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Examining the Performance of Older and Younger Adults When Interacting with a Mobile Solution Supporting Levels of Dexterity

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Abstract: The purpose of this research is to develop and evaluate a mobile game to support the needs of adults aiming to strengthen their perceptual and dexterity skills. The game itself is an advanced version of a Whack-A-Mole style game, in which the user is required to select visual targets, as quickly and accurately as possible. In this version of the game, the user is able to modify the speed, target size, and availability of distracters. In this paper, the performance between older and younger users has been compared. Older adults had spent more time and missed more compared to the youth adults, highlighting the challenges with manual dexterity faced by older adults. Therefore, different ways were examined in which features of the game can be designed to better meet the needs of older adults. The paper has significant implications for elderly patients, physicians, technology designers and service providers.

INTRODUCTION

Individuals with physical disabilities represent a large number in our societies. According to Johns Hopkins Public Health Library, there are approximately 5.3 million Americans live with a long-term disability as a result of traumatic brain injury (TBI), and about 200,000 people with spinal cord injuries or dysfunction (Johns Hopkins Public Health Library, 2014). Usually, the reasons behind physical injuries include car accident, falls, and sometimes, extreme sports. People with physical disabilities cannot easily accept the fact of being disabled, especially those who have permanent disabilities. They might experience several difficulties in their daily life and they could not perform basic tasks without reliance on others. Physical therapy plays a pivotal role to help in the recovery of injuries, and bring back the patients to their normal states in order to resume their ordinary lives. It also teaches individuals with permanent disabilities on how to exploit their remaining abilities to adapt with their situations for the rest of their lives. Physical therapy includes physical exercises that would help the patients to move and stretch their muscles.

According to the physical disability council of New South Wales (NSW), physical disability is the state of losing totally or partially a part of body or some body functions whether the disability exists from birth or individuals acquire the disability later in their life due to car accident or stroke (Physical disability council of NSW, 2013). Unlike those who were born with physical disabilities, individuals who have acquired a severe physical injury would find difficulties to adapt with their new situations, especially if the disability is permanent. They face both the trauma that caused the injury and the fact of being physically disabled (Quale et al., 2010). People with physical disability suffer from several challenges in different aspects of their daily life (Lai et al., 2002), which prevent them from performing their tasks autonomously. These challenges vary from a situation to another depending on the severity of disability and the amount of assistance provided by a surrounding environment. They range from personal needs (Lai et al., 2002) through social interactions (Thomas et al., 1988) to computer accessibility in which they cannot use conventional input devices like mouse and keyboard because of their abnormal postures and limited movements (Wu et al., 2002).

Usually, people without physical disabilities are more likely to be active and conduct physical exercise than those who have physical disabilities due to limitations in their movement, and sometimes the lack of exercise facilities nearby. According to the Healthy People 2010 report, 56% of adults with chronic back conditions do not practice physical activity in any leisure-time compared to 36% among adults without disability. Furthermore, the level of education plays an important role in increasing the motivation among individuals with disabilities to engage in physical activities. The report also indicated that 27% of disabled adults with college education are not physically active in their leisure time and the rate increases among those who have less than high school education to reach 56%. Although the physical

therapy is at utmost importance for patients in order for them to get better, they remain inactive most of their days after injury or stroke. More importantly, the amount of exercise provided during the physical rehabilitation session is not sufficient (Lang et al., 2007). However, Haughnessy et el. (2006) shows that only 31% of individuals with physical disabilities reported their adherence to the regular physical exercises (four times a week) as recommended by therapists.

With the development of information technology, we can expect that physical exercises, to a larger extent, will be performed with the help of computer systems and portable devices. The potential benefits of these exercises mainly depend on the psychological readiness and the positive response of the patients toward the treatment. However, most patients do not have the desire to engage in a physical rehabilitation session (Lang et al., 2007). So, the role of researchers is to find ways to motivate those patients and get them involved in physical exercises. The goal of this paper is to develop and evaluate a mobile game, which enables users to strengthen their dexterity, in a fun and engaging way. Considerations have been made relating to ways in which users can be motivated to continue playing the game. The game itself is an advanced version of a Whack-A-Mole style game where the user is required to select visual targets, as quickly and accurately as possible. In this version of the game, the user is able to modify the speed with different levels, target size, and availability of distracters.

The paper provides the following contributions to the literature. First, it is of the first attempts to develop user interfaces that mix entertainment with exercise to help target people to cure or help themselves get through their injuries; second, it helps technology designers and service providers better meet old people's needs and preferences to use smart phones and exercise using these phones; third, the proposed system is the first mobile application that can be used in rehabilitation to help target people to exercise and cure; fourth, the system could be used in rehabilitation centers to help doctors in physical therapy treatment especially it is easy to use and very.

The paper is organized as follows: next section discusses the related work. Section three describes the design of the system followed by evaluation method and results in sections four and five, respectively. Section six provides a discussion of the major findings. The paper concludes by section seven.

RELATED WORK

This section briefly discusses the related work and the major limitations of existing systems. Wu et al. in 2002 proposed procedures called computer access assessment (CAA) that can be used as evaluation guidelines for therapists and developers who want to develop devices to enable people with physical disabilities to easily access computers. They should take in considerations the positioning and seating needs of the individuals with disabilities and develop input devices accordingly. The keyboard and mouse should be adjusted so that they can be appropriately used by the functioning body parts of individuals with disability who have severely impaired hand function. The Online-Gym system was proposed by (Cassola et al., 2002) to provide new possibilities for improving the physical and social well-being of people with restricted mobility. The Online-Gym is built based on an online 3D virtual world's platform, which allows users to participate and interact with the system through the use of a motion capture device, which is a Microsoft Kinect. Further, the objective of this system is to create an "online gymnasium" which is a virtual three-dimensional space where different users are physically apart, participate in a shared workout session coached by a monitor, all of the users connected over the Internet and directly animated by the movement captured by the Kinect devices which are connected to each personal computer. The experiment results for this system showed that there are some requirements stemming from existing systems integration, especially in the synchronization of the movements and their impact on the network for other users, but also regarding the need to have a clear identification of the monitor and custom controls for him/her.

A Kinect-based system was developed by (Chang et al., 2013) to assist people with cerebral palsy and physical disabilities. The system was developed using the Microsoft Kinect connected to a laptop in which its audio system and screen are used to interact with users. The screen provides visual interaction, as it displays real-time movements that help the users to control and adjust their actions. The study was carried out using 2-phases ABAB model where A indicated the baseline and B indicated the intervention phase. The participants demonstrated improvement in the number of the correct actions when exercising with the Kinect. Levels of motivation were found to be higher when exercising with the device. Considerable effort is not needed to use or learn the system. In order to motivate usage, users could see their favorite cartoons each time a correct action was achieved and listen to music when a type of movement was completed. However, the results were achieved based on only 2 participants and hence, the overall

conclusion might not be accurate regarding the efficacy of the system. A virtual reality-based system was proposed by (Jack et al., 2000) to facilitate exercises for people who survived a stroke and living with physical impairments. In particular, it is used for rehabilitating hand functions in stroke patients. The system used two hand input devices, a CyberGlove and a force feedback glove, to enable users to perform and interact with system. The CyberGlove is used to track and capture finger bends and wrist flexion, and the force feedback glove is used to measure the position of the fingertips in relation to the palm. There are four virtual reality exercises that concentrate on four parameters of hand movement including range, speed, fractionation, and strength. The first three parameters are evaluated by the CyberGlove whereas the last parameter, strength of hand movement, is evaluated by the force feedback glove. The system seems to be enjoyable as the exercises take the form of simple, interactive game to motivate users to continue using it. On the other hand, both gloves are costly and complicated and may not be affordable to many people with motor disabilities.

A system was also developed by (Lin et al., 2014) to help children with cerebral palsy to promote physical activities. The system consists of conductive material and a Makey-Makey circuit board that is connected to a personal computer. Both the conductive materials and the Makey-Makey circuit board (which is used to convert physical touches into digital signals to be interpreted by the computer as keyboard presses or mouse clicks) are used as an input device. The system communicates with users through using Flash and Scratch multimedia software in which it was automatically set to play for 5 seconds then, pause waiting for the next interaction from the users. The idea of the system is that the users can touch the conductive materials and then listen to (or watch) the desire multimedia for 5 seconds. This means that the users are motivated to make a movement each 5 seconds which leads to stretch and strength their muscles. The system is easy to use in which users just need to touch the conductive materials to interact with it. The users can enjoy using the system since it has interactive multimedia as a response to their actions. However, the system needs to be customized for each individual according to their condition. For example, individuals with upper body physical impairments will need to customize their version of the software differently to those who have lower body physical disabilities. The study was evaluated and the results were achieved based on just 2 participants which might not be convinced for audiences of this study.

In addition, a study was undertaken examining motor development of disabled children. The researchers developed a framework, which is based upon tracking devices for the Kinect sensor (Meleiro et al., 2014). The proposed framework can assist children with spastic diplopia and hemiparesis in the rehabilitation process. Further, it enables physical exercising for the children in a stimulating environment and with an adequate progress space with the respect to their disabilities. The researchers tested the framework on target people consisted of five aged between 8 and 12 old. The participants were asked to perform different tasks including raising the arm above the head, sequence of pose, side step, and scissor jump. The results show that the Kinect sensor has potential to be used in the motor rehabilitation context and the impaired children were able to benefit from the proposed system. However, there are some limitations for this proposed system including some detection inaccuracies, and some difficulties in keeping tracking of the exercises during continuous execution. The developed framework seems to be effective for the physical rehabilitation for children with disabilities and the study shows some good results. However, there are some limitations have to be taken in consideration and validate the given results on different group of target people. Standen et al (2011) evaluated the use of a Wii Nunchuk as an alternative assistive device for people with physical disabilities who used typical switches such as roll ball, mouse, and wobble stick to interact with computers. The Wii Nunchuk is a device used in contemporary gaming technologies to interface with personal computers. The number of participants was 23 students with physical disabilities who were selected according to certain criteria. They were asked to do three different tests including the activation, the release, and the repetition tests. The results showed that there was no significant difference between the performance of the participants using familiar devices and the Wii Nunchuk except for the release test where they did better using their familiar devices. Some participants encountered several difficulties using Wii Nunchuk, which can be addressed with different positioning or sensitivity of the trigger switch. However, the Wii Nunchuk can be easily grasped by individuals with physical disabilities as opposed to typical switches which are surface-based devices. In addition, the Wii Nunchuk is considered to be a low cost alternative compared to other custom made devices.

(Yeh et al., 2012) developed a game, which used a Kinect sensor device to interact with the virtual environment. The main goal of the proposed system is to implement the practice of the upper limb action. Further, it is mainly used to maintain rehabilitation training for those people who suffer from the stroke. The researchers stated that their system has many advantages more than the traditional rehabilitation such as: it is not very expensive and the training time is short comparing by the traditional rehabilitation therapy. The developed system uses the Kinect sensor device to

interact with the virtual environment. The Kinect sensor device is used to recognize the upper limb action of the patient. Moreover, the patient who is under the test has to let Kinect be able to detect his action through the extension of the arm and the controlling of the ball receiving direction by the virtual figure is then corresponded in the virtual reality environment. In addition, the researchers conducted different experiments in the academic examination department of the University of Southern California. They tested the proposed system on different patients. Additionally, the results of these experiments are promising. Patients have shown great improvement in terms of balance of upper limb action. Therefore, it's a good sign of starting a new era for rehabilitation therapy with the modern technology.

Guillaume and Nadine (2010) studied the influence of age on user's performance using touch screen interface. The main part of the interface is the colored target area where users should click on the required color (according to some instructions) within a specific period of time. There were two groups of populations participated in the experiment. The first group included 63 people aged from 15 to 52 years. In the second group, 24 older adults aged between 63 and 88 years were recruited for the experiment. In general, the results indicated that the number of clicks on wrong targets increased according to age (i.e. the people of high age would have more wrong targets). A brain computer interface system (BCI) (Jiang et al., 2011) was developed to translate the user's mental condition such as the attention state, into game control. The researchers have leveraged the advanced technologies and virtual reality to measure a user's attention level to control a virtual hand's movement and exploit 3D technology. Moreover, the proposed system is important for training people who suffering Attention Deficit Hyperactivity Disorder (ADHD). Furthermore, the developed system is designed to simulate a hand to pick up a fruit. In this study, 10 participants were employed to test the game. The results of this study showed the proposed game was very interesting, easy to use, and accurate. In addition, this study showed that the developed game could be helpful for those people whom suffering from ADHD, however, they did not mention that they tested it on the target people.

Kobayashi et al. (2012) conducted an experiment to evaluate the interaction of elderly users with mobile touch-screen interfaces, including pinch and spread tasks. They used tablet and phone-size touch screens to complete the experiment. They reported task execution times. They found that spreading tasks were more difficult than pinching tasks for their participants. In general their results showed that mobile touch-screen interactions are enjoyable for seniors, and their performance has increased when provided with one week of training. More recently, Findlater et al, (3013) compared the spread and pinch performance of older adults to younger adults on an iPad device. They reported both task execution time and error rates, and found the opposite result of Kobayashi et al. in which their participants were faster on the spreading tasks than the pinching tasks. Stößel et al. (2010) compared old users to young users in 42 different gesture inputs for touch-screen devices and measured their speed and accuracy. They found that older users tend to perform touch gestures more accurate than younger users but move slower.

In summary, existing works have major limitations and gaps that require a further exploration. Most of the proposed systems are neither cheap nor easy to use and learn. Further, these systems need to be customized by the patients according to their condition. For instance, individuals with upper body physical impairments will need to customize their version of the software differently to those who have lower body physical disabilities. Additionally, researchers and clinical staff have to be with the patients while exercising using existing systems. Some systems are also complicated and may not be affordable to many people with motor disabilities. Limited research provided a comparison between different groups of users in using the systems and used usability questionnaire.

In order to fill the knowledge gap, this paper aims to answer the following research questions: How to develop a mobile game to strengthen elderly people's perceptual and dexterity skills? What do motivate elderly people to continue playing a mobile game? To this end, we developed and evaluated a mobile game to support the needs of adults aiming to strengthen their perceptual and dexterity skills.

SYSTEM DESIGN

The prototype system has been developed for Google's Android operating system using App Inventor application. App Inventor is an open source application that offers graphical interface and drag-and-drop blocks for Android programmers. It was first developed by Google and now maintained by Massachusetts Institute of Technology (MIT). As the system is intended to help and motivate people with physical disabilities to engage in physical activities and perform practical exercise, we take in our consideration that not all situations should be treated equally, and physical disabilities could vary from one situation to another in terms of the ability of movement and reaction. Accordingly,

the system was designed to satisfy the needs of different situations by including several levels of speed and different image sizes.

The system consists of four interfaces. The first interface is used to allow the users to login the system. The second one allows the users to specify the game settings according to their needs. Another interface would be the screen where the users can actually play the game. The last one is used to track the highest and the lowest scores, which implicitly encourages the users to exert more effort to attain the highest score. During design, the priority was to optimize the order of interfaces and support navigation between them .So, the system was designed to enable the users to seamlessly navigate between the interfaces. Users can navigate from the login to settings interface. Then, they can go back and forth between the settings screen and game interface. Also, it is possible to access the score interface from the game interface, and go back from the score to the settings interface. Figure 1 illustrates the interface structure of the system.

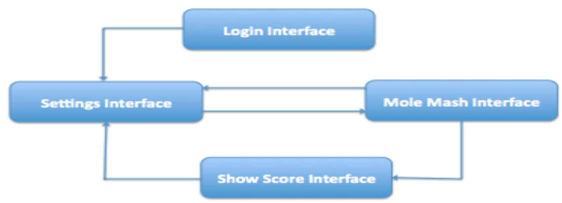

Figure 1. Interface structure

The system interfaces will be explained in detail in the following subsections.

Interface 1: Settings

The interface is intended to allow the users to specify the settings of the system according to their needs. It consists of several buttons and a check box. The first six buttons are dedicated to change the speed level of the target to be selected (image of a mole). The movement speed of image around the canvas is measured in milliseconds, which means that the level1 indicates the lowest speed while the level6 is the highest. The large and small buttons allow the users to select the size of image that is suitable for them. Once any button is selected, the text color of the button is changed to red indicating that the button is active. The last button in the interface is the start button, which moves the user to the whack-a-mole mash interface to start playing the game. The check box is used to indicate whether or not the users want to play with a distracter. It means that if the users check this box, then they will have another image moving around the canvas along with the main image (in mole mash interface). Figure 3 shows a screenshot of the settings interface.

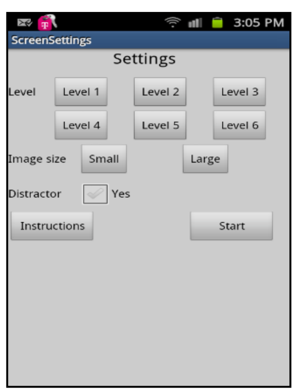

Figure 3. Setting Interface

Interface 2: Whack-a-Mole Mash

The whack-a-mole mash is considered as the main interface of the system where the users can actually play the game. The majority of the screen is occupied by the canvas where the image moves around to different randomized positions in a timed sequence. The properties of the image (speeds, size) are exported from the setting interface. Directly below the canvas, there are three labels; score label that is used to hold the score and increases it each time the user successfully hits the image, missing label that holds the number of hits on canvas, and level label to show the current level number. Furthermore, when the user chooses to play with distractor, the distraction label appears to show the number of hits on an on-screen distractor. The users can move from level 1 to level 2 once they reach the specified score of level 1 which is 20, also the score does not reduce if the user misses the target. Similarly, the score that the users must gain to move to level 3 was set to 40 and so on. The interface also contains several buttons. The reset button is used to reset the score to zero. The system provides the users with a way to select their own images by clicking on the pick an image button. Also, the user can restore default settings by using the default button. The setting button enables the user to go back to the setting interface. By pressing the show score button, the user will move to the score interface, which holds the highest and the lowest score. The exit button allows the user to terminate the game. Figure 4 shows a screenshot of the mole mash interface.

Figure 4. Mole Mash Interface

Interface 3: Show Score

The goal of this interface is to show the highest as well as the lowest score that the users have gained over time. It consists of two labels and one button. The labels are used to hold the highest and lowest score. The go back button allows users to go back to the settings interface to select their preferred settings and start the game over. Figure 5 shows a screenshot of the Show Score interface

Figure 5. Show Score Interface

EVALUATION METHOD

A small study was conducted to examine the feasibility and usability of this prototype. One variable was defined for the number of missing scores which corresponds to the number of times the participant targets canvas instead of the target image. There were two independent variables, which are age group (younger and older adults) and types of game (large image, small image, distraction with large image, and distraction with small image).
Furthermore, three hypothesizes were formulated:

- Main affect for age group.
- Main affect for the type of game.
- Interaction affect between age and game.

Participants

18 participants were recruited for the study, who were divided to two groups by age. The first group has 9 young participants aged between 22 and 35 years. In the second group, 9 older adults aged from 60 to 75 years were recruited to perform the experiment.

Procedure

The procedure of the study consists of three tasks, and participants were asked to complete each task within five minutes. The first task was to play the game at different levels (different speeds). They were then asked to play the game using different target sizes. The third was to play the game with distraction. Upon finishing these tasks, participants were encouraged to experience other features of the prototype such as: see what the highest score for the game is, and change a picture in the game. Furthermore, they were encouraged to think aloud and provide feedback about their experience that they had regarding the system's use, the design of the interfaces, and the efficacy of the functionality. Additionally, the participants were asked to complete a usability questionnaire after they finished these three tasks. The description of these tasks and the usability questionnaire are given as below.

Task 1: Play the game with different levels of speed without a distractor

Before the participants begin the first task, they were provided a brief overview about the system's objective and how the system would motivate users to maintain levels of activity. Moreover, the system was installed on a Nexus 1 android phone and the participants were allowed to familiarize themselves to interact with the application. At the beginning of the tasks, the participants were given a list of instructions to know how to interact with the game application along with username and password to login into the application. The subject can choose the desired level of the game to play with. Then, the subject has to proceed with the game and try to target the graphical stimuli presented, to improve their score. The game will automatically move from one level to another when the subject reaches the required score designated for each level. The task ends when the specified time (5 minutes) is up.

Task 2: Play the game with different size of images

The subject asked to choose different sizes of graphical stimuli (e.g. small or large images of a mole) from the setting screen. He/she played the game at his/her desired level of speed (based on his/her experience from Task 1). Additionally, subjects picked a different image from the gallery and played with it instead of using the default image in the application.

Task 3: Play the game with a distractor

The subject asked to check the distractor check box in the setting screen to play the game with an on-screen distractor (e.g. other images appearing on the mobile interface). The subject had to avoid selecting the distractors. The distractors were added in the game to make it more challenging for the users. After the participants completing this task, they were given a usability questionnaire to evaluate the system.

Data Analysis

The data that was collected for this study is composed of the responses to the usability questionnaire, feedback, and suggestions from the participants, and the observations that made by the researchers about how participants interacted with the application.

Feedback and Observations

The researcher's notes were organized into three main categories including feedback, suggestions, and errors. The feedback that was provided and errors that were made during the experiments were revealed through analysis. Further, these categories will be discussed in the result section in this paper.

Usability Questionnaire

The usability questionnaire that was used to evaluate the system was inspired from IBM computer usability satisfaction (IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use). We manipulated the questionnaire little bit to quite fit with our system. It is a 22- question scale survey in which participants can select a number ranging from 1 which indicates strongly disagree to 5 which indicates strongly agree.

RESULTS

We did not consider the results of task 1(the speed level) as it can be done in task 2 and task 3. The game has four levels of game including large image, small image, distraction with large image, and distraction with small image.

ANOVA Summary					
Source	**SS**	**df**	**MS**	**F**	**P**
Age	2913.39	1	2913.39	25.68	<.0001
Games	1306.06	3	435.35	3.84	0.0136
r x c	420.27	3	140.09	1.23	0.3061
Error	7261.78	64	113.47		
Total	11901.5	71			

Figure 6. Two–way ANOVA results

By using two-way ANOVA analysis on the missing scores of age group for different types of games, we found that younger adults made significantly fewer errors (M=15.06) compared with older adults (M=27.78), F (1, 64) =25.68, p<0.01 as can been seen in Figure 6. Also, two-way ANOVA analysis of the missing scores on different levels of game revealed that there was a significant difference for the number of mistakes for the different types of games, F (3, 64) =3.84, p=0.01. Moreover, Tukey post hoc test showed that participants accessing the small image (M=25.05) made significantly more errors than in the large image with distracter condition (M= 14.28), and that participants interacting with the small image with distracter condition (M=24.22) made a significantly larger number of mistakes, compared with the large image with distracter condition. However, there was found that no interaction affect between age group and the type of game, F (3.64) =1.23, p=0.31. Figure 7 shows the average number of mistakes for both groups in this experiment.

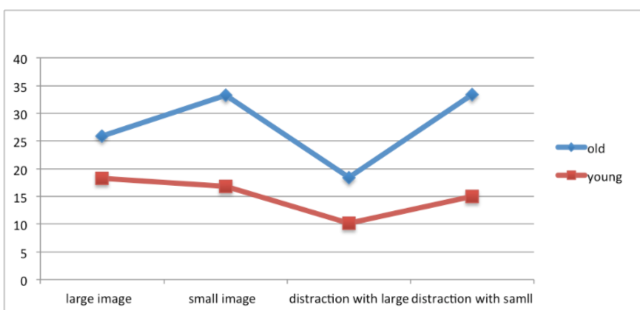

Figure 7. Game average mistakes for both groups

DISCUSSION

Statistical analysis provided valuable information on the performance of participants. These also permit us to confirm some hypotheses. The analysis of missing scores shows that the number of these missing scores increased among older people. Some research that is relevant to this issue provides some support for this assertion. Guillaume and Nadine (2010) found that the number of clicks on wrong targets rises according to the age. In addition, the number of missing scores are significantly affected by image size and by the on-screen distractor. The subjects realized more errors when they played with a small size image along with on-screen distractor. More importantly, the game can be a useful tool to train users' attention as well as their dexterity. The design of the interfaces was the main area that the participants criticized and gave suggestions for improvements. This result was inferred from analyzing usability questionnaire and from the direct feedback of the participants as well.

The analysis of responses, feedback, and suggestions of participants along with usability questionnaire reveals that the system was easy to use, and they were generally satisfied with its functionality and graduality of complexity. They also praised the flexibility and easiness of navigation between the interfaces of the system and switching between different tasks. Further, most the participants stated that their focuses were increased during playing this game and they are willing to play it after completion of the experiment. Participant number 15 said that his attention was increased during the test and he was able to make fewer errors in the last two tasks. However, they had hard time to chase and hit the target image when they selected to play the game using high-level speed (level 6). Participant number 2 showed that the level 6 of the game is too fast for him, and that's why he made a lot of errors (missing hits). He recommended to put reward for those people who play well, also he suggested to see other's score to get motivated to play the game to see how he/she is doing compared to others. Participant number 12 stated that the game improves the focus and concentration. Participant number 13 stated that the game is great for keeping my arthritic fingers loose and keeps them moving. Further, it keeps her/his eyes on the target and not stray. She/he felt like exercising his/her hands in addition to the brain training. It employed the eye, hand, brain attention and focus in the meantime which is good as he/she said. Participant number 4 stated that the game keeps him/her focus. He/she likes the different options that the game has and its design. Participant number 10 stated that the game increases hand/eye coordination and it can be entertaining. One of the older adult participants did better during experiments and his errors were few in number compared to his group. He was in good health. We investigated more and found out that he exercises in the daily basis and walks more 10 miles every day which most people do not. So his focus was high. However, some of older adult participants were worried about their dexterity and they said that the game was a good exercise for them to improve their dexterity.

The paper provides several theoretical and practical implications. Theoretically, it enriches the disability literature by proposing a new mobile system for elderly people, it enhance the theoretical foundation of existing literature by extending previous work with usability questionnaire. In practice, the findings of the paper provide various practical implications for elderly people, physicians, technology designers and service providers. It helps elderly to break all the barriers for playing a mobile games, it help physicians to use the system as smart method in the rehabilitation process or physical therapy since the system merges entertainment with exercising and finally it provides some design implications and practice toward an easy to use system.

CONCLUSION

This paper discusses the development of an android-based system to strengthen dexterity skills among older adults. We make a comparison study to compare performance of younger and older users using a mobile interface. Our study permits to show that the age has a clear impact on performance. There were 18 participants tested this system. Further, the findings showed that the system is an easy to use software to train users' attention and their dexterity. The paper has significant implications for elderly patients, physicians and technology designers and service providers.

For future work, the researchers are planning to evaluate the application with large sample of participants, to better understand the differences between both older and younger populations. More importantly, the improvement of the interface design will be in the top of our priorities. Furthermore, the researchers will add many features to the current system. First, they are going to determine time for the game in which a specific time will be assigned to each level

and a user has to reach the targeted score within this period of time. Second, to make the game more interesting, it will start over if the number of missing scores reaches a specific score (the half) with respect to the targeted score of the current level. Finally, a multiplayer mode feature will be added to the system in future to allow more than one user to play the game in the meantime.

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