Abstract

Individuals who present as locked-in are unable to communicate verbally or perform functional movements but have capable cognition. Brain computer interfaces (BCI) have been developed to provide communication opportunities to such individuals. Transcranial Doppler ultrasound (TCD) is a medical imaging technique used to assess the blood flow velocities of major cerebral arteries and can be used to develop a BCI. In comparison to a resting state, cognitive activity results in an increase in cerebral blood flow velocity (CBFV) in the major cerebral arteries. Generally in right-handed individuals, verbal cognitive tasks elicit a greater increase in blood flow in the left hemisphere in comparison to the right hemisphere while spatial tasks result in a greater blood flow in the right hemisphere. A TCD-based BCI system was previously implemented using verbal and spatial tasks as control signals; however, the spatial task required a visual cue (looking at the image of a geometric shape and identifying its match from several rotated alternatives), which is not feasible for those with visual impairments and restricts the BCI to a system-paced paradigm. Therefore, this thesis investigated new right side lateralized tasks that do not require a visual cue. The cognitive tasks were evaluated as control signals in an online three-class TCD-based BCI system. An average online accuracy of 62.4 ± 10.8% (n=10) was achieved with an average information transfer rate of 1.08 ± 0.69 bits/min. These results demonstrate the feasibility of an online three-class BCI, user-paced, vision-free TCD-BCI system.