The Neural Asymmetry Deviations between Guitarists and Pianists

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Abstract Submission

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Introduction:

Music training has a relatively high requirement of motor control and auditory system (2010 Wan). Many studies have shown the relationship between long-term music training and brain plasticity differences by comparing musicians with non-musicians (2009 Jancke; 2010 Bojo). Additionally, different instruments involve diverse training regimes and hand use (2002 Victor). Many researches have shown the relationship between the instrument and neural structural differences (2014 Vollmann). However, few researches focus on the neural asymmetry aroused by different hand use. In addition, the guitar is the representative of asynchronous bilateral training, while the piano emphasizes the balance of both hands (2000 Jancke; 2010 Wan). Therefore, we are eager to find the neural deviations in asymmetry associated with bimanual symmetric and asymmetric training by comparing guitarists and pianists.

In this experiment, we recruited guitarists and pianists (at least 5 years music training) to explore the neural asymmetry of them when performing bimanual tasks. An experiment based on hand-eye coordination and asymmetric hand motion paradigms was designed. Thirty-three subjects (11guitarists, 11 pianists and 11 normal people) participated in four experiments. All the subjects were naïve to the purpose of the experiments and had normal vision with no history of neurological disorders. Their EEG signals were recorded during the experiment.

Methods:

Task Design

During the experiment, subjects are asked to put each finger on corresponding buttons as shown in Fig.1 Experiment Procedure. Then, subjects are required to press the buttons corresponding to the numbers shown on the screen. This experiment contains four blocks. Specifically, only a single hand is involved in the first two blocks and both hands are involved in the third block. In the last block, the above three conditions are randomly mixed.

The tasks were designed and presented with E-prime 3.0 software.

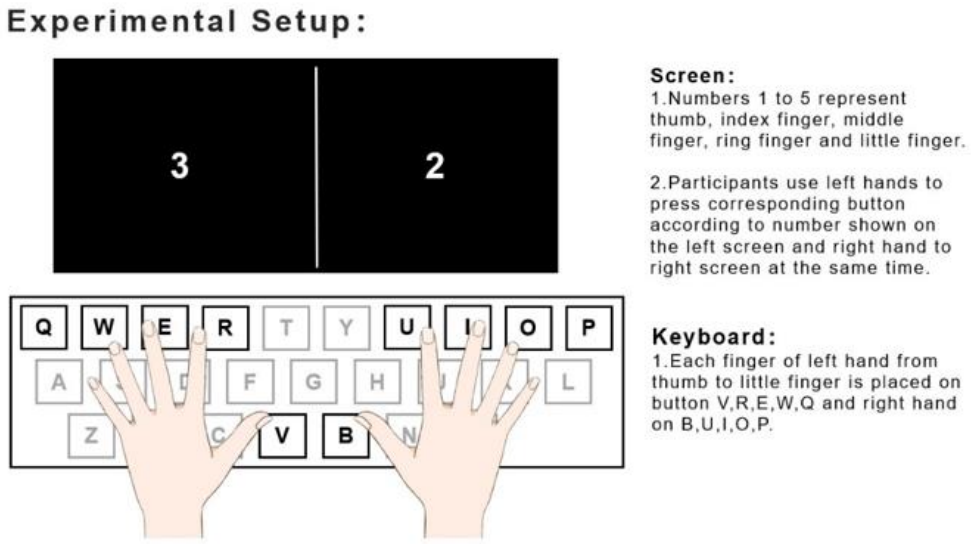

Fig.1 Experiment Procedure

EEG and Data Processing

The EEG signals were recorded by the Brainvision acticHamp Plus with 64 active electrodes at a sampling rate of 1000 Hz and were band-pass filtered from 0.5 Hz to 50 Hz.

EEG was preprocessed by the common average reference (CAR) and 0.5–50 Hz bandpass filtering in Brainstorm software. In order to investigate neural mechanism deviations, the brain connectivity was calculated by PLV (Phase Locking Value). Power spectrum in beta band was calculated as beta waves are characteristics of mind engagement during music performance. The behavioral data, including response time and correctness, were collected.

Results:

Results are shown in Fig.2 Data Analysis for Bimanual Task and Fig.3 Power Spectrum in Single Hand Task. In behavioral analysis, pianists demonstrate significantly shorter response time in bimanual task. In bimanual task， through power spectrum, we found that frontal and parietal areas in guitarists and pianists compared with control have higher intensity. Moreover, guitarists have shown higher intensity in left and right frontal area compared with pianists. In terms of connectivity, a prominent increase of connection in fronto-parietal network (FPN) could be observed in bimanual task. In left hand task and right hand task power spectrum analysis, guitarists show asymmetry in FPN.

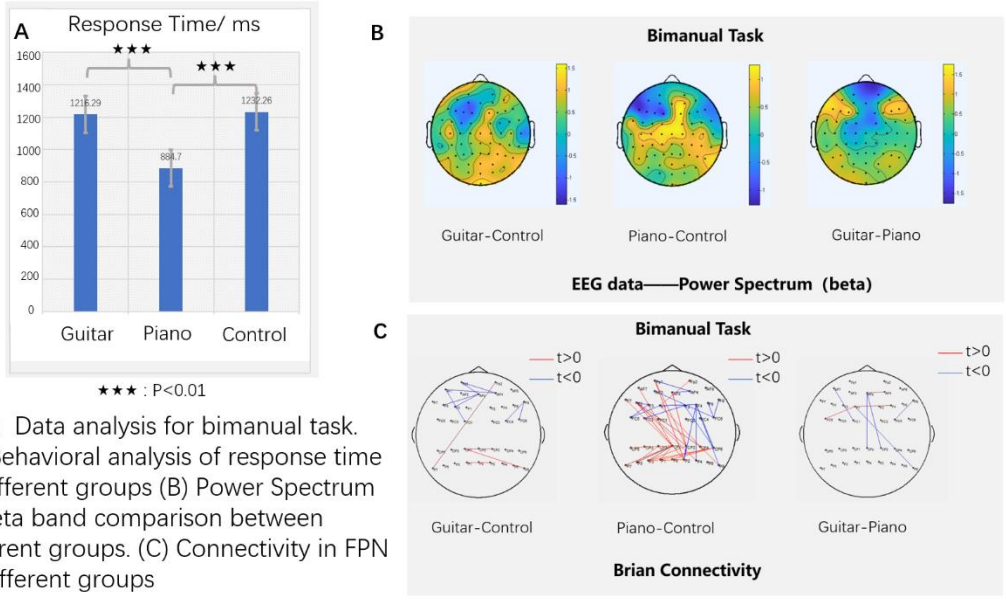

Fig.2 Data analysis for bimanual task. (A) Behavioral analysis of response time in different groups (B) Power Spectrum in Beta band comparison between different groups. (C) Connectivity in FPN of different groups

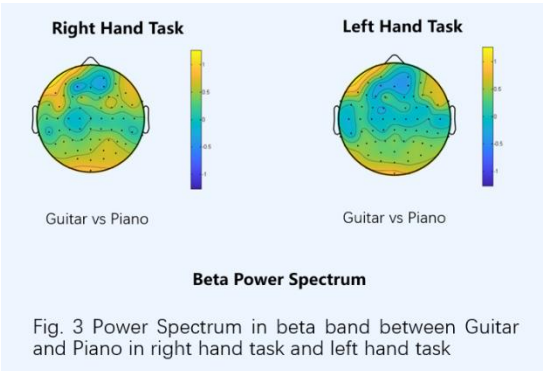

Fig. 3 Power Spectrum in beta band between Guitar and Piano in right hand task and left hand task

Conclusions:

In this study, we investigate in the neural deviations in asymmetry aroused by different music training. We provide evidences of stronger connection in FPN by comparing musicians and control group. Specifically, more prominent asymmetric activation in FPN could be observed in guitarists. This may be because of the more asymmetric hand use in guitar that results in different motor execution strategy. Generally, this finding could help unveiling the relation between behavioral asymmetry and neural plasticity laterality.

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