

# User Experience Evaluation in BCI: Mind the Gap!

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**Abstract.** Generally brain-computer interface (BCI) systems are evaluated based on the assumption that the user is trying to perform a specific task in the most efficient way. BCI for entertainment yields interesting applications for both patients and healthy users. Then the purpose is to create positive experiences that enrich our lives. To evaluate such systems, the user experience needs to be taken into account to understand how a system can satisfy these needs. This paper points at the gap in user experience evaluation currently in BCI research, and shows how user experience evaluation could benefit BCI, through increased user acceptance, enjoyment, BCI task performance, enhanced human-computer interaction, and improved selection of suitable mental tasks in a given context.

**Keywords:** Brain-computer interfaces, user experience evaluation, entertainment

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## 1. Introduction

The purpose of brain-computer interface (BCI) entertainment applications is creating positive experiences that enrich our lives. To evaluate such systems, we need to look at the user experience (UX), to understand how the system can satisfy human needs that go beyond simple task execution. BCI systems are generally evaluated based on the classification accuracy, or the communication speed in terms of bit rates. Besides these common measurements of efficiency (how quickly a task can be executed), usability (the ease of use of a product) also consists of learnability, memorability, error handling, and satisfaction [Nielsen, 1994]. An investigation in 2008 of 105 BCI papers revealed that these issues of usability were hardly ever looked into [Adams et al., 2008]. Including them could improve user efficiency and satisfaction, but would still leave out other important aspects that influence the perception of the user: the user experience [Hassenzahl and Tractinsky, 2006]. Although UX is rarely evaluated in current BCI research, here we review the few studies which do mention UX, and show the value UX evaluation can provide.

## 2. BCI Studies that Evaluate User Experience

**Increase User Acceptance** User-centered approaches increase usability and user acceptance of the new technology. Thus, some BCI groups have started taking this approach to develop BCIs [Lightbody et al., 2010; Zickler et al., 2009]. This generally consists of user involvement in the design process, assessment of user needs, and development of user and system requirements. These studies do involve users, but they do not evaluate the UX during or after interacting with the BCI.

**Increase Enjoyment** An interesting category of applications is BCI for recreation (e.g. games, creative expression). Standard performance evaluation is insufficient for such applications, as they are about enjoyment. Most of the examples mentioned in [Moore Jackson and Mappus, 2010] are not properly evaluated as they just serve as proof of concepts. For those that are evaluated, a performance measure based on task execution or mental task detection is used. One system has been evaluated for the influence of different visuals and user tasks on the UX with the game experience questionnaire [Ijsselstein et al.; Oude Bos and Reuderink, 2008; Van de Laar et al., 2009]. When designing systems to provide enjoyment, it is a logical step to evaluate whether they actually succeed in this.

**Increase BCI Task Performance** A system that is perceived as more beautiful is also perceived as more usable, and this perception remains after actual use of the system [Tractinsky et al., 2000]. Some BCI studies mention a potential relation between motivation and BCI task performance [Nijboer et al., 2010]. Such relationships between the user and performance could be discovered, proven, and used to maximum benefit by evaluating and improving the UX.

**Enhance Human-Computer Interaction** The user's mental state, derived from brain activity, can be used to adapt the user interface or the interaction with the application itself. The goal of this is to improve the interaction and UX, for example by supporting the user in the tasks they are trying to accomplish (error handling, or adjusting information according to workload), or by changing the difficulty of a video game to keep the user in the optimal state of flow [ Zander et al., 2009; Solovey et al., 2009; Plass-Oude Bos et al., 2010].

**Investigate Influence of BCI on User Experience** One study explored if imaginary movement for walking in a virtual world increases presence, using the Slater-Usoh-Steed presence questionnaire plus an open interview [Friedman et al., 2007; Slater and Steed, 2000]. In a follow-up experiment the presence experienced with a P300 interface was compared to eye gaze and wand [Groenegress et al., 2010]. Here the BCI interface had a negative influence on presence. But the influence of BCI on UX is not limited to presence alone. If the influence of certain mental tasks on specific aspects in specific contexts are known, it is possible to find the optimal tasks for a given application.

### 3. Conclusions

Evaluating the usability and UX of BCI systems is not common practice. Through the few studies that did include user experience, we showed how it has a positive influence on many different aspects, such as increased user acceptance, enjoyment, BCI task performance, and enhanced human-computer interaction. Besides, to decide what mental tasks are most suitable in what contexts, we need to know the effect of the BCI on the UX. For further reading on the evaluation of UX in BCI systems, refer to [Gürkök H, et al., 2010] and [Van de Laar et al., 2010].

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