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Neural evidence for functional roles of tactile and visual feedback in the application of myoelectric prosthesis
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Abstract
Objective. The primary purpose of this study was to investigate the electrophysiological mechanism underlying different modalities of sensory feedback and multi-sensory integration in typical prosthesis control tasks. Approach. We recruited 15 subjects and developed a closed-loop setup for three prosthesis control tasks which covered typical activities in the practical prosthesis application, i.e. prosthesis finger position control (PFPC), equivalent grasping force control (GFC) and box and block control (BABC). All the three tasks were conducted under tactile feedback (TF), visual feedback (VF) and tactile-visual feedback (TVF), respectively, with a simultaneous electroencephalography (EEG) recording to assess the electroencephalogram (EEG) response underlying different types of feedback. Behavioral and psychophysical assessments were also administered in each feedback condition. Results. EEG results showed that VF played a predominant role in GFC and BABC tasks. It was reflected by a significantly lower somatosensory alpha event-related desynchronization (ERD) in TVF than in TF and no significant difference in visual alpha ERD between TVF and VF. In PFPC task, there was no significant difference in somatosensory alpha ERD between TF and TVF, while a significantly lower visual alpha ERD was found in TVF than in VF, indicating that TF was essential in situations related to proprioceptive position perception. Tactile-visual integration was found when TF and VF were congruently implemented, showing an obvious activation over the premotor cortex in the three tasks. Behavioral and psychophysical results were consistent with EEG evaluations. Significance. Our findings could provide neural evidence for multi-sensory integration and functional roles of tactile and VF in a practical setting of prosthesis control, shedding a multi-dimensional insight into the functional mechanisms of sensory feedback. © 2022 IOP Publishing Ltd.

Author Keywords
alpha ERD; prosthesis control; tactile feedback; tactile-visual integration; visual feedback

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