For Making More Accurate Measurements

in fNIRS

(functional Near-Infrared Spectroscopy)

Japan Optical Functional Brain Imaging Society

Contents

1. Introduction

fNIRS is an abbreviation for functional near-infrared spectroscopy and indicates a novel technology measuring biological functions, primarily the higher order brain functions, using near-infrared spectroscopy. The Japan Optical Functional Brain Imaging Society has made this booklet for improvements in the measuring techniques and the reliability of the fNIRS data. This booklet describes the main points about fNIRS measurements to guide beginners in this field or researchers out of this field toward adequate operations of the instruments and acquiring effective data without the help of skilled instructors. Appendix 1 describes the principles of fNIRS for measuring the higher order brain functions, and the readers are recommended to acquire better data in fNIRS under correct understanding of the principles. Also please refer to Appendix 2 for definitions of technical terms. There are two types of fNIRS instruments, stationary and wearable, which are commercially available, and the contents of this booklet apply to both types of instruments.

In most cases of measurements using human subjects, it is necessary to gain approvals from the ethical committees of the corresponding organizations. This booklet is made with the assumption that the ethical committee approves are necessary for the measurements. Please refer to the guidelines or regulations established by the government in each country.

2. Planning of measurements

2-1. Purpose of measurements

Note Decide what brain function you want to measure.

It is necessary to be clear about what brain function you want to measure. In fNIRS experiments, you may want to measure how the activity of a brain region of a participant changes in response to the action of some task. However,

electroencephalography (EEG) as shown in Fig. 2-3. It may be possible to obtain higher reproducibility by checking the probe positions using equipment like a 3D position sensor.

Two examples in which stable measurement data can be obtained even by beginners are shown below. Once you observe the specific brain activities in these examples, you may proceed to measurements for observing activities in other brain regions or measurements with the tasks of event related designs in which effective data are somewhat difficult to be acquired.

2-5-1. Example 1 of the head region for measurements: Finger tapping task

For the finger tapping task mentioned as the example 1 of the task design, Fig. 2-4 shows an example of the head regions with the probe arrangement using two pairs of three by three probes. The red circles, blue circles and white squares indicate the source, detector and data points, respectively. In the case of measurements at the motor areas for both hands, two pairs of the probes are normally arranged symmetrically to the center (Cz) of the line connecting the nasion (Nz) and inion (Iz).

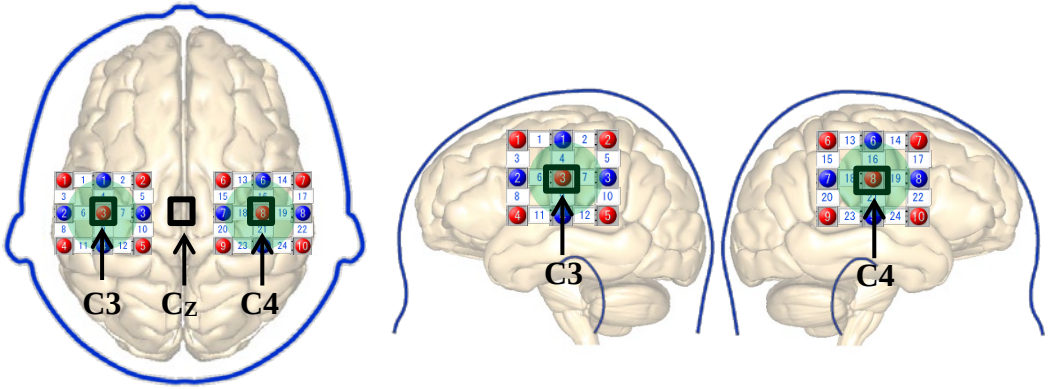

Fig. 2-4 An example showing the head regions with the probe arrangement for the finger tapping task. The green regions are the estimated motor areas. (Referring “BodyParts3D, Copyright© 2008” under the license CC-BY SA 2.1JP from the Database Center for Life Science, Japan)

2-5-2. Example 2 of the head region for measurements: Verbal fluency task

For the verbal fluency task listed as example 2 of the task design, Fig. 2-5 shows an example of the head regions with the probe arrangement of five by three probes. The red circles, blue circles and white squares indicate the same as in Fig. 2-4. Because the region around Broca's area is to be measured for the verbal fluency task, the position corresponding to T3 in the international 10-20 system is marked, and the probes are arranged so that the center probe in the lowest row is located on the mark.

For more details on the head regions for measurements, please see references No. 1, 2 and 3.

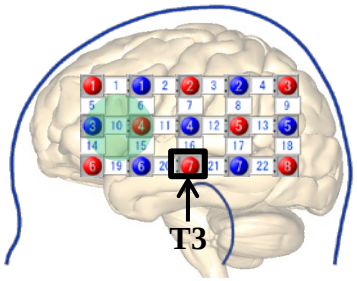

Fig. 2-5 An example showing the head regions with the probe arrangement for the verbal fluency task. The green region is the estimated Broca’s area associated with various language tasks. (Referring “BodyParts3D, Copyright© 2008” under the license CC-BY SA 2.1JP from the Database Center for Life Science, Japan)

with the body surface. When the source light far from the body is sent to the body surface by optical fibers, or when the reemitted light from the body surface is sent to the detector far from the body by optical fibers, the regions of the optical fibers in contact with the body are defined as the probes. When the source and detector devices are in direct contact with the body, the devices are defined as the probes.

- Rest: A status of a participant under a resting state.
- Smoothing: A method of processing the time-series data to smooth out the short-term fluctuations and highlight longer-term trends in the time-series data.
- S/N ratio (signal-to-noise ratio): The ratio of the signal intensity in interest to the noise intensity. The reliability of the data is higher with higher S/N ratios.
- Target task: A task which a participant is given to induce a specific brain activity. “A target task” is frequently called as “a task” simply.
- Task: A subject which a participant is given to conduct.
- Task design: A design or plan for how to combine the target and control tasks.
- Total-hemoglobin: Naming of the addition of the oxy- and deoxy-hemoglobins, and abbreviated as total-Hb.

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