Usability Evaluation of Brain-Computer Interaction (BCI), Based Game for Normal Users

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Summary
The next growing generation of human-computer interaction is Brain-Computer Interaction (BCI), in which the user directly interacted with the computer through brain signals only. BCI has been revolutionized human life more than human-computer interaction. First special design of BCIs was for disabled persons. But now BCIs technology has been used for entertainment by healthy people. Gamers are the potential users. To use BCI technology as assistive, usability evaluation is necessary. In this paper we have created and evaluated BCI based game for normal users using ISO 9241-11 usability model. The usability parameters that we have considered are (a) Effectiveness (b) Efficiency and (c) User-Satisfaction. We have calculated the Effectiveness and Efficiency through Automated and the User-Satisfaction determined through Questionnaire. Results revealed that our proposed BCI game has 82% Effectiveness, 77% Efficient and User-Satisfaction is significant respectively.

Key words:
BCI game, Usability Evaluation, NeuroSky Mindwave, Users Satisfaction, Android Studio.

1. Introduction

Brain-Computer Interface is a growing field of human-computer interaction, playing significant role in human society. It is the new development of Human Computer Interaction (HCI), in human-computer interaction people can interacts with computers through various channels, such as keyboard, mouse etc, however, all these channels dependent on muscle movements, which is not easy to use for potential users [1].A brain-computer interface is defined as a "direct communication system that does not depend on the brain's normal output pathways of peripheral nerves and muscles" or A direct connection between computer(s) and human brain, which is first developed for disabled persons [2]. The Brain-Computer system depends and measures the users specific brain signals such as attention, relaxation, Eye moment, Motor Imagery and Facial expressions etc and use all these signals to build direct communication between computers and human brains [3].

Initially the BCIs technology developed for disabled users, promising to the invention of assistive technology. BCIs have made possible to restore the movement ability for physically challenged or confined users and substituted lost motor functionality [4].The research of BCIs expended and has encouraged the researchers to study of BCIs involvement in the life of healthy persons for entertainment. With the combination of Human-Computer Interaction and Brain-Computer Interaction new applications are also being developed for entertainment and education which are interesting for disabled as well as for normal persons [5].

Nowadays, non-invasive brain–computer interfaces (BCIs) are getting a lot of attention as alternative human–computer interaction devices for games and virtual environments. Non-invasive BCIs operate by recording the brain activity from the scalp with Electroencephalography (EEG) sensors attached to the head on an electrode cap or headset without being surgically implanted. However, they still have a number of problems and they cannot function as accurately as other natural user interfaces (NUIs) and traditional input devices such as the standard keyboard and mouse, the main reasons behind this are related to accuracy, speed, price of the device, and mostly the BCI studies are performed in laboratory environments under controlled circumstances. However this is not always possible in real-life applications and makes current BCI technology not quite suitable for practical applications and widespread use [6] [7]. However, the transfer of BCIs from the lab to the daily life of people is slow and

It has been argued that BCIs need to significantly improve in terms of usability to achieve assistive technology [8].

The main aim of the paper is to evaluate the usability of BCI interface on Human-computer interface elements inside a game which is not done before. An EEG-based device BCI device was used: The NeuroSky Mind wave. New interface is built in Android Studio to properly get the data from human mindset and present on the mobile screen. Every android mobile user can use it easily. We checked and analyzed the game on educated healthy users and record the original data and analyzed. On the basis of different experiments we presented final results which are discussed in great detail.

The rest of the paper is structured as follows. **Section 2** provides background information for the game and BCIs. **Section 3** presents Materials and Methods. **Section 4** Implementation and Results **Section 5** Conclusions.

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2. Background Study

BCI is the new development of human computer interaction. Traditionally user interacted with computer through Mouse, keyboard, pen etc, but brain-computer interaction reads brain signals from different locations of user head, translated these brain waves into computer instructions that can run computer, wheel chair etc. the BCI can guided to several applications particularly for paralysis persons such as (i) one can play game using their thoughts, eye blinking, facial expression and motor imaginary etc. (ii) social communication(iii) Via BCI handicap persons can interact with computational devices.(iv) through BCI people can understand about their brain activities and neural networks. Not only human but also animals can use computer by moving cursor on the screen [9].

Recently, many studies [10] have been done to improve the usability of BCIs and to specify the proposed design requirements, so that, to surely make the technology transfer and general acceptability. Through BCIs, one can recover their hand motor functional after stroke, in this eight patients (N=8) and fifteen (N=15) therapists took part in the experiment, they receive their visual feedback of their own hands moments, the application was evaluated by acceptability and usability by means of participants mood, motivation and user-satisfaction [11]. Some researcher was only focused on accuracy of BCI controlled communication application for disabled persons [12].

Usability of EEG based BCI applications (spelling, web access and entertainment) evaluated on non-expert healthy users and sever paralysis users with gel-based and dry electrodes, all healthy participants achieved high accuracies with both gel-based and dry electrodes but speed was moderate but paralysis users accuracies were lower and satisfaction rate of potential users were lower as compared to normal users [13]. Comparison of Dry electrodes and Gel electrodes of P300 BCI evaluated on healthy participants, both types of electrodes are evaluated through performance and usability parameters, all the participants demonstrated that's dry electrode BCI system was better than gel electrodes in many ways, comfortable, and it require no gel and reduced preparation time, require low power [14].

The usability of Hybrid BCI system has been evaluated and analyzed and was suggested that usability factors (Effectiveness, Efficiency and User-satisfaction) increases in Hybrid BCI [15]. Sensor motor rhythm (SMR) based BCI gaming application prototype has been evaluated on four disabled users, using gel-based electrode system, the usability was in terms of effectiveness (Accuracy), efficiency (ITR and subjective workload) and user-satisfaction, the effectiveness of the BCI-gaming was medium, consequently, ITR was low ,the total workload was moderate, user-satisfaction was medium, reasons of dissatisfactions were , electrode gel and cap, low effectiveness, time consuming adjustment and not easy to use freely[29]. So the quality of life of persons suffering from severe motor disabilities can advantage from the use of BCI-based assistive technology [16].

The effectiveness of wheelchair controlled prototype has been determined, in which NeuroSky mindset device was used; the prototype was evaluated on 9 disabled users [17]. Three different acquisitions based dry, water and Gel based BCIs P300 Interfaces evaluated technically on 10 different users, Technically Gel based BCI is more effective as compare water and dry based BCI but on the bases of User perspective Dry based BCI is more comfortable and prefer to use in daily life [18]. BCIs technology has been used in every field by disabled persons. The sensor motor rhythm based BCI used in game control, and evaluated the BCI in game field by usability parameters such as Effectiveness (accuracy), Efficiency (information transfer rate and subject work load) and Users Satisfaction involving 4 severely motor restricted participants. But all parameters were low to medium, did not use in daily life [19].

BCIs technology is also dependent on both attendant and ignored events in the pattern recognition; larger matrix was suitable in P300 amplitude for attended versus ignored events than smaller matrix, two factors (effectiveness and accuracy) in the EEG evoked evaluated by different matrix size. It was concluded that larger matrix size was suitable for pattern recognition accuracy, for better performance and for user satisfaction [20].

From these previous studies, we can conclude that BCIs can be usable, even when effectiveness is sometimes moderate, but that usability issues should continue to be addressed [21].

3. Materials and Methods

This section presents the overall setup of the game and resources required for that game.

3.1 Participants

Twenty (N=20) healthy user (all males) took part in the study. Participants were informed through our personal networks. The participants have recruited with diverse range of age and education but they were all males. Their age mean was 25 ranging from 22 to 30 years old. Two participants have bachelor and remaining eighteen (N=18) have graduated degrees.

3.2 Procedure

Before experiment the participants introduced themselves orally .Then learnt about the game play and setup of the brain-computer interface device .then the players were recruited that how to increase their attention level and how to blink yours eyes to control the game.

3.3 Hardware

A BCI device name NeuroSky Mind wave headset is a single channel and inexpensive device produced by NeuroSky Company has been used in this study. It is used to measure electrical activity in the living brain. The device composed of eight (8) main parts, ear clip, flexible ear arm, battery area, power switch, adjustable head band, sensor tip, and sensor arm and inside think Gear chipset. fig 3.3.1. The brain-computer interface (NeuroSky mind wave) based on Electroencephalography (EEG), means that it is measuring the raw brain signals from the Frontal Lobe (FP1) of the brain (alpha, beta, delta, gamma, and theta), attention level, mediation level and blink detection [22].But in this research only two features (Attention and Eye blinking) have been used.

Fig. 1 NeuroSky mindwave headset

3.4 Experimental Design

The experiment was done in comfortable room. Twenty different users took part in the experiment. The Participants were seated in a comfortable chair half meter away from a mobile screen that displays the game. The game composed graphical user interface elements. Displaying randomly different numbers in addition along with three options, in which the one is correct and the two other are incorrect. The game controlled by player attention and eye blinking using brain-computer interface (NeuroSky). The player was move from first option to second option as well as from second option to third option by increasing attention. The Player selected any option by eye blinking, in fig 2.

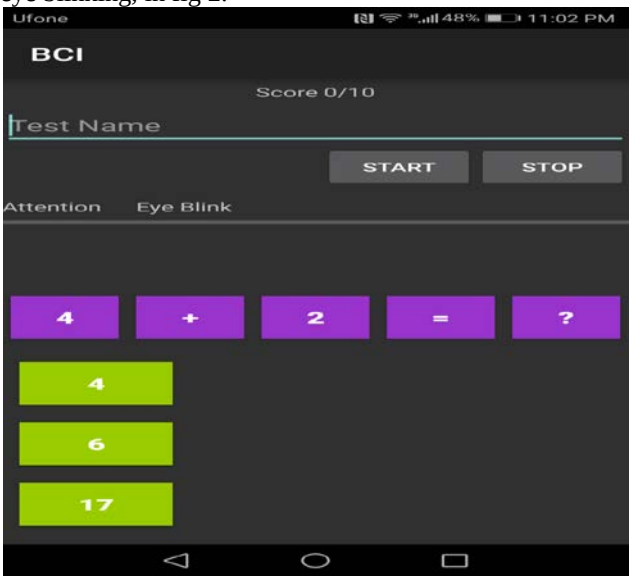

Fig. 2 BCI based game

3.5 Data acquisition

The Mindset device use a technology called Think Gear, connecting the device to the wearer's brainwaves. The sensor of this technology touches the forehead, on the ear pad and the on-board Chip the contact and reference points are processing all the data. Both eSense Meters and raw data are calculated on the Think Gear chip. These data then sent to computer through Bluetooth. ESense is a NeuroSky proprietary algorithm for characterizing mental States. The Think Gear technologies magnify the raw brainwave signal and eliminated the noise and muscle movement [23].

3.6 Tools

The NeuroSky Mind wave support tools such as, C/C++, C#, Java, IOS, and MATLAB [24]

3.7 Significance of the NeuroSky Mindset

Using NeuroSky mind wave headset is more beneficial over other BCI and EEG devices. Many BCI devices are preventive because of wiring. The NeuroSky device, however, is wireless and consequently suggest free of motion permitted for easy transport and setup, which is very significant in very day usage. Another advantage of the device is, it does not require conductive gel for electrode, making it easier to put on and use. User does not

wash their hair after using the NeuroSky device. The main advantage is that the device inexpensive [25].

3.8 Questionnaire

The parameter (User-Satisfaction) has been determined through questionnaire. Every participants filled questionnaire after the game completion. In this study the questionnaire [26] consist of 5-point Likert scale in which the questions variation range is strongly disagree to strongly agree, then all participants proceeded to rate the error rate, easiness, learn ability, confidents, awareness, result satisfaction and user comfort ability etc in the game on the 5-point Likert scale (1=strongly disagree, 5=strongly agree), the intermediate point (3) was left unlabeled.

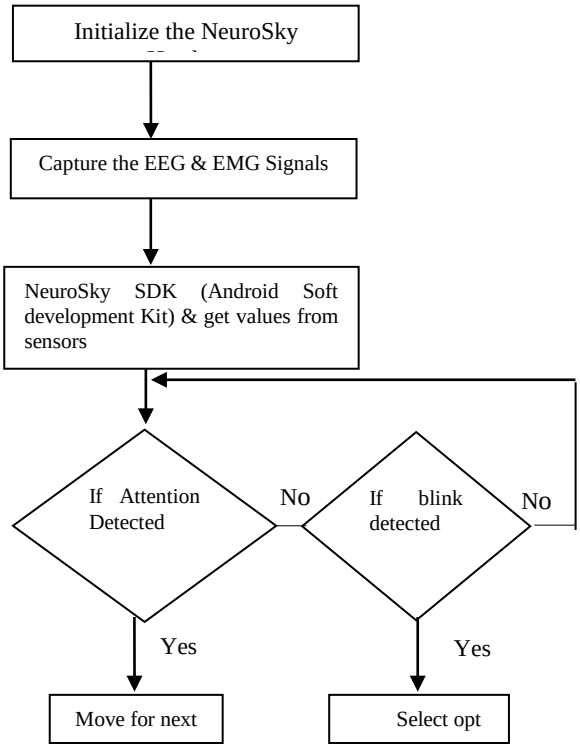

Fig 3 Design flow of brain controlled interface.

3.9 Evaluation

In this research the usability model "ISO 9241-11" [27] has been used in the evaluation processes. The definitions of the usability model as 'the extent to which a product can be used by specified user to achieve specified goals with effectiveness, efficiency and user-satisfaction in a specified context of use' these usability parameters were defined for evaluating the BCI-based application in this research.

3.9.1 Effectiveness

The accuracy with which a user can complete tasks (moving a cursor from option to option through attention and the selection of the option is done by eye blinking) signified how effective the game is for a specified player. In this study the Average effectiveness (accuracy) of each task for each user was calculated by the following formula [28].

$$Effectiveness = \frac{Number\ of\ tasks\ completed\ successfully}{Total\ number\ of\ tasks\ taken} \times 100 \quad (1)$$

3.9.2 Efficiency

The efficiency of the game is calculated by the time spent of the specified player to complete the task in the game (how much time spent in moving the cursor from one option to another option along with the selection time of the option). Efficiency of the game for each task was calculated through following formula [28]

$$Efficiency = \frac{\sum_{j=1}^{R}\sum_{i=1}^{n} n_{ij}t_{ij}}{\sum_{j=1}^{R}\sum_{i=1}^{n} t_{ij}} \quad (2)$$

3.9.3 user-satisfaction

User-satisfaction was determined by using 5-point Likert scale questionnaire [29] including Ten (10) questions. Each user rated the satisfaction on the scale between 1and 5 (1=strongly disagree, and 5=strongly agree). 20 users were participated in this survey; every user responded to each question and gave the answer using the questionnaire. Then proceeded and imported all the questionnaires data in SPSS for processing.

3.10 Statistical Analysis

One Sample T-test has been applied on the data, in which the data was analyzed through four assumptions such as the data was ordinal or continues, the data was independent, there were no outliers in the data and the data was normally distributed.

4. Implementation and Results

NeuroSky software development Kit used for interfacing with the NeuroSky Mind wave. The interface of the game is designed in XML (extensible Markup Language), Backend coding is done in java. The sensor of NeuroSky (Think Gear) is connected via Bluetooth, and signal is processed using NDK. The results of each player are being recorded in SQLite Database. The records are stored

against the user name, the time spent from one to other option and eye blinking time of each user and total time spent on the test are being recorded and displayed.

4.1 SDK Tool

SDK is set of development tool that allows developer to create software applications for specific platform. The used tool in the software development is Android SDK includes sample projects, libraries, emulator, debugger etc. It contains tools to create, compile, manage and package android based applications.

4.2 Java SDK

Android Applications are developed in Java so for that Java SDK are very important. It includes Java Runtime Environment (JRE), compiler, an archive (JAR) to aggregate all files into single file, interpreter, loader, java doc and many other features that support android.

4.3 NeuroSky SDK

For our proposed BCI application we have used NSDK, It contains set of tools and Application program interface (API's) for EEG headset to create application to read the mental state.

4.4 Results and Discussion

To proceed with implementation work, we have evaluated and implemented the proposed application using User-Centered design model. In the experiment, we have calculated the usability parameters such as effectiveness, efficiency and user-satisfaction of our proposed Graphical User Interfaces based game.

4.4.1 Effectiveness

Effectiveness has been measured by correctively selecting the correct options in the game. We have calculated the accuracy of each Graphical user interface elements in the proposed BCI game in percentage. In Figure 4 we have considered accuracy in percentage on Y-axis. While number of users on X-axis.

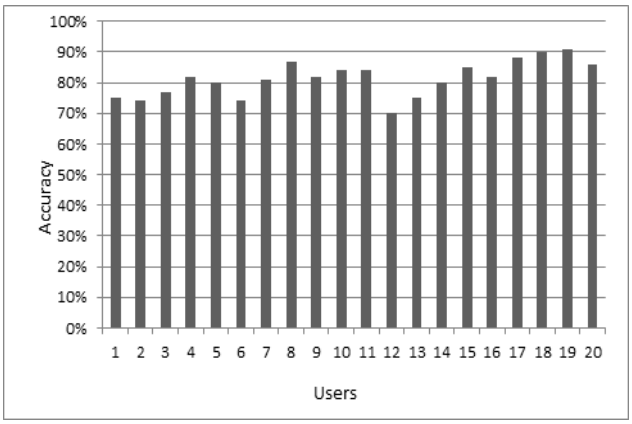

Fig. 4 Effectiveness

4.4.2 Efficiency

The time spent to obtain specified goal is called efficiency, or the resources used in relation to the accuracy and completeness with which users obtain goals. In this study the efficiency of the game is calculated by the time spent on moving from one option to other and selecting the options (correct or incorrect options). We have calculated the efficiency of our proposed application of 20 different users. The results of our proposed BCI interface are plotted in Figure 5.

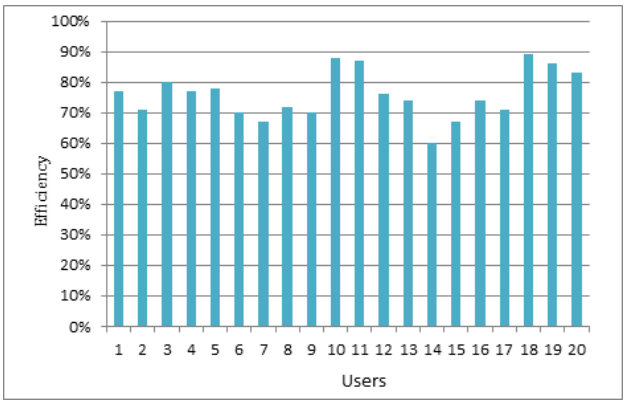

Fig. 5 Efficiency

4.5 User-Satisfaction

All the end users are significantly satisfied with the proposed BCI based game. In this study one sample T-test was done, in which the population means was compared with 2.5 test value, the user data was metric(i.e. the dependent variable measured by scale), also the questionnaire data was independent , there were no outliers in the data, and also the data was normally distributed.

As a result of one sample T-test, the statistical significance value (p-**value**) was p < .**05**, therefore it is concluded that the population's means was lower than the normal value which is 2.5. Also all data variables significant means were greater than 2.5. In this overall the user are highly satisfied with the proposed BCI based game as compared existing BCI game (immediate satisfaction). All the questions results of one-sample T-test have been shown in below tables 1 & 2 respectively.

Table 1: One Sample statistics.

	N	Mean	Std. Deviation	Std. Error Mean
Application-less-error	20	3.2000	1.05631	0.23620
Game-easy-use	20	3.7500	1.01955	0.22798
Using-Brain-Signals-in-this-application	20	2.9000	0.91191	0.20391
Application-quick-learnable	20	3.9500	0.88704	0.19335
Feel-confident-using-game	20	3.6500	0.81273	0.18173
Through-usage-the-application-more-aware	20	4.4000	0.75394	0.16859
Result-satisfaction	20	3.5000	0.51299	0.11471
User-comfortable	20	3.1000	0.71818	0.16059
Enjoyable-game	20	3.9000	0.64072	0.14327
Overall-user-satisfaction	20	4.0500	0.75915	0.16975

Table 2: One Sample test

	Test value=2.5					
	t	df	Sig.(2-tailed)	Mean Difference	95% confident interval of Difference	
					Lower	Upper
Application-less-error	2.964	19	.008	.70000	.2056	1.1944
Game-easy-use	5.483	19	.000	1.25000	.7728	1.7272
Using-Brain-Signals-in-this-application	1.962	19	.065	.40000	.0268	.8268
Application-quick-learnable	7.310	19	.000	1.45000	1.0349	1.8651
Feel-confident-using-game	6.328	19	.000	1.15000	.7696	1.5304
Through-usage-the-application-more-aware	11.270	19	.000	1.90000	1.5471	2.2529
Result-satisfaction	8.718	19	.000	1.00000	.7599	1.2401
User-comfortable	3.736	19	.001	.60000	.2639	.9361
Enjoyable-game	9.772	19	.000	1.40000	1.1001	1.6999
Overall-user-satisfaction	9.131	19	.000	1.55000	1.1947	1.9053

5. Conclusion

Usability is the key to ensure a BCI based application as assistive technology. Though BCIs are novel and still progressing technology, the usability evaluation is up to now underestimated. We have created and evaluated new BCI based game using ISO 9241-11 usability model. The performance evaluation parameters that we have considered are Effectiveness, Efficiency, and User-Satisfaction. We have calculated the result of newly BCI game which is composed of different graphical user interfaces. The result shows that our proposed BCI application in respect of usability parameters such as Effectiveness, Efficiency and User-Satisfaction are significant.

References

[1] Yuan Yang, Joe Wiart, Isabelle Bloch, "Towards next generation human-computer interaction-Brain computer interfaces: applications and challenges", 2013.

[2] Jonathan .Wolpaw, Niels Birbaumer, William. Heetderk, Dennis J. McFarland, "Brain–Computer Interface Technology: A Review of the First International Meeting", IEEE, 2000.

[3] Tan, D., and Nijholt, "A. Brain-computer interfaces and human-computer interaction", Springer 2010.

[4] Van Erp, Lotte, Tangermann,"Brain-Computer Interface: beyond medical applications" 2012.

[5] Bi L, Fan X-A, Liu Y, "EEG-based brain-controlled mobile robots: a survey. Human-Machine System", IEEE, 2013.

[6] D.P.O.Bos, H.Gukok, B. Reuderink, M.poel, "Improving BCI performance after classification", ACM 2012.

[7] D.P.O. Bos, B.Reuderink, "Human-computer interaction for BCI games: usability and user experience", Springer, 2010.

[8] F.Lotte, "Brain-computer interfaces for 3D games", ACM, 2011.

[9] Riccio, A. et al. "Hybrid P300-based brain–computer interface to improve usability for people with severe motor disability: electromyography signals for error correction during a spelling task"2015.

[10] Giovanni Morone, Iolanda Pisotta, ,Floriana Pichiorri, Sonja Kleih, Stefano Paolucci, ,Marco Molinari "Proof of Principle of a Brain-Computer Interface Approach to Support Poststroke Arm Rehabilitation in Hospitalized Patients: Design, Acceptability, and Usability" 2015.

[11] McCane LM, Sellers EW, McFarland DJ, Mak JN, Carmack CS, et al, "Brain-computer interface (BCI) evaluation in people with amyotrophic lateral sclerosis" 2014.

[12] Ivo Käthner, Sebastian Halder, Christoph Hintermüller, "A multifunctional brain-computer interface intended for home use: An evaluation with healthy participants and potential end users with dry and gel-based electrodes", 2017.
[13] Christoph Guger, Gunther Krausz, Brendan.Allison and Guenter Edlinger, "Comparison of dry and gel based electrodes for P300 brain–computer interfaces", 2012
[14] Angela Riccio , Elisa Mira Holz,Pietro Arico, Francesco Leotta,Fabio Aloise, Lorenzo Desideri, , Andrea Ku, "Hybrid P300-Based Brain-Computer Interface to Improve Usability for People With Severe Motor Disability: Electromyography Signals for Error Correction During a Spelling Task" 2015.
[15] Elisa Mira Holz, Johannes Höhne, Pit Staiger-Sälzer, Michael Tangermann, "Brain–computer interface controlled gaming: Evaluation of usability by severely motor restricted end-users", 2013.
[16] F. Cincotti, D. Mattia, F. Aloise et al., "Non-invasive brain-computer interface system: towards its application as assistive technology," 2008.
[17] Razali Tomari , Rozi Roslind Abu Hassan, Wan Nurshazwani Wan Zakaria, Rafidah Ngadengon "Analysis of Optimal Brainwave Concentration Model for Wheelchair Input Interface". International Symposium on Robotics and Intelligent Sensors, 2015 IEEE.
[18] Andreas Pinegger, Selina.Wriessnegger, JosefFaller and GernotR.Müller-Putz, "EvaluationofDifferentEEGAcquisitionSystemsConcerning TheirSuitabilityforBuildingaBrain–ComputerInterface: Case Studies" 2016.
[19] Elisa Mira Holz, Johannes Höhne, Pit Staiger- Sälzer, Michael Tangerman,Andrea Kübler "Brain–computer interface controlled gaming: Evaluation of usability by severely motor restricted end-users", 2013.
[20] Brendan Z. Allison and Jaime A. Pineda, "ERPs Evoked by Different Matrix Sizes: Implications for a Brain Computer Interface (BCI) System", IEEE, 2003.
[21] Kübler, A., Holz, E., Kaufmann, T. and Zickler, "A user centred approach for bringing BCI controlled applications to end-users in Brain-Computer Interface Systems", 2013.
[22] "Processing and spectral analysis of the raw EEG signal from the Mind Wave", West Pomeranian University of Technology, 2014.
[23] Athanasios Vourvopoulos Madeira-ITI, Sergi Bermudez i Badia Madeira-ITI, "Usability and Cost-effectiveness in Brain-Computer Interaction: Is it User Throughput or Technology Related?" 2013.
[24] "Unleashing Brain Powers: A Study on Development of BCI-enhanced Computer Games" spring 2011.
[25] Stuart J. Johnstone, R Blackman, "EEG from a single-channel dry-sensor recording Device" 2012.
[26] Arnold M. Lund, "Measuring Usability with the USE Questionnaire", 2001.
[27] Mario Simoes-Marques and Isabel L. Nunes "Usability of Interfaces", 2012.
[28] Justin Mifsud, "Usability Matrices-A guide to quantify the usability of Any System", 2015.
[29] John Brooke, "SUS - A quick and dirty usability scale.
[30] Elisa Mira Holz, Johannes Hohne, Pit Staiger-Salzer, "Brain–computer interface controlled gaming: Evaluation of usability by severely motor restricted end users" 2013.
[31] "Unleashing Brain Powers: A Study on Development of BCI-enhanced Computer Games", spring 2011.
[32] "Introductory Guide to EEG & BCI for Entertainment", NeuroSky body and Mind, Quantified.
[33] Avinash Kumar Singh, Yu-Kai Wang, lun-Tai King, Chin-Teng Lin, and Li-Wei Ko Brain Research Center National Chiao Tung University Hsinchu, "A Simple Communication system based on Brain-Computer Interface", 2015.
[34] "NEUROSKY. NeuroSky eSense™ Meters and Detection of Mental State", 2009.
[35] Andrea Ku¨ bler, Elisa M. Holz, Angela Riccio, Claudia Zickler, Tobias Kaufmann, "The User-Centered Design as Novel Perspective for Evaluating the Usability of BCI-Controlled Applications"2014.
[36] Ku¨ bler A, Holz EM, Kaufmann T, Zickler, "A User Centered Approach for Bringing BCI Controlled Applications to End-Users", 2013.

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