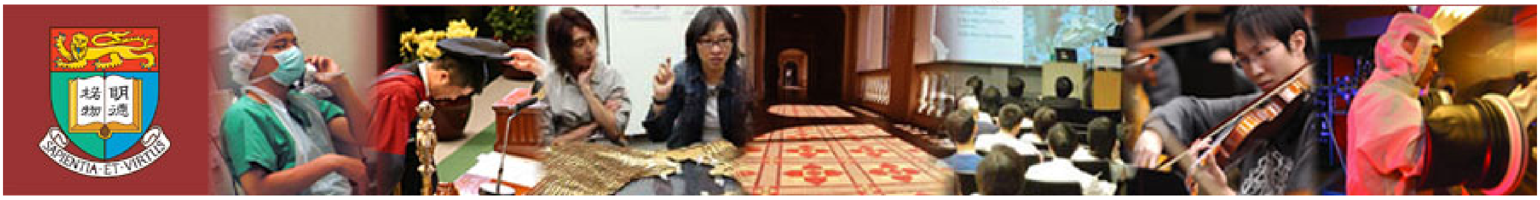

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Potential Use of Electrical Somatosensory Modality for Brain Computer Interface

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Introduction: P300 is commonly used in noninvasive brain computer interface (BCI). Most P300 based BCIs were focus on visual and auditory stimulation [1]. Several previous reports present the potential use of vibrotactile stimulus for P300 BCI [2,3]. As an alternative, electrical somatosensory stimuli can be used for BCI purpose [4]. This paper is to propose a P300 based BCI by using electrical somatosensory stimulation.

Material, Methods and Results: Ten healthy subjects (5 males and 5 females, age ranged from 20 to 28 years old) were recruited with written informed consents. P300 were recorded from each subject by 3 sensory modalities (visual, auditory or electrical-somatosensory) respectively. Each modality has two kinds of stimuli 'Go' and 'No-Go', i.e. Visual stimuli: red solid circle (No-go) and green solid circle (Go), auditory stimuli: low frequency (1kHz) monotone (No-go) and high frequency (2kHz) monotone (Go), somatosensory stimuli to the left index finger: lower intensity (No-go: two times of sensory threshold) and higher intensity (Go: three times of sensory threshold). Go and No-go stimuli were randomly present in 1 to 2 ratio, i.e. 60 Go stimuli and 120 No-go stimuli in each modality. P300 was recorded with a sampling frequency of 1000 Hz and band-pass filtered between 0.1-30 Hz. The linear discriminate analysis method (LDA) was selected to perform classification analysis [4]. Fig. 1 demonstrated P300 of the 'Go' and 'No-Go' at channel 'CPz'.

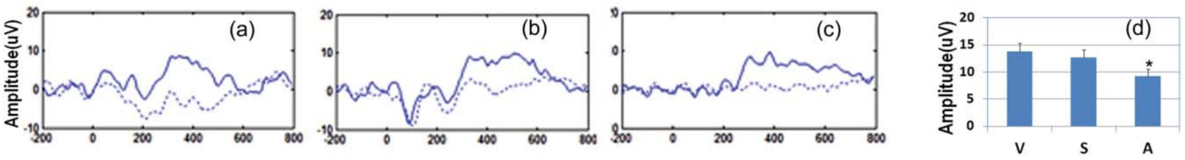

Figure 1. *Sample waveforms of P300 responding to (a) visual (b) electrical, and (c)auditory stimuli, while the solid line is in response to Go stimulation and dot line is in response to No-go stimulation. Comparison of Go P300 amplitudes in 3 modalities (d) shwed that auditory P300 has significant lower amplitude than visual and electrical P300 (P<0.01 by one-way ANOVA), while there is no significant difference between amplitudes of visual and electrical P300 (P>0.05 post-test by Tukey after one-way ANOVA).*

Comparison of performance among 3 modalities, accuracy ranged from 52% to 79% in electrical condition, with a mean accuracy of 66.99%; 63% to 77% in visual condition, with a mean accuracy of 70.93%; 51% to 69% in auditory condition, with an average at 59.40%. The visual modality had better performance than other two modalities. Electrical modality had higher classification accuracy than auditory modality for each participant.

Discussion: The present study is to prove that electrical stimuli can elicit reliable P300s in rough comparison to visual and auditory stimuli, which can be an input of P300 based BCI. Results showed that electrical stimuli can produce significantly larger amplitudes than for the auditory stimuli and as large as for the visual stimuli. The results are in agreement with previous somatosensory BCI [3], which presented 5 subjects with accuracy ranged from 50% to 100% with mean of 70%. The performance results presented a higher accuracy in electrical modality than that in auditory modality, and an equivalent accuracy as visual modality.

Significance: This study has demonstrated the usefulness of electrical somatosensory P300 based BCI as good as visual stimuli and auditory stimuli.

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