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Using wearable optical topography to measure the brain activity of two people working on a cooperative task

- Analyzing the relationship between brain activity and cooperation through a repetitive button-pushing task -

Tokyo, Japan, 19th July 2011 – Hitachi, Ltd. (NYSE: HIT/TSE: 6501, hereafter, Hitachi) today announced that wearable optical topography*[1] was used to analyze the relationship between brain activity and cooperative work by measuring the brain activities in the prefrontal lobe of two subjects partaking in a cooperative task. In the experiment, two subjects forming one team were given a cooperative task of pushing a button at the same time after ten seconds from a given starting point, and asked to repeat this task ten times. The brain activity of the subjects were simultaneously measured during this cooperative task. Statistical analysis of the brain-activity patterns of six pairs of subjects and the timing of pushing the button revealed that the greater the similarity in pre-frontal lobe brain activity, the closer the timing was for pushing the button.

At the frontier of brain science research, work is beginning on “social brain science” to elucidate how the brain processes information during social interactions such as collaboration and confrontation between people. The results of this experiment indicate that the wearable optical-topography system which is able to measure brain activity under conditions similar to daily life, is an effective measurement tool in “social brain science” research.
In recent years, with the development of brain function imaging methods is enabling the relationship between individual external stimuli and brain activity to be analyzed. In social brain science research, however, it is important to simultaneously measure and analyze the brain activities of several people performing a cooperative task in a daily environment. To date, the results of brain activity measurement of many people using several units of electroencephalograph*[2] or fMRI*[3] have been reported, however, if it is possible to easily measure regions of brain activity in a daily-life environment, then greater advances in social brain science can be expected.

To this aim, Hitachi undertook the simultaneously measurement of the brain activity of two subjects during a cooperative task using a wearable optical topography system. The measurement method and results are summarized as follows.

(1) Two subjects forming one team were seated facing each other. Eyes closed, each subject was asked to count ten seconds and then push a button at the same time as their counterpart. After both subjects had pushed the button, a sound was issuedto indicate the difference in timing between the two subjects in pushing the button thus allowing each subject to adjust the timing with their counterpart after the first trial. This task was conducted ten times by six pairs of subjects. The brain activity of each pair was measured using wearable optical topography technology, and the time difference between the button pushing was also recorded.

(2) The wearable optical-topography system monitors brain activity by measuring blood-volume changes in the cerebral cortex of the frontal lobe. Inter-subject covariance*[4] of brain-activity distribution was calculated on the basis of the temporal blood-volume changes in the frontal lobes before the subjects pushed their buttons, and the calculated covariance was normalized so that mean and variance of the covariances are the same for each pair. (Covariance shows the degree of similarity between two people's brain-activity distributions.)

(3) Based on the calculated covariance, the data from 53 trials (60 trial results less 6 first trial results and one unused data result) were divided into two groups: higher-than-average-similarity in brain activity (32) and lower-than-average-similarity (21). The button-pushing time intervals of each group were compared in terms of average and standard deviation,*[5] and a significant statistical difference was found between the average time interval of the two groups. Further, the subjects whose frontal-lobe brain-activity distributions had higher similarity pushed their buttons with closer timing.

These findings indicate that the relationship between the brain activities of two people partaking in a cooperative task in natural settings can be analyzed using a wearable optical-topography system to simultaneously measure their brain activities. This wearable optical topography system will contribute to the advancement of social brain science by allowing the brain activity of multiple people interacting in natural settings to be simultaneously measured and analyzed.

These results were published in the Journal of Biomedical Optics on 18th July 2011.

Notes

*1. Wearable optical-topography system: A compact and light (approx. 1kg) optical topography system that can be worn on the head. It can pinpoint regions of raised brain-activity by measuring changes in blood volume which occur during increased brain activity by irradiating the scalp of a subject with a weak near-infrared light. Using wireless LAN, data from four subjects can be simultaneously measured and sent in real-time to a notebook PC. This system has been commercially available as a research tool since 2010.
*2. Electroencephalograph: A device that measures electrical activities of nerve cells from small potential changes on the scalp.
*3. fMRI: Functional magnetic-resonance imaging
*4. Covariance: A measure of how much two variables change together; namely, the mean of values obtained by multiplying two deviations from a mean in terms of each variable.
*5. Standard deviation: A measure of data dispersion.

ABOUT HITACHI

Hitachi, Ltd., (NYSE: HIT / TSE: 6501), headquartered in Tokyo, Japan, is a leading global electronics company with approximately 360,000 employees worldwide. Fiscal 2009 (ended March 31, 2010) consolidated revenues totaled 8,968 billion yen ($96.4 billion). Hitachi will focus more than ever on the Social Innovation Business, which includes information and telecommunication systems, power systems, environmental, industrial and transportation systems, and social and urban systems, as well as the sophisticated materials and key devices that support them. For more information on Hitachi, please visit the company's website at http://www.hitachi.com.

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