Effect of Psychomotor Learning on EEG Activity during Aiming

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Introduction

Learning is defined as a set of processes associated with practice or experience leading to relative permanent alters in the capability for responding (Schmidt, 1988). In 1967, the notion of stages of learning was presented by Fitt and Posner (1967) which explain patterns of skill progressing. Sakai et al. (1998) showed different regions of brain being activated during different stages of learning a visuomotor task which shifted activities with participating functions. Electroencephalogram (EEG) can sensitively reflect variations in attention and cognitive demands (Smith et al., 1998). Michael and Smith (1998) showed both hemispheres involved in a given specific task with verbal or spatial demand. Landers, Han, Salazar, Petruzzello, Kubitz, and Gannon. (1994) conducted a study with 11 novices that at pre-test there was no difference between temporal sites during aiming period. After 12 weeks of practicing, the T3 showed more synchronization and no difference was observed in the right hemisphere. The results of Hauffler, Spalding, Santa Maria, and Hatfield’s (2000) study indicated that experts showed more alpha power in left hemisphere than the novice. The phenomena that right hemisphere was more activated probably result from more verbal task involved in cognitive stage. Therefore the alpha frequency, as a resting index, increased as the function of repeating practice on a task (Gliner et al., 1994). However, Smith, McEvoy, and Gavin (1999) suggested the patterns of cortical activity of EEG could be used to reflect the result of practice but the manner in spectral feature of the ongoing EEG changes as function of skill acquisition has not been fully investigated. Hence, the aim of this study is to investigate change in specific EEG activity pattern which may have occurred as result of learning.

Methodology

Subjects. One male and one female ages 24 and 25, respectively. Neither subject had prior shooting experience.

Procedure. The task was conducted indoor with a toy air rifle. The purpose was for the subject to aim the rifle at a 5m-distance target. The subject allowed to take 10 unrecorded shots as warm up. Each task consisted of 4 sessions with each session containing 10 trials. The scores were recorded. The subjects could take a two-minute break after each session. The subjects were told to stay in the shooting position for at least 7.5 seconds before shooting. The subject would then practice for a period of 30 days.

Data selection and reduction: EEG activity was recorded from 28 channels using the 10-20 international system with Neuroscan 4.2. Data was acquired at a sampling rate of 256Hz. Impedance was maintained below 5KΩ. EEG contained artifacts were rejected by
visual inspection. The EEG data of the last second prior to the trigger pull was analyzed.

**Results**

Using t-test: With Subject 1, the coherence of T3-T4 was higher than the coherence of T4-Fz (alpha band: t=2.12, p=0.09; Beta1 band: t=5.58, p< 0.001; Beta2 band: t=5.07, p< 0.001). With Subject 2, there was no significance between T3-Fz and T4-Fz. Correlation between practice time and coherence was analyzed using Spearman’s coefficient. For Subject 1, practice time was positively correlated with the coherence of T3-Fz (r=0.378, p< 0.33 in alpha band; r=0.793, p< 0.001 in beta1 band; r=0.822, p< 0.001 in beta2 band) and T4-Fz (r=0.665, p< 0.001 in alpha; band; r=0.849, p< 0.001 in beta1 band; r=0.855, p< 0.001 in beta2 band). For Subject 2, however, no significance was found. Correlation between score and coherence was analyzed using the Spearman correlation. A positive relationship was observed between T3-Fz (Beta1 band: r=0.348, p< 0.001; Beta2: r=0.333, p< 0.001) and T4-Fz (Beta1 band: r=0.386, p< 0.001; Beta2: r=0.393, p< 0.001) versus score for Subject 1. A positive relationship between score and coherence was also found in T3-Fz (Beta1 band: r=0.290, p< 0.001; Beta2: r=0.228, p< 0.001) and T4-Fz (Beta1 band: r=0.173, p< 0.001; Beta2: r=0.255, p< 0.001) for Subject 2.

**Discussion**

The present study was to investigate whether the effects of learning were reflected on the changes of EEG’s patterns. The hypothesis was that the EEG patterns from two hemispheres would change differently after practice. Also, coherences between T3-Fz and T4-Fz would be changed as the shooting performance improved. The study found that T3 and T4 showed high coherence to FZ. As a consequence of learning, Subject 1 showed T3-Fz’s coherence significantly less than T4-Fz after practice but this pattern was not observed in Subject 2. According to Fitt and Posner (1967), subjects tended to adjust movement by both self-instruction and object-attention but declined when skill advanced. Deeny et al. (2003) suggested that lower coherence is associated with better performance. In this study, the positive correlation between score and practice time implied that subjects’ performances were improved. The scores, however, were significantly positively correlated to coherence on both subjects. The explanation for these inconsistent results is that the performance may be improved conspicuously in the initial stage but regions of the brain are still consume exceeded resource to adjust movement. In this study, we failed to see the same activity pattern in both subjects during early learning. It is more likely that a longer practice period may be needed for the changes in cortical activity. The patterns of EEG activity in the early stages of skill acquisition for novices may be different from patterns obtained from experts.

**Conclusions**

In a shooting task, both T3 and T4 showed high coherence to Fz in the early learning stage and coherence of T3-Fz showed less value than T4-Fz in one subject after practice but failed to see the same patterns in the other subject. Coherence was positively correlated to
performance improvement. These results may exhibit the activity of a subject in the early learning stages of a task.

References