with the patterns observed among general public respondents. However, experts showed significantly greater interest in "research schedule and futures of research on BI" (46; 42.6%) and "new forms of communication using BI" (41; 38.0%), both of which ranked among the top expert-selected items and differed significantly between groups ($p < 0.01$).

Figure 6 shows the factors that respondents considered important for social acceptance of BI technologies. Among the general public, the three most frequently selected items were "seriousness of potential risks and accidents" (668 responses; 33.4%), "whether society can prevent abuse and misuse by regulation" (538; 26.9%), and "whether experts can deal with

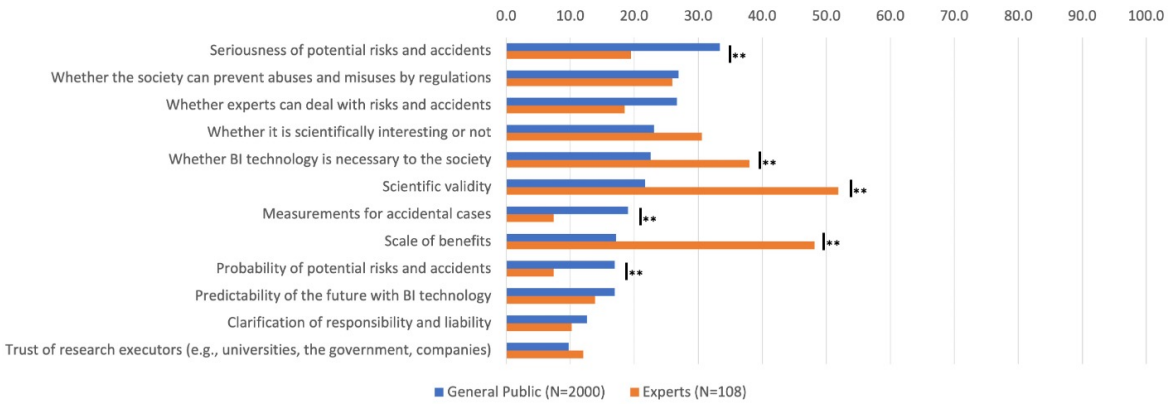

Figure 6. Comparison of factors considered important for the social acceptance of BI use between the general public and experts. Respondents could select up to three items. General public respondents (N = 2,000); experts (N = 108). χ^2 test: ** $p < 0.01$, * $p < 0.05$.

risks and accidents" (533; 26.7%), followed by "whether it is scientifically interesting or not", "whether BI technology is necessary to the society", and "scientific validity".

In contrast, experts most frequently selected "scientific validity" (56 answers; 51.9%), "scale of benefits" (52; 48.1%), and "whether BI technology is necessary to society" (41; 38.0%), all of which differed significantly from general public responses ($p < 0.01$). Another frequently selected expert-rated item was "interesting or not from a scientific perspective" (33; 30.6%). Notably, only 21 experts (19.4%) selected "seriousness of potential risks and accidents", the top-ranked item among the general public respondents ($p < 0.01$).

Figure 7 presents responses regarding which items should be included in ethical guidelines for the use of BI technologies and their perceived significance. Among the general public, items related to "data management", "privacy", "responsibility in accidental cases", and "psychological continuity" were most highly prioritised, with more than 80% of respondents rating each as important (5) or somewhat important (4). Neuroscientists similarly rated these items as highly important. By contrast, issues related to stigma, accessibility, enhancement, and well-being were assigned lower importance by the general public than by neuroscientists; stigma, in particular, was more highly rated among expert respondents.

3.5 ▪ *Perceptions of mass media coverage, social incidents, and institutions related to neuroscience*

Figure 8 shows sources of information on neuroscience-related topics, sorted by the proportion of responses from the general public respondents. The most frequently cited sources were television (981 responses; 49.1%) and the Internet (976; 48.8%), followed by newspapers, expert commentaries, and research institutions, indicating that, in addition to the Internet, traditional media outlets such as television and newspapers also hold considerable value as information sources.

Figures 9 and 10 compare public perceptions and neuroscientists' perceptions of mass media coverage of neuroscience. Overall, neuroscientists evaluated media coverage more negatively than the general public did across multiple dimensions, including accuracy, objectivity, balance, bias, and volume.

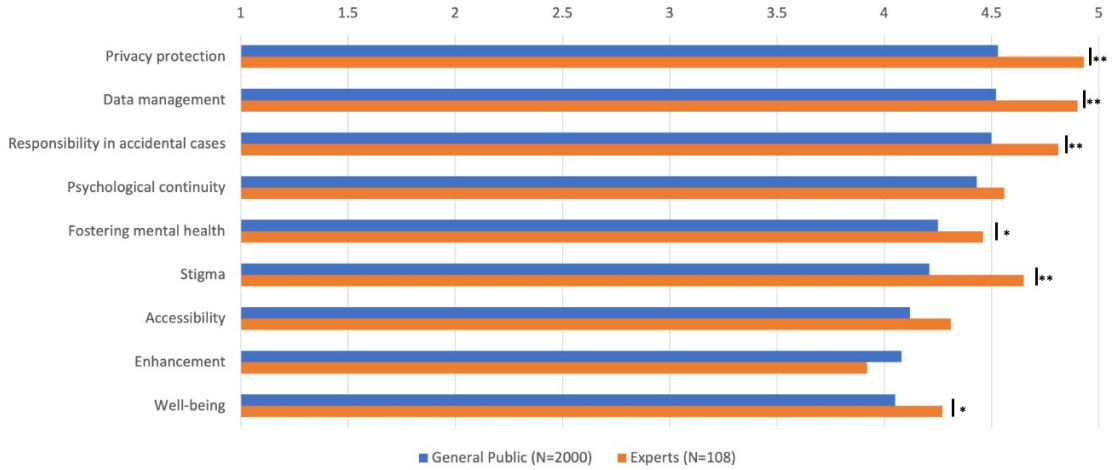

Figure 7. Comparison of attitudes between the general public and experts regarding items to be included in ethical guidelines for BI use. Respondents rated each item on a five-point scale from 5 (important) to 1 (not important). General public respondents (N = 2,000); experts (N = 108). *t*-test: ** $p < 0.01$, * $p < 0.05$.

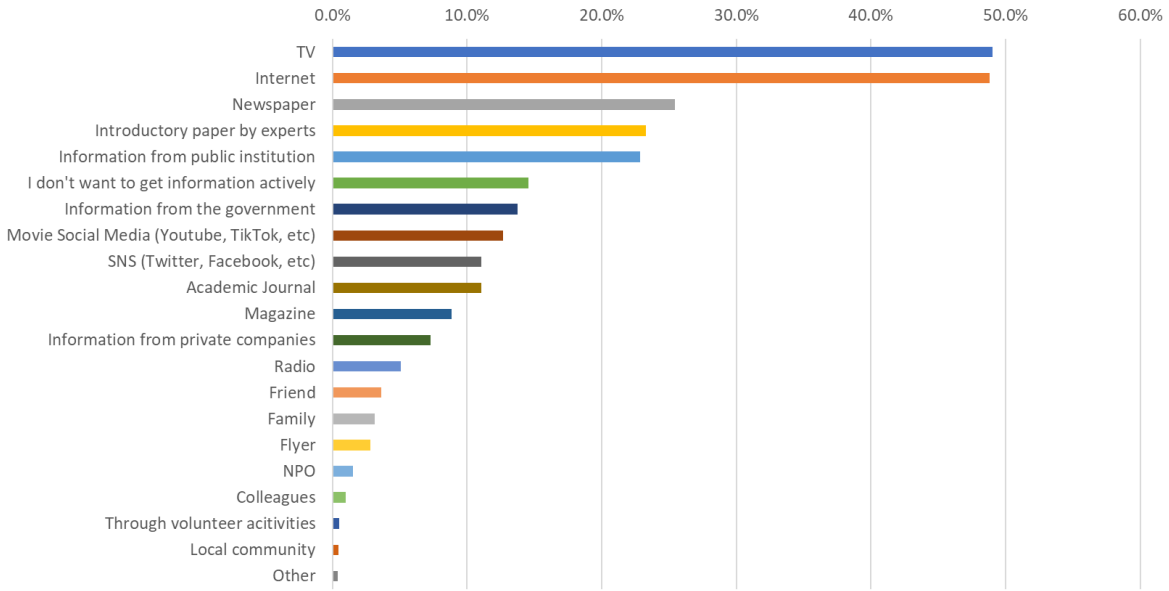

Figure 8. Preferences of the general public respondents for sources of information about neuroscience-related topics (up to 5 response options could be selected).

Neuroscientists also perceived the influence of mass media on public opinion and individual decision-making to be substantially greater than the general public did. For instance, when asked whether “people can choose appropriate information from the abundance of neuroscience-related content in society”, 562 general public respondents (28.1%) expressed disagreement, compared with 79 experts (73.1%). Similarly, for the statement “the public usually does not tolerate sensational media coverage”, 454 general public participants (22.7%) responded negatively, whereas a significantly larger proportion of experts (76; 70.4%) did.

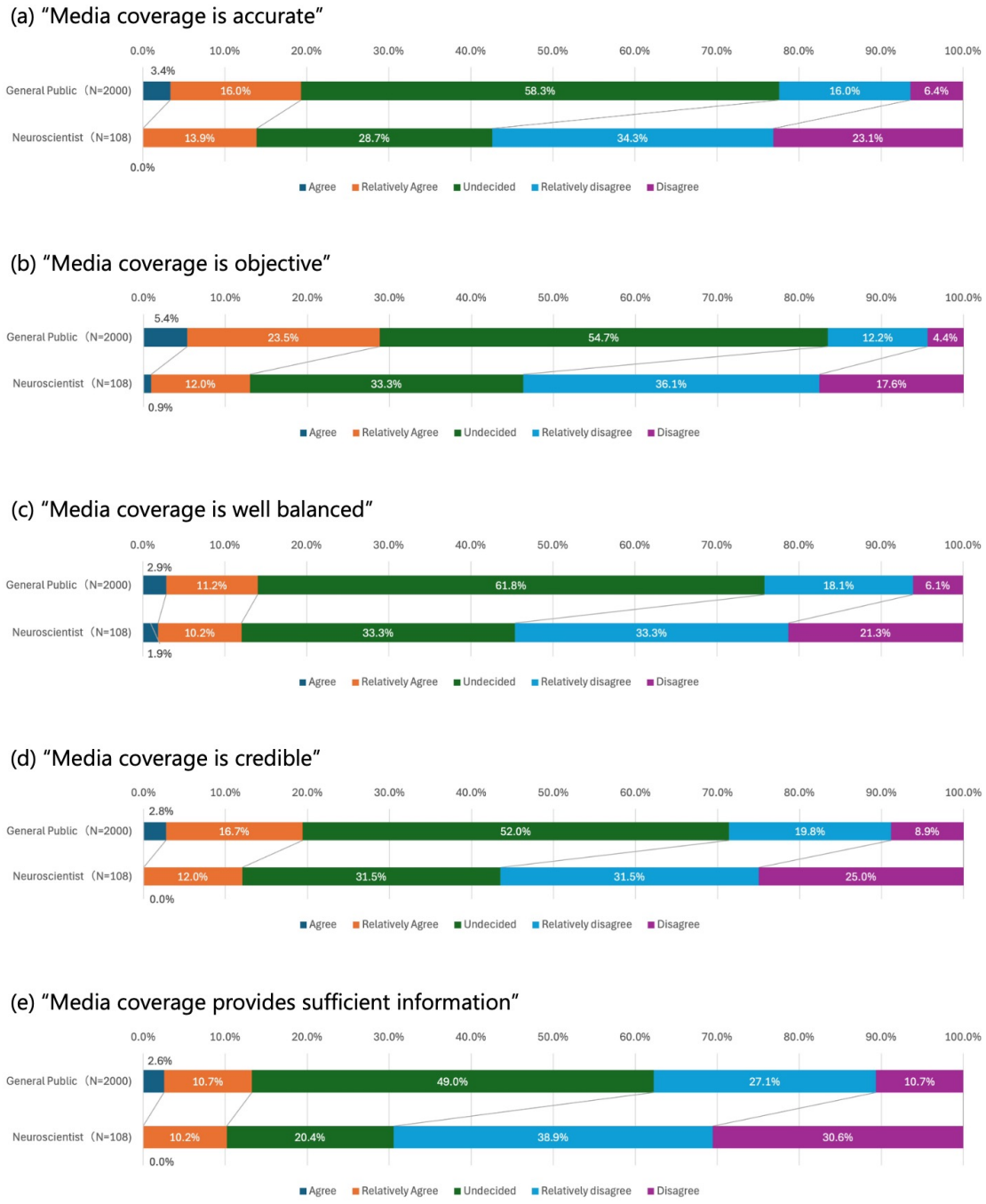

Figure 9. Comparison of attitudes toward mass media between the public and the neuroscientists. (General Public: N = 2000, Neuroscientist: N = 108).

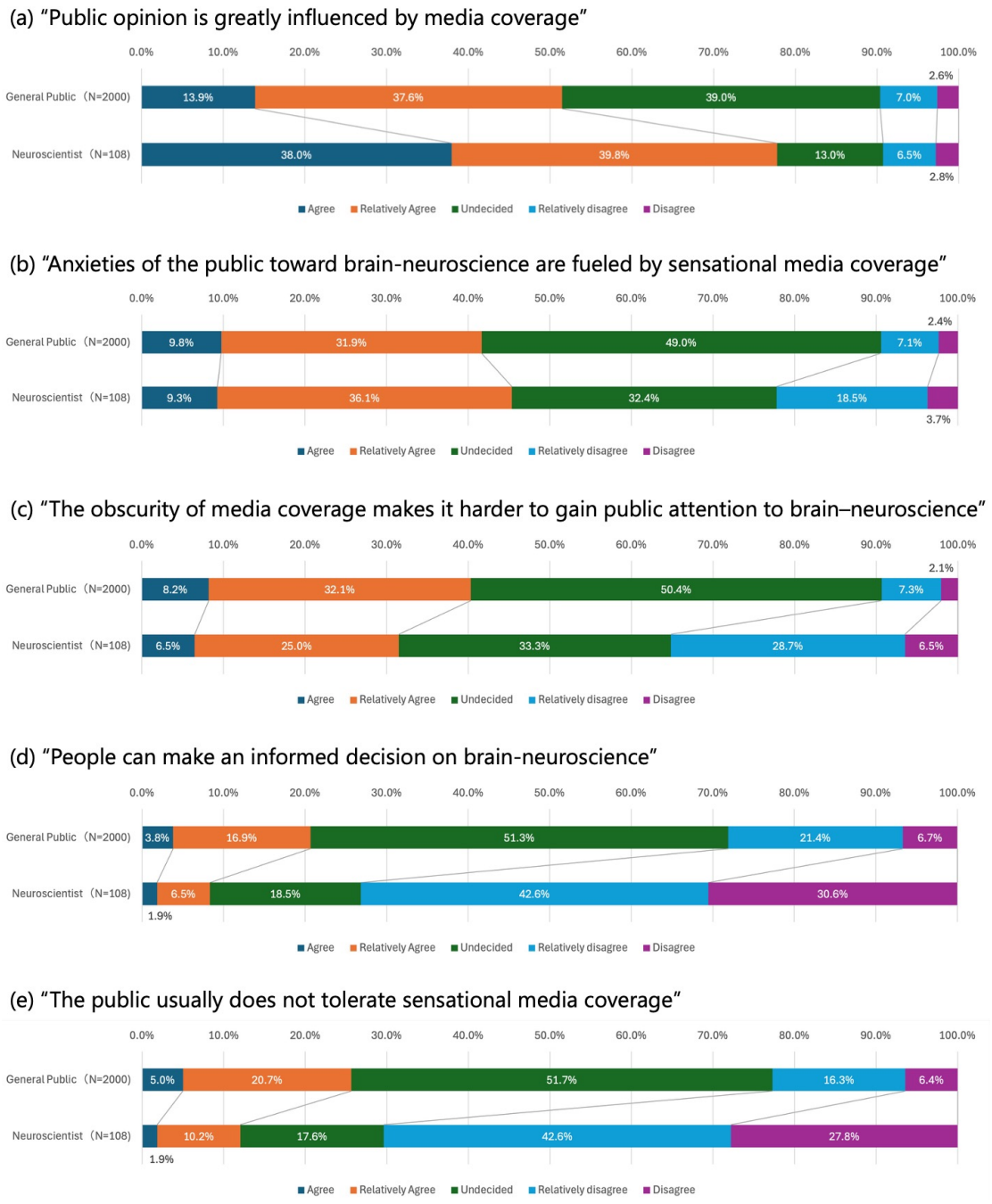

Figure 10. Comparison of opinions toward mass media between the public and the neuroscientists. (General Public: N = 2000, Neuroscientist: N = 108).

4 ▪ Discussion

Our study provides several insights into the expectations and concerns surrounding neuroscience and the use of BI technologies among the general public and expert neuroscientists in Japan.

First, the general public expressed high expectations for neuroscience research and BI use, while simultaneously demonstrating a cautious "wait-and-watch" attitude resulting from limited understanding of these fields. Medical applications of BI were perceived as having the greatest potential for social acceptance, whereas commercial use was approached more cautiously.

Respondents from the general public also expressed interest in more active communication about the implications and potential applications of BI use. In particular, respondents expressed notable interest in governance-related issues associated with social implementation of this cutting-edge technology, including data governance and the potential effects on psychological continuity. However, issues such as responsibility and trust in research institutions received relatively less attention, a pattern that differs from Japanese non-expert views on regenerative medicine, another emerging biotechnology [Shineha et al., 2018, 2022].

Second, neuroscientists placed greater emphasis than the general public on scientific rigour and communication, while sharing common concerns regarding data governance. In discussions of ELSI in BI technologies, particular attention was paid to several issues, including that of stigmatization. Therefore, neuroscientists may have a comparable advantage in ELSI discussions owing to their specialized knowledge and their engagement with salient topics that are yet to receive full attention from the general public.

This advantage could be leveraged to support information sharing and to develop strategies that address information gaps among the public. Such efforts have already been initiated by individual neuroscientists and projects with various methods and participants [Roskams & Popović, 2016; Gage, 2019; Gau et al., 2021]. Findings from our study of Japanese citizens underscore the need for similar efforts and suggest that such public engagement initiatives may be valuable not only in Western societies but also in non-Western contexts. At the same time, however, translating expert knowledge into effective public engagement faces practical challenges, including limited time and resources for researchers [Das et al., 2022]. Hence, institutional support — such as providing accessible platforms, financial resources, and appropriate recognition of outreach activities alongside traditional scholarly achievements — may be essential [Shineha et al., 2017].

Third, mass media remains — and is likely to remain — a primary source of information on neuroscience in Japan. Neuroscientists evaluated media coverage more critically than the general public did, perceiving it as exerting a strong influence on public opinion. Meanwhile, our findings reveal a notable trend on the part of the general public as well: they appeared more cautious about the accuracy of neuroscience reporting, as reflected in a higher proportion of "undecided" responses, compared with their attitudes towards media coverage of regenerative medicine in a previous study [Shineha et al., 2017]. Given that these attitudes do not reflect *indifference* — respondents expressed high expectations for applications of BI technologies, particularly in clinical contexts — this pattern may suggest that Japanese

citizens approach media portrayals of brain science with greater scepticism than they did with earlier biotechnology.

Consistent with this interpretation, prior research indicates that Japanese newspaper coverage of neuroscience is generally more positive than that of other biotechnologies, such as regenerative medicine and genetically modified organisms [Takeda et al., 2025]. While this relative positivity may help stimulate public interest, it may also contribute to inflated expectations. Notably, exaggerations in media reporting can originate from scientists themselves [Sumner et al., 2014], underscoring the need to consider the broader media ecosystem when developing science communication strategies. Moreover, much of the neuroscience-related information circulating online originates from traditional mass media, thereby sustaining the agenda-setting power of these media outlets [McCombs, 2014]. Collectively, these considerations suggest that the active dissemination of high-quality information by experts remains particularly important and thus is encouraged.

Again, notable disparities were observed between the normative concerns highlighted by neuroscientists and those highlighted by the general public. As expected, experts paid more attention to scientific and technological aspects, but they also placed greater weight on certain normative issues, such as stigma, than the general public did. Rather than deciding which group holds the "right" concerns, acknowledging and addressing these disparities is crucial for effective science communication, guideline development, and institutional design.

Furthermore, areas of convergence between expert and public perspectives were evident, most notably in data governance. Within the related literature, data-related concerns have often been framed through a "data lifecycle" approach [Fothergill et al., 2019; Eke et al., 2022]. This framework covers issues such as the ownership and value of personal data; the use of open or broad consent for data provision beyond traditional informed consent; the potential for dynamic consent to support ongoing research participation; adherence to data protection regimes like the European Union's General Data Protection Regulation; and challenges surrounding data anonymization. In this context, Salles et al. [2017], as part of the Human Brain Project, proposed a set of data protection recommendations for neuroscience, including (1) establishing a coherent data governance framework; (2) adopting a privacy model for anonymizing data intended for secondary use as a default approach; (3) implementing "privacy by design" or comparable system development methodologies; (4) exploring ICT tools to support privacy management, data protection, and dynamic consent; (5) assessing the feasibility of broad consent in light of existing data protection regulations to promote trust and transparency; (6) designing systems resilient to technical failure; and (7) conducting regular reviews to assess whether technological advances may enable the re-identification of anonymized data. Collectively, these discussions provide important reference points for future data governance discussions in Japan, though some adaptation may be required to reflect its specific societal and regulatory context.

Finally, some limitations should be acknowledged. In our survey, there were large differences between the general public respondents and neuroscientists. However, as a common limitation of online surveys, our study may not fully reflect the actual situation in Japan. In addition, neuroscientists were recruited by posting on neuroscience-related academic society websites and by emailing them and CiNet researchers, which may have also introduced sampling biases. For instance, neurosurgical specialists may be underrepresented among the "expert" respondents in this study, unless they are also captured by our recruitment

method as specialists in basic neuroscience or neuroinformatics. However, this is one of the first reports with a large number of general public respondents. Thus, we believe that our results will provide an important reference for discussions of science communication in neuroscience.

Currently, rapid advances in neuroscience and BI make it difficult to accurately envision the future, complicating discussions of the expected state of governance. We hope our findings will help facilitate dialogue among a wide range of stakeholders.

5 ▪ Conclusion

In this study, we compared the attitudes of the general public and neuroscientists toward neuroscience and BI. The general public expressed high expectations for neuroscience research and BI use; however, they also expressed a cautious "wait-and-watch" attitude. Notably, several different framings of concerns regarding BI use exist. For instance, although both parties agreed on the importance of data governance, the general public also showed interest in the philosophically laden issue of psychological continuity, whereas neuroscientists placed more emphasis on scientific content. Simultaneously, neuroscientists also engaged in more careful discussions around ELSI, such as the issue of stigmatization and enhancement. This advantage should be leveraged in information sharing and in developing countermeasures. Moving forward, we need to advance the dialogue, considering these different framings and attitudes toward the media's effects on public understanding of neuroscience.

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Data/software/code availability statements
Data will be supplied according to requests.

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