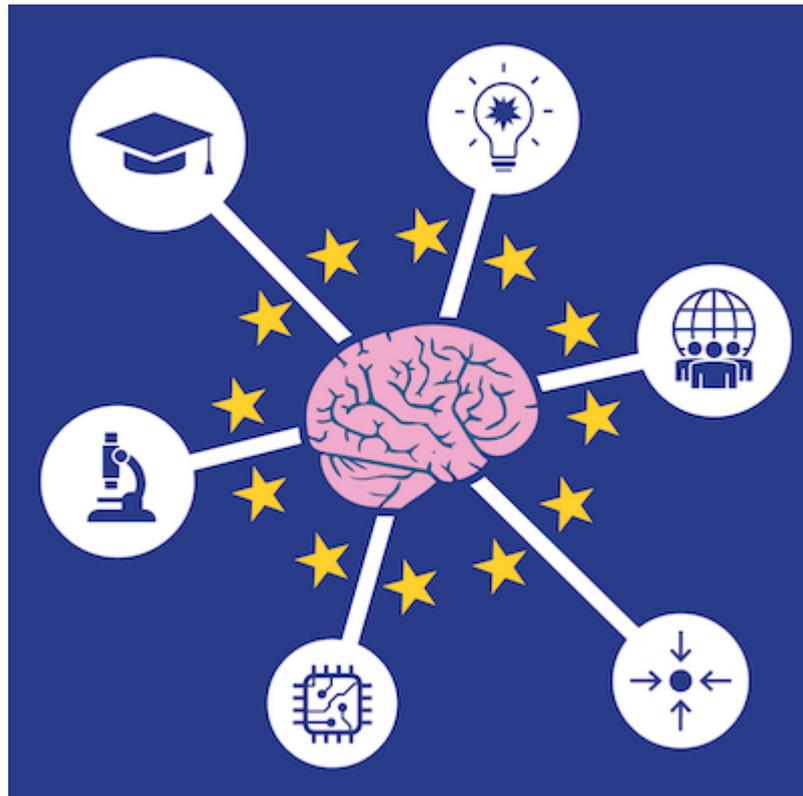


# Neurotech<sup>EU</sup>

The European University of Brain and Technology



[D6.1]

[Societal Innovation Hubs (OpenLabs)]

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## Introduction

The economic and health burden caused by neurological diseases can be regarded as a global public health challenge. They are the leading cause of Disability Adjusted Life Years (DALYs) and the second leading cause of death, with a tremendous estimated cost (over 1T EUR in Europe alone) [1,2].

Neurotechnology, rapidly emerging and a relatively new field, may be the game-changer that will alleviate the burden of this public health challenge. It is a broad field of study that offers numerous possibilities, aiming to enhance our understanding of the human brain and improve human health through technological engagement. These possibilities include brain-computer interfaces (BCIs), magnetic or electrical stimulation, prosthetics, and diagnostic tools.

The field of neurotechnology encompasses a broad spectrum of different perspectives. On one end of the spectrum, enthusiasts see it as a field that offers numerous ways to engage technology to improve human health. On the other end, skeptics view neurotechnology as controversial, expressing concerns about the potential “wiring up” of human brains to machines [3]. Regardless of where one stands on this spectrum, societal involvement is crucial.

For enthusiasts, societal involvement is invaluable in ensuring realistic expectations and promoting responsible and ethical use of neurotechnology. For example, it is essential to acknowledge the risks associated with multiple neurotechnologies, such as unexpected side effects or the risk of infection. Skeptics can benefit from societal involvement by understanding the immense possibilities of neurotechnology and its potential to reduce the global burden caused by neurological diseases.

As the field of neurotechnology is regarded as a nascent field [4], it can prove challenging to illustrate its potential real-world impact, especially given the complexity of the brain. Explaining new technologies, such as ‘brain reading technologies’ (also named ‘mind-reading technology’) that record, process, and decode neural signals, can be difficult, particularly in popular media, which hinders their popularization and societal trust [5]. To address these challenges, several national and international initiatives, including societal innovation hubs, have been developed.

## Societal Innovation Hubs (SIHs)

Societal hubs are defined as co-working spaces used for social collaboration, knowledge sharing, and learning. They have historically been used to foster collaboration for the benefit of society as a whole, rather than just individuals [6]. The main goal of a societal *innovation* hub (SIH) is to facilitate the creation of new approaches and solutions to meet societal challenges. Such challenges may include inequality, sustainability, healthcare, and education issues. They provide a supportive and collaborative environment where people can share ideas, concerns, resources, and knowledge. Societal Innovation Hubs (SIHs) perfectly synchronize with the field of neurotechnology, as they actively work towards facilitating the creation of and engaging potential (new) innovative technologies to meet societal challenges. The hubs, thus, play a critical role in the development and adoption of neurotechnologies.

From an economic perspective, SIHs can also facilitate connections between different stakeholders that can not only forge potential new research collaborations, but can also help researchers attract potential funders and investors – all critical steps for developing and scaling neurotechnology.





## Why NeurotechEU?

NeurotechEU is the European University Alliance for neurotechnology. Currently, the alliance consists of nine partners spanning across Europe. NeurotechEU is the only University Alliance in Europe with a dedicated focus on education and research in neurotechnology. It serves as an international bridge connecting key stakeholders in the field of neurotechnology, with a primary focus on education. Consequently, NeurotechEU plays a prominent role in shaping the position and profile of neurotechnology in society, both now and in the future. Due to its designated role, NeurotechEU should utilize SIHs.

## NeurotechEU Societal Innovation Hubs

As defined in the Grant Agreement of NeurotechEU, technological innovation within NeurotechEU necessitates societal innovation to foster community building, preparedness and the adoption of new technologies in addressing society's challenges. This effort encompasses various fields, including humanities, economy, and politics. SIHs play a crucial role as facilitators in the adoption and implementation of new (neuro)technologies. SIHs bring together relevant stakeholders, disseminating information about developments and actively contributing to the European neurotechnological ecosystem.

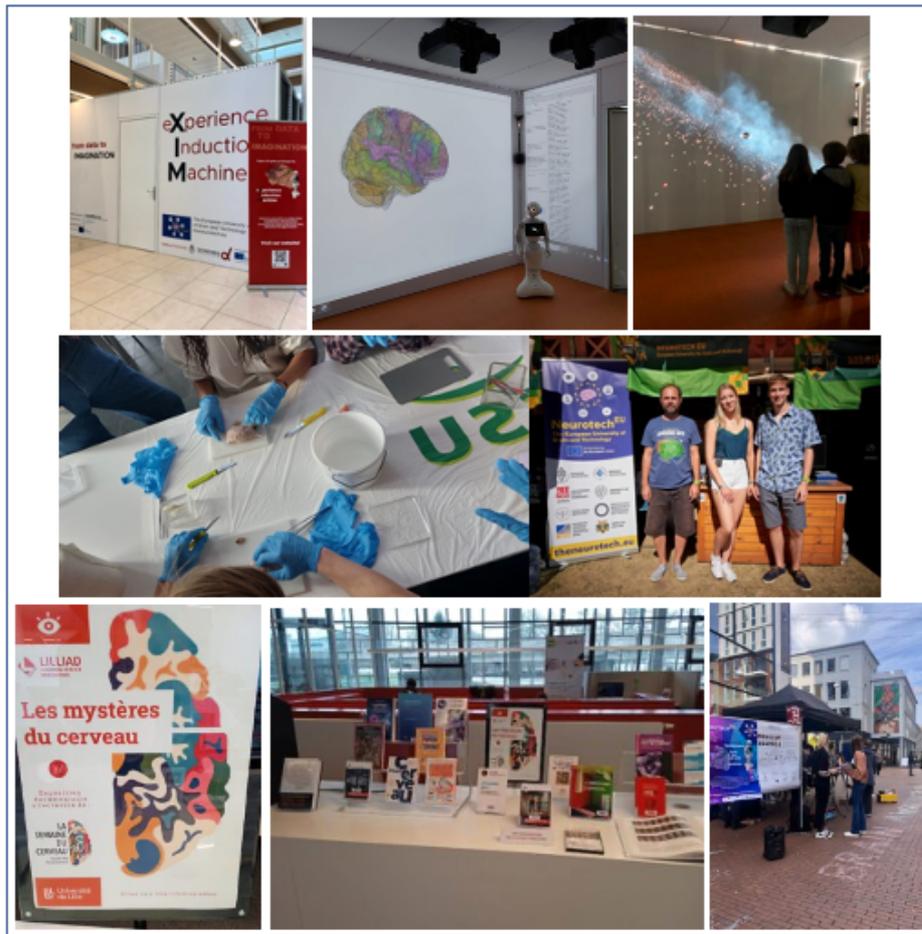
The world is currently facing increasingly complex and interconnected problems that require innovative and collaborative approaches to solve. SIHs provide the ideal ecosystem for fostering such developments.

Since its establishment in 2020, NeurotechEU has already been involved in creating and maintaining several SIHs. Here are a few examples:

1. The eXperience Induction Machine (XIM): This immersive room equipped with sensors and effectors serves as a multi-purpose and portable environment for studying human behaviour and conducting mixed-reality experiments [7]. Additionally, it can educate and inform society about advancements in brain technology through simulated mixed-reality experiences. The NTEU installation premiered at Radboud University in October 2022 during an Open House exhibition at the Faculty of Science (see [here](#)). It received over 250 visitors, including children, students, and adults of all ages, who had the opportunity to explore 3D models of the human brain and learn about their practical applications. The XIM setup is transportable, allowing the hub to be hosted by all European partners. After its premiere, the installation was moved to a different location in Nijmegen (Radboud UMC) for one week in May 2023, where its portability was successfully tested. Nevertheless, a more convenient and portable version of XIM is currently being developed, as the current design is a 5.0 x 5.0 x 3.0 metre box. This will make the hub even easier to install, including in locations further afield.
2. Organisation of national BrainBee competitions: BrainBee is a national competition for high school students, assessing their knowledge of the brain and neuroscientific research. It provides an exciting opportunity for students to visit universities, meet researchers and students, and inspires them to pursue careers in medicine or neuroscience. National BrainBee competitions have been organised or are being organised in some partner universities' countries, specifically targeting high school students. For instance, BrainBee competitions have been organized in [Hungary](#) and the [Netherlands](#). This contributes to knowledge transfer and nurtures the younger generation of researchers and students within European society.



- Active participation in Brain Awareness Weeks: [Brain Awareness Week](#) is a global campaign aimed at raising public awareness of the progress and benefits of brain research. It unites the efforts of all NeurotechEU partners in this week-long celebration that is usually organised in mid-March and supported by some of the largest neuroscientific organisations (including the Society for Neuroscience and FENS). NeurotechEU actively participates by organising and hosting many different Brain Awareness Week activities and events that attract thousands of attendees and help promote neuroscience and technology.



**Figure 1. Examples of NeurotechEU Societal Innovation Hubs are depicted.** The top row showcases the portable museum corner XIM. The middle row displays images from national BrainBee competitions at Radboud University (left) and the University of Debrecen (right). The bottom row features images from Brain Awareness Week in partner cities Lille (left and middle) and Nijmegen (right).

The first example mentioned earlier, the XIM, was initiated entirely by NeurotechEU partners. Although the concept of XIM had been used previously by the SPECS lab at Radboud University, NeurotechEU took this concept to the next level by transforming it into a portable museum corner (for details, see NTEU Deliverable D8.2). After its premiere at Radboud University in October 2022, different groups and organisations expressed interest in exploring the use of XIM tailored to their specific needs. This could mark the beginning of a wide range of applications presented by XIM, designed to address specific societal needs. XIM, therefore, has the potential to serve as a SIH-on-demand.

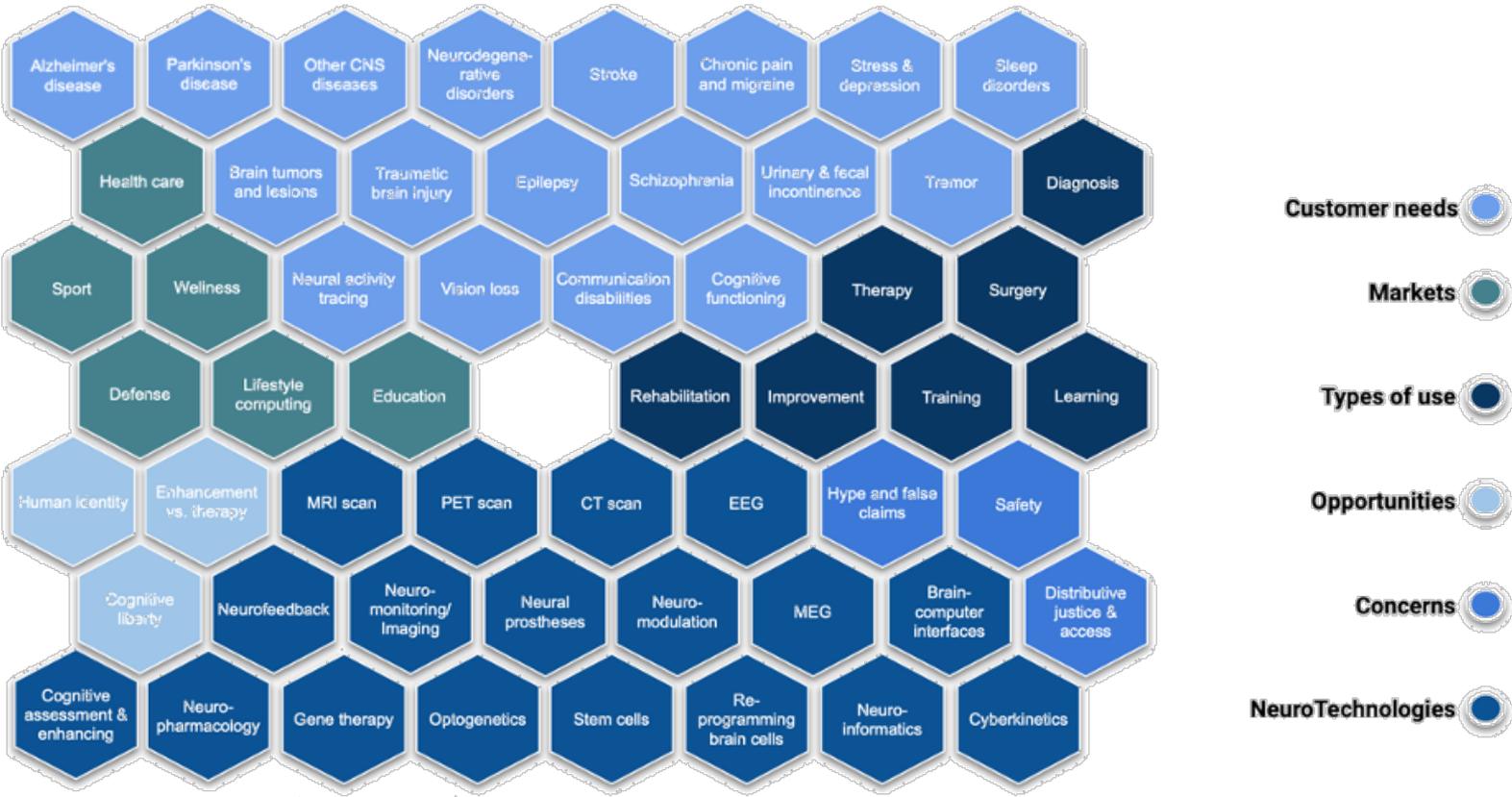
The second and third examples listed above are pre-existing platforms that NeurotechEU uses to promote neuroscience and technology under the umbrella of the NeurotechEU framework. In other words, NeurotechEU leverages these established platforms and events to effectively connect with community networks, enabling them to stay attuned to the community's priorities and concerns. However, these platforms have the disadvantage of limiting the degree of freedom and their content depends on community-identified domains, which may exclude areas that are societally important but not explicitly identified as such.

### Key Considerations for NeurotechEU SIHs

In addition to the aforementioned examples, NeurotechEU strives to initiate and maintain additional SIHs. Since the fields of neuroscience and technology are broad, the scope and content of a SIH can be extensive. Nevertheless, there are several key considerations taken into account when establishing SIHs, including:

1. **Public engagement and education:** The hubs should actively engage with the general public to raise awareness about neurotechnology. This step is crucial before introducing neurotechnological innovations to society as it facilitates the uptake and dissemination of such innovations, contributing to a better-informed society.
2. **Ethical considerations:** Building upon point #1, many neurotechnological innovations raise societal ethical concerns. An example would be the potential fear of brain-reading technologies, as mentioned earlier. Therefore, it is important for the hub to inform society about the ethical, legal, and social aspects (ELSA) associated with developing and implementing neurotechnologies.
3. **Policy advocacy:** SIHs can play a role in information neurotechnology-related policies, making this an important consideration. They can contribute to policy discussions, advocate for responsible regulations, and provide evidence-based recommendations.
4. **Industry collaboration and entrepreneurship:** Similar to point #3, SIHs can facilitate collaboration with industry, bridging the gap between research and commercialisation. While NeurotechEU primarily serves as an educational programme, fostering intersectoral interdisciplinarity within SIHs can result in better-trained students.
5. **Promote interdisciplinary collaboration:** Neurotechnology involves a wide range of researchers from different fields. SIHs can provide a space for bringing together diverse disciplines and backgrounds, thereby stimulating collaboration.

Given these key considerations, it is vital to address the needs of society. In 2020, NeuroTech Analytics conducted a comprehensive landscape overview that provided insights into the entire field of Neurotechnology. This overview encompassed societal needs, opportunities, concerns, and more (**Figure 2**) [8]. It serves as a general guide for identifying needs and opportunities. However, it is important to extend this analysis to local institutions since needs and opportunities may vary between countries.



**Figure 2 | An overview of the societal landscape of Neurotechnology in 2020.** The overview highlights specific subfields within Neurotechnology, and six broader domains under which they fall.



## References

- [1] Feigin, V. L., Vos, T., Nichols, E., Owolabi, M. O., Carroll, W. M., Dichgans, M., ... & Murray, C. (2020). The global burden of neurological disorders: translating evidence into policy. *The Lancet Neurology*, 19(3), 255-265.
- [2] The Economist Group (2022). The value of action: Mitigating the global impact of neurological disorders; Findings report. *Economist impact*.
- [3] Müller, O., & Rotter, S. (2017). Neurotechnology: Current developments and ethical issues. *Frontiers in systems neuroscience*, 11, 93.
- [4] Robson, J. A., & Davenport, R. J. (2014). Neurotechnology: A new approach for treating brain disorders. *Rhode Island Medical Journal*, 97(5), 18-21.
- [5] Rainey, S., Martin, S., Christen, A., Mégevand, P., & Fournier, E. (2020). Brain recording, mind-reading, and neurotechnology: ethical issues from consumer devices to brain-based speech decoding. *Science and engineering ethics*, 26, 2295-2311.
- [6] Al-Kilani, M., Verkuil, A.H., Meyer, R. (2021). Sustainability of Societal Innovation Hubs: *Critical Evaluation*. *Interdisciplinary Journal of Economics and Business Law*. Vol. 10, Issue 2, pp. 71-97.
- [7] Bernardet, U., i Badia, S. B., & Verschure, P. F. M. J. (2007, October). The experience induction machine and its role in the research on presence. *Proceedings of the 10th annual international workshop on Presence* (pp. 329-333). Barcelona: Xim.
- [8] NeuroTech Industry (2020). Global NeuroTech Industry Landscape Overview Q4 2020. Obtained from: <http://analytics.neurotech.com/q4/industry-landscape-overview-teaser.pdf>

