

## Heuristic Evaluation for Interactive Games within Elderly Users

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**Abstract**—This paper presents the results obtained after performing a number of demonstrations followed by a series of interviews concerning the usage of interactive games as a tool to improve both physical and mental well-being of elderly persons. This study points out the importance of a proper design regarding the usability of video games for the aged to ensure the elderly benefit from such games.

**Keywords**—elderly; game design; interactive game; usability.

### I. INTRODUCTION

According to recent studies, both Australia and the entire world, are dealing with a dramatic increase of the aged population which could be considered a crisis, if this problem is not addressed effectively and in a timely fashion [1]. Furthermore, there has been a huge increase in the development of systems which have improved the well-being and quality of life of seniors looking for the prevention of diseases and injuries related to ageing. The usage of some interactive technologies such as video games, has shown a positive impact in health outcomes for the elderly [2]. Research has been applied to find feasible methods to encourage and engage seniors with the use of these games [3], [4]. However, recent studies [4], [5] also state that those practices could result in undesirable consequences, even negative impacts regarding issues related to the usability of the video games among older users.

The goal of this paper is to present the results of the evaluation of four Nintendo Wii balance games under the observation of six experts in health and wellbeing techniques. For our research, we conducted a series of recorded and transcribed structured interviews where the suitability of the games for the elderly users was assessed.

This paper provides an overview of previous studies related to this topic, a description of the games assessed and the scenario of our interviews. We present the factors assessed and the results that we obtained, as well as a discussion concerning the findings, followed by our conclusion.

### II. BACKGROUND

The usage of video games as a method to keep and / or improve the health condition of the elderly has shown both positive and negative effects [4]. Regarding the former, there have been improvements after the use of videogames as a tool for balance disorder treatments and post-stroke

rehabilitation [3], [6],[7]. These practices have demonstrated the benefits of involving interactive technologies for maintaining wellbeing and improving health outcomes. However, the usability of these games for the elderly needs to be improved [5]. It is relevant to mention that the new genre of games require a different way to interact with them. Currently the youth-oriented interfaces feature sounds, flashing lights and colours which create enjoyable experiences for young players, but could lead to negative feelings for the elderly users. Some of the most notable problems include confusion caused by pressing or releasing buttons in the appropriate time or anxiety and stress engendered by the inability to reach the game goals [4]. Because of the above, efforts have been made to establish formal methods and techniques to assess the usability of videogames. Some methods are focused on technical issues such as the game aesthetic, sound events and programming errors instead of evaluating game interfaces, the mechanics of the game and how enjoyable it could be. One approach to this is the ISO 9241 standard of usability which uses *effectiveness*, *efficiency* and *satisfaction* as basic metrics [8]. However, the technique of heuristic evaluation of video games has been gaining status because of its flexibility and adaptable nature [9]. The term *Heuristic Evaluation* is an inspection technique where a set of usability principles is established and used by evaluators to explore an interface. These principles are called heuristics.

In [8], the heuristic evaluation is divided into five stages. These are: (1) the identification of usability problems as well as their categorization; (2) the observation of players while interacting with the videogames under the observation of evaluators; recording facial expressions, verbal reactions, etc; looking for new problems which could be missed from the first stage; (3) the re-categorization of usability problems; (4) the description of the ways to resolve problems encountered previously by the creation of heuristics; (5) the testing of heuristics applying the methodology of user logging combining the thinking aloud protocol.

TABLE I. INTERVIEWEES' DETAILS [10]

<b>Traditional Medicine</b>	<b>Expert 1:</b>
	Professor Aged Care, Sydney Hospital Researcher and director of Health and the Aged Centre.
	<b>Expert 2:</b>
	Physiotherapist at an large Aged Care Facility in Sydney
<b>Alternative Health Techniques</b>	<b>Expert 3:</b>
	Associate Professor Chronic Care at a Sydney university.
	<b>Expert 4:</b>
	Certified Feldenkrais Movement Practitioner in Sydney.
	<b>Expert 5:</b>
	Certified Alexander Technique Practitioner in Sydney. Own Practice.
<b>Expert 6:</b>	
Expressive Arts & Music Therapy Specialist at a university in Sydney as well as having a Sydney private practice.	

III. METHODOLOGY

During July and August 2010, we demonstrated and then evaluated four Wii balance games (see Table 2) with the cooperation of six health professionals, three of them representing alternative health techniques, and the other three representing traditional medicine (see Table 1).

Overall, the sessions were conducted by following these stages: (1) One semi structured interview with each health professional concerning the procedures which each one performed with the patients over 65, as well as their experience, if any, involving interactive technologies within their practices. (2) A demonstration of the four Wii balance games which were: Skate Board Arena, Tightrope Walk, Balance Bubble, and Table Tilt; all of them part of the Wii Fit Plus suite (see Table 2). These demonstrations were performed by one of our researchers. In one interview, our interviewee offered to perform the activity. During all the demonstrations, the interviewee was providing oral feedback by remarking on the strengths and weaknesses of the video games. They offered suggestions to make the games much more enjoyable and suitable for their elderly patients.(3) This material was transcribed and has been analysed using Leximancer, a specialist analytics technology for unstructured, qualitative, textual data [13].

IV. THE HEURISITC EVALUATION

Based on previous studies, our heuristics were focused on the usability of videogames for elderly users. They concerned factors such as: engaging with the game, avoiding mental distress and physical damage by controlling extreme emotions and considering the changes related such as loss of cognitive and motor abilities.

TABLE II. GAME'S DESCRIPTION [11]

Game	Objective <sup>1</sup>	Procedures <sup>2</sup>	Rules <sup>3</sup>	Conflict
<b>Balance Bubble</b>	Navigate it along a river to the rainbow finish line.	Shift weight to propel the bubble along the river.	Hazards such as rocks and river banks, and bees.	Reach the goal avoiding hazards and respecting the time limit.
<b>Table Tilt</b>	Tilt the tables so that the balls drop into the hole(s).	Shift weight to tilt the table. The table could have at least one hole in it; the balls must be guided into the hole(s).	Hazards such as: unguarded edges, slopes, blocks.	Dropping balls could lose more balls as well as causing delays, time limit.
<b>Tightrope Walk</b>	Walk a rope strung between two buildings.	Walk across the rope, jump when biting machines appear.	Biting machines, obscured view, and wind.	Leaning, falling off the rope, unbalanced jumps, time limit.
<b>Skateboard Arena</b>	Show off your technique with a skateboard.	Turn the balance board through 90 degrees clockwise, push off with your back foot to start and jump when obstacles.	Ramps, half-pipes, etc.	The scoring depends on your tricks on ramps or half-pipe.

After following the heuristic evaluation methodology we developed this list which contains a general categorization of the problems found [8], [9]:

- a) *Customization Issues:* User cannot modify the game settings according to their needs.
- b) *Inability to avoid non-playable content:* User cannot skip introductory videos or parts of the game which are repetitive.
- c) *Control of actions:* Excess or deficiency of sensibility of controllers.
- d) *Training:* The video game does not provide training practices before playing the real game.
- e) *Goal feasibility:* Extreme difficulty to avoid hazards respecting the time limits. Too many obstacles and limited time periods.
- f) *Correspondence between user movements and display:* The game must respond according to the user movements, mirroring the real world. Connection between what the users see and do.

<sup>1</sup> According to the game design theory, *Procedure* is everything that player can do respecting the rules.

<sup>2</sup> The *Rules* describe objects and behaviours.

<sup>3</sup> *Conflict* is everything which does not let you reach the goal directly. [12]

g) *Provision of Rules, Information and Instructions:* Lack of explanation, inadequate timing, content and/or format of the provided information. For example the inappropriate usage of language.

h) *Mental Health:* Feelings of stress, anxiety and/or disturbance due to excessive memorization, inadequate concentration requirement and dealing with the conflict of the game.

i) *Physical Health:* Physical issues caused by tightening up, falls, loss of balance, excessive requirement of workout, coordination and flexibility.

j) *Engagement:* Lack of commitment and/or engagement due to the thematic, challenges and/or *diversion factors of the video game.*

TABLE III. GAME'S DESCRIPTION [11]

Categories	Experts						Total
	1	2	3	4	5	6	
D. Training	1						1
E. Goal feasibility	1				1		2
F. Correspondence between user movements and display				1		1	2
G. Provision or Rules, information and Instruction	1	1			3	3	8
H. Mental Health	1				1	1	3
I. Physical Health		1			2	2	5
J. Engagement	2	1	1			1	5
<b>Total</b>	<b>6</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>7</b>	<b>8</b>	<b>26</b>

After categorization, we developed our heuristics. Some categories were deleted due to their lack of occurrence (Category A, B and C) and one resulted in the union of related categories (Category H and I which became Heuristic V). The final game heuristics are listed below:

1) *Provide training phases:* The game should have training phases before the real game starts, allowing the users to become familiar with the technology. Additionally, these training stages must be easy to skip when they are not required anymore

2) *Create feasible goals:* The goals must be reachable by adapting the difficulty of hazards to take into account the physical abilities of the aged cohort.

3) *Establish appropriate relations between movements and display:* The game must respond according to the user movements.

4) *Provide rules, information and instructions in an adequate way:* The information regarding rules, suggestions and instruction should be given before and during the game, so the user does not have to read instructions and operate at the same time. Also, this information should be provided by audio.

5) *Consider the mental and physical condition of the player:* The player should not feel frustrated and upset because of hard goals. The objective of a game is to

entertain the player, so practices involving excessive memorizing must be avoided. Avoid unnecessary requirements for workouts involving coordination and flexibility outcomes. If possible, preclude the need for complex movements so the elderly users do not require frames to maintain balance.

6) *Engage the user:* The thematic of the video game must be in accordance with the audience's interest to avoid lack of commitment.

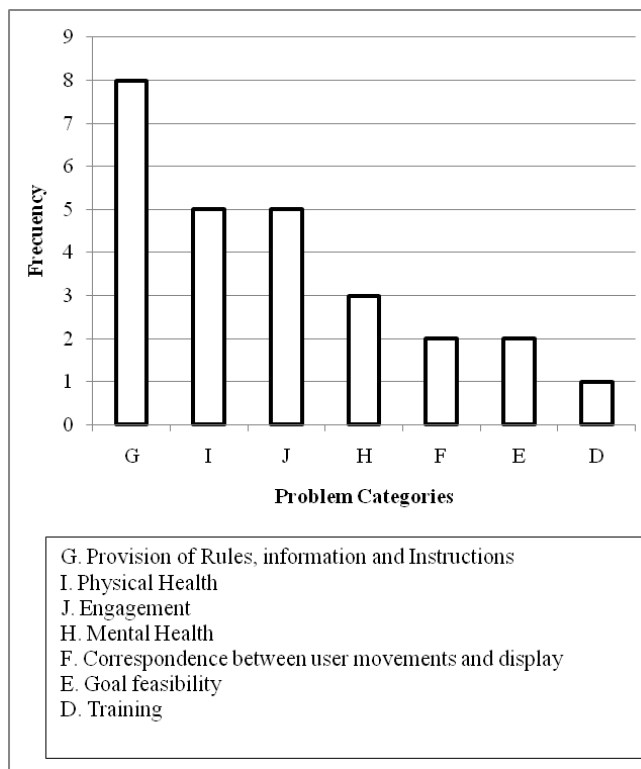


Figure 1. Frequency of the problems ordered by their occurrence.

## V. RESULTS

After running the evaluation and categorizing the problems found, we concluded that the total number of unique usability problems was 26. Each health professional found around 4 problems on average and the range of problems seen for each specialist was between 1 and 8 (see Figure 1 and Table 3). We now map the appropriate heuristic to address each particular problem that has been identified.

Figure 1 shows the frequency of problems found for each category ordered by their occurrence. It was found that the main problems were related to the provision of rules, information and instructions. One participant mentioned *that reading instructions spread across the screen may be confusing and less compatible with kinesthetic awareness than auditory feedback.* Such games require a variety of instruction mechanisms such as text and audio together (Heuristic IV).

The next three most common problem categories were concerned with the physical health, engagement and mental health of the user. One of the experts stated *that falling from a tightrope between two skyscrapers is an anxiety-producing stimulus, which makes people tighten their necks and shoulders and sabotages their balance reflex* resulting in risks for the physical condition of the elderly. Additionally, when playing the Balance Bubble, one of our interviewees said *If the elderly are learning from this game to lean back in response to wanting to slow down it could actually lead to falling backwards*, that is potentially dangerous for the aged (Heuristic V). Also, some of our evaluators believed that providing a balance frame could be useful for older people when playing this kind of game, so they could hold onto it to gain confidence and avoid getting injured. During the evaluation of the *Skate Board* game, some of the experts stated that elderly people could reject playing this game because it was outside their own experiences and more suited to a younger audience. This supported the idea that the thematic of a video game is a relevant factor when trying to engage an elderly user (Heuristic VI).

The remaining categories F, E and D concern problems relating to the correspondences between the user movements and display, goal feasibility and training. We found that games like *Tightrope could be a bit confusing for the user as the picture is opposite to what they do e.g. the picture shows one foot in front of the other; however, on the board, the feet are apart* (Heuristic III). Although game theory points out that the conflict of the game creates a challenge which is the main reason to engage the user [12], one of our experts claimed that *you don't want to have activities that are impossible to achieve as it becomes too distressing for people and they just give up*, losing their commitment to the game (Heuristic II). Consequently, it was found that some games could require preliminary training as well as customisation allowing the aged user to get familiar with the activities provided by the video game. Regarding the above, it was suggested that *they could pick up speed over time: Start very slowly until they get used to these things* (Heuristic I).

#### DISCUSSION

As explained earlier in this paper, the use of videogames by aged people requires a deep inspection to guarantee optimum results on health outcomes. The use of heuristic evaluation to assess the usability of interactive video games, and the insights of health specialists, revealed some unexpected results about the mental and physical health of the elderly. A disconnect between what is on the screen and what the user is actually doing, may cause confusion for the player, resulting in feelings of anxiety and frustration while also affecting their balance reflex and mental satisfaction. As users age, their sight and hearing often deteriorates making it difficult for them to read or listen to instructions while the game is running.

#### CONCLUSION

The usage of video games and interactive technologies for health purposes has shown positive outcomes for the aged. However, these practices could also result in drawbacks for them if their mental and physical conditions are not taken into account. Furthermore, testing the usability and suitability of videogames is critical to obtain the improvements expected. In this paper we have applied heuristic evaluations to assess the suitability of such games for the elderly. The interviews with six healthcare experts were crucial in this investigation. They helped us to identify hidden problems in the chosen video games. We believe that much more effort should be applied to develop reliable guidelines which would help designers to create games especially for the elderly. In our next investigation we will be examining the suitability of the Kinect system for this cohort [14].

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