An exploration of seniors' motivation to use mobile brain-exercise software

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D. O'Brien, R.B. Knapp, O. Thompson, D. Craig, S. Barrett. An exploration of seniors' motivation to use mobile brain-exercise software. Gerontechnology 2013;11(3):436-444; doi:10.4017/gt.2013.11.3.002.00 This article reports on the development of an iPhone-based brain-exercise tool for seniors involving a series of focus groups (FGs) and field trials (FTs). Four FGs with 34 participants were conducted aimed at understanding the underlying motivational and de-motivational factors influencing seniors' engagement with mobile brain-exercise software. As part of the FGs, participants had approximately 40 minutes hands-on experience with commercially available brain-exercise software. A content analysis was conducted on the data resulting in a ranking of 19 motivational factors, of which the top three were challenge, usefulness and familiarity and 15 de-motivational factors, of which the top-three were usability issues, poor communication and games that were too fast. Findings were used to inform the design of three prototype brain-exercise games for the iPhone contained within one overall application, named Brain jog. Subsequently, two FTs were conducted using Brain jog to investigate the part that time exposure has to play in shaping the factors influencing engagement. New factors arose with respect to the initial FGs including the motivational factor feedback and the de-motivational factor boring. The results of this research provide valuable guidelines for the design and evaluation of mobile brain-exercise software for seniors.

Keywords: motivation, brain-training, user-centred design, dementia prevention

The research presented is part of the preliminary phase of a study known as SONIC[2]S (Stirling-Oregon-Northern Ireland-Chicago Cognitive Stimulation Study) that aims to design, develop, and validate a mobile phone-based brain-training software suite targeted at senior users, using iterative person-centred design methodologies. The SONIC[2]S Study will represent a long term (15 year), large scale (n=12,000), embedded clinical trial that aims to determine the efficacy of brain-exercise as a preventative treatment for dementia or cognitive decline.

It is anticipated that participant compliance in such a study will be a significant concern. This study seeks to identify the key motivational and de-motivational factors influencing seniors' engagement with mobile brain-exercise software in order to inform the design of a bespoke tool which is acceptable and enjoyable to target users. The Ethics Committee at the School of Music and Sonic Arts, Queen's University Belfast granted approval.

Games research with seniors

There is a lack of games-related research with seniors when compared with younger generations[1]. However, applying the results of existing research conducted with younger cohorts to the senior population may be inappropriate[2] as much of this work tends to emphasise the immersive aspects of game play[3], most likely a reflection of the different content preferences of younger generations[2]. In support of this, many studies involving seniors have revealed a preference for 'casual games'[2,4,5], i.e. games that have "generally appealing content, simple controls, easy-to-learn game play, fast rewards, or support for short play sessions"[6]. Also, puzzle games[1,5] and computerised versions of existing games seem popular[7]. This is in contrast with the genres of 'sports', 'shooter', or 'role playing' games typically preferred by younger generations[2]. Further, adolescents typically value 'competition' over older players' preferences for 'challenge', for example[2]. Also, a higher proportion of senior gamers within the casual games genre are women[8]. The effect

that this may have on motivational preferences needs consideration.

Perhaps the most common motivational theme running through games research for seniors is in relation to 'social interaction'. Social interaction with family or friends via computer games is widely considered to offer potential benefits, either by encouraging such interaction[9], strengthening and maintaining social networks[10] or simply by facilitating fun experiences during play[11]. 'Challenge' is also a prominent theme emerging from the literature with some findings highlighting the importance of this factor to a greater[1,2,4] or lesser[12,13] degree. The part that player personalities may have in affecting challenge-seeking behaviour[14] could account for some of these discrepancies. Also, the perceived 'usefulness', benefit or real value of computer games is thought to positively influence seniors' engagement. Some authors believe that the older generations have a preference for information over entertainment[2,15] or have a need for games that serve a useful purpose, i.e. educational games[7], whilst others have found that seniors like puzzles because they are perceived as 'good for the brain'[5].

In terms of de-motivational themes, usability or playability issues are commonly reported as barriers. Possible reasons are a mismatch between games that are too fast and issues of age-related physical decline[9,16], the generation effect caused by a lack of exposure to digital technology[16,17] or games being perceived as overly-complicated[9]. Some seniors harbour negative associations in relation to war, addiction, and social isolation[7]. There is a social stigma in playing games for some older adults, created from their peers' perception of games as an activity for children[11] and this, combined with age-related usability issues could culminate in a failure to satisfy seniors' need for 'inclusion, affection, and control'[4].

However, despite these relatively common themes, research explicitly targeting motivational and de-motivational factors within the context of the brain-exercise genre and mobile platform remains scarce.

Initial Focus Groups

Method

Participants

Thirty-four participants took part in four FGs (23F, 11M). Participants responded to questions in relation to age and level of education in terms of ranges rather than discrete values. Median age range was 60–64. Median level of education was certificate–honours degree. Overall, 22 played some form of puzzles at least weekly and five played monthly or less. Twenty-one had more than 10 years experience and 12 used some form of computer-based platform to play.

Procedure

Each FG lasted approximately 2 hours and consisted of four sections that were guided by a questioning route:

(i) The introduction

Participants were informed that the purpose of the FG was to identify what would motivate or de-motivate them to use brain-exercise software. Questions designed to introduce the topic under discussion were asked.

(ii) The transitional activity

Participants were given approximately 40 minutes hands-on experience with commercially available brain-exercise software on a variety of platforms. Participants were encouraged to try out multiple platforms and games. During the transitional activity, participants recorded any motivational and de-motivational aspects that arose during play on a sheet.

(iii) The key questions

This section was designed to extract the data of interest. Discussions in relation to the games played during the transitional activity were focused according to these main questions:

- Are there any aspects in particular that would motivate you to play again?
- Are there any aspects in particular that would turn you off playing again?
- Is there anything that could be added to these games that would compel you to play them more?

Following this, participants were given a sheet describing nine prominent motivational factors discovered through a search of the literature in order to further stimulate the discussion. They were asked to consider the importance of each motivational factor in groups of two before discussing with the group as a whole:

Which of the [nine] motivations, if any, do people think would be reasons to play if they were factored into computer-based puzzle games?

The last key question gave participants, individually, the chance to voice what they felt were the most important issues:

All things considered then, what would be the main motivating and de-motivating factors?

(iv) Finally, the main points raised were summarized and put to the participants for agreement or correction.

Equipment

During the transitional activity, mainly iPhones and iPod touches were used since this was the chosen platform of development. However, other platforms were also involved which included the Nintendo DS, the MacBook Pro and Internet connected PCs.

Analysis

Content analysis[18] was the method by which data from the FGs were analysed. The variables to be coded were 'motivational factors' and 'de-motivational factors' influencing seniors' engagement with brain-exercise software. The unit of analysis, i.e. the smallest data point by which variables can be subdivided, was determined to be the 'comment which expresses a point'. Units ranged from one word (provided there was sufficient contextual information to portray a 'point') to several sentences. Finally, comments were counted and categorized using SPSS to give a ranking of motivational and de-motivational factors. For the analysis there was only one coder. However, in order to aid in the consistency of coding and in tackling ambiguous content, a series of coding rules were developed and utilised. Furthermore, at the end of this procedure, codings were re-checked for consistency and, where appropriate, re-coded.

Results

Arising from the coding procedure, 237 motivational comments made up 19 motivational factors and 123 de-motivational comments made up 15 de-motivational factors that were all ranked (*Table 1*). Only motivational and de-motivational factors that accounted for more than 5% of comments are discussed.

Table 1. Motivational and de-motivational factors derived from the initial focus groups

Factor	Comments received	%
Motivational factors		
Challenge	59	25
Usefulness	40	17
Familiarity	30	13
Entertainment	21	9
Relaxation	17	7
Achievement	15	6
Ease of use	14	6
Others (each <5%)	41	17
Total	237	100
De-motivational factors		
Usability issues	34	28
Poor communication	19	15
Too fast	15	12
Difficult	8	7
Social isolation	8	7
Time consuming	7	6
Others (each <5%)	32	26
Total	123	101

Motivational factors

Challenge was the highest ranked motivational factor across all FGs with 25% of all recorded comments. Comments often indicated that a 'good' challenge provides a means to experiencing a sense of achievement. Whilst participants typically enjoyed trying to get a better score or trying to beat the game, comments implied that the level of difficulty was such that achieving these aims seemed possible.

"I find them quite challenging. When I finish I think: 'see if I can better that score'".

Overall, 17% of comments related to the games perceived practical benefits or the potential for such, within the games. Some participants felt that they needed more evidence about the games' cognitive benefits, whilst others already believed that brain-exercise would provide such. For some, this belief had motivated them to engage with brain-exercise games previously. Other participants were motivated by the 'use it or lose it' idea, i.e. that it is necessary to keep the brain active in order to prevent cognitive decline.

"It's certainly a case of use it or lose it. If you don't use it you're going to lose it".

Overall, 13% of comments related to the importance of familiarity in terms of the content of games. Some made suggestions to make the games resemble already existing games or quizzes. Some participants valued familiarity in terms of past associations and others in terms of present interests or vocations.

"I enjoyed the math ones [games] *better than matching shapes* [games]*… I'm an accountant and numbers are my life…".*

Overall, 9% of comments related to the importance that the games provide some form of basic entertainment. Some valued the games as a potential leisure activity. Some expressed that the games shouldn't be a chore whilst others indicated this would be important in terms of maintaining interest. Other comments expressed a preference for entertainment by way of negating the importance of other motivational factors such as competition or usefulness mentioned by others.

"I would only consider the thing [brain-exercise games] *as an entertainment thing, you know?".*

Overall, 7% of comments related to relaxation. Some participants implied that relaxation was important generally and that the games would be suitable in fulfilling this need. Some felt that the games could act as a welcome distraction from the demands of everyday life whilst others stressed the potential of the games to act as a way to unwind after more demanding activities.

"I find that if I have a piece of work to do and I'm getting too bogged down in it, if I do something that's puzzle-based then I can come back and my mind is a bit fresher".

Overall, 6% of comments related to a feel-good factor arising from a sense of accomplishment or achievement. Participants referred to agreeable outcomes either in terms of reaching milestones within the games or a sense that they had learned something.

"I'm able to get this thing [iPod touch] *on now. I couldn't get it on in the beginning. I have learned that today. If you gave me it yesterday, I couldn't do that…".*

Overall, 6% of comments related to the physical aspects of interacting with the games. Some made suggestions for improving ease of use whilst others expressed this factor in terms of an affinity for various platforms or modes of interaction such as the portability or 'handiness' of mobile devices.

"[The] *portability would be motivating. The fact that I could sit down at a chair that I thought was comfortable to do it".*

De-motivational factors

'Usability issues' was the highest ranked de-motivational factor with 27.6% of all comments. Comments often related to physical problems interacting with the technology either because of device limitations such as a small screen, over-sensitivity (or lack of responsiveness) of input controls, or physical limitations occurring as a result of ageing.

"I used to play snake on the mobile but as you get older it gets harder, firstly from an eyesight point of view and secondly, because they become fiddly".

Overall, 15% of comments related to poor communication, usually in the form of poor instruction and typically resulting in confusion on the part of the participant in relation to how to play. Some felt that the games should be able to communicate how to play intuitively and not have a requirement for written instructions whilst others did not understand the meaning of feedback from the games in relation to performance.

"Instructions - Why keep an eye on the time? No reason given. Felt uncertain about what to do" [Written comment].

Overall, 12% of comments related to timed games being too fast. Some highlighted how games that are too fast can exacerbate usability issues whilst others stressed that being timed is not of interest and can cause unwanted feelings of anxiety.

"… I think the timing thing, having that pressure of time, can increase anxiety".

Overall, 7% of comments related to a perception of games as being overly difficult. Comments usually implied a sense of disappointment or de-motivation arising from unfavourable results, repeated failures or difficulty in learning how to overcome challenges.

"*Totally de-motivating because of* [the] *result"* [Written comment].

Overall, 7% of comments related to a perception of the games as socially isolating. Some commented on the undesirable solitary nature of the games. Others implied that the games would deprive one of engaging in other, more social activities while others focused on what they perceived as the negative societal implications.

"I just hate the idea of a world where we're all sitting with our little earphones in and we're playing mindless games like 'X's and O's'."

Overall, 6% of comments related to a perception of the games as overly time consuming. Some felt that investing time in brain-exercise would risk wasting time should no benefits arise. Some stated that they simply would not have time to play given their current life circumstances whilst others suggested that the games would be a low priority over other activities.

"The way I look at it is, as a waste of time... to me it's a matter of allotting your time. There are so many things to do".

Game design

The ranking of motivational and de-motivational factors from the initial FGs were used to inform the design of three prototype brain-exercise games for the iPhone and iPod touch, contained within one overall application, to be known as Brain jog. The individual games are outlined in the following sections.

Tiles game

The Tiles game was primarily designed to address the motivational factors of familiarity and challenge. This game was based on the well-known puzzle game, 'Fifteen' in which the user has to rearrange a jumble of tiles, numbered 1–15, on a 4 x 4 grid, into ascending numerical order with the use of one free space (*Figure 1, left*). 'Fifteen' was first introduced and became an international craze as early as 1880[19]. Since then, several commercial versions of this game have proliferated the market with some claiming it as one of the most popular mechanical puzzles of all time[19].

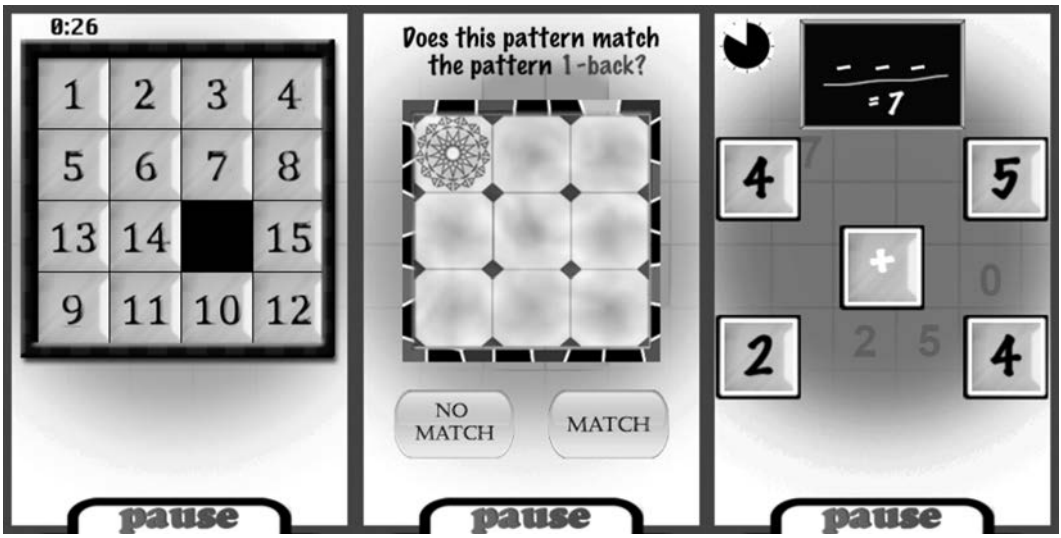

Figure 1. Games from 'Brain jog' used in the trial; from left to right: Tiles, N-back, and Reverse math

Based on the history of 'Fifteen', it was thought that this game would cater for the highly ranked motivational factor of familiarity. Also included was a timer that counted upwards from the start of the game. There was no time limit within which the user had to complete the game. It was thought that this would add an optional challenge where the user might decide to make a mental note of the time in which they completed the game for comparison against future attempts.

N-back game

The N-back game was primarily designed to address the motivational factors of usefulness and challenge. This game was based on the 'N-back test' which is a standardised test often used in neuro-imaging research and neuropsychological assessments (*Figure 1, middle*)[20].

To play, the user was presented with a sequence of fifteen + n images. The user had to decide whether the location of the floral pattern inside the square, matched the location of this floral pattern N images back in the sequence. The user indicated their answer by touching a button that read either 'match' or 'no match' (*Figure 1, middle*). N-back had the ability to adapt difficulty levels according to user performance and, as such, was thought to address the need for appropriate levels of challenge. Further, given the positive results reported in the literature and the scientific validity of the N-back test[21], it was thought that this game may have gone some way to fulfilling the motivational factor usefulness.

Reverse math game

The Reverse math game was primarily designed to address the motivational factors of familiarity and challenge. This game presented the user with a sequence of ten equations for which the answer was already given. The users had to complete each equation by selecting the correct operands and operator from multiple choices (*Figure 1, right*).

Similar to N-back, this game had the ability to adapt difficulty levels, i.e. the number of operators and operands, according to user performance and was thought to address the need for appropriate levels of challenge. Furthermore, the theme of the game was thought to provide imagery to which most users would be able to relate. Also, mental arithmetic often formed part of the school curriculum for the older generations[22] and was thought to be a task to which target users would feel well suited.

Field trials rationale

An effective design strategy should be capable of meeting the needs of potential users who in reality are expected to engage repeatedly with the software over timeframes of weeks, months and, potentially, years, according to the procedural demands of a study like SONIC²S. With this in mind, two consecutive FTs were conducted using 'Brain jog' to investigate the part that time exposure has to play in shaping the factors influencing engagement.

Note that between the initial FGs and the subsequent FTs, two usability studies, not reported here, were conducted which were designed to eliminate barriers to usage. After each study, 'Brain jog' was redesigned in an attempt to remove those barriers that were identified.

Field Trial 1

Method

Participants

Six participants took part (5F, 1M). Median age range was 65–69. Median level of education was secondary or post-graduate. Four reported doing puzzles at least weekly and two played rarely. Three had more than 10 years experience. One reported using some form of computer-based platform to play. All participants (six) reported that they never use a smartphone.

The trial

Participants were given a device (iPhone 3GS or 2nd generation iPod touch) with 'Brain jog' installed to take away and play for a period of one week. Participants were requested to play the games 'at their leisure' but to 'give it a fair go'. Each participant was also provided with a diary in which to record the reasons for starting and stopping each time they played.

Post-field trial focus group

Following the FT, participants met again for an FG discussion. Each FG consisted of three sections and was guided by a questioning route, which consisted of largely the same introductory and key questions sections as was used during the initial FGs (see above).

Analysis

A content analysis was performed on the audio from the FG and text from the participant diaries according to the same procedure described for the initial FGs.

Table 2. Ranking of motivational and de-motivational factors derived from the first field trial

Factor	Comments received	%
Motivational factors		
Challenge	17	21
Usefulness	16	20
Feedback	11	14
Mechanics	9	11
Entertainment	8	10
Positive affirmation	6	7
Others (each <5%)	14	17
Total	81	100
De-motivational factors		
Boring	15	32
Usability issues	9	19
Difficult	6	13
Mechanics	4	9
Time consuming	3	6
Too fast	3	6
Others (each <5%)	7	15
Total	47	100

Results

Arising from the coding procedure, 81 motivational comments made up 14 motivational factors and 47 de-motivational comments made up 11 de-motivational factors that were ranked (*Table 2*). Only the 'new' motivational and de-motivational factors with respect to the initial FGs are described. Note that quotes for the motivational and de-motivational factors of 'mechanics' are not given as this factor is essentially a composite of operational issues relating specifically to 'Brain jog'.

Motivations

Overall, 14% of comments related to the need for feedback with regards to progress within the games. This was most often expressed as a need to know one's progress relative to the possibilities or level structure offered by the game.

"*I think it might be useful to know what the potential within the game is. I mean, I wasn't aware that there was a level 4* [referring to the Reverse Math game]*... but that would have been an extra challenge had I known*".

Overall, 7% of comments related to an appreciation of positive affirmation from the games in relation to users' progress.

"*When it said 'Wow! You only got 1 wrong.'… That was brilliant*".

De-motivations

Overall, 32% of comments related to boredom with the games. Some were bored by the repetition in playing the games over the weeklong period of the FT. Some stressed that boredom can arise from a lack of success whilst others experienced boredom resulting from certain game mechanics or modes of play.

"[Referring to the Reverse Math game]… *I thought that it would go on from* [the] *plus* [operator]*... to... multiply, divide... minus... and I think that's a bit boring actually for anybody; to just have the plus*".

Redesign

Prior to the second FT, a redesign of 'Brain jog' was conducted using the findings of the first FT. The most prominent de-motivational factors and those motivational factors that were direct suggestions for improvement were used to inform the redesign. To help in addressing the top-ranked de-motivational factor of boring from the findings of the first FT, a number of changes were made. The biggest change involved adding variety with a fourth game to test verbal fluency entitled Word Web[23]. Also, the most frequent

design suggestion made by participants of the first FT was for a feedback mechanism revealing to users their progress within each game. To accommodate this need, a progress viewer was added which was presented to the user at the end of each game.

Field Trial 2

A second FT was conducted with the redesigned version of 'Brain jog' involving a different group of participants with substantially different demographics to the first, and over a longer time frame, in order to build a more complete picture of what motivational and de-motivational factors influence seniors' engagement with brain-exercise software, over time.

Method

Participants

Initially eight male participants were recruited. However, two participants did not complete the study and one participant's data was discarded after completing the study, as this participant was later found to suffer from significant hearing loss. Median age range was 75–79. Median level of education was 'none' (no primary school education). Two reported rarely doing puzzles. One had more than 10 years experience of doing puzzles and none reported using some form of computer-based platform to play. One participant reported using a smartphone daily, one rarely and three never.

Procedure

The procedure was the same as for the first FT except for the differences outlined in the following sections.

The trial

The FT ran for the duration of three weeks instead of one.

Equipment

Participants used the redesigned version of 'Brain jog', i.e. the one including the Word Web game and the progress viewer, just described.

Results

Arising from the coding procedure, 85 motivational comments made up 11 motivational factors and 22 de-motivational comments made up 8 de-motivational factors that were ranked (*Table 3*). Participant quotes are only given for new motivational / de-motivational factors with respect to the initial FGs and the first FT.

Motivational factors

Overall, 11% of comments related to the need for the games to have some element of social interaction. Some comments related to the need for game play to involve a social element whilst others specifically suggested that they would be more motivated to engage if family could play together.

"*If it was brought into a social thing* [situation] *where a family could play... plug it in... from the iPod to the TV where you have a larger screen*".

Overall, 7% of comments related to a sense of curiosity. All comments were entered in the participant diary as 'reasons for starting' and implied that this initial curiosity had some motivating power influencing engagement with the games.

"[To] *try various functions*".

Overall, 7% of comments seemed to place a value on the potential of the games to pass time. All comments were entered in the participant diary as 'reasons for starting'.

"[To] *pass time in the morning*".

De-motivational factors

Overall, 27% of comments related to the tiring effects of playing the games. All comments were entries in the participant diary, entered as 'reasons for stopping' and suggested that an element of fatigue caused the participants to stop playing.

"*After 15 minutes couldn't concentrate*".

Overall Discussion

The findings in terms of motivational factors identified are similar to those identified in the literature. In particular, the motivational factors chal-

Table 3. Ranking of motivational and de-motivational factors derived from the second field trial

Factor	Comments received	%
Motivational factors		
Challenge	37	44
Social interaction	9	11
Achievement	7	8
Curiosity	6	7
Entertainment	6	7
Pass time	6	7
Usefulness	6	7
Others (each <5%)	8	9
Total	85	100
De-motivational factors		
Difficult	6	27
Tiring	6	27
Social isolation	3	14
Boring	2	9
Poor communication	2	9
Others (each <5%)	3	14
Total	22	100

lenge and usefulness were ranked high. However, there was a notable exception in relation to the motivation factor social interaction, which didn't seem to be as important to participants in these studies. In relation to de-motivational factors, the common themes of usability and playability issues within the literature were also mirrored somewhat in the results of the current studies.

The findings also fit with a well-known model within the discipline of Information Systems known as the Technology Acceptance Model (TAM). According to TAM, perceived ease of use (PEOU) and perceived usefulness (PU) are key factors that influence users' behavioural intention (BI) to use a technology[24] and, indeed, subsequent technology usage[25]. Many studies have shown TAM to be a powerful and robust model in explaining BI and actual usage behaviour[26]. Findings from the FGs support findings from TAM research in that, the motivational factor usefulness and the de-motivational factor usability issues were generally ranked highly. It's interesting to note that, during the evolution of TAM, PEOU has largely been found to be an antecedent to PU and not to directly effect BI, and subsequently actual usage, as much as PU[24]. Again, these results seem to be reflected in the current findings, which found usability issues to be the top-ranked de-motivational factor whereas, the corresponding motivational factor, ease of use, was ranked relatively low. This indicates that findings from TAM research, which have been taken from a wide range of technologies and user ages[26], have relevance to the specific technology and user age-range under investigation in the current research. However, the fact that challenge was by far the most prominent motivational factor and the discovery of other motivational and de-motivational factors suggests that the model may need to be revisited within the context of mobile brain-exercise software for seniors.

The findings of this research make a valuable contribution to knowledge: The rankings begin to fulfil the need for a reliable benchmarking tool, i.e. a means of comparing and contrasting between software iterations and / or competing products. The examination in the FTs of the part that time of exposure has to play in shaping these factors uncovered some new and recurring themes, which offer some useful guidance on how to maintain motivation over time. The contribution of the de-motivational rankings is worth emphasising since the scarce amount of existing research is heavily biased toward the positive, motivational side. Research on affect has shown positive affect and negative affect to be orthogonal constructs[27]. This could mean that whilst users may be motivated to play a brain-exercise game for any number of reasons, they may also be de-motivated by certain aspects simultaneously and the ranking of de-motivational factors could provide a means to identify such problems.

Lastly, the rankings can be used as inputs for the creation of much needed tools for the measurement and evaluation of the game experience. For example, they could be used to formulate a series of items for a summative rating scale, much as was done for the construction of the game experience questionnaire for younger users[28] or an automated evaluation procedure such as Microsoft's Playtest technique[29].

It is emphasised that the study design was qualitative and exploratory and the rationale behind counting and ranking was not in making inferences beyond the population from which the sample was taken. Because of the preliminary nature of the research and the unequal proportions of male and female participants, future work should concentrate on running a higher number of studies with an equal split of randomly selected men and women participants in order to improve the generalisability of findings.

Also, a study involving the general release of 'Brain jog' through the iTunes Application Store[30] is currently underway.

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