Bakardjian, H., Cichocki, A., Classification of Fast Imagined Motion responses for a Human-Computer Interface, Proceedings of the 42nd Annual Conference of Japanese Society for Medical and Biological Engineering, Sapporo, Japan, June 3-5, 2003, p.462.

Classification of Fast Imagined Motion Responses for a Human-Computer Interface

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Introduction

Visual motion is one of the most common stimuli in everyday life. While "smooth" motion (SM) perception is the visual processing of natural, gradually-moving objects, "apparent" motion (AM) corresponds to a series of occluded or discrete images shown in rapid sequence [1], for example on a cinema screen. Although both types of stimuli are perceived similarly as motion under proper conditions, some of the early (40-100ms) pathways the cortex uses to process them may be different. We hypothesized that subjects would be able to voluntarily modify their perception about the particular type of motion that they are experiencing, thus altering the electrical potentials on the surface of the head.

Methods

Our experimental setup consisted of a high-density EEG system (EGI Inc.) with 256 sponge-type electrode array. The visual motion stimulus was a thin vertical white bar on a black background projected frontally on the left side of a screen and displaced centripetally and centrifugally by 5 degrees. The motion duration was 50ms in all three experimental conditions: 1) single-jump apparent motion (AM) with random displacements; 2) smooth motion (SM) with the same ISI and displacements as in 1); 3) apparent motion stimuli as in 1) but the subjects were instructed to bias as much as possible their actual perception of the sudden motion jumps towards imagining (IM) the smooth motion experienced in experiment 2). Three paid healthy subjects participated (two female and one male, 22.3+-4.9 years old). Following standard eye movement artifact rejection and segmentation into 40 single epochs per motion type with 1024ms lengths, half of the epochs were averaged and used for defining individually the classification channels. The remaining single epochs for each type of motion were processed using independent component analysis (ICA) [2]. We used a 4^{th} order TQR-ICA algorithm in order to extract the early peak components (≤100ms) in visual motion.

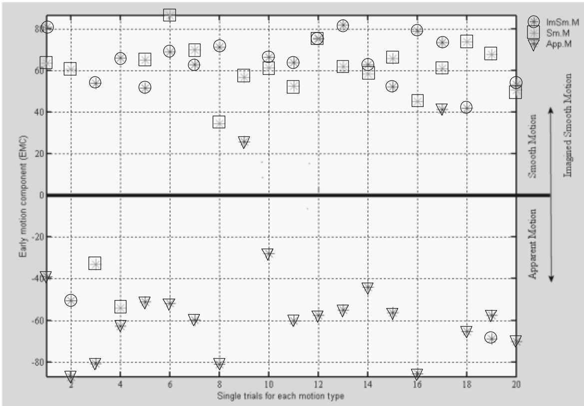

Fig. 1. Classification results for all three motion types

Results

Our preliminary results showed that it is possible to separate the early apparent-motion AM from smooth-motion SM components using only 10 electrodes from our high-density electrode array, located over the inferior parieto-occipital cortex (approximately corresponding to standard TP8). Furthermore, in the same motion-processing locations, the imagined-smooth cortical responses IM were extracted with a rate of success of 90%, so that in most single trials (Fig.1) the early IM components (circles) were closer to the SM (squares) than to the AM responses (triangles).

Conclusions

In conclusion, in our study the subjects were able to activate smooth-motion-specific responses in the inferior parieto-occipital cortex even when the actual stimulation consisted of just two flashes of sampled apparent motion. These fast controllable motion-based potentials could be used to increase the degrees of freedom in emerging human-computer interface communications.

References

[1] Bakardjian H et al. Magnetoencephalographic study of speed-dependent responses in apparent motion. Clin. Neurophysiol., 113:1586/1597 (2002)

[2] Cichocki A and Amari S. Adaptive Blind Signal and Image Processing. John Wiley & Sons (2002)