Investigating Physiology of Untruth in Cerebral Cortex by Functional Near-Infrared Spectroscopy (fNIRS)

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Abtract — **Physiological measurement has been deeply investigated in microenvironment. The physiology on molecular or biochemical levels is examined to diagnose disease in early state. With new brain imaging techniques such as multi - channel near – infrared spectroscopy (NIRS), the functions of the cognitive brain activities can be determined. In this study, the relationship between specific physiology of brain cortex and psychology of untruth is assessed through measurements of the changes in concentration deoxygenated hemoglobin (HHb) and oxygenated hemoglobin (HbO2)by multi - channel NIRS. Moreover, we found the complex combination at prefrontal cortex (Cz) is related to physiology of truth and untruth.**

Keywords — **physiology of truth, physiology of untruth, prefrontal cortex, central zone, NIRS, FUSION.**

I. Introduction

With brain imaging techniques such as PET, fMRI…, the functions of cognitive brain activities can be determined**.** These techniques require strictly motion restriction, so most of participants feel stressful during experiments. However, NIRS is a non-invasive measurement.

Due to important role of untruth physiology of human being, the United States and Russia produced many devices such as Polygraph (Lie detector), детектор лжи, etc…. These techniques were used to measure and analyze data based on blood pressure, heart rate, breathe rate and electrical skin impedance…. These parameters are determined to be linked to the physiology of untruth in different levels.

In this study, multi -channel NIRS technique was used as an equipment for investigating of particular relationship between physiology of untruth and the change concentration of HbO2 and HHb in brain cortex.

II. Methodology

A. Participant

Nine healthy adults (2 female, age 19 - 22 years) have been included in our experiment. Each subject was tested three times in 180 seconds. Between tests the rest from 30 to 60 second is taken for preparing next tests. During NIRS measurements, participants had to communicate face to face with researcher and answer to his questions related to psycho-physiology of untruth.

B. Material

We acquired data of the cerebral tissue oxygenation from all participants by Shimadzu FOIRE-3000 NIRS machine (Fig. 1). This new imaging technique is designed with three different wave lengths of 780, 805 and 830 nm to monitor changes in the oxyhemoglobin (HbO), deoxyhemoglobin (DeHbO) and total hemoglobin (TotalHb).

Fig. 1 Shimadzu FOIRE-3000 NIRS machine

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III. Data analysis

There are two approach to be applied for data analyses in our study:

- Analysis based on FUSION software.
- Application by statistical mathematic.

1. *Approach 1(FUSION software)*

- *Method*

We used MRI-FUSION software as a tool for analyzing data in real time with NIRS measurement.

- *ROI (Region of interest)*

Right hemisphere was checked as significant cortical region where the intensive changes of HHb and HbO2 in channel 3 (Fig. 2) were observed.

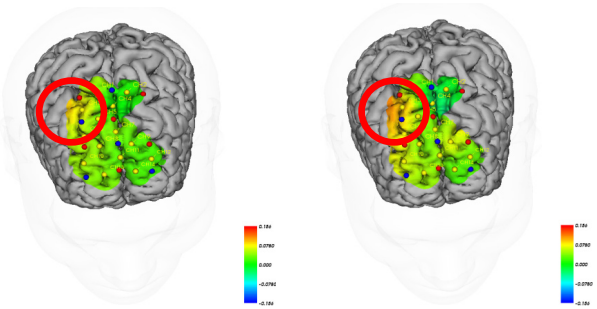

Fig. 2 The changes of HHb and HbO2 in channel 3

- *Results*

Three periods in accordance with 5th, 25th and 45th seconds of the tests are important to be under carefully examination on the changes of HHb and HbO2 concentration. Through the different colors expressing different intensiveness of HbO2 consumption at Channel 3 in three periods mentioned the untruth is checked. The period where the changes of HbO2 concentration increased higher and repeated much more than in other periods is considered as linked to untruth psycho-physiology. It was recognized that the period that much more changing in color indicated to the untruth cases. Moreover, we noticed that each participant had different level of changed colors.

2. *Approach 2 (Statistical mathematic)*

- *Method*

Data of each experiment was separated into three stages, in accordance with three periods (5th, 25th and 45th seconds). For each stage the statistical characteristic such as variance, mean, etc were determined. Then these characteristics were compared to that of other stages. Their maximum or minimum values (in dependence on gender) are considered as linked to untruth psycho-physiology (untruth cases).

- *Result*

Applying this method for Channel 3 given results presented in Table 1.

Table 1 The result of true test analyzed by statistical mathematic method

Date	Name	Sex	Test1	Test2	Test3
26/9	N.M.N	Male	T	T	T
	L.H.D	Male	T	1/2T	1/2T
	T.C	Female	T	2/3T	1/2T
27/9	V.N.T	Male	T	T	T
	B.N.H	Female	T	T	F
	N.M.D	Male	F	T	T
28/9	T.N.N.M	Male	T	T	F
	T.Q.V	Male	T	F	T
	D.N.H	Male		F	F
	Overall		**87%**	**70%**	**56%**

- *Notices*

- The method correctness is about 70% of tests with taking into account the participants' gender and individual differences in level adaptation and in psycho-physiology.

- The decreasing precision of method according to tests order shows the different adaptation levels of each participant in experiment

IV. Conclusion

Near – infrared spectroscopy (NIRS) is sensitive to physiology of truth. There is complex combination of cerebral cortex regions, related to physiology of untruth. The untruth states can be detected by FUSION and statistical mathematic methods. The more subtle algorithms are needed to improve results of data analysis.

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