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ORIGINAL ARTICLE

Designing intergenerational play via enactive interaction, competition and acceleration

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Abstract We report on the design process and the design rationales of a physical mini-game, to be played by seniors and youngsters. First, we explain that we seek enactive interaction, rather than physical action. Next, we elaborate on how competition correlates with social interaction, relying on FIRO theory. Then, we analyze how the sensor technology within the WiiMote affords acceleration. Via an evaluation of existing physical mini-games, seniors and youngsters empirically verify these three design rationales on *enactive interaction*, *competition and acceleration*. We conclude that these rationales result in *ease-of-use*, *equality-in-ease-of-use* and *visibility-of-player-action*, which in turn stimulate competition and consequently intergenerational play. Finally, we present the design and user evaluation of our physical mini-game, designed in accordance with these rationales.

Keywords Intergenerational play · Social interaction · Competition · Seniors · Youngsters · Physical gaming · Enactive interaction

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1 Meaningful play for the elderly

Elderly users are a growing population. de Jong Gierveld [1] estimated that 15–25% of the European population is 60 years or older. While the grey market has become a major one, the number of games designed for an elderly population do not reflect this statistic. In the past decades, research and development on digital games for elderly was mostly placed under the umbrella of *gerontechnology*. Unfortunately, this view of senior life as frail or dependent does not correspond to the large group of seniors that still lives an independent, active and healthy life.

In *Digital Games for the Elderly*, IJsselsteijn et al. [2] argue that besides being used for therapeutic means, digital games also offer the benefit of connecting different age groups while playing, especially grandparents and grandchildren. Similarly, Tarling [3] claims that being able to play with grandchildren is an important incentive for seniors to play a computer game.

However, digital games that focus on intergenerational play are rare. The authors are aware of few design research projects that have an ambition of connecting grandparents and grandchildren via a digital game. Curball [4] is a prototype of a distributed bowling game for older people, to be played with grandchildren over the internet. Age Invaders is a physical game allowing elderly to play together with children in the same physical space, via an interactive floor. Distributed Hide-and-Seek [5] is a technological prototype, seeking to re-connect intergenerational relatives. With the e-Treasure research project[1]

[1] Funded by IWT-Vlaanderen (IWT-nr.:60135 start:1/01/2007 end:1/01/2009), "e-Treasure—Gebruikergestuurd ontwikkeling van een digitaal spel voor kennisuitwisseling tussen senioren en jongeren.," n.d.

Fig. 1 Blast from the Past!

(Fig. 1), we aimed to contribute to this small but necessary pool of intergenerational games.

1.1 Player-centered design of a computer game for seniors and youngsters

The e-Treasure research project aimed at developing a digital game by means of a player-centered design process [6, 7], including seniors and youngsters from the beginning until the end. Via ethnographically inspired research methods and a participatory design process, the e-Treasure game took the shape of a Nintendo Wii game, called *Blast from the Past!*.[2] The aspiration of the game is to foster intergenerational play and to facilitate knowledge transfers between youngsters (7–10 years old) and seniors (65 years or older). The game is played in the living room by four players, addressing popular culture of the past 60 years. *Blast from the Past!* (Fig. 1) contains six quiz rounds and two physical mini-games.[3]

The discussion of the entire player-centered design process is beyond the scope of this paper. Instead, we highlight one specific part of the research project, namely the design process, and especially the design rationales behind one of the physical mini-games. We first elaborate on how we build design rationales on the basis of theoretical accounts and benchmarking of the WiiMote technology. Next, we empirically verify our design rationales with our target users, via existing mini-games. We discuss how we refine our design rationales to focus on the drivers of ease-of-use, equality-in-ease-of-use and visibility-of-player-action for competition. Finally, we describe how we implement these design rationales and drivers into our own mini-game.

2 Constructing design rationales for intergenerational play

While anecdotic accounts of Wii play in homes for the elderly [8] suggest that physical game play has its merits, there is little scientifically validated information on how physical interaction with digital games can and should be designed for elderly people. When designing intergenerational games, the needs and skills of both youngsters and seniors need to be balanced carefully. Youngsters have had far more exposure to digital technology. For seniors, the lack of experience in dealing with digital appliances [2] might be problematic. Furthermore, elderly players may suffer a decline in memory, visual functions or motor ability. Therefore, intergenerational physical mini-games should be able to deal with sensory, motor or cognitive limitations of elderly users.

2.1 Design rationale on physical play: design for enactive interaction

We might understand the benefits of physical game play for elderly better when discussing enactive knowledge and interaction. Enactive knowledge, a term first coined by psychologist Bruner [9], is "*knowledge stored in the form of motor responses and acquired by the act of doing.*"[4] Enactive interfaces are capable of conveying and understanding these motor responses or gestures of the user. According to this definition, most Wii games provide enactive interaction.

While enactive interaction emphasizes physical action, it also highlights the importance of previous experience of motor acts within real life. For seniors, who might lack mental models of interacting with computing devices or complex game controllers, enactive interaction offers true benefits. Rather than having to memorize complex mappings between in-game actions and specific button presses, a senior can fall back on his everyday life experiences, e.g., how to swing a tennis racket or hammer down a nail. Thus, the benefit of enactive interaction resides not in the actual physical body movements but rather in the fact that seniors can rely on existing mental models to interact with the game.

Therefore, the quality of enactive interaction cannot be analyzed by focusing on the type of physical action alone,

[2] Blast From The Past! is the artistic translation of the Dutch title 'De Grote Teletijdshow!'.

[3] Mini-games are short, self-contained games, based around a single principle [20].

[4] EnactiveNetwork.org.

but also requires addressing by *what is fed into the perceptual system*. What we see, hear and feel will shape our actions [10], and vice versa we will perceive the environment through the actions it affords. Indeed, Wii games rely heavily on digital affordances; the artificial game world helps the player understand which actions he or she should make. The exact meaning of the WiiMote (being a tennis racket or a golf club) is mainly brought about by the representation within the artificial game environment. Therefore, analyzing enactive interaction also involves the representation of that physical action in the game world. More specifically, the quality of enactive interaction in games relies on how tight the relationship is between a player's physical actions and the game's representation.

Based on these theoretical accounts, we formulated the first design rationale about physical play and enactive interaction.

- Design rationale 1: In order to stimulate physical play between generations, the game should offer enactive interaction.
- In order to offer enactive interaction, the game should rely on existing mental models of everyday life experiences, addressing well-known physical actions and provide clear digital affordances.

2.2 Design rationale on social interaction: design for competition

Lucas and Sherry [11] stress the importance of studying the interpersonal dynamics among game players, relying on Schutz's [12] fundamental interpersonal relationship orientation (FIRO) theory. FIRO theory states that human behavior is oriented by three interpersonal needs: inclusion, affection, and control. *Inclusion* points toward the need of individuals to interact with others and to be part of a group. *Affection* points toward the need for closeness and warmth within the relationship. *Control* expresses the need of individuals to have influence over the actions of others and refers to attaining a dominant or a submissive position over others in life. Lucas and Sherry point out that playing games are a means toward fulfilling these interpersonal needs.

When researching people's motives for playing games, Sherry et al. [13] unveiled that social interaction is a prevalent reason for playing digital games. In fact, social interaction is found to be the strongest predictor of the amount of time people will spend on playing games across a number of studies [14, 15, 16]. According to FIRO, the game motive of social interaction extends the fundamental needs of inclusion and affection. Further research on the effect of the social setting on game experience demonstrates that multiplayer games have a positive effect on the game experience; it is more fun to play against friends then to play against a computer [17, 18]. Furthermore, co-located multiplayer game play is preferred over mediated multiplayer gaming [19]. The salience of *the other* augments the game experience.

When thinking about co-located, multiplayer game play, aiming at intergenerational interaction, one could envision collaborative game play where players of different generations aid each other in achieving a common goal. However, research on game gratifications not only shows the prevalence of the social interaction motive, it also shows that the social interaction motive most strongly correlates with the competition motive [14, 16]. Gamers, who mainly play for social interaction, are often competitive players as well. Games that score high on social interaction score high on competition as well. The correlation between social interaction and competition can be understood by FIRO's third interpersonal need: the need for control. Indeed, competing with others are attempts at controlling each other, an essential part of interpersonal dynamics.

Therefore, rather than aspiring collaborative game play to stimulate intergenerational play, we aimed for competitive game play. With competitive play, we adhere to the taxonomy and definition of Mueller, defining competitive games as those were the goal can only be attained by one competitor to the exclusion of the other opponents [21]. Mueller makes a distinction between parallel and non-parallel play. In non-parallel play, players can influence each other directly during the game, actions of one player benefit or hamper the other player directly, e.g., shooting at each other. In parallel play, players can play alongside each other without directly influencing the game play of competitors, e.g., a race with participants on separate tracks. Although Mueller acknowledges that there is no research that provides decisive arguments on whether parallel or non-parallel activities facilitate more social interaction, he does point out that in sport psychology it is common for authors to associate non-parallel play with social effects such as team-building and the forming of social bonds more often than parallel play [22]. Consequently, we envisioned that games that provide non-parallel play stimulate competition more than parallel play.

Based on these theoretical accounts, we formulated the second design rationale about social interaction and competition.

- Design rationale 2: In order to foster social interaction between generations, the game should stimulate competition.
- In order to stimulate competition, the game should offer a goal that can only be achieved by one player, to the exclusion of other competitors. Furthermore, the game should offer non-parallel play where players should be

able to directly influence each other's actions in the game.

2.3 Design rationale on sensor technology: design for acceleration

To discuss 'the motion sensor' technology of the WiiMote [23], it is important to realize that actually three different sensor systems are embedded into one game controller.

2.3.1 Optical sensor system

The optical sensor system consists of two parts: an infrared camera inside the WiiMote and a LED bar that is positioned on top of or directly below the television. Physical action and game play that rely on the optical sensor system mainly use *pointing*. Because the sensor bar has a limited detection area and because small movements of the player are enlarged, the pointing mechanism favors physical action that is directed and well-controlled. The pointing mechanism requires players to stay still in front of the television screen and works best when one can sit down and support the pointing arm.

When thinking about the type of enactive interaction the optical sensor system supports, one can think of shooting at targets, painting walls, drawing objects or beaming with a laser gun.

Unfortunately, the pointing mechanism is fragile within an intergenerational context, seniors that suffer from tremors or shivers might feel uncomfortable when using the optical sensor system. Furthermore, the design team noticed that in smaller living rooms, where the distance between players and LED bar is limited, the detection area for pointing is too small for four players. Consequently, the players positioned too far on the left or right side *fall off* the screen.

2.3.2 Acceleration sensor system

The acceleration sensor inside the WiiMote senses *fierce movements* in three axes. Besides acceleration, when pitching and rolling with the WiiMote, the acceleration sensors acts as a gyroscope and can detect slow and steady movements as well, due to the gravity force. However, this does not work when yawing; a steady movement in this plane parallel to the floor, cannot be detected by an acceleration sensor. Triggering the acceleration sensor requires more exertion or physical action than the optical sensor system. Consequently, with this type of movements, game actions are highly visible to the other players.

When thinking about the type of enactive interaction the acceleration sensor system affords, one can think of swing a tennis racket, throwing a ball, moving a hammer, etc.

Unfortunately, the design team noticed that with this type of sensor system, game play often lacks good synchronization between physical action and on-screen representation, resulting in a lack of natural mapping. In terms of Normans Human Action Cycle [24], there is a gulf of evaluation, hampering enactive interaction.[5] The best enactive interaction is achieved in those games where the in-game action relies on simple but fierce actions, resulting in clear, straightforward actions. Where physical action is implemented as multistep action (e.g., performing several different movements directly after each other), game play becomes complicated and enactive interaction breaks down.

2.3.3 Buttons

Finally, there are still many buttons on the WiiMote; besides the directional cross button, there are seven other buttons that can be pressed. Many actions, carried out with the WiiMote, are in fact a combination of *button pressing* and physical action. Game play that emphasizes button pressing does not allow enactive interaction and turns gaming in a cognitive mode of interacting, favoring players that can rely on previous experience with game controllers.

2.3.4 Conclusion

Since the mini-game was to be played with four players, and because seniors might have problems holding their arms steady, the optical sensor system was problematic. Button pressing was omitted as well, to avoid a cognitive load and a bias in favor of experienced gamers. As a result, we favored the acceleration system; it brings the physical play to the foreground and stimulates the visibility of the actions.

- Design rationale 3: In order to stimulate intergenerational play, the game should rely on the acceleration sensor system.
- In order to design for the acceleration sensor system, games should avoid complex, multistep actions and rather choose simple but fierce movements that result in straightforward actions.

3 Verifying the design rationales: a user evaluation of existing physical mini-games

The construction of the design rationales was carried out within the confines of the design team. Adhering to a

[5] This problem is commonly known: the current acceleration sensor in the WiiMote does not allow for perfect synchronization, there is a gap between detecting an acceleration and the in game mapping. Nintendo announced that it will release the Wii MotionPlus, promising a true 1:1 response in their game play.

player-centered design process, we deemed it essential to empirically verify these design rationales on intergenerational play (Fig. 2) with the actual user group.

3.1 Selection of physical mini-games

Since it was too early in the design process to test actual gaming prototypes, four commercial mini-games from Mario Party 8 were selected to be played by seniors and youngsters. Similar to our aim, these mini-games last approximately 2 min, aim to foster social interaction by emphasizing friendly competition (as a party game) and require physical action with the WiiMote. The mini-games were carefully selected to represent diversity with respect to compliance with the design rationales of enactive interaction (DR1), competition (DR2) and acceleration (DR3) (see Table 1).

Breakneck Building requires players to hammer a nail, saw a log and paint a wall as fast as possible. The game relies on simple, one-step but fierce movements, sensed by the acceleration sensor (DR3↑). The game is also high in enactive interaction, it relies on life experiences of carpentry and offers clear digital affordances (DR1↑). Although high in enactive interaction, this game scores low on competition, the game does not offer non-parallel play. Players play in split screens and do not directly influence each other during the game (DR2↓).

Surf's Way Up requires players to steer a surf board in space to hit balloons. Holding the WiiMote as the surfboard you can steer up, down, left and right in a 3D space, relying on the acceleration sensor functioning as a gyro sensor, yet movements are not fierce (DR3→). While the physical action is easy, most people do not have previous experiences of steering surfboards with hand movements. Furthermore, digital affordances that indicate how you should hold the WiiMote are lacking (DR1↓). Yet, *Surf's Way Up* scores high on the competition dimension. Being in one space, players are expected to bump each other out of the way to compete for balloons filled with points (DR3↑).

Lob to Rob requires players to shoot balls at a target in order to score points. Instead of the acceleration sensors, the optical sensor system is relied upon. More precise and restrained, pointing is necessary to complete this game (DR3↓). The game does score high on enactive interaction, having to shoot balls by pointing (DR1↑). Lob to Rob does not score high on competition. Each player has his own window and does not directly compete against the others but against a clock set by the game itself (DR2↓).

Finally, *Frozen Assets* requires players to move around in the same game world and enables players to push and kick each other while competing for diamonds. Frozen assets is a typical console game that relies entirely on buttons (DR3↓). Because of the cognitive mode of operating, any type of enactive interaction is lacking (DR1↓). Yet, *Frozen Assets* provides many opportunities for competition, offering options of defense and offense strategies (DR2↑).

3.2 Participants and procedure

We asked five pairs consisting of a senior and a youngster to play all four games twice. Three of the pairs had a

Fig. 2 Overview of the three design rationales for intergenerational play

Table 1 An overview of the four selected mini-games with respect to the design rationales

	Description	Enactive interaction (DR1)	Competition (DR2)	Sensor system (DR3)
Breakneck Building	Sawing, hammering, painting	High (↑)	Low (↓)	Acceleration sensors (↑)
Surf's Way Up	Rolling and pitching to steer a surfboard	Low (↓)	High (↑)	Acceleration sensors (gyrosensor) (→)
Lob to Rob	Throwing balls (by pointing)	High (↑)	Low (↓)	Pointing sensors (↓)
Frozen Assets	Picking up objects while kicking others	Low (↓)	High (↑)	Buttons (↓)

grandparent–grandchild relationship, two of them were acquaintances. Before playing, the pairs received a short, verbal introduction on how to play the game. If any difficulties were encountered, the researcher would intervene after the first time the game was played, to make sure that the game was played correctly the second time. After playing all games twice, we asked the pairs to rate the games from most favorite to least favorite. First they could rank the games on an individual basis, then we asked for one ranking the pair agreed upon. In order to further our understanding, the ranking exercise was followed by a short interview with the researcher prompting *why* one game was chosen over another.

Although set up as a pseudo-experiment, the user evaluation was qualitative in nature, relying on user observations of game play and the ranking exercise. We were trying to understand the *meaning* of our design rationales for our players. Rather than establishing an absolute ranking of the mini-games, we were interested in the discussion that would unfold between seniors and youngsters and their reasons for choosing one game over another, especially with regards to the design rationales.

3.3 Results

Breakneck Building was the favorite of most players, both seniors and youngsters. As stated, this game is high in enactive interaction and consequently we observed that this game was easy to control for both seniors and youngsters. The game does not rely on digital competences or necessary mental models of how to operate digital appliances, and it offers clear digital affordances. In addition to *ease-of-use*, we also noticed *equality-in-ease-of-use*, we did not encounter a difference in the ability to play the game between seniors and youngsters. Although at an older age one might experience a decline in perceptual-motor functions, this did not seem to influence the game play afforded by the acceleration sensors. Furthermore, we observed an immediate and enjoyable competition between all pairs, laughing about the physical (and often ridiculous) gestures of the partner and themselves. Contrary to our expectation that competition would be low for this game, quite the opposite was true. During the game, players were keeping a (peripheral[6]) eye on each other and making remarks like "*Come on Grandma?*", "*Oh, no, you are ahead of me*" or "*Yes, I'm the master*". It seemed that although the game did not provide non-parallel play, the high *visibility of physical actions*, the ease-of-use, and the equality-in-ease-of-use did stimulate competition and foster social interaction.

Lob to Rob was also favored by our players. Seniors had no problem using the pointing mechanism and did not encounter major problems. This game also provides enactive interaction. However, youngsters were clearly better at this game; we noticed that the pointing mechanism does place higher demands on the perceptual-motor mechanism and requires rapid hand–eye coordination. Therefore, we noted ease-of-use but not equality-in-ease-of-use. We also noted that this game play was more contained and more serious; the game players were not commenting on each other as the game activity was challenging and required full attention of the players. Only after the game was over, players compared scores. Might this be attributed to pointing gestures that are less visible for the other player than the fierce movements that *Breakneck Building* requires or was this due to the lack in equality-in-ease-of-use?

Contrary to our expectation, *Surf's Way Up* was not liked at all, by both seniors and youngsters. The observations and interviews show that this was mostly due to the lack of enactive interaction. The players expressed discomfort when playing the game, uttering sentences like: "*What are you supposed to do here? Is this how it goes? I don't understand!*" Both seniors and youngsters experienced these difficulties, which were still not resolved when playing a second time. As a consequence the lack of ease-of-use, there was really no meaningful play and no competition.

Finally, *Frozen Assets* yielded mixed results. As expected, seniors expressed a great dislike for this game, while their younger counterparts clearly enjoyed the game and knew how to control it. Youngsters were not always as patient as they should have been, focusing on individual challenges and turning game play into a more individual experience. Seniors had great difficulty to master the game, due to a lack of experience with game controllers. Therefore, competition between generations was not possible, although the game offered non-parallel play. The lack in *equality-in-ease-of-use* hampered competition.

3.4 Conclusions based on the user evaluation

From this exercise, we conclude that our design rationale on enactive interaction proved correct (DR1). Relying on previous life experiences and offering clear digital affordances provides *ease-of-use*.

The choice for the acceleration sensor was reinforced as well (DR3A). The physical movements afforded by the acceleration sensor were found to favor both youngsters and seniors, providing *equality-in-ease-of-use*, both seniors and youngsters were as good. This enabled real competition between generations with different digital competences.

The fierce movements and the enactive interaction also increased the *visibility of the player's actions* which in turn stimulated competition between players. The optical sensor

[6] Although the player's main focus was on the screen, we had a strong impression that the other players were still in the peripheral vision.

Fig. 3 An overview of the design rationales with the refined design rationale on competition

system put seniors at a disadvantage because of the precise movements, leading to inequality-in-ease-of-use. Furthermore, it lead to more constrained game play, players did not track each other's progress and consequently there was less competition. The buttons pressing excluded seniors from participating in the game experience, rendering competition impossible.

While it was clear that competition stimulated the exchange of verbal comments and laughter, we could not find support for stimulating competition via non-parallel play. Ease-of-use, equality-in-ease-of-use and especially visibility-of-player-actions were found to be more important drivers for competition. Based on this exercise, we refined the second design rationale on competition (Fig. 3).

- In order to stimulate competition, the game should provide ease-of-use, equality-in-ease-of-use and finally visibility-of-player-action.

In hindsight, de Kort and IJsselsteijn [25] already emphasized that sociality characteristics should not only be looked for within the game (as with non-parallel play), but also in the ability to monitor the other player's actions and emotions in the real world. It is important to see the other users within the real world. Gonzalo Frasca, quoted in [26], emphasized this aspect as well when observing physical play with the EyeToy: "*The first and obvious reason is that it is extremely easy to learn and it involves a very natural interface: body movements. But the most important reason for its popularity is that it is also a fun game to watch. People make a lot of goofy movements while playing it, so it is very enjoyable for non-participants*." Dalsgaard and Hansen [27] explain that with this type of movements, game actions are highly visible to the other players, transforming games into performances and players into spectators and actors. Our observations subscribe to these finding.

4 Designing the Atomium mini-game

Strengthened by the evaluation and refinement of the design rationales, we designed our own mini-game (Fig. 4), in which players help to restore the Atomium.[7]

[7] The Atomium was built for the national World Fair in 1958 and still functions as a symbolic building for many Belgians.

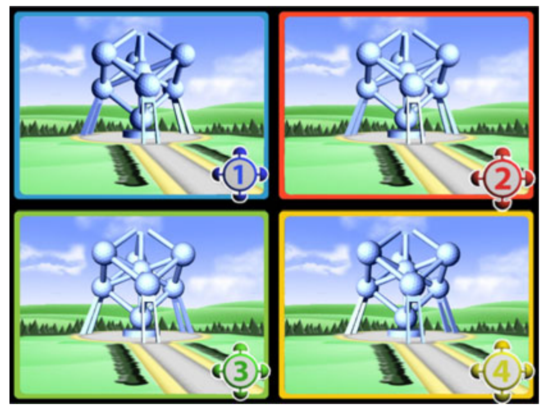

Fig. 4 The Atomium mini-game

Fig. 5 A screen shot of the in-game action

Playing the game is done solely with the WiiMote acceleration sensors, no button pressing or pointing is necessary (DR3). The players need to make fierce movements, but these are simple, one-step movements.

Players have to screw (by rotating the WiiMote as a screwdriver), rub of some dirty spots (by rubbing in the air with the WiiMote) and put one of these balls in the right place by swinging a crank (Fig. 5). Whoever finishes first, is the winner.

Similar to Breakneck Building, this game aims to provide enactive interaction, relying on prior life experiences such as screwing or cleaning. Furthermore, the designers aimed at offering clear digital affordances (DR1). Players

Fig. 6 Participants in action

cannot directly influence each other scores, each player has his own window, thus offering parallel play. Yet we aimed for competition via the drivers of ease-of-use, equality-in-ease-of-use and visibility-of-player-action.

5 User evaluation of our mini-game

Finally, we evaluated our mini-game with our audience (Fig. 6). Adhering to a design research approach, the aim of this testing was to explore the user reactions to our game. We were concerned with our seniors and youngsters experiences, perceptions, and feelings about the game, especially with relation to the refined design rationales.

5.1 Participants and procedure

In four trials, seven seniors (and one 45-year-old stand-in[8]) and eight youngsters played the game. Each trial, the mini-game was played by four players, two youngsters and two seniors. In the first two trials, there were no family ties between seniors (and stand-in) and youngsters. In the last two trials, the youngsters were grand children of the grandparents. Two trials took place at the usability lab of the university, two in a living room of one of the researchers. The duration of playing the mini-game is approximately 5 min (with about 3 min of physical play). The total duration of the test (including the play of the quiz) was approximately 60 min. After playing the quiz, an interview was held to further inquire for responses toward the quiz and more specifically the mini-game.

[8] Due to a sudden absence of one senior, a benevolent professor agreed to participate in one of the user tests.

5.2 Results

As a first observation, we noted that most seniors and youngsters quickly understood how to play the game, pointing toward *ease-of-use*. We did, however, notice that some seniors looked at the youngsters for guidance and copied their moves. Although requiring fierce movements, we did not see a difference in performance between the younger and older generations. Twice a senior won, twice a youngster won when playing these games, in line with our aim for *equality-in-ease-of-use*.

We also noticed that both seniors and youngsters immersed themselves into the activity and forgot about the cameras in the research lab or the researcher's living room. The fierce physical action ensured high *visibility-of-player-actions*. Again, we noticed a peripheral eye on the player's competitors. Comments during the game play made clear that the players were tracking each other's progress and that *competition* was fierce: "*What, you are faster?*", "*Grand dad, I am going to kick your ass.*" In one occasion, one of the female seniors triumphed when finishing first, shouting to the other (younger) players "*You didn't expect that, did you?*", a behavior we did anticipate from our youngsters but not from our seniors. After the competition was over, players would still enjoy and talk over the 'performance' they had given. One grand dad promised his grandson that next time, he would "*hammer him*". These statements underline the competition element that stimulated intergenerational play.

After playing the mini-games, we interviewed the seniors and youngsters, asking them for their opinions about the mini-game. All players stressed that they particularly liked the physical mini-game within the confines of a quiz game. When asking for their favorite quiz round, the Atomium game was mentioned most often, by both seniors and youngsters. For seniors, movements via the acceleration sensors seemed most spectacular to players; it seemed as if they could magically manipulate on-screen actions. This also explains why some seniors looked at youngsters for guidance. While they had experience with screwing, they had idea that they were able to actual screw from a distance with a WiiMote. Not surprisingly, they lacked a mental model of how motion sensors and Bluetooth work. However, the visibility of the competitor's actions gave guidance to start playing anyhow.

6 Discussion

Through the design process of this mini-game, we propose that it is not physical action but rather enactive interaction that ensures *ease-of-use* for seniors and youngsters. The use of enactive knowledge avoids relying on digital competences and/or mental models of how to operate digital appliances which would favor youngsters. The decline of perceptual-motor skills, associated with older age, did not seem to influence the game play of our seniors when making fierce movements that are sensed by the acceleration sensor. Therefore, designing for acceleration, together with designing for enactive interaction also implies *equality-in ease-of-use*, seniors and youngsters are equally good in playing the game. These fierce movements and the enactive interaction also support *visibility-of-player-actions,* transforming game play into a performance and players in actors and spectators simultaneously.

We argue that designing for acceleration and enactive interaction results in ease-of-use, equality-in-ease-of-use and visibility-of-player-actions. These drivers promote competition, fulfilling the interpersonal need of control, and consequently stimulate intergenerational play.

We acknowledge that these specific drivers uncovered in this study are preliminary insights, explored on a limited scale, with a limited number of users, as is typical for the qualitative nature of design research. We therefore put them forward as hypotheses needing further validation with confirmatory research modes.

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