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# Look Ma, No Cameras!

## On Future Exertion Interfaces

**Anton Nijholt**

University of Twente  
PO Box 217, 7500 AE Enschede  
The Netherlands  
anijholt@cs.utwente.nl

**Abstract**

In this position paper we take the rather unusual position that brain-computer interaction is interesting from the point of view of exertion interfaces. Until now brain-computer interfacing has been considered mainly from the point of view of medical applications. Recently we see game companies taking an interest leading to some games where movements of the 'healthy' user help to intensify brain patterns that control a virtual environment.

**Keywords**

Brain-computer interfaces, physical movements, intentions to move, multimodal interaction, games, exertion interfaces

**ACM Classification Keywords**

H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces (D.2.2, H.1.2, I.3.6).

**Introduction**

In Brain-Computer Interfacing brain electrical activity (brain patterns) are used to give commands to robots, computers, or prosthetic devices (artificial limbs). Especially the latter topic - give commands to artificial limbs - has been explored for several years. This means that the majority of BCI users are patients that do not

have control, or fully control, of their muscles and that have to learn to control a prosthetic device, a communication device, or a mobile device (e.g., a wheelchair) by thought.

There are various reasons to look at the use of BCI technology in the context of exertion interfaces [2] for healthy users [6]. They are:

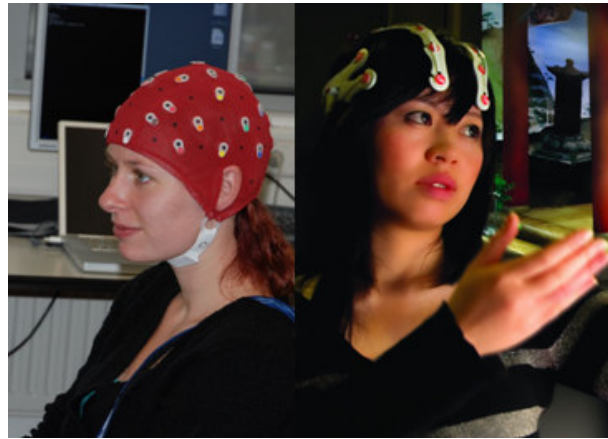
- Finding out about the user's mental state and trying to adapt the interface and the interaction modalities to this mental state. Obviously, there are other modalities that can be considered too, for example, physiological information or information obtained from nonverbal cues (pose, facial expression, prosody). In exertion interfaces monitoring this information can help to adapt the required or desired exertion efforts to the user's physical and mental state [3,4,5]. Existing exertion interfaces only have limited knowledge about the user. For example, in a mediated football game [chi] the interface knows about who kicked the ball that hits a wall, where the wall is hit, and how strong the wall is hit. More direct information about the player is, however, not available. Adding knowledge about brain activity to knowledge obtained from other measured input modalities helps to adapt the interface to the user.
- Making exertion interfaces more interesting and engaging by adding a new modality to the already available and more 'traditional' input modalities for exertion interfaces. Again, existing exertion interfaces have not only poor knowledge about their users; they also make poor use of modalities that are available for the user to control the

exertion interface. Obviously, it should be mentioned, that depending on the interaction that is required, there is not always a need to take into account all possible input modalities for an exertion interface. Nevertheless, BCI provides an extra input modality. That is, BCI allows the adding of an extra input modality to the ones that have already been made available for a long time. This input modality consists of voluntarily and consciously produced or externally evoked brain activity that can be recognized and translated into commands to the interface.

### **BCI and Interface Commands**

As mentioned in the introduction, we can measure brain activity. That is, using EEG measurements, we can measure the brain activity that tells us what a subject experiences and the brain activity that tells us what a subject wants to control in the interface.

Obviously, brain activity serves many functions. An external source can ask for attention and get it because it is recognized, we can realize that we made an error, we can relax and reduce brain activity, we can make a decision to move, et cetera. Frequency of activity and brain region are important. Assuming non-invasive measurement of brain activity we often see the use of EEG caps. This 'hardware' is improving. Some game companies provide rather fancy caps (Figure 1) and it is expected that wireless technology will allow a gamer to move around freely in an environment, rather than being connected through cables to a computer. In addition software tools become available for classifying brain patterns, for specialized machine learning algorithms, and for removing noise and artifacts.



**figure 1.** Left: A traditional EEG cap for research purposes. Right: A helmet used in commercial applications.

An interesting class of brain activity is related to motor imagery. That is, the user imagines a certain movement. For example imagining a left foot movement can be distinguished from imaging a right foot movement. These kinds of mental simulation of movement can be measured and distinguished. Not only for feet, but also for arms or hand, the tip of the tongue, et cetera. Intending to move, imagine a movement, planning a movement, they all activate similar cortical areas.

This explains the success that BCI has for patients who are not able to use hands or feet, or patients who suffer the locked in syndrome (ALS) and are not able to move or to speak. In various applications it has been shown that they can learn to move a cursor on a screen, to navigate in a virtual world and to control a wheelchair. Much of the current BCI research concentrates on

improving such medical applications and also at looking at other ways to improve the quality of life of those patients.

However, although not really of interest for ALS patients and other disabled patients, these imagined movements activate the brain areas that are also activated by the execution of the same movements. Hence, for able users it becomes possible to activate brain patterns by consciously produced movements and have these brain patterns measured and translated into commands for a computer, in order to navigate in a virtual world, to move or lift (heavy) virtual objects (Figure 2 [1]) or to control a robotic device. Moreover, it allows us to design games, game environments, and exertion interfaces that are also controlled by body movements but where the capturing of the body movement is not done by sensors or cameras, but by measuring associated brain activity.



**figure 2.** Lifting a heavy stone in a Stonehenge game designed by Emotive Systems.

Investigating the possibilities of BCI for HCI and game applications, including exertion interfaces, is one of our tasks in the Dutch national BrainGain project. Apart from fundamental research on distinguishing various types of brain activity when the user (or gamer) is involved in various tasks, using different modalities to perform this task, we will also introduce BCI versions of games and exertion interfaces we have introduced previously. One example is the 'Jump and Run' exertion interface where the gamer controls the movements of an avatar, who moves at high speed in a virtual world and has to avoid obstacles (Figure 3). A camera observes the movements of the human player and our aim is to play the same game by measuring brain activity associated with imaginary and/or real movements in such a way that no cameras are needed anymore. "Look Ma, No Cameras!"



**figure 3.** The 'Jump and Run' exertion interface

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