

Temporal Behavior of Human functional Near-infraredgraphy (fNIR) using Single-Word Speaking Trial

T. Kato*, Y. Yamashita†, A. Maki†, T. Yamamoto†, N. Ichikawa‡, H. Koizumi†

*CMRR, University of Minnesota, Minneapolis, MN, 55455 USA

†Central Research Lab. Hitachi Ltd., Tokyo, Japan

‡Hitachi Medical Corporation, Chiba, Japan

Introduction

A temporal behavior model for human mental operation was presented as cerebral multi-phasic sustained response (CMSR) using fMRI (1). This CMSR indicates that different cerebral regions have differing temporal behavior of activation after a task period. Recently, this physiological behavior was observed in the language and visual system (2, 3) Functional near-infraredgraphy (tNIR) can provide the real-time changes of the regional cerebral blood volume (rCBV), the regional Oxy-Hb and the regional Deoxy-Hb from skull at the bedside. We developed the principal method of human functional spectroscopy using the scattering light NIR (4). In this study, we test the hypothesis that CMSR can observe a single-word speaking trial using INIR

Methods

fNIR experiments: The rCBV Oxy-Hb + Deoxy-Hb, HbO₂, and Deoxy-Hb were estimated using a tNIR system with 24-channel or 48-channel (Hitachi Medical Corporation) (5, 6). Light for the tNIR from two laser diodes was directed into the head through a fiberoptic bundle (1 mm in diameter). Near-infrared light with wavelengths of 780 and 844 nm was used. The distance between the photon probes was 3cm. The sampling time for each photon count was 0.5 sec. The changes in the Oxy-Hb and Deoxy-Hb concentration were calculated using the differences in the absorption indexes for the two wavelengths. The center of 48 or 24 channels (90 x 90,mm or 60x60/ square) was located in skull surilice related to the bilateral inferior frontal lobe and the superior temporal lobe. A total of 9 imaging sessions with 6 normal volunteers were performed. The paradigm consisted of two control periods that embedded the external speaking task period using a single-word. External speaking task of a single-word: The subject (S) is given the name of an animal once and repeats it overtly. For example, S hears "cat" Trials were performed during 7-10 ON/OFF epochs, each a 45s OFF period. Maps and time courses of functional activation were generated by the Hitachi Medical Corporation made software package (3). The time courses were averaged with 7-10 epochs.

Results

A single-word speaking task induced the activation in the following areas: auditory area, bilateral inferior frontal lobe and Wernicke's area. Time courses from activated areas included CMSR after a single trial. Broca's area (BA 44/45) showed the double peaks of rCBV. Broca's area showed longer responses after the task period than the auditory area

Conclusion

This observation demonstrates the CMSR relate to the external speaking of a single-word trial fNIR is able to use for the communication research using an external speaking task.

Acknowledgments

Supported by NIH grants P41 RR08079.

References

1. Kato T, et al. NeuroReport 9 1041-7(1998).
2. Kato T, et al. NeuroImage 7: S167 (1998).
3. Kato T, et al. NeuroImage 7: S864 (1998).
4. Kato T, et al. JCBFM 13, 516-20(1993).
5. Maki A, et al. Med.Phys. 22, 1997-2005 (1995).
6. Yamashita Y, et al. Rev. Sci. Instrum. 67, 730-2(1996).

