EUROPEAN ACADEMIC RESEARCH
Vol. IX, Issue 5/ August 2021

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

The Brain Display Interhemispheric and Interlobular Symmetry in Simple and Asymmetry during Complexes Non-Learned Finger Coordination Tasks

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Abstract

Introduction: *Efforts have been added to exploring the brain, and to understand more about the functional interactions during fine and global motor skills is needed to elucidate the interaction between areas and functions of specific regions* ***Objective:*** *Was to verify the interlobular and interhemispheric functional activity of the cortex during simple or complex fine motor coordination.* ***Methods:*** *30 volunteers were selected and tested at the two experimental tasks, being*

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one at a simple, and the other with high complexity. Electroencephalographic signals were obtained during the rest and tasks, follow, several data interactions and interpretations was performed. The Statistical inferential analysis was performed by One Way ANOVA and Scheffé post-hoc test with 5% of significance. ***Results:*** *The data showed strong activation of frontal gyrus and sensory motor area during the simple and the complex actions to the ipisi and contralateral hand activation. The frontal lobe displays greater power output during complex than simple tasks if compared with their self and with the sensory motor area, but this last area was more active during simple tasks than complex.* ***Conclusion:*** *Those results providing some evidence that both brain hemispheres and two different lobes act symmetrically in a functional interaction during the architecture and control of simple fine motor tasks suggesting symmetry, but, during complexes fine motor tasks, the frontal lobe exhibit more activity indicating inter lobe asymmetry and that in the activities that need more cognition the frontal lobe assumes a greater role in the movement control.*

Keywords: Brain activity. Fine Motor Coordination. Quantitative Electroencephalograph. Brain Asymmetry During Movement Control. Brain Symmetry During Movement Control.

INTRODUCTION

Human neural motricity can be defined as an integration between the motor, mental and cognitive functions that occur under the nervous system, and the multiple relationships between motor activity, the mind, brain, and affectivity in a neuromotor action are highlighted. In the current conception of related scientific knowledge, it is difficult to think of separation between motor, neuromotor and perceptive-motor functions and other purely intellectual and/or affective functions (Fonseca, 2014; Klem et al., 1958).

For science in general, a clear understanding of how neuromotor integration occurs is fundamental, both for health-related issues and for the biological operability of the being in his/her life of relationships and/or other nuances. In the context of motor activity, for example, the question would converge to the need to elucidate how the brain organizes itself to mold and control motor coordination functions as sophisticated as the ones requiring fine manual ability. Or fine coordination, a competence normally cited in the literature as hierarchically being one of the most elevated levels of the brain for structuration of motor actions (Fonseca, 2014, 2010). In this perspective of the brain hierarchical functions, the Brodmann area 8, due to its implicit relationship to motor learning, point to this area a line of constant research. The correspondent literature has indicated this area as being mainly responsible for starting, keeping, coordinating and planning complex movement sequences (Rushworth et al., 2004), as well as being directly involved in the mental functioning of the working memory (Rowe & Passingham, 2001) and in a cognitive control process that acts in the modulation of emotional events that occurs during any motor actions (Frank et al., 2014).

Even though of the functional competence of the Broadman's area 8, for interacting in fine motor coordination production, the level of performance on this type of motor task depends on how this area interact with others neural mechanisms to appropriately compose any type of motor action. For instance, cerebral lateralization and regional specialization are two such conditions that impose to the brain structuring functional asymmetry. This dependence has been shown evidences that a specific hemisphere exerts a main role as compared to its homologous in events of language, praxis, tests of intelligence and visual processing (Dellatolas et al., 2012; Moss et al., 2012).

Specifically, to motor control, the neurologic literature has directed great emphasis on questions of how a hemisphere exerts control over the other during contralateral or ipsilateral movements, whether the exertion of the thought flows at same proportion to the members operating the action, and how the content of those possible neural flows relates to the hemispheric dominance of the individual executing the movement.

Although the left hemisphere has been highlighted, in some clinical pathological studies as having a dominant role in motor control, other studies have also shown that both hemispheres are equally important in controlling contralateral and ipsilateral movements (LaPointe et al., 2009; Sadato et al., 1997). Unfortunately, most of such information is based on studies related to the effects of brain lesions upon movements control (Lewis & Perreault, 2007; Neubert et al., 2010; York Haaland & Delaney, 1981). For hemispheric dominance, these studies confirmed the existence of functional hemispheric asymmetry in the primary sensorimotor cortex and the lateral premotor area and affianced the predominant role of the dominant hemisphere, over the non-dominant one, deduced from tasks configurated to be performed in a version ipsilateral between a hemisphere and the hand performing the action.

However, other studies using the functional imaging technique, in which the subjects were asked to perform repetitive overlearned finger movements, the results pointed at different conclusions. This controversy, as one would infer, would be due to the characteristics of the experimental tasks in which right-handed subjects may be exposed to a less ‘conscious effort’ with the dominant hand than with the non-dominant hand.

For most of the studies addressing neural correlates of cerebral activation, the electroencephalography technique is perhaps the more usual, it because its use may easily demonstrate the cortical changes occurring during motor performance (Hatfield et al., 2004), and coordinately may show differences in the brain state described when performing an effective strategy for the development of cognitive (Smith et al., 1999), visuo-motor (Slobounov et al., 2000) and sensorimotor skills (Grunwald et al., 2001).

As one could infer from the above discussion, there is a gap in the line of motor control that needs to be elucidated in order of to add knowledge for an appropriate and scientifically based notion of how the brain controls movement during motor tasks execution. The determination of whether there is a set of brain areas involved in a such motor action, with equitable activation, or not, can be an important information for the elaboration of ways of treatment, therapies and training for interventions in neuromotor disorders, as well as for the deepening of the knowledge regarding the human neurophysiology. Therefore, the hypothesis argue whether, during events of motor coordination the brain acts within a pattern of multiple interactions and if these possible interactions would relate to convergences between the frontal and the parietal cortex. These questions will be tested with the use of motor tasks structured to be performed in ipsilateral and contralateral versions of the hemisphere and the hand operating the motor action.

METHODS

Subjects

A sample of 30 volunteers aged between 20 and 30 years old including both sexes was selected with a mean age of 23.9 ± 2.82 years. All participants slept at least six hours the night before, did not present cognitive deficit, physical or mental health impairment and did not use any psychoactive or psychotropic substances. A questionnaire was applied to identify and exclude any subject from the experiment that could contaminate future experiments. Fifteen subjects are left-handed and the last five are right-handed.

Acquisition of electroencephalographic signal

The EEG signal capture was performed using the BrainNet-BNT device 36 (EMSA, Medical Instruments, Brazil). Twenty monopolar electrodes were arranged following the 10/20 International System Protocol. The impedance of the electrodes was maintained between 5 and 10 kΩ. Recorded data had a total range of less than 70 µV. The data signal was amplified with a gain of 22,000, analogically filtered between 0.01 Hz (high-pass) and 80 Hz (low-pass) and sampled at 200 Hz. The *Data Acquisition* software (Delphi 5,0™, USA) from the Brain Mapping and Sensory Motor Integration Lab was employed with the digital notch filter (60 Hz).

Data processing and analysis

Visual inspection and independent component analysis (ICA) were applied to remove possible sources of artefacts produced during data collection. The data were collected using a bi-auricular reference, and they were transformed using the average reference after ICA was applied and artefact elimination was concluded. Through ICA and visual inspection, all the ranges which clearly showed artefacts such as blinking, and muscle-related movements were removed. A classic estimator was applied for the power spectral density (PSD) performed by MATLAB 5.3 (Matworks, Inc.).

For the data from the present study, the high ALPHA band located between 10 and 12.9 Hz was chosen because of its association with motor activity. For each task, three 70-second tracks were collected; however, the initial and final five seconds were discarded, and the remaining 60 seconds were considered valid data. Therefore, for each subject, in each task, we obtained 180 seconds of valid data.

The analysis was done following several interactions among F3, F4, C3 e C4 monopolar electrodes and to answer the study questions a sequence of steps was taken. First, we did the comparison from the rest and activity to each electrode individually, so, F3 rest to F3 activity, and F4 rest to F4 activity; C3 rest to C3 activity, C4 rest to C4 activity, for to determine the activation of the brain area. Second, we did the comparison among the C3 activity vs F3 activity, C4 activity vs F4 activity to determine the activation among the frontal and parietal lobe. Third, we compare the opposite and the same side electrode C3 and F3, or C4 and F4 in relationship to the hand activity. The figure 1 shows the methodology of data analysis above.

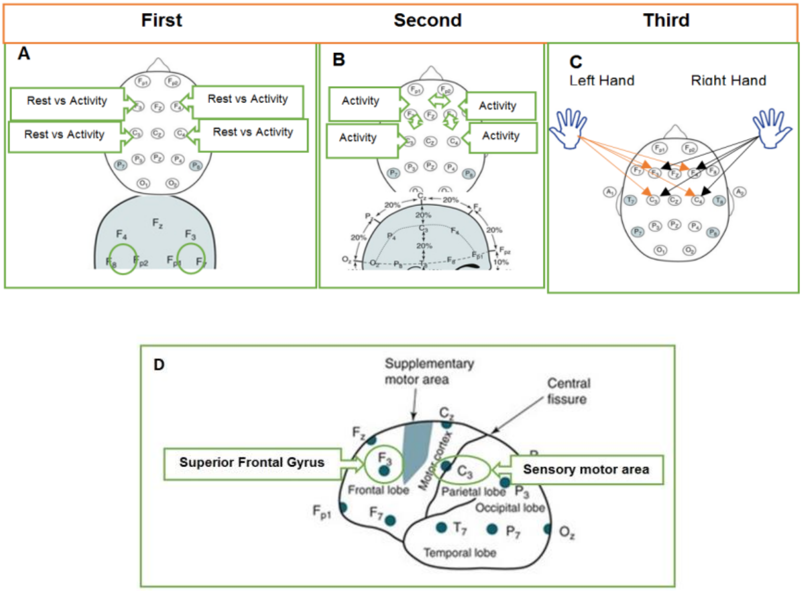


Figure 1: Scheme of testing the interaction of these work. Thirty subjects done two fine coordination tasks. Before and during the motor activity, the electroencephalographic data was acquired. Here was showed the first, second and third analysis interaction. **(A)** scheme of the activation from the F3, F4 C3, and C4 pré and during motor tasks. **(B)** scheme of the comparison of the F3 vs C3, and F4 vs C4 electrodes during the motor tasks. **(C)** scheme of the comparison of the brain F3, C3, F4, and C4 activation during left hand, right hand or both hands during the motor tasks. All figures were adapted from https://neupsykey.com/clinical-electroencephalography-and-nocturnal-epilepsy/.

Motor tasks

All performance evaluations were neglected, and the execution time of the movement was increased, to increase the amount of usable data for analysis. The motor tasks choice follows two rationales. First, a complex and non-familiar task with the both hand also, this, could led to a hoped high level of the brain activation marked to the alpha wave band. Second, a non-familiar movement could avoid a learning effect that a familiar movement could propose and, consequently, less cortical activation during the motor tasks here proposed.

Two tests were selected from Victor da Fonseca's Psychomotor Battery: finger tapping and manual dynamic coordination. These two tests were slightly modified in reducing muscular artefacts during the collection of electroencephalographic signals.

The finger tapping test is most simple that the second task. This consist of individually moving the fingers of the hands by flexing them and then extending them consecutively from one finger to the other. The adaptation that the test suffered was the need to support both arms and maintain them flexed at 90º on a table, seeking with this provision to decrease shoulder joint mobility associated with the ulna. In the first 20 seconds, all subjects executed the task with the left hand, in the next 20 seconds with the right hand, and in the last 20 seconds with both hand. All possible behavioral assessments, that is, quantitative performance analyses, were neglected because of a greater acquisition of real data.

The manual dynamic coordination test is the more complex task. Consists of connecting and disconnecting paper clips consecutively until all the paper clips are connected and then disconnected. Ten clips were completely connected and disconnected. All possible behavioral assessments, that is, quantitative performance analyses were neglected because of greater data acquisition.

Statistical analysis

To verify the data originated from the experimentations, factorial analysis was used, taking in account specific points as references and comparing them with others specifically related to each question of the study interest. For this accomplishment an One-Way ANOVA within a level of 5% for accepting or rejecting an hypothetical notion was selected and followed by the Post-hoc Scheffé Test to verify the direction of possible interactions being detected by the main analysis.

RESULTS

The superior frontal gyrus and the sensory motor area display functional activation during both motor tasks from the rest to activity

The finger tapping tasks demonstrate that there is no difference between the activation of the superior frontal gyrus and the sensory motor area and, also, there is no inter-hemispheric difference between the same lobules, but, stood evident that this task was able to activate the frontal and sensorimotor cortex (Fig. 2) (*=α>0.0001).

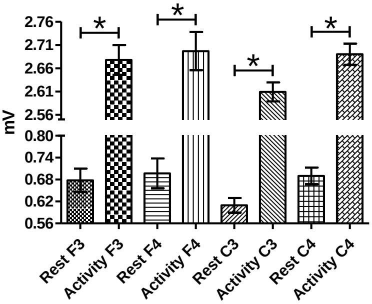
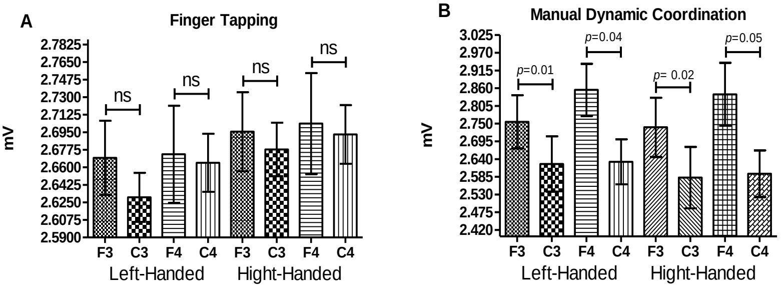


Figure 2: The activation of brain during the finger motor function. Cortex Activity during the rest, and the Finger Tapping Test and during Manual Dynamic Coordination. (B) Comparison ipsilateral frontal and sensorimotor cortex during the Manual Dynamic Coordination Test. (C) mV = Millivolts. F3 electrode located at position F3, C3 electrode located at position C3, F4 electrode located at position F4, and C4 electrode located at position C4 according to Jasper's 10-20 arrangement (1958). An ANOVA One Way test was used along with the Scheffé set up at of 5%. (**A** *=α>0.0001). To assess the Scheme of testing the interaction see figure 1A.

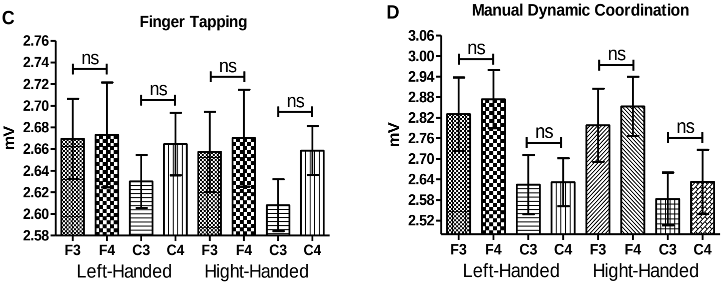
The cortex display functional connectivity among the bout hemisphere and lobes during simple tasks, but interlobular asymmetry, and higher absolute power output in the frontal cortex to complex fine motor tasks

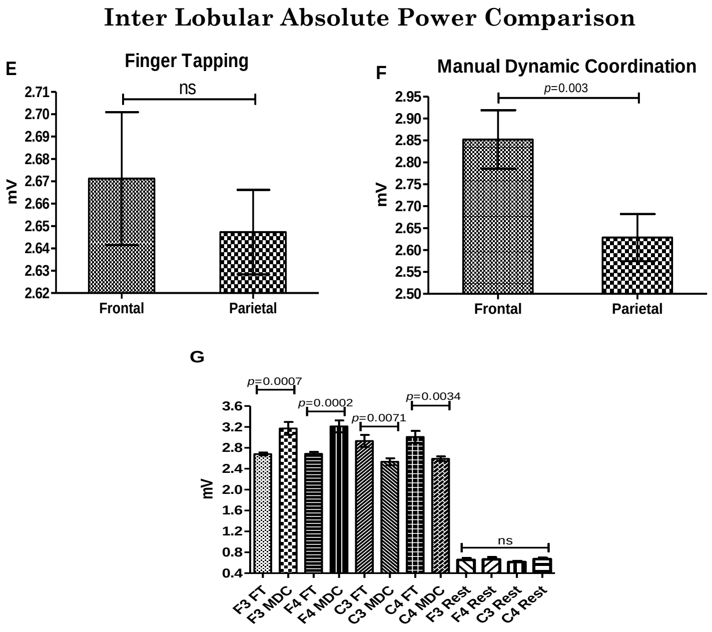
The figure **3A** shows that during the ipsilateral comparison, but different lobule in the simple tasks to the left hand, the electrode F3 (2.682±0.293mV) if compared to C3 (2.640±0.308mV) showed no difference (α= 0.950), and F4 (2.712±0.298mV) when compared with C4 (2.695±0.298mV) showed no difference (α= 0.997). About the right hand, the electrode F3 (2.696±0.118) if compared with C3 (2.678±0.081) showed no difference (α=0.33) and F4 (2.704±0.152mV when compared with C4 emitted 2,693 ± 0,087mV showed no difference (α=0.38). During the complex tasks to the left hand the figure **3B** shows that the electrode F3 from the left-handed (2.756±0.26mV) if compared with C3 (2.625±0.272mV) showed difference (α=0.01), F4 (2.855±0.256mV) if compared with C4 (2.631±0.423mV) showed difference (α=0.04). To the hight hand movement the electrode F3 (2.739+0.0259mV) when compared with C3 (2.583+0.269mV) showed difference (α=0.02), and F4 (2841+0.275) if compared with C4 (2,594+0.204). The Figure **3C** shows that to the inter hemispheric comparison in the simple task of the left hand the F3 (2.682+0.293mV) when compared to F4 (2.712+0.298mV) showed no difference (α=0.944), C3 (2.640+0.308mV) if compared with C4 (2.695+0.298mV) showed no difference (α= 0.400). Figure **3D** shows that the electrode F3 (2.757+0.400mV) if compared to F4 (2.808+0.418mV), showed no difference (α= 0.458), and C3 (2.699+0.410mV) when compared with C4 2.619 ± 0.423mV, showed no difference (α=0.933). The figure **E** show that in the comparison among the frontal and parietal lobule, to the most simple task the frontal lobe (2.671+0.132mV) if compared with parietal lobe (2.647+0.084mV) showed no difference (α=0.179), and, finally, the figure **F** during the complex task the frontal lobe (2.852+0.29mV) in compared to parietal lobe showed difference in the absolute power output (α=0,0037). The Figure **G** display the activation between the frontal and parietal lobe during the finger tapping (FT) and manual dynamic coordination (MDC) were, the F3FT (2.682+0,118mV) if compared with F3MDC (3.173+0.517mV) showed difference (α=0.0007), F4FT (2.686+0,153mV) if compared with F4MDC (3.212+0,474mV) showed difference (α=0.0002), C3FT (2.921+0.485mV) if compared with C3MDC (2.535+0.28) showed difference (α=0.0071), and C4FT (3.01+0.487mV) if compared with C4MDC (2.592+0.185) showed difference (α=0,0034).

Interlobular Ipsilateral and Contralateral Area Comparison to the Left and Hight-handed



Inter Hemispheric Comparison to the Left and Hight-handed





Inter Lobular Absolute Power Comparison

Figure 3: Absolute power of the activation of frontal and sensorimotor electrodes of frontal, sensorimotor lobes and two brain hemispheres. **(A)** Comparison ipsilateral of superior frontal gyrus and the sensory motor area during the finger tapping task for hight-handed and left-handed. **(B)** Comparison ipsilateral of superior frontal gyrus and the sensory motor area during the Manual Dynamic Coordination task for hight-handed and left-handed. **(C)** Comparison contralateral of superior frontal gyrus and the sensory motor area during the finger tapping task. **(D)** Comparison contralateral of superior frontal gyrus and the sensory motor area during the Manual Dynamic Coordination task. **()** mV = Millivolts. F3 electrode located at position F3, C3 electrode located at position C3, F4 electrode located at position F4, and C4 electrode located at position C4 according to Jasper's 10-20 arrangement (1958). **(E)** **(F)** **(G)**An One-Way ANOVA test was used along with the Scheffé set up at 5%. (**A** *=α>0,0001) and (ns = not significant). To assess the Scheme of the Ipsilateral Interlobular Comparation see figure 1B and 1D and to Contralateral Interhemispheric Comparation testing and the interaction see figure 1C.

The activation of the two hemispheres has the same magnitude during movements of left hand, right hand and two hands concomitantly hand.

The figure denotes that the contralateral, ipsilateral, or both hand activate the two hemispheres in the same magnitude without differences among all assays (Fig. 4A, 4B, and 4C) (α>0,05).

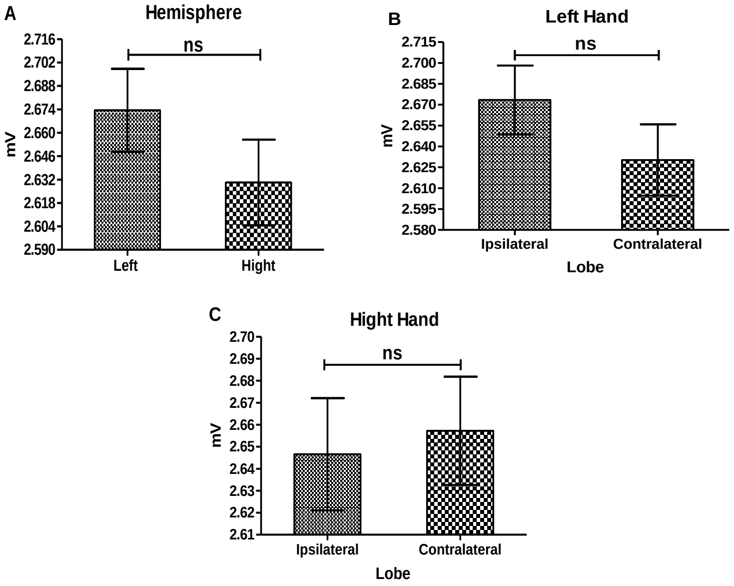


Figure 4: Absolute power of the both hemispheres during the both hand, left hand, or right hand finger movement. **(A)** Finger tapping task with both hand concomitantly. **(B)** left and **(C)** right hand of the finger tapping task. mV = Millivolts. F3 electrode located at position F3, C3 electrode located at position C3, F4 electrode located at position F4, and C4 electrode located at position C4 according to Jasper's 10-20 arrangement (1958). The Anova One Way test was used along with the Scheffé set up at 5%. (ns = not significant). To assess the Scheme of testing the interaction see figure 1C.

DISCUSSION

This study explored the activation of ipsilateral, contralateral activation of motor cortices during simple or complex finger movement. Previous studies have reported to find greater contralateral than ipsilateral activation of the left both hemispheres during fingers movements implying left cerebral dominance for motor control, but, here, the both hemispheres and cortical areas showed activation in the same magnitude contradicting previous works as in (Furtado et al., 2016).

The non-dominant hand is generally less motorically facile, and as other studies of complex movements with the dominant hand have reported ipsilateral activation (Koeneke et al., 2004), the possibility existed that ipsilateral activation was really a functional sign of the degree of motoric familiarity or automaticity.

To specifically address the relationship of complexity and unfamiliarity of the task to ipsilateral activation, in contrast to the earlier studies (LaPointe et al., 2009), here was examined subjects during a complex and non-familiar task with the both hand also, this, could led to a hoped right level of the brain activation marked to the alpha wave band without the learning effect that a familiar movement could propose. Here, was evident a strong asymmetry from the frontal lobe when compared with the parietal lobe, indicating that the frontal lobe activation could be a strategic support for the planning and support to the complex non-familiar movement. To circumvent this problem, we used a qEEG that can show the temporal and multi-region activation in a global data collection. Our results demonstrate ipsilateral cortical activity during dominant, non-dominant and dual hand motor tasks. In general, the activation was equal in the all cortical motor areas.

The degree of ipsilateral and contralateral cortical activity does not vary in the different cortical motor regions and across the different moments of the task. However, within the constraints of the task design of the current study, the finding of increased ipsilateral activation during the dominant hand task, similar to what occurs during the nondominant hand task, suggests that recruitment of contralateral and ipsilateral areas occur automatically to manage the motor behaviour per se, and is not an indication that cerebral organization do not is different for the nondominant and dominant hands or that one hemispheres do not has a greater role in motor control (Miller & Cohen, 2001; Petrides, 2005).

The presence of contralateral and ipsilateral activation with the same magnification is in accordance with neuroanatomical evidence of the descending corticospinal projections from the motor area remain uncrossed (Jones & Wise, 1977; Koeneke et al., 2004; Ugawa et al., 2002).

Somatosensory activity involves reciprocal and dynamic activity between structures, with a continuous flow of information between the areas involved and their related body sensors, and those coordinates and dynamics induce quantifiable changes in the flow of information including a decrease in entropy, increased mutual information, integration and complexity within specific regions including the frontal and somatosensory region (Lungarella & Sporns, 2006).

The absolute potential emitted by these areas by qEEG was compared. Many scholars have reported the role of the frontal lobe in the preparation of movement by demonstrating activity in the moments prior to motor activity (Koch et al., 2006; Lee, 2006; Petrides, 2005). Just as it has been shown that the pre-motor cortex, or supplemental motor area, plays an important role in the planning and execution of unit and bimanual sequences (Toma & Nakai, 2002). The frontal lobe is very active in visuomotor functions (Toma & Nakai, 2002) and, although these areas were active, the sensorimotor cortex was equally active during the simple, but not during the complex tasks (Sadato et al., 1997).

The data found demonstrated strong activity in the frontal and somatosensory areas during the simple fine motor coordination tests. The F3 and F4 electrodes, located over the frontal area, were compared with electrodes C3 and C4, located over the somatosensory area, according to the 10-20 international system, with the occurrence of hight ALPHA waves between 10 and 12.9Hz, and, in fact this indicate a information flow and a symmetric activation of the brain during simple tasks. The dorsolateral prefrontal cortex and the posterior parietal cortex are automatically interconnected and involved in operational memory and in the preparation of all movement (Lungarella & Sporns, 2006).

The interaction of these cortical areas has been shown to decrease the delay time between the stimulus and the response (Poldrack, 2005; Quintana & Fuster, 1999). This relationship corroborates the data found here, which suggest activity of equal amplitude between the frontal and parietal lobes demonstrating clear coupling. These data corroborate the fact that the lateral prefrontal cortex plays an important role and is particularly involved in the cognitive support of motor task control (DeWolf & Eliasmith, 2011). At another time, the functional cooperation between cortical areas during a manual task was shown by nuclear magnetic resonance imaging (MRI), demonstrating that the primary and supplementary motor cortex along with the lateral pre-motor areas are also activated during movement (Chen et al., 2010; Neubert et al., 2010). This statement also corroborates the data found in the present study which found no difference in cortical activation between electrodes F3 and F4 located in the anterior region of the cortex where the primary and supplementary motor cortex along with the lateral pre-motor areas are located.

It was evident that there is an interaction between distinct cortical areas during fine motor coordination tasks. When investigating different global and fine-natured movements, there was an interregional coupling of sevrral areas of the cortex (DeWolf & Eliasmith, 2011; Quintana & Fuster, 1999), especially between homologous central motor areas in the two cerebral hemispheres between the contralateral primary sensory cortex and medial pre-motor regions, including the supplemental motor area (Koch et al., 2006).

These findings suggest that information processing in the human motor cortex drives distinct regions at the same time, but that they can also function independently of one another, i.e. the motor cortex does not only respond with increased regional activation, but can exchange information between the lateral and medial motor cortex along with the sensory-motor regions in both hemispheres, even in simple movements when it would be expected that areas in different hemispheres presented different activation amplitudes due to unimanual activation, mainly in the primary and supplemental motor areas, since it is known that the contralateral cerebral cortex controls different sides of the human body, even though other studies have demonstrated that there is activation with the same amplitude (Chen et al., 2010; DeWolf & Eliasmith, 2011; Quintana & Fuster, 1999).

The distinct areas of the cerebellum, motor, supplementary motor, sensory, inferior frontal areas and the entire parietal lobe were active in positron emission tomography (PET) during manual tasks (Chen et al., 2010), corroborating with our data obtaining a robust amount of data which indicates a continuous flow of information. Manual activities generate activation in both cerebral hemispheres (DeWolf & Eliasmith, 2011), suggesting that different areas work together, with special activity in the frontal and parietal areas. Moreover, it was observed that the learning process linked a complex tasks generates more complex activities, here evidenced to great activation of the frontal cortex, which involve more structures and regions of the cortex around the activity (Chen et al., 2010; Miller &

Cohen, 2001). In another pathway there is a modulation of the emitted power in the primary sensorimotor cortex (Mayhew et al., 2012)if compared to the activation power between the primary sensorimotor areas and superior central gyrus. This, in fact, leads us to imagine that a more complex activity that has not previously been learned requires greater planning of areas with a higher cognitive hierarchy, a information that suggests the need for greater cognitive involvement in architecture and movement control.

In this same line it was observed that there are many areas involved in the acquisition of learning motor tasks (Neubert et al., 2010), and these areas decrease their activity as soon as the learning happens, suggesting that these regions are closely linked in learning new tasks (Mayhew et al., 2012) suggesting a continuous flow of information between the frontal and parietal lobes, as verified in the literature. Simple finger movements activate the primary sensorimotor area, the supplemental motor area, the somatosensory, the auditory, the sensory integration region, and the inferior temporal lobe during simple tasks, but, to complex tasks, the activation of the frontal cortex occur in great magnitude than the parietal cortex. The frontal lobe has been associated with cognitive functions or complexes taks that need more cognitive participation to solve the problems (Abe et al., 2007), but the parietal lobe has been active and previous studies have shown that cognition undergoes specific processes in the dorsal pre-motor and primary motor cortices, however, this interaction is still unclear yet. Here, we showed that although has an interaction for to do complex motor tasks, but not simple proves, the frontal lobe showed more activation of the absolute power than parietal lobe.

One study aimed to identify differences in cortical activation in bimanual tasks, noting that the brain chose a hand as the protagonist of the movement when the force used in the movement produces the same amplitude in both. These data reaffirm the present findings with symmetry between the cortical hemispheres, since the C3 electrodes when compared to C4, and F3 when compared to F4, showed no differences in the power output captured.

Several authors have suggested that motor tasks of a global or fine nature create a front-parietal circuit (Abe et al., 2007; Abe & Hanakawa, 2009; Hughes et al., 2011) and infer that there is a continuous flow of information with distinct temporal and spatial characteristics in both directions, showing a rooting of information, which clarifies the effects of interactions of neural processes in relation to the specific role of several creation component systems and control of cognitive and motor behavior (Moraes et al., 2007; Ramnani, 2006). Synergism between the frontal and parietal lobe, however, is an important finding because it clearly suggests that there is a coupling that provides a continuous flow of sensory and motor information in the architecture and coordination of movement.

The data found in the literature have characteristics and coincident findings with the ones observed in present study. For the data here we can suggest that the cortex is a complex of structures and substructures which wholly Interact during motor actions, as explained by some other studies (van Mier, Tempel, Perlmutter, Raichle, & Petersen, 1998); in other words, it is an integrating system functioning in the creation, implementation, command and control of specific motor actions. Thus, functionally the brain is an integrator master of functions whose flow of information shows itself as being the key point that exist in the neural system as controller of cognitive and motors behaviors.

When do we talk about more complexes tasks, we could think that by the nature of the prove, the cortex behavior may be different, but, all analyses performed here showed that the frontal cortex, sensorimotor cortex, and both hemispheres has the same activity to perform simples tasks denoting a functional interconnectivity between this areas during the movement control and, as hoped, this finding do contrast with findings of a few authors (Fonseca, 2014, 2008; Nascimento et al., 2012), but, in the complexnon learned tasks, the frontal lobe acquire very important activity in the movement control.

CONCLUSIONS

There is robust evidence of information flow between the frontal and parietal lobes probably in both directions with strong interregional coupling, so, it seems correct to state that somehow the frontal lobe captures sensitive information to plan fine motor actions demonstrating the same magnitude of activation in simple tasks, but, in complex tasks takes on the lead of the motor control, suggesting that these two regions are functioning to the fine motor architecture and control agreeing with other data in the literature. This data can corroborate with part of the literature that show a coupling between several brain areas during one or two hands include the interlobular and interhemispheric activation by these tasks growing the evidences around the notion that during the fine motricity has a functional interlobular and interhemispheric connectivity.

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