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Characterization of Cortical Patterns Using High-Density EEG in Motor Tasks Related to Musical Note Execution

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INTRODUCTION & AIM

The execution of complex motor actions involving processes such as planning, decision-making, and execution, entails a certain cognitive workload (CWL), engaging the involvement of multiple brain areas and processes related to the coordinated activation of muscles. Factors such as context, previous experience, stimulus complexity, required precision, among others, can establish basal cortical patterns from which those related to the specific motor task are generated. Electroencephalography (EEG) is a non-invasive technique that can provide informative characteristics about CWL, characterizaded by offering excellent temporal resolution.

Aim. We propose a study to characterize cortical patterns before and after the execution of musical motor.

METHOD

Fig. 1 Experimental setup for keyboard for one subject.

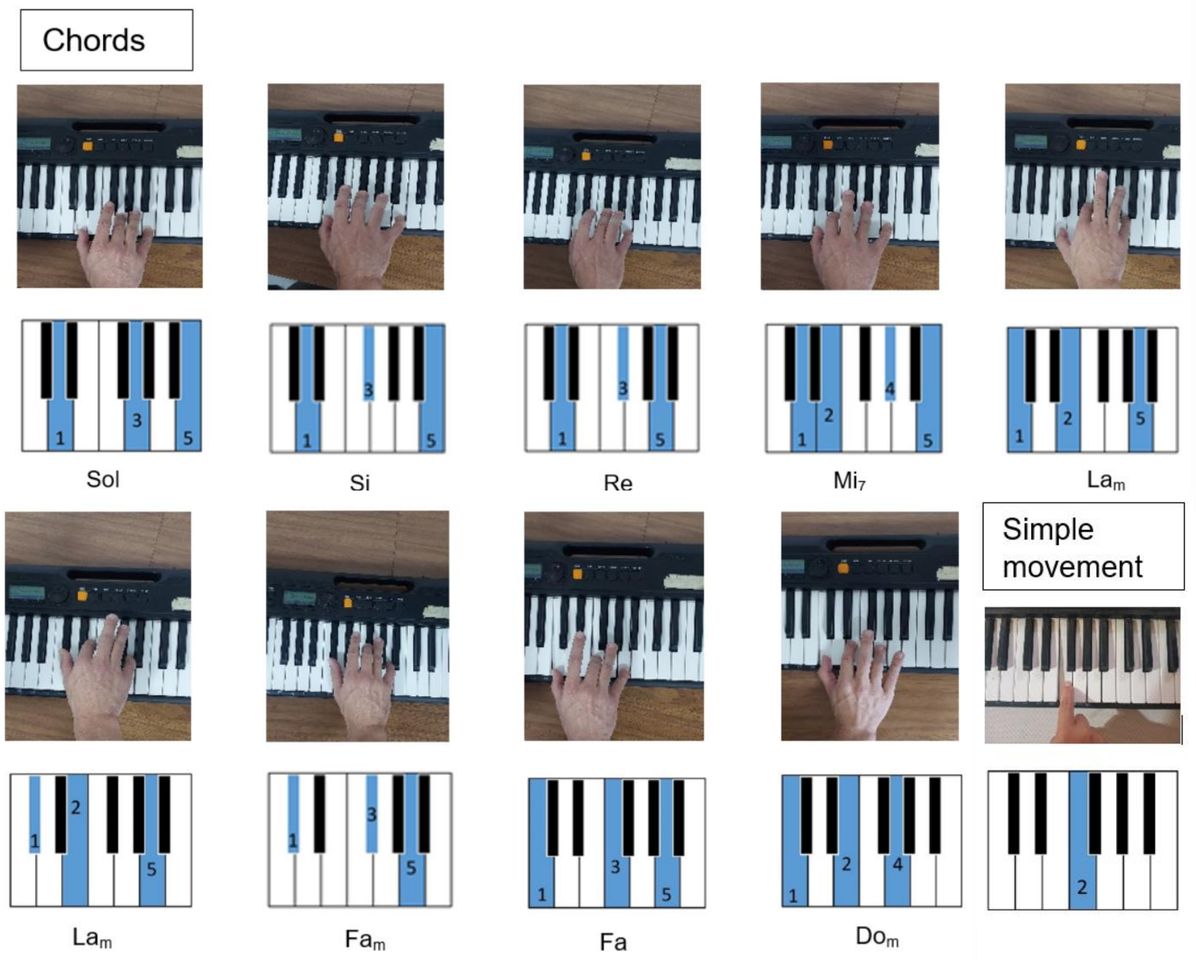

Fig. 2 Images corresponding to the series of gestures indicated for playing the chords. The images appeared in random order and were repeated 10 times.

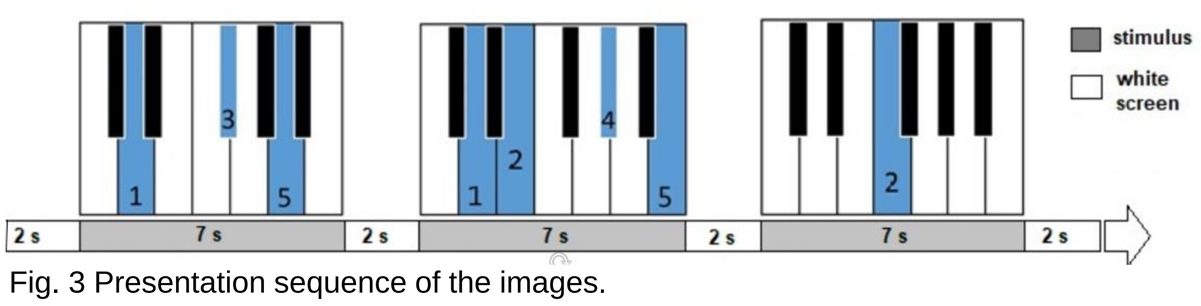

Fig. 3 Presentation sequence of the images.

RESULTS & DISCUSSION

Spectral power (7 – 13Hz)

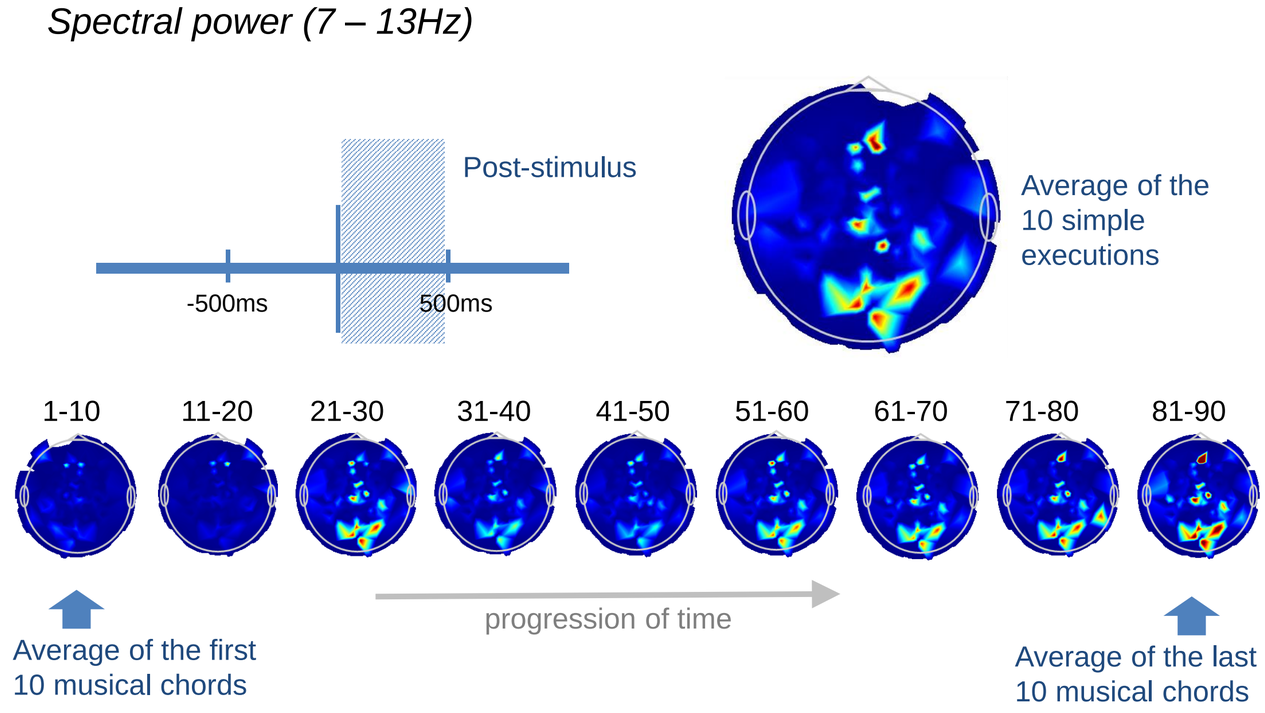

Fig. 4 The analyzed time region corresponds to the 500 ms following the stimulus. The energies in the alpha band were obtained from spectral estimation using the Welch method. The simple movements (control) were performed throughout the entire duration in a random order. The chords from 1 to 10 were presented in a random order without repetition. This same procedure was applied to the other intervals, from 11 to 20 up to 81 to 90.

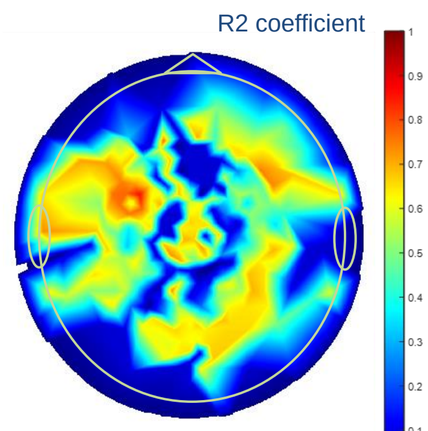

Fig. 5 Could trends in spectral energy levels in the cortex be observed due to the repetition of musical performances? This figure shows the cortical regions with increasing linear trends ($R^2 > 0.6$) in alpha band energy values over time. The contralateral motor region of the hand performing the task is highlighted.

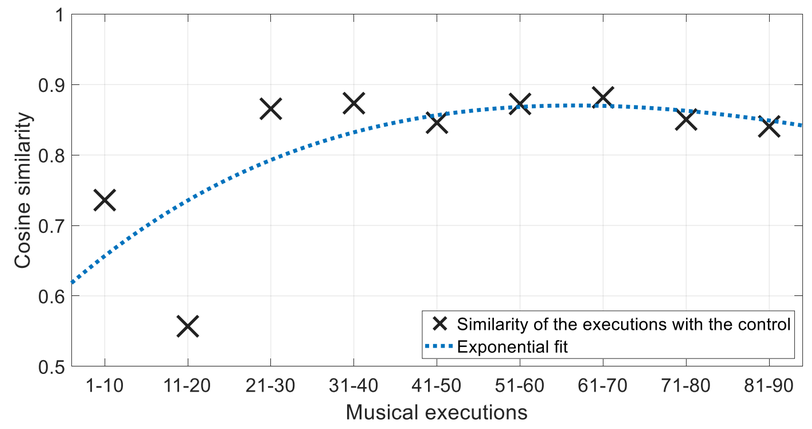

Fig. 6 Calculation of the similarity between the control execution and the averages of 10 musical performances. The similarity was calculated using the cosine similarity metric, which is commonly used to measure similarity in vector spaces.

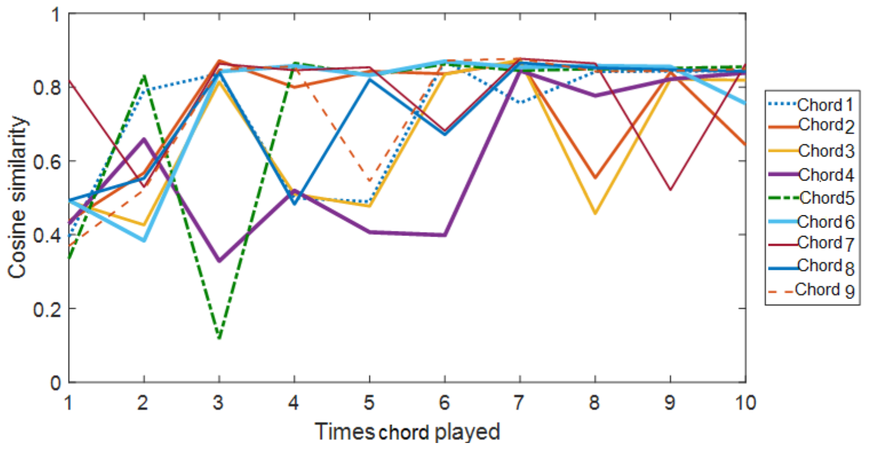

Fig. 7 Measures of similarity between cortical activity in the alpha band during the control situation and the performances conducted over time. The variable on the x-axis is the number of times the chord was played. In this figure, it can be observed that, in particular, chord 4 might be associated with a slower learning process, while chord 2 might have a faster learning process. This could be related to the motor difficulty required to form the musical chord with the fingers.

CONCLUSION

The results of this study allowed us to characterize the cortical dynamics evoked by the performance of musical chords. Likewise, it has enabled us to speculate that it would be possible to determine the cognitive loads demanded on subjects by musical instructions.