SYNERGY BETWEEN THE FRONTAL AND PARietAL LOBULE During Motor Global Coordination Tests

João Rafael Valentim Silva1 professor_joao_rafael@hotmail.com
Roberto Fares Simão Junior2 robertosimao@posugf.com.br
Walter Jacinto Nunes3 nunes.walter@ig.com.br
Conceição Eleonora Ferreira Vasconcelos4 eleonoravas@terra.com.br
Vernon Furtado da Silva1 vernonfurtado2005@yahoo.com.br
doi:10.3900/fpj.8.5.360.e

ABSTRACT

Introduction: The nervous system is the master of the human body functions. It has been stated that the frontal lobe is responsible for the global and fine coordination, and might be more active than other areas of the cortex. In such a way, the present study aimed at identifying if the frontal lobe is more active than the somatossensorial area during tasks of global coordination. Materials and Methods: Braintech 3.000 was used (EMSA Medical Instruments, Brazil) for collecting the electroencephalographic signal. Results: The tests of global coordination, oculo-manual coordination were the electrode F3 (1.799±0.225mV) versus C3 (1.789±0.218mV), F4 (1.815±0.223mV) versus C4 (1.828±0.227mV), foot-eye coordination F3 (2.735±0.228mV) versus C3 (2.720±0.280mV) and F4 (2.821±0.267mV) versus C4 (2.763±0.258mV). None of the results presented any difference in the ANOVA one-way with 0.05 sensitivity. Discussion: The results showed great activity of the frontal cortex; however, there is an activation of the same magnitude in the somatossensorial area, suggesting an interregional coupling of information during tasks of global coordination.

KEYWORDS

Electroencephalography; Psychomotor Performance; Frontal Lobe; Parietal Lobe.
The frontal lobule has motor functions primordially, as innumerous authors say, and, lately, the function in learning and in cognitive tasks has been argued.

Its main role is still the involvement since the most senile stages of the movement, as preparation, elaboration and planning, till its execution properly said.

The parietal cortex has great importance in sensations and in the synestetic system, and it also presents motor functions, forming a circuit with motor and pre-motor areas and interacting with process sensorial and motor information, forming an area of motor sensory integration.

In several studies, with image or electrophysiological exams, the frontal and parietal lobule presented an increase in activities during motor tests. Many methodologies were used to test the hypothesis that the frontal lobule activates concomitantly with parietal areas, and the results found were similar.
The assumed hypothesis for the present study was that the frontal cortex should be more active than the parietal lobule. Thus, the objective of this study was to identify if the frontal lobule is more active than the somatosensory area during global coordination tests.

**MATERIALS AND METHODS**

This paper was approved by the Ethics Committee of Universidade Castelo Branco, in conformity with resolution n. 196 of October 10, 1996, from the National Health Counsel under protocol number 063/2007.

**Universe and sample**

A sample with ten subjects was chosen, with ages varying from 20 to 30 years old of both sexes, completing a mean of 23.9 years old (d±2.82). All the participants slept at least six hours in the previous night; did not present any cognitive deficit, physical or mental health implications and did not use any psychoactive or psychotropic substance. A questionnaire to identify and exclude from the experiment any subject that could contaminate future studies was applied.

For the electroencephalographic sign collect, the equipment Braintech 3000 (EMSA, Instrumentos Médicos, Brazil) was used. This system uses an analogical-digital convertor plate (A/D) of 32 channels with 12-bit resolution, joined to a slot ISA of one Pentium III composed by a 750Mhz processer. A bonnet with electrodes disposed according to the system 10-20 with reference electrodes placed in the earlobes (biauricular). The whole system was duly filled up with earth in order to avoid problems of energy variation.

**Procedures of data collection**

The room used for electroencephalographic sign caption was prepared with acoustic isolation and, during the sign acquisition, the lights were quickly reduced. The individuals sat comfortably in a chair with support for the arms in order to reduce the muscular artifacts.

A previous experimentation was carried out, which lasted close to five minutes for all the tests, and an explanation of how to proceed in the data collection was done. For all the tests, the procedure adopted was the itinerary explanation, answering to all the doubts that might have appeared.

For data collection effect, 70-second-tracks were collected, the five first and last seconds were despised aiming at eliminating any spurious caption caused by any command, and the left 60 seconds were used as data. A total of three tracks for each test were collected, with a minimum interval of 60 seconds between the tracks to avoid psychological and physical fatigue.

All the individuals were oriented to avoid blinking, doing ocular and neck movements, so that the electrophysiological artifacts deriving from muscular activities diminish.

**Motor tests**

All the performance evaluations were despised and the movement execution time, increased, in order to amplify the data quantity used for the analysis.

**Global coordination**

**Eye-hand coordination**

This test consisted in throwing tennis balls inside a box in a distance of 3m. Therefore, the subject was settled in a chair with the feet sustained in the floor, the arm that would effect the movement supported at 90º in the latero-lateral axis and cranial-podalic related to the trunk. The movement consisted exclusively in bending the arm to throw the ball, extend it doing the throw and at the same time catching another ball and redoing the pitch until one minute is completed).

**Foot-eye coordination**

On the other hand, the foot-eye coordination consisted in kicking tennis balls between the feet of a chair, in a 3m distance. The subject was settled in a chair, with the feet without contacting the earth and kicked tennis balls offered to him with the aim of hitting between the feet of the referred chair until one minute was completed.

**Electroencephalographic data**

The high ALPHA band located between 10 and 12.9Hz was chosen, by its association with motor activity. For each task, three tracks of 70 seconds were collected, however, the first and last five seconds were discarded, and the remainder 60 seconds were valid. Hence, for each task 180 seconds of valid data were obtained.

**Statistical treatment**

The factorial analysis was used to verify data, having as reference specific points and comparing them to others of the research interest. For it, the ANOVA one-way was used with α≤0.05 index, and for the direction of the possible interactions performed, the post hoc test of Scheffé was used.

**RESULTS**

**Global coordination**

**Eye-hand coordination**

Figure 1 shows the data of the eye-hand coordination test. Data evince that the electrode F3, issuing a potential...
of 1.799 mV (dp=0.225) and compared to C3 1.789 mV (dp=0.218) did not present any differences (α=0.993); F4 1.815 mV (dp=0.223) when faced with C4 1.828 mV (dp=0.227) did not also show differences (α=0.996), according to the ANOVA one-way and α≤0.05.

Foot-eye coordination

Figure 2 shows the eye-hand coordination test data. They show that the F3 electrode issuing a potential of 2.735 mV (dp=0.278), compared with C3 2.702 mV (dp=0.280) did not present any differences (α=0.964), and F4 2.821 mV (dp=0.267) when confronted with C4 2.763 mV (dp=0.258) also did not show differences (α=0.978), according to ANOVA one-way and α≤0.05.

DISCUSSION

The present study investigated the frontal and parietal lobule activity during the global motor coordination tasks. It has been affirmed that the frontal lobules should be more active than all the others during the global coordination tasks12, knowing that this area is the most responsible for the structuration, control and correction of movements of this nature.

The somatosensory activity involves a reciprocal and dynamical activity between structures, with a continuous flow of information among the involved areas and the body sensors that are related10, and those co-ordinates and dynamics induce to quantifiable changes in the flow of information including reduction of entropy, increase of mutual information, integration and complexity inside specific regions comprising the frontal and somatosensory region15.

Hence, the objective of the present study was to verify if the frontal lobule would be more active than the somatosensory area during global coordination tests. To this, by quantitative electroencephalography, the absolute potential issued by these areas was compared.

Many studious reported the role of the frontal lobule in preparing the movement when demonstrating activity in the moments that preceded the motor activity8,9,10,11,16,17. As it was also demonstrated that the pre-motor cortex, or supplementary motor area, has an important role in planning and executing uni and bimanual sequences19.

The frontal lobule is very active in visual-motor functions and, although these areas were actives, the sensory-motor cortex seemed to be equally active during all the tests19.

Data showed strong activity in the frontal and somatosensory area during tests of global motor coordination. The F3 and F4 electrodes located over the frontal area were compared with the C3 and C4 electrodes, localized over the somatosensory area, according to the international system 10-2014, checking the alpha waves emission between 10 and 12Hz.

The dorsolateral prefrontal cortex and posterior parietal are automatically interconnected and implicated in the operational memory and movement preparation. The interaction of these cortical areas seemed to decrease the delay time between the stimulus and answer14. This relation confirms the data herein found, since they suggest an activity of equal amplitude between the frontal and parietal lobule. The data corroborate when it is showed that the prefrontal lateral cortex has an important role, and is particularly implicated in the cognitive support of the control of activated motor tasks20.

In another moment, the functional cooperation between the cortical areas during a manual task was certified by nuclear magnetic resonance by image (NMR), showing that the primary, supplementary motor cortex and the lateral pre-motor areas are equally activated during the movement21.

It is evident that there is an interaction between the different cortical areas during the global motor coordination tasks. When different movements of global and fine nature are researched, an inter-region coupling of all the cortex areas22 was verified, especially between the homologue central motor areas in the two cerebral hemispheres among the contralateral primary sensorial cortex and the pre-motor medial regions, including the supplementary motor area21.

These findings suggest that an information processing in the human motor cortex activates jointly different regions, but they can also work independently from the
other, i.e., the motor cortex does not answer only with an increase in the regional activation, but it can change information between the lateral motor and medial cortex and motor sensory region in both hemispheres, even in simple or unimanual movements\textsuperscript{21,22}.

The different areas of the cerebellum, motor areas, supplementary motor, sensorial, inferior frontal and all the parietal lobule were active in the tomography by emission of positrons (PET) during the realization of manual tasks\textsuperscript{23}, corroborant with our data and encountering with Vitor Fonseca’s affirmation, which our hypothesis was assumed. Although the author’s information has been about a more prominent activity of the frontal lobule on other cortex areas, it can not be forgotten that it was strongly activated during all tasks, indicating that its activity is undeniable; however, other cortical regions were active indicating a continuous flow of information.

Manual activities generate activation in both cerebral hemispheres\textsuperscript{19}, suggesting that there is a combined work in different areas, with special activity in the frontal and parietal area. Still, learning process creates more complex activities, which involve more structures and regions of the cortex around them\textsuperscript{24,25}.

In another way, there is a modulation of the potency issued in the primary motor sensory cortex\textsuperscript{26}, although there are no differences in the activation potency between the primary motor sensory areas, pre-motor cortex and the motor sensory association areas. This is similar to the data from this study, which show an accentuated increase in the ALPHA band potency. This discrepancy may have happened because of the difference between cortical electrophysiological frequencies assessed. The present paper evaluated a frequency range of 10 to 12.9Hz, and these data were obtained when analyzing a frequency between 13 and 20.9Hz.

A study with NMR showed that the pre-motor and supplementary motor cortex are equally active during the manual tasks, having a support role fundamental in planning the motor plans\textsuperscript{13} and the putamen, globus pallidus and tailed are involved in the learning acquisition. In the same line, it was verified that there are many involved areas in the motor tasks learning acquisition\textsuperscript{26}, which suffer a decrease in the activity right after the learning happens, suggesting that these regions are intimately connected to the learning of new tasks.

Data found suggest a continuous flow of information between the frontal and parietal lobule, as well as verified in literature\textsuperscript{13,19,22,23,25,26,27,28,29,30}.

Simple movements of the fingers activate the primary motor sensory area, the supplementary motor area, the somatosensory, the auditive, the sensorial integration region and inferior temporal lobule\textsuperscript{29}.

The frontal lobule has been associated with cognitive functions\textsuperscript{12}, still, the parietal lobule was active, but previous studies demonstrated that the cognition passes through specific processing in the pre-motor dorsal cortex and the primary motor\textsuperscript{25}, therefore, this interaction is still not clear\textsuperscript{25}.

There were no differences between electrodes for the tasks, including the fine motor coordination. A study tried to identify differences in the cortical activation in bimanual tasks, noticing that the brain chose the hand as a protagonist of the movement, when the strength employed was of same amplitude in both\textsuperscript{21,22}. These data reaffirm our findings when noticing symmetry between the cortical hemispheres, non-disclosed data, even if it has not been the objective of the study.

Several authors have suggested that the global and fine motor tasks create a fronto-parietal circuit\textsuperscript{12,13,22,23,28,29,30,31,32} and deduce that there is a continuous information flow with time characteristics, which clarifies the effects of the neural processing interactions related to the specific role of several systems that are components of creation and control of the cognitive and motor behavior.

All data found in literature and in the present study suggest that the cortex is a structure and substructure complex that interacts in a very holistic manner, i.e., integrator of systems and functions to create, command and control the specific motor activity. Thus, functionally, the brain is an integrator conductor of functions in which the information flow seems to be the key-point to the control of cognitive and motor behavior.

The hypothesis of the present study was formulated from Vitor da Fonseca\textsuperscript{1}, who affirmed that the frontal lobule should be more active than the other cortex areas during global tasks, since this is the responsible one for architecture, structuration and its control.

The data herein presented support the mentioned affirmation and indicate that there is a strong frontal activity in the cortex during the realization of global movements; however it amplifies the understanding when noticing that the parietal lobule is active during the realization of these motor tasks.

The current findings suggest an information flow among the areas during global movements. The results corroborate with most of the modern and contemporary authors who study the cortical activity during motive tasks, reassuring that there is a neural interface between the frontal and parietal lobule.

Thus, from the present data it can be affirmed that the frontal lobule presents strong activation, in a magnitude equal to the parietal lobule, with both as the main responsible for architecting and controlling movements of global nature.
REFERENCES


Received on: 05/09/09 – Accepted on: 07/10/09