IoB Fundamental Technologies

Moonshot Research and Development Program Goal 1 Kanai Project

Building Trust in Neurotechnology: Guidebook, Evidence book, & TMS Robot

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Overview

As consumer neurotechnology rapidly expands, three issues limit its responsible use: (1) limited literacy among users and developers, (2) fragmented scientific evidence, and (3) uncertainty about potential effects on the human body. This project addresses these issues through **knowledge sharing**, **evidence consolidation**, and **standardized physiological assessments**.

For knowledge sharing, we created the Neurotech Guidebook series. Vol.1 explains core concepts, major measurement and intervention methods, and common risks. Vol.2 provides a structured handbook for responsible development, covering legal requirements, safety, scientific validity, and information disclosure. For evidence consolidation, we conducted 12 systematic reviews on non-medical neurotechnology and published the results in the Evidence Book, Both the Guidebook and Evidence Book are cited in the OECD Neurotechnology Toolkit and are internationally referenced. Finally, for standardized physiological assessments, we developed an automated TMS robot for safe and reproducible evaluation of cortical functions, now used at several domestic and international sites, with commercialization progressing. Through these initiatives, we aim to build a safe, reliable, and fair ecosystem for consumer neurotechnology.

Development of Guidebooks for Consumers and Developers

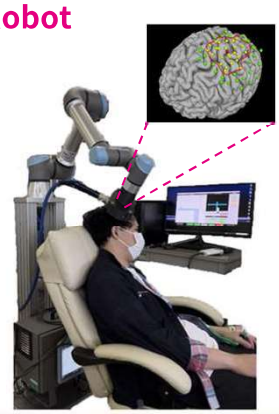
We created a common language and practical guidance for Neurotechnology, covering both everyday use and pathways toward commercialization. Vol.1 organizes core concepts, major measurement and intervention methods, and key risks and precautions in a clear format, offering a shared foundation for consumers and developers to judge product value. Vol.2, designed as a handbook for responsible development, systematizes requirements related to regulation (advertising rules, medical-device boundaries, and protection of personal and neural data), safety, scientific validity, and consumer-facing information. Their content is aligned internationally through dialogue with multiple global organizations.

Evidence Consolidation of Non-Medical Neurotechnology

Consumer neurotechnology operates outside the strict regulatory framework used in medicine, which makes this area prone to misunderstanding and inflated expectations. To address this, our project focused on the non-medical domain and defined 12 key questions—for example, “Does neurofeedback enhance motor performance?”, “Does non-invasive stimulation improve memory?”, and “Is EEG a marker of relaxation?”. We assessed the effectiveness, safety, and reliability of each topic through systematic reviews and published the results in the Evidence Book, which provides concise conclusions and the supporting evidence for each question. More than 40 researchers from six countries, from undergraduate students to professors, contributed to the reviews, bringing diverse perspectives. Several of the reviews are also published as preprints or peer-reviewed original papers.

Automation of Physiological Assessment: Development of a TMS Robot

Transcranial Magnetic Stimulation (TMS) non-invasively stimulates the brain with short magnetic pulses, allowing evaluation through responses such as hand muscle activity. We developed a TMS robot that performs this assessment safely and accurately in an automated manner. With this system, even non-experts can obtain high-quality measurements in a short time, improving reproducibility and throughput. This enables robust multi-site studies of neurophysiological effects. The TMS robot is now safely operated at multiple sites in Japan and abroad, and commercialization is in progress. Our next step is to integrate additional physiological signals—EEG, pupil diameter, ECG, EMG—to estimate brain states and autonomously optimize stimulation patterns. Although the current system focuses on motor-cortex function, multi-signal integration will allow extension to other functional domains and support autonomous exploration of new stimulation protocols.



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Graduated from the Faculty of Science and Technology, Keio Uni in 2011. Completed the Doctoral Program at the Graduate School of Science and Technology in 2015, earning a Doctor of Engineering degree. Subsequently worked as a postdoctoral researcher/tenure-track faculty member at the Danish Research Center for Magnetic Resonance (Denmark), the Graduate School of Education, The University of Tokyo, and the Graduate School of Science and Technology, Keio Uni. Assumed current position in 2025. Specializes in neurotechnology and motor control.

Future Prospects

In line with global trends in rule-making, the next five years will focus on implementation. First, together with domestic academic societies, we are developing educational materials—including lecture videos, experimental demonstrations, and Python exercises—and will publish them in Japanese and English. Our aim is to establish shared concepts and procedures and eventually to help align international discussions regarding Neurotechnology governance. In parallel, we will expand our international evidence-evaluation network so that results from different countries can be cross-referenced, accelerating building trust in neurotechnology. Finally, inspired by Japan’s “Foods with Function Claims” framework, we will propose a two-tier scheme for “Devices with Function Claims” through peer-reviewed publications, with the goal of creating practical standards that are acceptable to developers, researchers, and users.

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Internet of Brains

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