POSTERIOR PARIETAL CORTEX ROLE IN A SENSORIMOTOR TASK PERFORMANCE

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Abstract – This study aimed to elucidate electrophysiological and cortical mechanisms involved in anticipatory actions when individuals had to catch balls in free drop; specifically through quantitative electroencephalography (qEEG) alpha absolute power changes. The sample was composed for 23 health subjects, both sexes, with ages varying between 25 and 40 years, absence of mental and physical illness, right handed and don't make use of any psychoactive or psychotropic substance at the time of the study. The experiment consisted of a task of catching balls in free drop. The three-way ANOVA analysis demonstrated an interaction between moment and position factors in left parietal posterior cortex (PPC) (p=0.001). Through the experimental task employed, this area demonstrated a differentiated activity involving expectation, planning and preparedness in the ball’s drop task.

KEY WORDS: absolute power, catch, qEEG, sensorimotor integration.

The posterior parietal cortex (PPC) plays a crucial role in relation to motor planning based on sensory information. Human functional magnetic resonance imaging (fMRI) experiments and electrophysiological recordings in nonhuman primates have shown that the PPC is neither sensory nor motor purely, but it is an area that encodes cognitive functions related to action¹,². The presence of sensory and motor specific representations together with high-level cognitive signals suggests that the PPC plays an important role for decision making related to action³. Such representations are elementary components in the preparation and adjustment of a motor act and they take part in the integration among different and specialized centers in the final movement production¹. This process occurs through sensorimotor integration, when sensory information is integrated by central nervous system to attend to motor programs.

Catching an object is a complex movement which involves not only programming but also effective motor coordination. Such behavior is related to the activation and

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recruitment of cortical regions which take part in the integration process that occurs between the information coming from the environment and the motor task performance. Plastic alterations might occur in brain areas regarding motor reactions (anticipatory movements and motor learning), which might lead to performance and gesture precision improvement. The quantitative electroencephalographic (qEEG) technique is able to detect the brain region activated during the preparation and execution of a certain task and the level of neuronal activity in different brain areas. Counting on a high temporal resolution, the qEEG has made the elucidation of cognitive processes and motor learning.

This study aimed to elucidate electrophysiological and cortical mechanisms involved in anticipatory actions when individuals had to catch balls in free-drop, specially through qEEG alpha absolute power changes.

**METHOD**

The sample was composed of 23 healthy individuals, both sexes, right handed, with ages varying between 25 and 40 years old. Inclusion criteria were: absence of mental or physical impairments (screened by a previous anamnesis) and not receiving any psychoactive or psychotropic substances. The experiment consisted of a task of catching balls in free drop. The balls were discharged by an electromagnetic system. The interval between the ball’s drops was 11 seconds, each ball was a trial and each block was made of 15 trials. The experiment consisted of six blocks, lasting 2 min and 30 sec each, with 1 min-interval between the blocks. These intervals favored the recovery of the active limb, avoiding muscular fatigue. The qEEG acquisition was collected using the international 10/20 system during 2 seconds before and after the ball’s drop. This methodology has already been utilized in other experiment conducted in the Brain Mapping and Sensorimotor Integration Laboratory. It was also done an electromyography (EMG) analysis in the experiment. EMG was used in order to detect and remove possible artifacts related to the ball’s fall that could affect the electroencephalographic signal.

**EMG**

Electromyographic (EMG) activity of the flexor carpi radialis (FCR), flexor carpi ulnaris (FCU), extensor carpi radialis (ECR) and extensor carpi ulnaris (ECU) was recorded by an EMG device (Lynx-EMG1000), to monitor and assess any voluntary movement during the task. Bipolar electrodes (2 mm recording diameter) were attached to the skin. The reference electrode was fixed on the skin overlying the lateral epicondyle near the wrist joint. The skin was cleaned with alcohol prior to electrode attachment. The EMG was amplified ($\times1000$), filtered (10–3000 Hz), digitized (10000 samples/s), and recorded synchronously to the EEG onto the computer’s hard drive. In each trial, the EMG signal was rectified and averaged over 500 ms from the trigger point.

**Spatial electrode localization and frequency bands**

The electrode pairs P3-Z and P4-Z represent the PPC, functionally related to sensorimotor orientation. The alpha band (8–12 Hz) was chosen due to its association with sensory, cognitive and motor mechanisms.

**Statistical analysis**

A three-way ANOVA and a post hoc test were utilized. The factors moment (pre and post ball’s drop), blocks (1 to 6) and position (P3-Z versus P4-Z electrode pairs) were compared ($p \leq 0.05$). The EEG absolute power values were log-transformed by SPSS software (version 15.0) to approximate a normal distribution.

**RESULTS**

Our data demonstrated an interaction between moment and position factors in the left PPC when compared with the homologous region ($p=0.001$). It was noted a significant decrease in absolute power values in pre ball’s drop period (mean=3.34; sd=0.077) in relation to post ball’s drop period (mean=3.68; sd=0.037) as observed in the Figure.

**DISCUSSION**

The current experiment is an attempt to understand cortical/electrophysiological mechanisms regarding anticipatory actions involved in voluntary movements, specially, when subjects had to catch balls in free drop. We observed an interaction between moment (i.e., 2 sec before and 2 sec after the ball’s drop) and scalp’s position (PPC). It was noted a decrease in power during the pre drop period...
in the left PPC (i.e., P3-PZ electrode pair) when compared with the right PPC (i.e., P4-PZ electrode pair). This behavior indicates an increase in activity in this region during motor planning of the contralateral limb (e.g., considering the inverse relation of alpha band). Previous experiments report that the PPC is responsible for initiation and sensorimotor guidance, limb motor preparation and handling of objects, and the integration of proprioceptive and visual information (spatio-temporal coordination regarding the ball’s contact with the hand). Therefore, in the pre ball’s drop period, the data suggest a strong integration between proprioceptive information (hand’s position) and visual information (spatio-temporal information available on the brief period of time in the subjects were able to exploit, additionally, the visual feedback information in real time, which could occurred a decrease in this specific cortical activation. Similarly, the subjects were able to exploit, additionally, the visual information available on the brief period of time in the early ball’s drop period (pre ball’s drop period). This sensory requirement becomes less active in the post ball’s drop period, which concerns the motor implementation or the hand’s movement to catch the ball.

Through the experimental task employed, the left PPC showed a differentiated activity involving expectation, planning and preparedness in the ball’s drop task. In this phase, the left PPC may provides information about arm’s coordination and finger movements when moved to visual targets and also anticipatory coordination of grip and load forces to maintain grasp stability during object manipulation, which occur before the motor execution as a basis for the movement organization. We recommend new investigations should replicate these findings maybe utilizing new paradigms, different objects and randomization time. Moreover, different population, other than healthy subjects, should also be considered for new experiments, for example, patients suffering from Alzheimer disease and Parkinson disease, in an attempt to observe specific variables such as attention, episodic memory, anticipatory movements, reaction time and motor planning and execution.

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REFERENCES