

Towards building health systems

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Abstract—This paper reports on a series of interviews with three mainstream and three alternative/complimentary health professionals about the use of interactive technologies as a tool to improve the physical and mental well-being of the elderly. The questions are based around an Analytic Framework for investigating Interactive Technologies and the elderly. Four balance games using the Wii were demonstrated to the interviewees and their opinion of the suitability or otherwise of these games are discussed. The chosen games did not meet with universal approval but did provide us with useful insights on how to ensure the development of appropriate games for the elderly.

Keywords-interactive games; balance; elderly; healthcare.

I. INTRODUCTION

The percentage of aged persons over 65 is increasing dramatically both in Australia and worldwide and unfortunately, as people age, their mental and physical health deteriorates and impacts negatively on their quality of life. This paper specifically investigates ways in which Interactive technologies, namely the Nintendo *Wii* could help to overcome functional decline, maintain independence and preserve social connectivity and engagement among seniors [1]. We report here on the results of semi-structured interviews with six health professionals who have specialized in caring for the elderly and infirm. Each of the interviewees answered a series of questions before being shown a demonstration of four *Wii* balance games. They were asked to comment on the suitability or otherwise of the games for their clients. Our project should, in time, reveal (a) the potential impact of interactive computer technologies on client and health carer outcomes and satisfaction levels, (b) the potential impact of clients' abilities to adapt to the introduction of new technologies, and (c) the potential benefits and obstacles to the application of interactive technologies in aged care environments, both at client's homes and at aged care facilities [2] [3]. Because of word limit constraints this paper only addresses some of the comments of the interviewees.

Research has shown that it is vital to encourage the elderly and infirm to do physical and mental exercises and support them throughout the process in order to maintain good health outcomes [1] [2] [3]. Current information and communication technologies on assistive healthcare mainly

focus on remote sensing using the Internet and wireless sensor networks for collecting health condition data of elderly people. Examples include the *ReMoteCare* system [4] [2] as well as the *Personal Health Monitor* developed at our university [5]. Very little effort has been made to support collaborative planning, implementation procedures for physical training (such as callisthenics and cardiovascular exercise), mental training and assessment such as described by [6]. Some further research on the use of the *Wii* for the elderly has been undertaken by [7] [8].

We have used an Analytic Framework based on work by [1] to investigate the aged population cohort, to study the economic and environmental factors and to help in assessing whether interactive technologies are useful for the elderly, chronically unwell and the infirm [3].

In Section 2 of the paper, we provide background information on the Analytic Framework and the interviewees. In Section 3, we describe the four chosen games and comments by the interviewees about their suitability or otherwise. We discuss the findings in Section 4 and draw our conclusions in Section 5, while pointing the way ahead for future research.

II. BACKGROUND

The authors have modified the Analytic Framework used by [1] in their landmark study on *Consumer Health Information Technologies* used by the elderly, chronically ill and underserved. Our modifications limited the technologies to Interactive Game Technologies, in this case, four *Wii* games that concentrate on balance. Figure 1 below sets out the Analytical Framework which served as a basis for our semi-structured interviews and demonstrations.

In July and August 2010 we conducted semi-structured interviews with six mainstream and alternative/complimentary health professionals who are used to dealing with the aged (See Table 1).

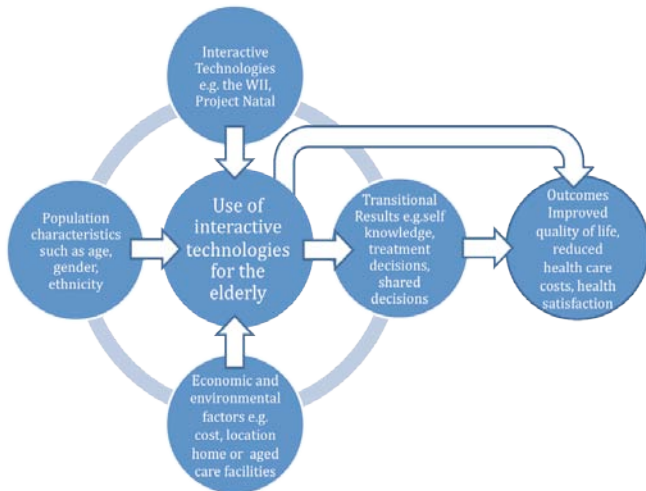


Figure 1: Analytic Framework (based on [1])

The questions sought to establish their background in using exercises for the elderly (over 65); their use or non-use of any interactive technologies with the elderly and the reasons; their awareness of the use of interactive technologies in either elderly persons’ own homes or at institutional care facilities; the types of exercises they actually used or devised and improvements or lack of improvements in physical and mental health outcomes. After each interview one of our researchers demonstrated the four chosen Wii balance games namely: *Tightrope*, *Bubble*, *Skateboard* and *TableTilt*. In one interview an interviewee performed the exercises.

Professor Aged Care works with people suffering from Parkinson’s disease so uses a *whole range of therapeutic activities like land based and aqua based strengthening exercises, balance, agility, memory, focus things*. For her patients recovering from stroke she uses *rehabilitation type exercises*. The only technology she has used is voice training [Lee Silverman Voice Therapy programme – LSVT] for recovering stroke patients. Her patients *do lots of gym work with treadmills, balance machines, getting in and out of beds, and on and off toilets*. They play manual games such as board, table and floor games to improve hand-eye coordination and arm movement to extend the range of movement and coordination. *If we actually teach somebody with Parkinson’s disease to dance they can stop that frozen movement and also the shaking movement because they are focussing on the neurological biofeedback of the task rather than the social situation.*

Feldenkrais Practitioner recently worked with the elderly in a Community Health Centre in conjunction with their *Stepping [On] Programme*. This program is a *falls prevention programme run by a number of area health services around [NSW] that is designed to teach physical activity leaders how to incorporate falls prevention*

TABLE I. INTERVIEWEES’ DETAILS AND PSEUDONYMS

Pseudonym	Details
Professor Aged Care: Sydney Hospital Researcher and director of Health and the Aged Centre.	Professor of Aged and Extended Care Nursing at a Sydney University examining aged and dementia care, health technologies, models of aged and dementia care, health technologies and the aged. Mainstream Health Professional.
Feldenkrais Practitioner: Certified Feldenkrais Practitioner in Sydney.	The Feldenkrais method is designed to improve movement repertoire, aiming to expand and refine the use of the self through awareness, in order to reduce pain or limitations in movement, and promote general well-being[10]. He teaches Feldenkrais method to a diverse range of people such as those with injuries, the elderly, actors, athletes, or those who just want to move more easily. Alternative or Complimentary Health Professional.
Physiotherapist: for 28 years the physiotherapist at an large Aged Care Centre in Sydney	Responsible for assessing [the patients]. There are objective assessments for patients when they enter the facility and a care plan is then instigated for use by the rest of the nursing staff and also for the physiotherapy assistants to carry on with walking assistance or passive class exercises etc Mainstream Health Professional.
Alexander Technique Practitioner: Certified Alexander Technique Practitioner in Sydney. Own Practice.	The Alexander Technique is a subtle but extremely powerful re-education process that seeks to restore the natural physiological organization for posture, balance and movement to the human system. Deals with patients aged from teenagers to over 90 years old. Also teaches Alexander Technique at a Community College in Sydney. Alternative or Complimentary Health Professional.
Music Therapy Specialist: Expressive Arts & Music Therapy Specialist at a University in Sydney as well as having a Sydney private practice.	Twenty years experience in working with single patients and groups in movement therapy, music therapy and personal development. Alternative or Complimentary Health Professional.
Associate Professor Chronic Care at a Sydney University.	Self management, secondary prevention and weight management in cardiac and chronic illnesses. Cardiac and Pulmonary Rehabilitation, recovery and psychosocial adjustment. Women and heart disease. Mainstream Health Professional.

exercises into their exercise programs. They train older people about improving balance. She had not used interactive technologies but had seen the Wii used by a

colleague for artistic purposes but not with the elderly. When I [first] started working with the elderly there was a programme developed in Melbourne called **Getting Grounded Gracefully**. The researcher [developed] it in conjunction with the National Research Institute on Ageing. They did a trial with the movements he devised to assess how effective they were for the elderly and it got a great, big tick [of approval]. She believed [the exercises] increased their confidence, enabled them to feel capable to leave their homes and navigate to places they need to go to with confidence. This decreased their feelings of isolation and the fear of being alone. [The exercises] improved their overall sense of wellbeing, because you do feel well when you move, and it improves their outlook.

Physiotherapist has worked for the last 28 years as the physiotherapist at an Aged Care Home in the Eastern Suburbs of Sydney. There are about 70 men and women (both low and high care) in the facility. Physiotherapist makes *objective assessments when the patients enter the facility and a care plan is instigated for use by the rest of the nursing staff and also for the physiotherapy assistants to carry on with walking assistance or passive class exercises etc.* She has not used Interactive technologies at all either in the Aged Care home or in her business. She states that many of her patients are high care and therefore she uses passive exercises such as helping the patient perform a stretch. She uses Thera Bands for resistance training (see Figure 2).

Alexander Technique Practitioner stated that most people over the age of 65 are displaying *some* infirmities in their balance. He has had considerable experience working through the Alexander Technique with that cohort. *The oldest student I had came to me when he was 96 years of age. He was very shuffly and it took him 10 minutes to get up the stairs to my teaching room, but he found it very beneficial. He had sessions with me for 4 years and passed away 2 months before his hundredth birthday.* Feldenkrais Practitioner does not actually teach people exercises but gets them to understand how their body is organized and how to release the wrong patterns that they have utilized since they went to primary school. He is not au fait with interactive technology but stated that after receiving our phone call and emails, he googled Wii programs and also Project Natal [11] and *I thought 'Wow! This is a pretty exciting field'. I wasn't really aware it existed.*

Music Therapy Specialist attended the same interview as Alexander Technique Practitioner as they work together on a number of levels. Her expertise is in the area of movement therapy, music therapy and personal development. Her comments are related specifically the Wii games as she actually did the exercises and these will be reported in Section 4.

Associate Professor Chronic Care works in Cardiac and Pulmonary Rehabilitation *with people with a history of a*



Figure 2: Exercising with Thera Bands. Source: [13]

cardiac events, of varying kinds including big heart attacks, or heart surgery as well as very small changes so we think of it as secondary prevention. She does not use interactive technologies with her patients because the physiotherapy gym is nearly always hospital based and it is multipurpose. *It has treadmills, bikes, elastic bands [Thera Bands], and steps for going up and down and that's the kind of the accepted thing.* She is familiar with the Wii as she has her own and stated *the Wii is a perfect way to do home based exercise. Our biggest problem is getting people to Cardiac Rehabilitation* because they must attend the gym at the hospital.

IV. THE GAMES

As can be seen from the above our experts therefore had little experience in the use of interactive technologies in their work with the aged but **Associate Professor Chronic Care** had used the Wii herself at home. In this section we discuss their reactions to the Wii games. Table 2 sets out details of the games that were demonstrated.

The Tightrope

Professor Aged Care felt that the Tightrope game would terrify the Parkinson patients as the instructions came up far too quickly. She did not feel it would be a problem for stroke patients if they were able walk independently. **Feldenkrais Practitioner** stated the Tightrope was *good for balance and weight shifting but could be a bit confusing for the user as the picture is opposite to what they do e.g. the picture shows you one foot in front of the other; however, on the board your feet are apart.* **Physiotherapist** commented that many of her high care patients would not be able to read

TABLE II. GAMES DEMONSTRATED

Description	Main purpose
Tightrope: Your avatar stands on the balance board and tries to keep upright.	Balancing on a tightrope – use both feet side by side although the avatar appears to place one foot in front of the other. An object may appear on the tightrope and you must jump over it. If you do not reach a goal within a period of time you cannot move up a level.
Bubble: The avatar appears in a bubble; navigate down a river safely.	Again use of the balance board – both feet are used to keep steady – the avatar mirrors what the person is actually doing on the screen. The aim is to avoid bumping into river banks. The longer the walk the higher the score.
Skateboard: Avatar appears on a skateboard and must keep upright	Again use of the balance board but this time the person must occasionally push off with a foot on the ground just as if he/she were on a real skateboard. Must avoid obstacles, jump over skate jumps and improve scoring. If you do not reach a goal within a period of time you cannot move up a level.
Table Tilt: A ball appears on a Table Tilt which has holes on it – the person must tilt the Table Tilt in order to get the ball to flow down the hole.	Person stands on balance board and by shifting weight the table tilts and the ball/s move towards or away from the holes. More balls and more holes appear so it is more difficult. If you do not reach a goal within a period of time you cannot move up a level.

the instruction, however she thought the low care patients would find it *lots of fun* and she suggested they could use rollators (See Figure 3) to keep themselves steady. **Alexander Technique Practitioner** also mentioned that his patients would find this game challenging and upsetting, particularly if their avatar fell. He believed it was difficult to read and do the actions at the same time and suggested audio feedback. **Music Therapy Specialist** stated that *falling from a tightrope between two skyscrapers is anxiety-producing stimulus, which makes people tighten their necks and shoulders and sabotages their balance reflex*. She did the exercises herself and mentioned that *reading instructions spread across the screen may be confusing and less compatible with kinesthetic awareness than auditory feedback*. **Associate Professor Chronic Care** felt it was a *useful exercise because it is about balance and shifting weigh* and commented our instructor was using his quads and a bit of his core. She thought this game would appeal more to men than women.

The Bubble

Professor Aged Care was more impressed with this one stating that it would need to be much slower *so they've got a chance of success. What would probably happen is they*

would probably keep hitting the side the whole time - it could be frustrating, worrying. They could pick up speed over time. Start very slowly until they get used to these things. **Feldenkrais Practitioner** indicated this game *allows movement forwards and backwards and side to side, which is a good strategy.* **Physiotherapist** thought this one was fun and could be easily used in the aged care facility or at home. She believed it could be used by people holding onto a balance frame or rollator for support. **Alexander Technique Practitioner** approved of this one also – the movement on the screen matched what the exerciser was doing – unlike the Tightrope. **Music Therapy Specialist** stated that *the side to side movements of the body correspond well with the screen movements, so this would be good for stimulating body awareness of weight distribution on the feet*. She criticized the technique for slowing down as the linking of speeding up of the image with leaning forward and slowing down with leaning back is a very unrealistic (and potentially dangerous for the elderly) since it does not correspond to human movement. *If the elderly are learning from this game to lean back in response to wanting to slow down it could actually lead to falling backward.* **Associate Professor Chronic Care** thought this one was *gentle and safe* but would not be useful for her cardiac rehabilitation patients as it did not raise their heart rate sufficiently. She stated it was better than Tightrope as a starting exercise.



Figure 3: Rollator for Stability(has brakes). Source: [14]

Skateboard

Professor Aged Care stated that her aged patients would not relate to Skateboarding as it is outside their experience. She suggested a game with a scooter or a bicycle would have more appeal to the elderly. She did feel it might appeal to males who were in better health or those classified as *High Functioning*. **Feldenkrais Practitioner** decided this one was good for counterbalance and gave locomotion practice as people have to kick off from the floor from time to time as on a real skateboard. **Physiotherapist** believed the younger and more able of her patients would find it useful and fun. She indicated patients would need good coordination and flexibility and it provide them with opportunities for *varied flexion and rotation*. **Alexander Technique Practitioner** was not keen on this as he felt you could not read and operate the skateboard at the same time. His patients could have issues with putting their foot on and off the board. **Music Therapy Practitioner** felt this game most corresponds to *realistic human movement simulation and the leaning and pushing off one needs to do on a real skateboard*. She too stated that elderly people may not have the experience or inclination to learn this skill because they would think it is for teenagers. She warned it would be necessary to be careful when first working with this one since turning is sometimes linked to a backward lean, which may be tricky for the elderly. **Associate Professor Chronic Care** felt this game was *more challenging and provided a better workout* but, although she liked it herself, she did not think her patients would.

Table Tilt

Professor Aged Care endorsed this game as it required *quite fine balance*, as the participant must just move the table slightly. *This one would be quite relevant because it is slow enough to be able to achieve something. You don't want to have activities that are impossible to achieve as it becomes too distressing for people and just give*. She said it was a familiar game for the elderly. **Feldenkrais Practitioner** also liked this game as it was a good exercise which worked well for elderly persons. Counterbalance is necessary. **Physiotherapist** stated that this one was good for concentration and would help her patients to stay focused. She believed it was a fun game as well. **Alexander Technique Practitioner** did not endorse this game as he believed it encouraged patients to tense up and lose balance He stated he wants people relax and loosen up. **Music Therapy Practitioner** did not comment on the Table Tilt. **Associate Professor Chronic Care** stated that patients would need posture help on this one. She suggested having a wider walking frame around the footpad for balance assistance if the patient *started to fall a bit*. She liked this game for the elderly as it would be familiar.

V. DISCUSSION

As can be seen from the above section the use of the Wii Balance Games we selected for examination by the health

professionals did not meet with universal approval. A common criticism concerned the fact that the participants would have to read the instructions while attempting to do the exercise. Many of the elderly have fading eyesight so this would be difficult for them. Some of the patients with whom our professionals worked could not read English as they were from a non-English speaking background. The use of audio instructions was suggested by some of our interviewees but again many elderly people have hearing loss so that too could give rise to problems. Training with the Wii games would be necessary because people do not like to fail or appear silly in front of their peers. **Feldenkrais Practitioner** emphasized that a lot of the movement strategies that she used also included getting up and down from the floor, *because that's what people fear, they fear falling and they fear that they can't get up. So this reduces their confidence too*. The alternative/complimentary practitioners concentrated more on every day type movements trying to get their clients to be more aware of their bodies and their sense of balance. Many of their exercises concerned getting up and down from a chair, from a bath or from the floor. They wanted their clients to feel confident in posture and balance and they could see the benefit of some of the Wii games.

It was also noted that no Interactive Technologies were currently in use in any of the areas in which the interviewees worked. They were however interested in the Wii games and thought that they could definitely be introduced into gyms and/or aged care facilities under supervision and that people would have to be introduced to the games slowly and see rewards or improvements. The mainstream professionals felt that many of the games would appeal more to men than women. They felt that the social aspect of using the Wii would be important. The interviewees were united in their opposition to the Skateboard game and commented that the patients would be attracted to games with which they were familiar e.g. Table Tilt and perhaps riding a bicycle rather than a skateboard.

VI. CONCLUSION AND FUTURE DIRECTIONS

In our ongoing investigation of the use of interactive technologies for the aged and infirm we believe that obtaining specific insights into how professionals look at balance exercises was extremely useful. We are aware now that reading the instructions whilst doing the exercises is probably not the best way for an elderly cohort. The use of a trainer to teach the elderly would be important as would the use of a rollator and/or frame to give the elderly a feeling of support once they were playing the games.

It is apparent to us that these games are more relevant to the young and we are currently investigating how to design games that are more age relevant. We also intend to investigate the new Project Natal [11] (now called Kinect [12]) when it arrives in Australia as it might prove to be more adaptable for the elderly cohort. One Kinect game called 'Your Shape-Fitness Evolved' serves as personal

trainer with a variety of exercises including Yoga and could be a possibility for elderly users. We have commenced our next task of testing the games on a cohort of people over 65 years of age to elicit their opinions and to see how whether their opinions accord with the professional professionals' perspectives.

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REFERENCES

- [1] Jimison H., Gorman P., Woods S., Nygren P., Walker M., Norris S. and Hersh W: "Barriers and Drivers of Health Information Technology Use for the Elderly, Chronically Ill, and Underserved". Evidence Report/Technology Assessment No. 175 (Prepared by the Oregon Evidence-based Practice Center under Contract No. 290-02-0024). AHRQ Publication No. 09-E004. Rockville, MD: Agency for Healthcare Research and Quality. November 2008.
- [2] Lawrence, E., Sax, C., Felix Navarro, K. and Mu Qiao: "Interactive Games to Improve Quality of Life for the Elderly: Towards Integration into a WSN Monitoring System". In Proceedings of The International Conference on eHealth", Telemedicine and Social Medicine (eTELEMED 2010), St Marteens, February 2010, pp. 10-17, doi: 10.1109/eTELEMED.2010.21.
- [3] Lawrence, E., Sax, C., Felix Navarro, K.: "Improving Health Outcomes for the Elderly: An Analytic Framework". 23rd Bled eConference eTrust: Implications for the Individual, Enterprises and Society", Bled, Slovenia, June, 2010, pp. 441 – 454, doi:
- [4] Fischer, M., Lim, Y.Y., Lawrence, E., Ganguli, L.K. and Kargl, F.: "ReMoteCare: Health Monitoring with Streaming Video". IEEE 7th International Conference on mBusiness, July 2008, Barcelona, Spain, doi: 10.1109/ICMB.2008.16.
- [5] Leijdekker, P., Gay, V. and Lawrence, E.: "Smart Homecare System for Health Tele-monitoring". International Conference on Digital Society, IEEE Computer Society, March 2007, pp. 3-3, doi: 10.1109/ICDS.2007.37.
- [6] Chilukoti, N., Early, K., Sandhu, S., Riley-Doucet, C. and Debnath, D: "Assistive technology for promoting physical and mental exercise to delay progression of cognitive degeneration in patients with dementia", Biomedical Circuits and Systems Conference (BIOCAS 07), IEEE Computer Society, November 2007, pp.235-238, doi: 10.1109/BIOCAS.2007.4463352.
- [7] Sugarman, H., Weisel-Eichler, A., Burstin, A. and Brown, R.: "Use of the Wii Fit system for the treatment of balance problems in the elderly: A feasibility study". Virtual Rehabilitation International Conference, July 2009, pp. 111-116, doi: 10.1109/ICVR.2009.5174215.
- [8] Gil-Gomez, J.A., Lozano, J.A.; Alcaniz, M. and Perez, S.A.: "Nintendo Wii Balance board for balance disorders". Virtual Rehabilitation International Conference, July 2009, pp.213–213, doi:10.1109/ICVR.2009.5174251.
- [9] IJsselsteijn, W., Nap, H.H., Poels, K. and de Kort, Y.: "Digital Game Design for Elderly Users". Proceedings of the 2007 conference on Future Play, May, 2007, pp. 17-22, doi: 2007 ISBN:978-1-59593-943-2.
- [10] Strauch, R.: "An overview of the Feldenkrais Method®". Sourced from: http://www.somatic.com/articles/feldenkrais_overview.pdf.
- [11] Project Natal: "You Are the Controller". Sourced 2nd May, 2010 from <http://www.xbox.com/en-US/live/projectnatal/>.
- [12] Anonymous Kinect gets gamers off the couch, sends Wii packing, Technotes, <http://www.apcmag.com>, August 2010, pp. 11
- [13] "Exercising with Thera Bands" . Sourced August, 2010 from: <http://www.stoningtonvna.com>
- [14] Sourced August, 2010 from: <http://www.gobilitymobility.com/Rollator.html>