신규 광학적 뇌−기계 인터페이스 시스템의 인간공학적 UI 디자인의 주관적 및 객관적 평가

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Subjective and Objective Evaluation of the Ergonomic User Interface (UI) Design of a New Optical Brain-Machine Interface (O-BMI) System

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ABSTRACT

Objective: The present study was intended to evaluate a user interface (UI) design of a new optical brain-machine interface (O-BMI) system using calcium imaging. **Background:** The UI of the new O-BMI system was designed in a previous study to provide design features such as task-oriented navigation, a modularized structure, a changeable and adjustable layout, and integrated functions by an ergonomic design process. **Method:** A usability test was conducted to subjectively and objectively compare the digital prototypes of the UI design with four existing systems (Miniscope, nVista, Mosaic, and Suite2p) by two operation tasks (video acquisition and signal extraction tasks). Ten participants (age = 27.1 ± 3.9), including five neuroscience researchers (work experience = 3.4 ± 1.1 years) and five ergonomic experts (work experience = 3.6 ± 2.7 years) participated in the usability testing. A usability questionnaire was used to subjectively evaluate the satisfaction and perceived cognitive work of UI designs. A screen recorder (RecMaster, Suzhou Aunbox Software Co., Ltd., Suzhou, China) and an eye-tracking system (faceLABTM, Seeing Machine, Canberra, Australia) were used to objectively measure the task completion time and scan-path length of a participant for each task of the UI designs. The usability testing experiment was conducted in three steps: (1) preparation of the experiment, (2) simulation of system operations, and (3) evaluation of perceived cognitive workload and satisfaction. **Results:** The results showed that the UI design of the new O-BMI system was significantly preferred to the UI designs of the existing systems by increasing satisfaction by 11.3% to 74.3% and reducing the perceived workload by 12.2% to 37.9%, task completion time by 10.1% to 70.2% on average, and the scan path length by 14.4% to 88.7% in data acquisition and signal-extraction tasks. **Conclusion:** The usability testing results of the present study showed that the proposed design features were effective for better usability for an O-BMI system. **Application:** The usability testing protocol of the present study can be used to design, evaluate, and improve UI designs of various systems in neuroscience research in the future.

Keywords: Optical Brain-Machine Interface (O-BMI), User Interface (UI) Design, Usability Test, Cognitive Load, Calcium Imaging Processing, Ergonomic Design

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