# WADSWORTH BCI RESEARCH AND DEVELOPMENT PROGRAM

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The principal goal of the Wadsworth BCI Program is a new non-muscular communication and control technology for people with severe motor disabilities, particularly those who cannot use conventional assistive technologies, which require some voluntary muscle control.

The program focuses on an EEG-based BCI that uses mu and beta rhythms generated in sensorimotor cortex. People with and without motor disabilities learn to use these rhythms to control movement of a cursor on a video screen. Recent and current work is continuing and expanding this focus. The principal aims are:

1. The basic protocol is short- and long-term intra-subject comparison of promising alternative methods. Recent improvements in spatial filtering, signal feature selection, and online adjustment of translation parameters have yielded information transfer rates of 10-25 bits/min (e.g., a user can choose among 4 selections in 4 sec with 90% accuracy).
2. To further improve BCI performance by incorporating additional signal features into the algorithm that controls cursor movement and target selection. Possible additional features include slow cortical potentials and an error potential that occurs when well-trained users make a mistake. The protocol is to assess these time-domain features during the course of standard mu or beta rhythm-based cursor control, and, based on the results, to incorporate them into cursor control and assess the effect on performance.
3. To test the current BCI system in people with severe motor disabilities and demonstrate that it can provide them with reliable basic communication. The prototype application is a simple word-processing program, and the first target population are people with early- or middle-stage amyotrophic lateral sclerosis. We hope to show that they can learn to use the BCI and can continue to use it as their disease progresses.
4. To continue development of BCI2000, a general purpose BCI system that can use any brain signals (from single neurons to slow cortical potentials), signal processing methods, translation algorithms, output devices, and operating protocols. Each of the four BCI2000 components (i.e., signal acquisition, signal processing, output device, operating protocol) can be modified without affecting any other component. BCI2000 facilitates comparison, combination, and optimization of signals, methods, outputs, and protocols. We are giving it to other research labs with source code, documentation, and analysis tools.

In pursuit of these aims, the Wadsworth group collaborates with groups in Tübingen (Birbaumer et al.), Graz (Pfurtscheller et al.), Atlanta (Moore and Kennedy), and Philadelphia (Heiman-Patterson). The work is supported mainly by the National Center for Medical Rehabilitation Research at NIH, and also by the ALS Hope Foundation in Philadelphia and the Deutsche Forschungsgemeinschaft (DFG).

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