End user performance in a novel social BCI application: the photobrowser

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Abstract. This study introduces the photobrowser, a BCI application specifically designed for severely handicapped end-users. It allows its user to be involved in manipulating and exploring a photo collection that is shared between the user and participating relatives. The end-user can thus participate in a socially interacting group of friends, even if those friends are geographically separated. The first results with one tetraplegic end-user are promising, with 100\% accuracy on all but one session.

Keywords: Social inclusion, EEG, BCI, ERP, P100

1. Introduction

Recently, social- and entertainment applications for BCI have gained interest. One example is the Brain painting application [Münssinger et al., 2010]. Another application could be the exploration and manipulation of, and interaction with a photo collection. Such an application is investigated here with an end-user.

The photobrowser is a social BCI application that was developed specifically for severely disabled end-users. It allows the end-user to be a social epicenter in a group of friends, where communication is expressed through the transfer of images, rather than through text. The photobrowser allows the end-user to receive, view and manipulate images from their friends and to subsequently select a subset of these images to be shared with the whole group. The end-user and their friends are provided with a tablet PC which functions as a photo frame. The devices also contain a camera and were configured to automatically share any newly captured photos with the end-user. In this way a rich social experience can be created for both the end-user and the participating friends. The photobrowser is jointly developed by the Berlin Institute of Technology and the University of Glasgow and implemented in the Pyff framework [Venthur et al. 2010]. It has been highly optimized in terms of usability and stimulation settings [Tangermann et al. 2011]. The photo frame software used on the tablet devices was developed at the University of Glasgow.

2. Material and Methods

So far the study includes a single, female end-user (FA) that has participated in several BCI experiments prior to this study. She is tetraplegic with severe dysarthria and dysmetria due to a brainstem stroke, that results in a lack of any functionally valuable (verbal) communication. The trials took place at Fondazione Santa Lucia, Rome, and are currently ongoing.

The user first participated in a training session where EEG data was recorded using a 61 channel montage and BrainAmp amplifiers (BrainProducts, Germany). The photobrowser was used with different stimulation modes (flash, complex and grid [Tangermann et al. 2011]; SOA: 200ms), but no feedback was given. Based on this high-density recording, a customized, reduced channel set was selected, covering occipital and midline electrodes (crosses in Figure 1). Furthermore, both this data and user preference supported the choice for the grid stimulation in subsequent sessions. After the initial session, the user participated in seven experimental sessions, which were recorded with a 16-channel g.USBamp (g.Tec, Austria). Unfortunately, due to technical problems, the first two sessions were corrupt. The results presented here are from the last five sessions only.

Each experimental session consisted of three phases: 1) calibration phase: 24 trials were recorded and used for training the classifier. 2) task phase: the user went through five tasks of increasing length, with predefined selections and actions. Data from this phase were used to construct an objective, online performance estimate. The number of iterations was fixed to six. 3) free phase: to emphasize the social aspect of the photobrowser, most of the experimental time was allocated to allow the user to freely...
explore and manipulate the photo collection. No labeled data is obtained from this phase, but the user experience is assessed through questionnaires (Riccio et al., these proceedings).

3. Results

In four sessions the online performance was 100%, with the remaining session reaching 93.2% (chance <3%). Thus, using only a relatively low iteration number, our end-user could operate the photobrowser with near perfect control. In fact, the average (offline) binary classification loss over all five sessions is as little as 5%. Thus, 95% of all single epochs is correctly classified to be target or not.

Figure 1 shows the ERP traces of PO7 and CPz (top). Though a strong N2 is usually found for visual BCI paradigms, our end-user additionally shows a remarkably strong and discriminative P1 component. This is probably due to the complex stimulation, which engages more cortical activity [Tangermann et al., 2011]. However, from CPz the P3 response that is typical for oddball tasks seems to be missing completely. This is also reflected in the (offline) binary cross-validation loss. When using only channel PO7, the (offline) binary classification loss increases from 5% to 13.5%. Though this may appear as a large increase, experience shows that this is high enough for successfully operating the photobrowser [Tangermann et al., 2011]. The remaining channels combined have a similar loss (10%).

4. Discussion

The results clearly show the feasibility of a BCI-controlled media application with an end-user. Due to the excellent performance, the user was highly engaged, as were her relatives [Quek et al., 2012]. The prior stimulus optimization clearly benefits the performance. In particular the early components are increased as opposed to previous studies with this user (not shown). This leads to a reduced channel number dependence, with a single channel capturing most of the information. This, and other improvements such as early stopping will be introduced to make the experience even more engaging.

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References


