Players' Opinions on Control and Playability of a BCI Game

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Abstract. Brain-computer interface (BCI) games can satisfy our need for competence by providing us with challenges that we should enjoy tackling. However, many BCI games that claim to provide enjoyable challenges fail to do so. Some common fallacies and pitfalls about BCI games play a role in this failure and in this paper we report on a study that we carried out to empirically investigate them. More specifically, we explored (1) active and passive interaction with BCI games, (2) BCI gaming as a skill and (3) playability of a BCI game. We conducted an experiment with 42 participants who played a popular computer game called World of Warcraft using a commercial BCI headset called EPOC. We conducted interviews about the participants' experiences of the game and ran a phenomenological analysis on their responses. The analysis results showed that (1) the players would like to play a BCI game actively if the BCI controls critical game elements, (2) the technical challenges of BCI cannot motivate the players to play a BCI game and (3) the players' enjoyment of one-time playing of a BCI game does not imply playability of the game.

1 Introduction

Brain-computer interfaces (BCIs) are physiological computing systems that satisfy or support the needs of their users by interpreting the user's brain activity [1,2]. There are different groups of BCI users and each of them has different needs. Besides paralysed individuals who use BCIs to satisfy their basic physiological needs for survival, there is a larger user group including not only paralysed but also healthy individuals who use BCIs to satisfy their psychological needs. BCI games are prominent applications for this group of users thanks to their capability to satisfy some psychological needs such as competence, pleasure and relatedness [3]. For example, by overcoming the challenges posed by a BCI game, people can satisfy their need for competence [4].

Many BCI games have been developed with the claim of satisfying psychological needs but without succeeding to do so. Common fallacies and taken-for-granted assumptions about BCI games (or BCIs) play a role in this. Our goal in the paper is to test some of these issues empirically so that we have a better

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understanding of them and that we can consider them while developing BCI games. The first issue is about active and passive BCI games. Active BCI games are those in which the players generate brain signals intentionally, in order to control the game. In passive BCI games, players do not generate brain signals for controlling the game but their naturally occurring brain signals influence the game play. The fallacy with active and passive BCI games is that they are thought of as distinct applications, as we have just introduced above as well. However, this is not necessarily the case. We conjecture that active or passive is a property not of a BCI game alone but rather of the interaction between the BCI game and its player. More specifically, while some players interact with a particular BCI game actively, others may do so passively. Furthermore, a player can interact with a BCI game in a dynamic manner, switching between active and passive interaction modes. This is the basis of the first research question (RQ) in the paper:

RQ1: When and why do players opt for active or passive interaction while playing a BCI game.

The second issue is about the challenges that BCI games pose and the player skills required to overcome them. We have mentioned that BCI games can satisfy people's need for competence by offering some challenges to them. Many BCI games claim to be challenging simply because the technical shortcomings of BCIs (e.g. noise in acquired brain signals) pose a fundamental challenge to players [5]. However, such technical challenges cannot satisfy people's need for competence because they cannot be overcome (merely) by the player's effort. The real challenge a BCI game should offer is to find out how to generate the desired brain patterns to control the game. This is the second research questions which is addressed in the paper:

RQ2: Do BCI game players consider BCI control as a skill?

The third issue concerns long-term interaction with BCI games. The majority of the user studies on BCI games have asked participants to evaluate their experience of a particular experiment that they took part in (e.g. [6,7,8]). The potential pitfall with such an evaluation is that participant responses may reflect their experience of, rather than the BCI game as a product, the whole experiment which includes visiting a new place, interacting with new people and trying novel technology. Participants may find *the experiment* to be *fun* but may not ever want to play the BCI game again. People's view of BCI games as products and their willingness to bring them to their homes and play as they do with other computer games is therefore as yet unclear. This is partly because the BCI games evaluated so far were simple toy games and/or they required expensive hardware (e.g. electroencephalographs or near-infrared spectrographs). Under these conditions, it would not be realistic to imagine playing BCI games as playing, for example, a casual game on a personal computer. However, the situation is changing with the emerging consumer grade hardware [9]. We envision people playing computer games in their homes using such hardware. This brings us to the third research question:

RQ3: Are people willing to play a non-toy computer game using consumer grade BCI hardware?

We opted for phenomenology to investigate our RQs due to its power in extracting lived human experience [10]. We let people play a popular computer game called World of Warcraft [1] (WoW) once using its default controllers (i.e. the mouse and the keyboard) and once using a consumer grade BCI hardware called EPOC[2]. This way, we could evaluate their experience of BCI control independent of their experience of the game. They could interact both actively and passively with the BCI version of the game. After they had played the games, we conducted interviews to collect people's experiences of the BCI game. In this paper, we present our findings of the analyses that we ran on the interview responses.

2 Methodology

2.1 Participants

To support generalisability of our findings, we tried to obtain a participant space that is as diverse as possible with respect to participants' age, gender, nationality and experience with computer games and the game WoW. We recruited the participants through the posters we hung around our institution, word-of-mouth, social media and our mailing lists from previous studies. Forty-two people (12 female, 30 male) participated in the experiment. Their ages ranged from 17 to 49 years (mean = 24.86). Three participants were Spanish, 2 were Chinese, 2 were German, 1 was Ecuadorian and the rest were Dutch. Thirty-six participants indicated playing or having played computer games. Fourteen participants were experienced WoW players (reached level 35 or above with their game character). The participants were paid according to the regulations of our institution.

2.2 Game

WoW is a massively multiplayer online role-playing game (MMORPG). At the time of writing, it was the world's most-subscribed MMORPG with more than 10 million subscribers[3]. It has frequently been used in human behaviour and experience [11,12,13] and also BCI research [14,15]. In WoW, people play the role of a fantasy hero. They control a character to fight other players' characters or non-player characters and complete quests. The more quests they complete, the higher the level they reach. Although there is a maximum level that players can

[1] From Blizzard Entertainment, Inc., CA, USA
[2] From Emotiv Systems, CA, USA
[3] http://www.ign.com/articles/2012/10/04/mists-of-pandaria-pushes-warcraft-subs-over-10-million

reach, the game does not end when this level is reached. Players can still keep on playing to finish awaiting quests, enjoy regular content updates or socialise with other players. By default, they use the mouse and the keyboard to interact with the game. The characters the players control belong to a class that determines the type of weapons and armor the character can use, as well as the abilities it can gain. For example, a character belonging to the class of Druids has the unique ability to transform into different forms (also called shapeshifting). For this, the players with a Druid character can click on the icon representing the form they want to transform into (e.g. an elf or a bear). Each form has its strengths. For example, an elf can cast attacking and healing spells, and attack from a distance while a bear can resist attacks for a long time and cause high damage in close combat. We created a BCI game based on WoW, called alpha WoW (aWoW), which infers the player's state of relaxation and transforms the player's character into an elf or a bear form [14]. We tried to achieve an intuitive match between the character forms and the player's relaxation state. If the player is relaxed, then their character transforms into the elf form. If they are not relaxed (but, for example, stressed or occupied with executing mental processes) then their character transforms into the bear form. A bar on the top left of the screen indicates the player's level of relaxation (see Figure 1). Relaxation is estimated by analysing the player's brain activity over the posterior region (see §2.3 for details). Players can also transform their character by clicking on the designated icons, as in the original WoW game. We consider aWoW as a BCI game that offers both active and passive interaction modes. In active interaction players might voluntarily regulate their relaxation to benefit from the advantages of a specific form while in passive interaction they might simply enjoy seeing the game reflect their natural state and improve their sense of presence.

2.3 Relaxation Estimation

In aWoW, the player's relaxation is inferred by analysing their alpha rhythm. The alpha rhythm oscillates between 8-13 Hz over the posterior region. It is blocked or attenuated by attention and mental effort. Therefore it has been associated with physical relaxation and relative mental inactivity [16]. The feedback of alpha rhythm has frequently been used in treatment of stress-related anxiety disorders [17].

To evaluate the estimation accuracy in aWoW, we conducted a pilot study with 10 participants (2 female). Instead of aWoW, we used a simpler game (see Figure 2) that used the same relaxation estimation method as aWoW. In this game, a ball fell from the top centre to the bottom of the screen in 7 seconds and the participants steered the ball to the left or right so that it hit the bottom at the target half of the screen. The target half was indicated by a green bar and the other half with a red one. The target half was randomly chosen for every falling ball. The ball moved to the left with increasing relaxation and otherwise to the right. If the ball hit the target half of the screen, the player score was increased by one. Participants first played 3 training sessions each of which contained 20 trials (i.e. 20 falling balls). We did not keep track of their training game scores.

Fig. 1. A screenshot from aWoW. The orange bar located to the top left corner of the screen, under the health and mana bars, indicates player's relaxation state.

Then, they played 5 sessions (i.e. 100 trials per participant) and we recorded their scores. For each participant we computed the relaxation estimation accuracy by averaging their game scores. The mean estimation accuracy over all participants was 74.1% (SD = 13.9). Although such an accuracy cannot compete with the reliability of traditional controllers (e.g. the keyboard), it meets the de facto threshold accuracy for BCIs[4]. According to this threshold assumption, half of the participants could not control the game since 5 people remained under the mean (as well as the threshold).

2.4 Experiment Protocol

Each experiment was carried out by one of three experimenters. To prevent biases, all three experimenters followed a written, itemised protocol strictly. The participants also received instructions written down in English so the experimenters refrained from giving oral instructions unless the participants asked for specific information. The basic instruction sheet introduced WoW and contained information on moving, quests, transformations, armors, areas, chatting with other players and how to re-start playing the game if the game character died. This sheet and an informed consent form were available to the participants online so that they could read them before coming to the experiment. They also

[4] An accuracy of 70% is widely assumed in the BCI community as the threshold to operate a BCI for communication [18,19].

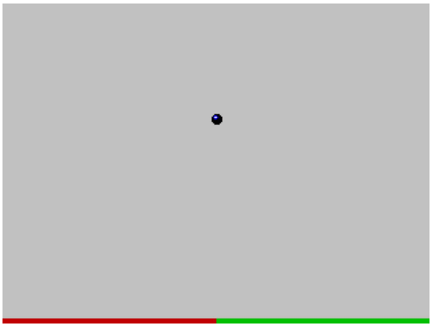

Fig. 2. A screenshot from the game used in the pilot study

filled out in advance an online demographic questionnaire. In addition to the basic instruction sheet, the participants received two additional instruction sheets; one before playing WoW with the default controllers and one before playing it with BCI. These sheets gave specific instructions on shapeshifting (e.g. not to use the icons to transform while playing with BCI). Participants could access the instruction sheets at any time during the experiment.

The experiment protocol was executed as follows. The participants signed the informed consent form while the experimenter mounted the EPOC electrode headset on them. The experimenter tilted the headset forward at an angle of approximately 25° (see Figure 3) so that the electrodes touched the scalp on the desired locations (see §2.3). After (re-)reading the basic instructions, the participants played the official tutorial of WoW with a level 1 character until they felt that they were comfortable with playing the game. Afterwards, they played the game with a level 28 character in two sessions. We chose a level 28 character because we wanted the game character to be sufficiently high level so that the participants could (1) transform into the bear shape, and (2) investigate an area that would remain interesting enough for some levels. In one of the sessions they used the default controllers and in the other the BCI. The order of these games were counterbalanced across the participants. In each session, the participants first received and read the additional instruction sheet. Then, the experimenter left the room. According to the instructions they had read, the participants rang a bell when they did not want to play anymore. If they did not ring the bell within 30 minutes the experimenter interrupted them, but this was not written in the instructions. After that, they filled out a user experience questionnaire[5] and took a break for as long as they wished. Finally, after completing both sessions, they took part in an interview.

The experiments were carried out in two separate rooms, using two separate laptops. Each laptop was associated with a different WoW account. This allowed two experiments to be carried out simultaneously. To ensure that the participants began playing the game under the same conditions, we created characters

[5] The questionnaire responses were analysed in the context of another study and the results are reported elsewhere [20].

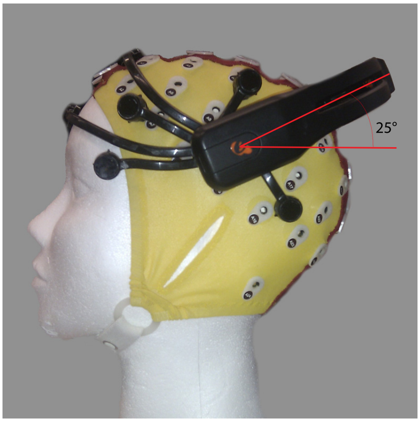

Fig. 3. Illustration of the mounted electrode headset

that were equally levelled on both accounts. Moreover, we placed the game character at the same location in the game world after each experiment with its armor repaired. The starting location of the game character was a safe area so that the participants would not need to start fighting as soon as they started playing. The layout of the experimental setup was consistent in both rooms. The experimenters were not in the same room with the participants during the play sessions but could monitor the participants through the cameras located to the top corners of the rooms.

2.5 Data Collection and Analysis

We recorded the play sessions and interviews using cameras with a microphone. Using Emotiv TestBench we recorded the electrical brain activity as electroencephalograms. We logged key presses along with corresponding screenshots. For the purpose of this paper, we only analysed the interview recordings.

Interview. We conducted semi-structured interviews with the participants to investigate their experience. The questions asked are:

1. You played the first/second game with BCI. In this game, you could have used BCI in two ways. The first way was to actively try to manipulate your state when you wanted to transform. The second way was to let BCI passively monitor and reflect your natural mental state. So in the first case, *you* would take the initiative to transform while in the second case you would let the *game* take the initiative. Which of these ways did you take?
2. In the BCI game, did things ever go wrong when you actively tried to transform?

3. In the BCI game, how did you feel when the game took the initiative and transformed you?
4. (If an experienced WoW player) How frequently do you play WoW?
(Else) Let's assume that you have WoW at home. How frequently, do you think, you would play it?
5. Let's assume that you also have this headset and the BCI version of WoW at home. How frequently, do you think, you would play WoW using the headset?
6. Do you think you can get better at controlling the transformations with BCI?
7. (If the participant rang the bell in one of the sessions) What was the reason that you stopped playing in the first/second game?

We asked the interview questions in the order they were written on the interview sheet. When necessary, we encouraged the participants to elaborate on their responses by telling us about specific events that happened during the experiment and the consequent experience they had. The interviews took place in English unless the experimenter spoke the native language of the participant. As a result 21 interviews were conducted in English and 21 in Dutch.

Adhering to the goal of phenomenology, the interview questions aimed at unfolding the participants' experiences, rather than collecting their abstract interpretations or opinions [21]. So, instead of questions that referred directly to our RQs, we asked questions that encouraged the participants to talk about their experiences during the game. The first question of the interview addressed our first RQ on active and passive BCI games. If the participants did not motivate their choice for an interaction mode then the experimenter asked explicitly for it. The second, third and sixth questions addressed our RQ on BCI control as a skill. More specifically, the second and third questions explored participants' opinions on who was responsible for the errors in active and passive shapeshifting respectively. The sixth question investigated whether the participants required the technology to improve or they thought that they could improve just by practising. The fourth, fifth and seventh questions explored participants' experience of playability; our third RQ.

We transcribed all the interviews except for two, which did not contain audio due to a software error. For each question, we performed decontextualisation and recontextualisation procedures as proposed by [22] and we took an immersion/crystallisation analysis style [23]. More specifically, from participant responses we extracted texts that were potentially significant to our hypotheses. Then, we assigned codes to units of meaning by looking at the relationships between the texts. Finally, we examined the codes to identify patterns and reduced the data into central categories and category relationships.

3 Most Important Findings

In this section we summarize the important findings concerning the most relevant questions in the structured interview.

Question 1: Did you play the game actively or passively? Only a small number of participants played the game actively. They came up with different strategies to generate the necessary brain signals to play the game and claimed that they succeeded in transformations. Some participants had control over transformation into an elf but not into a bear. Many other participants played the game passively but their responses implied that passive play was not a free-will choice but a consequence of failure with active play. In short, all participants did want and try to play the game actively but only some succeeded.

Question 2: Did things go wrong during active play? None of the participants indicated that they could control the transformations perfectly. Some participants explained that they could trigger transformations but they were transformed back quickly by the BCI. Others could not trigger transformations at all. One of the reasons stated was simply their failure in figuring out how to trigger transformations. Another reason was the competition between the attention required to transform and that required to play the game. The detrimental influence of competing attentional demands on play experience while playing BCI games has been reported before as well [24].

Question 3: How did you feel during passive play? Participants appreciated functional passive play mainly for pragmatic reasons. They liked it when the game transformed them at the 'right' time and saved the effort of issuing explicit commands for transforming. When the transformations did not comply with the mental state that they believed to be in, the participants trusted their self-assessment rather than the assessment of the BCI. One of the factors that damaged the credibility of the BCI was the seemingly randomness of transformations. Another prominent factor was the instability of transformations.

We will not elaborate on the responses to Question 4 as this question served as a baseline for Question 5.

Question 5: How frequently would you play aWoW? Participant responses to Question 5 were divided into two. One group indicated that they would never play the game using the headset and stated three main reasons for that: controllability, equal opponents and comfort of the headset.

The other group indicated that they would like to play the game using the headset. However, their responses implied that rather than playing the game, they would actually like to interact with the headset itself because the BCI was not accurate enough to steer the game.

Question 6: Can you get better in transformations? Participants had two distinct views. One group hypothesised that they could get better in time with practising. On the one hand, some had theoretical reasoning. On the other hand, some had empirical reasoning. They expressed that their control over transformations already improved during the experiment.

The other group was more skeptical. Some indicated that they would not be able to improve without the help of, for example, pointers or tricks. Some participants indicated that their ability of control was conditioned on personalisation of the BCI.

Question 7: Why did you stop playing the game? There were three main reasons for the participants to stop playing aWoW. The first one was the frustration caused by lack of control. The second reason was the discomfort with the headset. The last reason was not related to BCI. At particular moments during play (e.g. upon completion of quests), some participants remembered that they were in an experiment and decided to stop.

4 Limitations of the Study

Although we were able to answer our RQs through the study we conducted, there are limitations to adopting our findings. Firstly, the phenomenology approach we took in this study is inherently subjective as the human is the instrument for analysis. To minimise the possibility of a biased analysis, we abided by the principles of bracketing.

Secondly, given the imperfect recognition accuracy of the BCI running behind aWoW and the prominent influence of lack of control on user experience as revealed by our study, it is possible that a more accurate BCI could have provided a different user experience and yielded different results.

Thirdly, we drew our findings from a single experiment in which we used a particular game and hardware. This means that the findings might not be generalisable to BCI games in general.

5 Conclusions for BCI Game Development

As we mentioned in §1, our RQs served as a means to inform our readers about the common fallacies and assumptions about BCI games. In this section, we will provide some guidelines for BCI development, drawn from the answers to our RQs.

- Not all BCI games are suitable to be played actively and passively. If the BCI is used in controlling critical game dynamics (e.g. movements of a player avatar, which needs timely action and the consequences of errors are intolerable) and if the control is imperfect (which is the case with current BCIs), then the players are expected to interact actively. They would hand the control over to the BCI only if they fail at active interaction.
- When interacting actively, players should predict (to some extent) the outcome of their mental activity. They should feel that they play a role in both successful and unsuccessful driving of the game. Thus, they should be able to overcome the challenges the BCI game poses. Because BCI is a faulty technology, an extra burden is put on game designers in order to make a BCI game both challenging and enjoyable.

– While interacting passively, players should be able to figure out the mapping between their mental state and game events. They should perceive that the actions the BCI game takes are reasonable (e.g. consistent) and stable.
– The attention required to control the BCI should not exhaust the overall attention devoted to the game. Players should be able to use other controllers, monitor the progression of the game and simply enjoy the game visuals.
– The experience of fun resulting from playing a BCI game once does not reliably represent the experience of pleasure that unfolds by playing the game. Thus, BCI games should be developed and evaluated for the pleasure rather than the fun they provide.
– The pragmatic quality (or usability) of a BCI game (e.g. the comfort of the headset, the amount of control a player has) is important for long-term user experience. Pragmatic quality of a BCI game should not be so low that it worsens or otherwise masks the game's hedonic quality.

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References

1. Gürkök, H., Nijholt, A.: Brain-computer interfaces for multimodal interaction: A survey and principles. International Journal of Human-Computer Interaction 28(5), 292–307 (2012)
2. Tan, D., Nijholt, A.: Brain-computer interfaces and human-computer interaction. In: Brain-Computer Interfaces, pp. 3–19. Springer, London (2010)
3. Gürkök, H., Nijholt, A., Poel, M.: Brain-computer interface games: Towards a framework. In: Herrlich, M., Malaka, R., Masuch, M. (eds.) ICEC 2012. LNCS, vol. 7522, pp. 373–380. Springer, Heidelberg (2012)
4. Nijholt, A., Reuderink, B., Oude Bos, D.: Turning shortcomings into challenges: Brain-computer interfaces for games. Entertainment Computing 1(2), 85–94 (2009)
5. Tatum, W.O., Dworetzky, B.A., Schomer, D.L.: Artifact and recording concepts in EEG. Journal of Clinical Neurophysiology 28(3), 252–263 (2011)
6. Mühl, C., Gürkök, H., Plass-Oude Bos, D., Thurlings, M.E., Scherffig, L., Duvinage, M., Elbakyan, A.A., Kang, S., Poel, M., Heylen, D.: Bacteria Hunt: Evaluating multi-paradigm BCI interaction. Journal on Multimodal User Interfaces 4(1), 11–25 (2010)
7. George, L., Lotte, F., Abad, R., Lecuyer, A.: Using scalp electrical biosignals to control an object by concentration and relaxation tasks: Design and evaluation. In: 2011 Annual International Conference of the IEEE EMBS, pp. 6299–6302. IEEE, Piscataway (2011)

8. Gürkök, H.: Mind the Sheep! User Experience Evaluation & Brain-Computer Interface Games. PhD thesis, University of Twente, Enschede, The Netherlands (2012)
9. Liao, L.D., Lin, C.T., McDowell, K., Wickenden, A.E., Gramann, K., Jung, T.P., Ko, L.W., Chang, J.Y.: Biosensor technologies for augmented brain-computer interfaces in the next decades. Proceedings of the IEEE 100, 1553–1566 (2012)
10. Sokolowski, R.: Introduction to Phenomenology. Cambridge University Press, Cambridge (2000)
11. Nardi, B., Harris, J.: Strangers and friends: Collaborative play in World of Warcraft. In: Proceedings of the 2006 Conference on Computer Supported Cooperative Work, pp. 149–158. ACM, New York (2006)
12. Yee, N., Ducheneaut, N., Nelson, L., Likarish, P.: Introverted elves & conscientious gnomes: The expression of personality in World of Warcraft. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 753–762. ACM, New York (2011)
13. Billieux, J., van der Linden, M., Achab, S., Khazaal, Y., Paraskevopoulos, L., Zullino, D., Thorens, G.: Why do you play World of Warcraft? An in-depth exploration of self-reported motivations to play online and in-game behaviours in the virtual world of Azeroth. Computers in Human Behavior 29(1), 103–109 (2013)
14. Nijholt, A., Plass-Oude Bos, D., Reuderink, B.: Turning shortcomings into challenges: Brain–computer interfaces for games. Entertainment Computing 1(2), 85–94 (2009)
15. Scherer, R., Friedrich, E.C.V., Allison, B., Pröll, M., Chung, M., Cheung, W., Rao, R.P.N., Neuper, C.: Non-invasive brain-computer interfaces: Enhanced gaming and robotic control. In: Cabestany, J., Rojas, I., Joya, G. (eds.) IWANN 2011, Part I. LNCS, vol. 6691, pp. 362–369. Springer, Heidelberg (2011)
16. Deuschl, G., Eisen, A. (eds.): Recommendations for the Practice of Clinical Neurophysiology, 2nd edn. Elsevier, Amsterdam (1999)
17. Moore, N.C.: The neurotherapy of anxiety disorders. Journal of Adult Development 12, 147–154 (2005)
18. Quek, M., Höhne, J., Murray-Smith, R., Tangermann, M.: Designing future BCIs: Beyond the bit rate. In: Towards Practical Brain-Computer Interfaces, pp. 173–196. Springer, Heidelberg (2012)
19. Vaughan, T.M., Sellers, E.W., Wolpaw, J.R.: Clinical evaluation of BCIs. In: Brain-Computer Interfaces: Principles and Practice, pp. 325–336. Oxford University Press, New York (2012)
20. Van de Laar, B., Gürkök, H., Plass-Oude Bos, D., Poel, M., Nijholt, A.: Experiencing BCI control in a popular computer game. IEEE Transactions on Computational Intelligence and AI in Games 5(2), 176–184 (2013)
21. Starks, H., Brown Trinidad, S.: Choose your method: A comparison of phenomenology, discourse analysis, and grounded theory. Qualitative Health Research 17(10), 1372–1380 (2007)
22. Tesch, R.: Qualitative Research: Analysis Types and Software Tools. RoutledgeFalmer, London (1990)
23. Malterud, K.: Qualitative research: standards, challenges, and guidelines. Lancet 358(9280), 483–487 (2001)
24. Gürkök, H., Nijholt, A., Poel, M., Obbink, M.: Evaluating a multi-player brain-computer interface game: Challenge versus co-experience. Entertainment Computing 4(3), 195–203 (2013)