Press Release

Keio University

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Keio University

Three Ethical Guidelines regarding the Rapid Social Development of Brain-Machine Interfaces Published in the Science Magazine
—Research results of an international and interdisciplinary team comprising of neuroscientists, ethicists, jurists and pedagogists—

Associate Professor Junichi Ushiba of the Department of Biosciences and Informatics (Laboratory for Rehabilitation Neuroscience) in the Faculty of Science and Technology at Keio University has, in collaboration with research groups in Germany, the United States, Canada, and Switzerland, formulated three ethical guidelines to be observed in relation to the rapid social development of Brain-Machine Interfaces (BMI). These have been published as a declaration in Science, one of the world's top three journals in the field of life sciences (published on June 30, 2017, Eastern Standard Time).

Considerable progress is currently being made in the development of BMI technology, which creates direct links between the brain and machines, and numerous corporations such as Facebook, Neuralink, and Panasonic have announced its commercialization. On the other hand, ethical concerns on the rights and wrongs of the cyborgization of human beings and the dangers of having one's thoughts read by BMIs are rapidly spreading throughout society. This declaration is expected to encourage corporations engaged in the industrialization of BMIs to observe and disclose their code of conduct, and to become a global standard for the implementation of BMI ethics. Furthermore, it is expected to lead to the enactment of scientifically appropriate legislation and social acceptance based on correct knowledge of BMIs.

1. Main Points of Research

- World-leading authorities researching BMIs that directly link the brain and machines from Germany, the United States, Switzerland, and Japan collaborated with ethicists, jurists, and pedagogists to formulate three ethical guidelines necessary for BMI technologies.
- Within this BMI research, the following three ethical guidelines were indicated as being necessary:

  Clarification of legal responsibility for accidents or incidents caused by BMI-induced actions (accountability)

  Protection of neuronal data and prevention of unauthorized access to the brain (protection of personal information)

  Promotion of social acceptance (public awareness) and advancement of ethical norms based on the swift disclosure and accuracy of technological information
- While global corporations such as Facebook, Neuralink, and Panasonic are progressing with the industrialization of BMI, this declaration is expected to be central to its sound implementation in society.

2. Background of Research

Currently, there is heightening enthusiasm in Silicon Valley for the development of a technology known as BMI (brain-machine interface) that controls computers using brainwaves. Facebook announced it was developing a telepathic technology capable of inputting characters through thought alone using BMI technology to read neuronal data when speaking and writing. Furthermore, the well-known co-founder of Tesla, Inc. and founder of Space X, Mr. Elon Musk,

established a new BMI company Neuralink, which declared that it was to develop technology capable of uploading and downloading thoughts, and technology for the cybernetic reconstructive treatment of physical paralysis caused by stroke and other neurologic conditions. In Japan as well, Keio University has developed a BMI in collaboration with Panasonic that adjusts the brain activity of severe hemiplegia patients who have been difficult to treat with conventional medicine. Clinical trials led by physicians at four hospitals in the Kanto region are currently underway (Pharmaceuticals and Medical Devices Law accreditation planned in 2018). In this way, the practical application of BMIs that directly link the brain and machines has moved beyond the world of science fiction and is rapidly progressing in the real world.

At the same time, however, ethical and legal concerns on the practical application of BMIs remain. Currently, many concerns have been raised on the dangers of having thoughts read against the users' will, fears toward the cyborgization of parts of the brain and body replaced with BMIs, and the extent of user responsibility for BMI-induced conduct and decisions. However, because BMI is an advanced complex technology that fuses neuroscience, medicine, artificial intelligence, and robotics, it is difficult to understand how it operates, what it is and is not capable of doing, and to what extent its use could modify the brain. Consequently, investigating the influence of BMIs on people and society has up until now been difficult.

Here, multiple world-leading authorities involved for many years at the forefront of BMI research and studying the industrialization of BMI with corporations have collaborated together with ethicists, jurists, and pedagogists as part of the following research group, formulating three ethical guidelines on BMI technologies.

[Research Group]

- Dr. Jens Clausen (Germany, Neuroethics)
  Neuroethicist researching the ethical and social problems caused by expanding brain functions using BMIs.
- Dr. Eberhard Fetz (United States, Neuroscience)
  World-leading authority who carried out the world's first successful BMI control experiment using monkeys.
- Dr. John Donoghue (Switzerland, Neuroscience)
  World-leading authority who conducted a successful experiment by directly controlling a robotic arm using brain signals by implanting needle electrodes into the brain of a spinal cord injury patient.
- Dr. Junichi Ushiba (Japan, Keio University, Neuroscience)
  Researcher who devised a method of BMI rehabilitation to assist the movement of paralyzed hands by directly operating a robotic device through the brain signals of severe stroke hemiplegia patients. He successfully recovered functions in cases of severe paralysis that have been difficult to treat with conventional medicine. A leading figure in this field, he is also pushing forward with the industrialization of BMI with Panasonic.
- Dr. Ulrike Spörhase (Germany, Neuroethics)
  Pedagogist researching accountability issues of medical intervention.
- Dr. Jennifer Chandler (Canada, Law)
  Jurist researching the legal responsibilities and moral rights of users whose brain functions are modified by BMIs.
- Dr. Niels Birbaumer (Germany, Neuroscience)
  World-leading authority on patient recommunication BMIs who successfully operated a computer by reading the brain signals of patients suffering from complete locked-in syndrome

caused by the neurological disease ALS.

・Dr. Surjo R. Soekadar (Germany, Neuroscience)
Researcher who demonstrated that it was possible for spinal cord injury patients to eat at restaurants in town through the movement of paralyzed arms by directly operating a wearable robot with brain signals using BMI.

3. Content of Research and Results

Pertaining to the ethical concerns that arise with the industrialization of BMI technology, which directly links the brain and machines, this declaration formulated three ethical guidelines: clarifying the legal responsibility for accidents or incidents caused by BMI-induced actions (accountability); protecting neuronal data and preventing unauthorized access to the brain (protection of personal information); and promoting social acceptance (public awareness) and advancing ethical norms based on the swift disclosure and accuracy of technological information.

1) Clarification of legal responsibility for accidents or incidents caused by BMI-induced actions (accountability)

Now that it is possible to directly connect the brain to BMI technology installed with artificial intelligence, which can instantly analyze volumes of information far exceeding the processing capabilities of human beings, and on the assumption that there will be accidents or incidents caused by BMI-induced actions uninfluenced by human volition, this research points out that there is a need to clarify the legal responsibilities, compensation problems, and onus of proof held by people and BMI manufacturing corporations, and to operate these technologies upon agreement thereon. These matters are in urgent need of consideration, since this problem affects criminal law and the design of the insurance system.

2) Protection of neuronal data and prevention of unauthorized access to the brain (protection of personal information)

Pertaining to the security of neuronal data transmitted wirelessly and the prevention of unauthorized access to the brain through hacking BMIs, this research points out that there is a need for the prior public disclosure of the development of products with technological countermeasures and their contents. These matters are in urgent need of consideration, since this problem affects the provision of laws on consumer protection and product liability.

3) Promotion of social acceptance (public awareness) and advancement of ethical norms based on the swift disclosure and accuracy of technological information

The research identifies the need to quickly disclose newly discovered characteristics of BMIs during research development and to promote social consideration based on this. For example, one of the authors of the article, Associate Professor Junichi Ushiba, discovered in 2011 that prolonged usage of BMI transforms the functions of the nervous system, publishing the details in an academic paper. Among the concerns voiced on the detrimental effects of BMI upon the human body, this discovery conversely gave birth to a movement for its medical application as regeneration treatment to improve neurological functions. Now, this treatment is capable of aiding the recovery of severe stroke hemiplegia. Consideration of the use of technology and regulations is desirable upon disclosure of the fact that BMI technology has developed within such fluctuations.

4. Future Developments

This declaration is expected to encourage corporations engaged in the industrialization of BMIs to observe and disclose their code of conduct, and to become a global standard for the implementation of BMI ethics. Furthermore, it is expected to lead to the enactment of

scientifically appropriate legislation and social acceptance based on correct knowledge of BMIs.

5. Special notes

Keio University Associate Professor Junichi Ushiba's BMI research relating to this publication was conducted with the support of AMED.

*(Reference) Article on the joint developments of Keio University and Panasonic:
""Nenjite ugokasu gijyutsu" BMI nanbyō chiryō no genba ni hirogaru ["Technology moved by thinking" the spread of BMI in treating intractable diseases]" (in Japanese) — *NIKKEI STYLE* (Feb, 2017)
http://style.nikkei.com/article/DGXKZO12499470T00C17A2TZQ001?channel=DF130120166089

Details of Journal Article

Jens Clausen, Eberhard Fetz, John Donoghue, Junichi Ushiba, Ulrike Spörhase, Jennifer Chandler, Niels Birbaumer, Surjo R. Soekadar. "Help, hope, and hype: Ethical dimensions of neuroprosthetics -Accountability, responsibility, privacy, and security are key." *Science* 356 (6345) (2017): 1338-1339.

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