AMBIGUITY, CURIOSITY, AND APPROPRIATION FOR LOW-THRESHOLD INTERGENERATIONAL ENCOUNTERS

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ABSTRACT

The growing number of video gamers over the age of fifty has sparked new interests in the transformative power of play and consequently, video games, for a larger demographic of citizens. Researchers have found that digital gaming can have positive effects on the physical, psychological and cognitive well-being of older adults. Of particular interest to this thesis is the potential of games to facilitate social connections between different generations of players. Intergenerational games have focused on improving relations between younger people and older adults by providing enjoyable interactions that can impart cognitive and physical benefits. While previous work has focused on enhancing intergenerational social connections between relatives, non-familial intergenerational encounters have scarcely been explored. Games often feature asymmetrical participation and require long term interest, all factors that can prove challenging to implement for public non-kin intergenerational gameplay. Previous works have shown that the successful use of games is dependent on a number of psychosocial and contextual factors that shape the player experience. One of them is the degree of familiarity between players. Familiarity has been linked to many of the core motivations associated with intergenerational play, exposing doubts of whether the same motivations can be used to inform the design of intergenerational games between strangers of different ages. In addition, for most socio-technical interventions designed for older adults, the characteristics of seniors have predominantly been framed around accessibility and decline. This limited perspective also tends to be true when discussing games designed for seniors. Finally, existing research on games for seniors has mainly focused on seniors who play conventional video games and self-identify as gamers, further marginalizing seniors who do not fit these descriptions. The current design of intergenerational games might not be ready for adoption by the broader society.

In response to these gaps, this thesis presents a research through design project aimed to investigate how a general population of older people (who may not be composed of video-gamers) perceive and experience game and play, and map this knowledge to promising playful approaches of intergenerational encounters while at the same time promoting a positive image of older adults as active and sociable members of society. The methodology featured a participatory approach that involved interview studies, co-design workshops, and playtests that helped to articulate the general requirements for an intergenerational game to be played in public spaces. The result of these formative exercises produced *Klang Verbindet* ("Sound Connects"), an interactive playful system that supports embodied interaction and group exploration of spaces. Designed to be played through body movements, the system employs vision-based algorithms and sound synthesis to provide an age-agnostic space for public play. Interactions with the system were evaluated in two different public contexts, using direct observations, semi-structured group interviews and post-game questionnaires. Based on these data and the design and implementation of the system, the thesis describes a number of important factors to be considered when designing and evaluating games for non-familial intergenerational interaction. The most important being, to design for short-term and low-entry engagements which are defined as "low-threshold intergenerational encounters". Within this space, the thesis discusses the distinctive value of - ambiguity, appropriation, and curiosity as drivers of gameplay for rapid mixed-aged encounters in the public context.

ACKNOWLEDGMENTS

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I overheard some D&D (Dungeons and Dragons) players in a restaurant, what they said made my heart full with joy. They said "magic is always better with friends". - Mark Mushiva, Facebook post from May 1, 2019

1. INTRODUCTION

Ever since the seminal work of Dutch cultural historian Johan Huizinga (1955) and perhaps even before, different practitioners have attempted to define play. Play has been lauded as a force of construction, destruction and everything in between. It has been described as a natural way of being in the world that transcends our species and is found in the animal world. Young animals play in order to learn important survival skills, our own human young roll and tussle alone or with others to learn important motor and social skills. Borrowing on Huizinga's (1955) definition of the magic circle as an instantiation of the environment of play, I posit that this is perhaps the most consistent feature of play. Almost all play takes place within the porous confines of a safe environment where learning, destruction and construction can take place. It is exactly this quality that I am interested in in this thesis. Play's ability to be a bridging force between realities and ultimately, between people.

The use of play as connecting force is not new and is present throughout history. Roman gladiatorial games, Mayan soccer (Poktapok), English jousting and theatrical play have all been spectacles that bring people together, whether through watching or playing. A modern-day manifestation of the inherently social nature of play can be witnessed from the diverse mix of nationalities, genders and identities that support team sports. In her book "How games move us: Emotion by Design", Katherine Isbister locates social interaction as a paramount activity for "human flourishing". From this she continues by stating that social play, in particular, serves a fundamental human need in a way that not even the most "intelligent" non-player character (NPC) can. The affective influence of playing with real people is more profound than that of playing with non-human agents. This has been widely demonstrated by studies that used questionnaires and physiological measures such as galvanic skin response [GSR] and muscle activity measured using electromyography (Isbister, 2017). Isbister (2017) elaborates that social play in gameplay is different from other passive forms of experiencing media such as watching a TV show or movie with other people. In gameplay, the actions of one player have real consequences on the experiences of other players, be it their physical bodies or those of their onscreen virtual avatars. This thesis focuses on social interactions in real life and investigate how gameplay can be used to facilitate low-threshold intergenerational encounters among strangers in public spaces. The topic was initially framed to contribute a different perspective to mainstream research on technology for active ageing and counteract its established ageism (Vines et al., 2015).

Whenever games researchers and theorists congregate, one can be sure to witness evocations of the differences between game and play. Play is often said to have a plurality whereby context determines the form of play. On the other hand, implementations of play in different contexts involving space, rules and materiality is what we usually consider as games, the most popular implementation of play. Games are considered as subsets of play where the same constructive and destructive nature of play is reined in by negotiated social constructs (rules) that dictate how play may be expressed. Play is a facilitator of social interaction in that when imbued with the slightest touch of structure and rule, playful action may be used to ensure that players interact, albeit in different ways.

Coordinated action can be considered as one of the foremost structures in fostering social play. The satisfaction that people get when they collaboratively solve a mental or physical challenge is exemplified by the universal fervour with which people support team sports. Players themselves have been known to become drunk with the excitement of having scored a goal over a feared rival. The popularity of collaborative human play transcends the analogue experience as we have seen with the explosive popularity of digital gaming platforms such as Massively Multiple Online Games (MMOs), it is fair to say that for the majority of people, "it's more fun to play together than alone" (Ibsiter,

2017).

1.1 Ageing and intergenerational games

There are mounting concerns about the rate at which the world's population is growing and this is especially true in Europe where experts predict that by 2020, a quarter of the population will be over the age of 60 (EC Europa). At the same time research shows that much of the new growth in population will converge around urban areas, lending credence to the thesis that citizens, national and foreign urban migrants will work and age in cities (Mushiba et al., 2018). This has special implications on future demographics of cities. Firstly, it suggests that cities are likely to experience a growth in older adult populations. Secondly, these new changes are likely to bring non-familial people from different cultural backgrounds into contact with each other as people migrate to cities for competitive opportunities. This will undoubtedly add both economic and social pressures on the social needs of a growing senior population. Increased social interaction is one of the ways researchers have proposed to counter social needs concerns of both senior and younger populations. Recent studies report that social interaction is a more reliable predictor of successful ageing than physical and mental conditions (Zhang and Kaufman, 2016). While the link between social interaction and well-being is not entirely clear, the benefits are often presented to contest the negative effects of social isolation (Mushiba et al., 2018). Social isolation has been reported to be prevalent amongst older adults and has further been identified as a cause of high-levels of dementia, depression and other deleterious medical conditions (Baecker et al., 2014). Many of the challenges related to social isolation require major changes in cultural norms, social policies and economic structures, however, the appeal of technical interventions to satisfy the physiological and social needs of older adults is quickly rising as an alternative.

There is a growing number of gamers over the age of 50 (ESA, 2009). This burgeoning market of senior gamers has given a complementary rise to research and development that explores the use of video games as a means to fulfil physical, psychological, and social needs of older adults (Gerling et al., 2011, Abeele and De Schutter, 2009, Zhang and Kaufman, 2015). There is initial evidence that video games have the potential to improve the cognitive and physical health of seniors through various means (Gerling et al., 2011, Zhang and Kaufman, 2015). For instance, video games can provide cognitive stimulation by challenging players to complete puzzles (Abeele and De Schutter, 2009). In parallel, exergames can provide enjoyable ways for seniors to complete physical exercises (Gerling et al., 2011) while intergenerational games have been shown to improve the social needs of older adults and younger relatives (Zhang and Kaufman, 2016). Developments in games research have started to give special attention to intergenerational digital games as a means to promote prosocial behaviour between different age groups. Increased social interaction has been linked to an increase in social participation, which in turn has been shown to promote physical activity (Ijsselsteijn et al., 2007) so it makes sense to focus on intergenerational digital games as useful tools to improve both the physical and psychosocial conditions of seniors and younger people.

To date researchers have mainly focused on 1) the effects of intergenerational interactions in digital games specifically designed for useful pragmatic purposes (e.g. physical and cognitive exercise), 2) defining the motivations behind familial intergenerational interaction and 3) what factors to consider when designing digital games for a purpose. While previous research has greatly advanced the field of intergenerational games, there are certain areas that still need expanding. So far, designers of intergenerational games have mostly studied the motivations for intergenerational interaction between relatives, such as those between grandparents and grandchildren. My own early research (Mushiba, 2018) on the topic signalled that the motivations for non-familial intergenerational interaction are scarcely explored. Subsequently, a review of previous work by Rice et al. (2012) revealed that motivations and preferences between non-familial players might be markedly different from those between kin. Moreover, the scarcity of research that illuminates behavioural factors or

even the effects of non-kin intergenerational relationships further highlights a gap in senior games research.

In light of the population dynamics mentioned above, an understanding of factors influencing non-familiar intergenerational interactions becomes particularly important for present and future urban contexts. Urban areas present differences in contextual, cultural and psychosocial constraints, all factors that are likely to affect how mixed-aged strangers interact (Mushiba, 2018, Fonseca et al. 2017). Attitudinal barriers have also been reported in familial intergenerational interactions, further bolstering the case for more investigations on non-familial interactions where attitudes are expected to be worse because of the typical age segregation we find in urban areas (Lloyd, 2015, Fonseca et al., 2017).

Despite demonstrating a wide variety of benefits, current video game interventions present several challenges for immediate adoption by seniors (Brown, 2012). Usability challenges around operating gaming devices, such as handheld and console systems, have been widely reported (Boot et al., 2013). Attitudinal barriers, like negative perceptions around playing video games have also been cited as a challenge, casting doubt on the suitability of the medium to meet older adult needs, especially in promoting social interaction (McLaughlin et al., 2013, Brown, 2012, De Schutter and Abeele, 2010, Boot, 2018). In addition, most video games for older players have been designed following medical requirements with little or no involvement of senior citizens at the early stage of the design process (Giaccardi et al., 2016, Ijsselsteijn et al., 2007, Cozza et al., 2017, Marston, 2012). Overall, current research on games for seniors tends to privilege the fulfilment of pragmatic design goals, such as accessibility and usefulness (Ferri et al., 2017), which may fail to satisfy those complex hedonic qualities such as fun, challenge, and immersion that are at the core of game adoption (Ferri et al., 2017). Seniors' conceptions and perspectives of video games as a creative resource is concerningly underdeveloped, leaving us to wonder what games might be if we allowed the voices of older adults to shape them.

1.2 Problem context

In a world were digital games are fast becoming a cultural force, attracting billions of players world-wide, researchers have found themselves asking, "what can games do apart from entertain?". In the last two decades playing digital games has been expanded from a nebulous activity reserved for reclusive young males to a trillion-dollar industry of all kinds of participants. Not only have games crossed over to be a commercial success but they have also been reimagined as social tools in the modern-day society. Every day, millions of gamers of all ages forge new relationships in Massive Multiplayer Online Role-Playing Games (MMORPG) and other social gaming platforms. This has left game designers with a challenge to design games that expressively aim to close social distance, a small departure from the purely entertainment aspect. Serious games or games for a purpose are games that are made for a motive other than entertainment (Michael and Chen, 2006). Intergenerational games can be said to belong to this larger category of serious games, through gameplay older adults and younger people are provided with opportunities for socialisation, enjoyment and mutual learning. Initial research suggests that the benefits that digital intergenerational games impart cannot simply be extended to non-familial players, prompting a need for understanding seniors' expectations and limitations of intergenerational games in more diverse contexts. More specifically, familial intergenerational games may prove unsuitable for public non-familial engagement because they often involve asymmetrical participation and require long-term interest to meet design goals. In order to offer a more appropriate alternative for non-kin intergenerational play, there is a need to overcome several challenges. Firstly, there is limited research that illuminates the state of attitudes between non-familial young and older people. Secondly, there is an equal lack of research that expounds on seniors' motivation for intergenerational interaction, especially those

between non-relatives. Thirdly, from the perspective of games as a means of social intervention, there are few examples of strategies that may be used in the design of games for non-familial cohorts.

Finally, in order to explore the potential for games to build relationships between mixed aged groups, the medium of digital games as a platform needs to be interrogated. Furthermore, if this potential is to benefit the broader society, the study of this field needs to extend beyond players who self-identify as gamers. Both the games research and games industry have been slow to offer seniors original game concepts that do not fall into the usability and usefulness category. This further exacerbates the challenge of wide digital game adoption by seniors. Studies have long reported resistance among elders to adopt digital technologies, alluding to a mismatch between seniors' needs and designers' conceptions on how those needs should be met. The challenges behind conflicting perspectives of seniors and game designers also affect the design of prosocial intergenerational games. In order to remedy this mismatch between what can be called "designer conceptions" and "senior realities", researchers have proposed the involvement of older adult stakeholders in the game design and development process (Marston, 2012). While this has been sufficiently theorized, there is little known research that demonstrates how this may be done practically. In order to contribute to closing this gap there is need for a fundamental understanding of senior motivations to engage in play and game, and their core conceptions of what game and play are. Expanding on these topics may very well produce new platforms of games that are suitable (enjoyable) for seniors and more importantly, that are more successful at reducing social distance.

Several emerging strategies in design practice present new directions in enhancing games that promote prosocial goals. I identify these to be ambiguity, curiosity and appropriation. While these strategies are not well established, they present novel opportunities for use in enticing, engaging, and retaining gameplay and therefore, improving the adoption of prosocial games. The thesis explores the use of these strategies and illuminates multiple ways in which they can be used in the design of mixed-aged prosocial games. Furthermore, I elaborate the challenges and opportunities of implementing these strategies within the context of public encounters between mixed-aged strangers.

Research questions

Given the aforementioned challenges in intergenerational games and senior games, the goal of this research is to design and study an intergenerational game artefact that is informed mainly by seniors' attitudes, expectations, motivations, practices and conceptions of intergenerational games, and emerging design strategies. In order to support an empowering vision of older adults as active members of society, I focus on older adults who live independently and who do not suffer from serious health impairments. I adopt an integrative design and practice-based approach influenced by psychosocial theories and interaction design practice. By doing this I attempt to answer the following research questions:

1. ***R1*** What are the motivations of older people towards non-familial intergenerational interaction?
2. ***R2*** How can we use curiosity, ambiguity and appropriation in the design of games that support non-familial intergenerational interaction?

   Sub-questions

   (i) What concepts of games do seniors hold?
   (ii) What are the ludic experiences of seniors?

1.3 Research design

In order to answer the research questions, I divide my methodological approach into three different phases, namely, (i) analysis of motivational context, (ii) design and development of prototype, and (iii) evaluation. The first phase provides many of the insights needed to answer R1 and sub-questions while the final two phases address R2. Notably, the second phase is comprised of two processes (design and development) that happen so frequently and dependent on each other that it makes sense to describe them as one process. Each phase of the process produces several outputs as illustrated in Figure 1. The research process is carried out in a Research through Design (Rtd) manner, which in brief, means that various design objects are created to develop an understanding of the design space rather than to solve one singular design goal. A more comprehensive description of the research through design approach is given in Chapter 3.
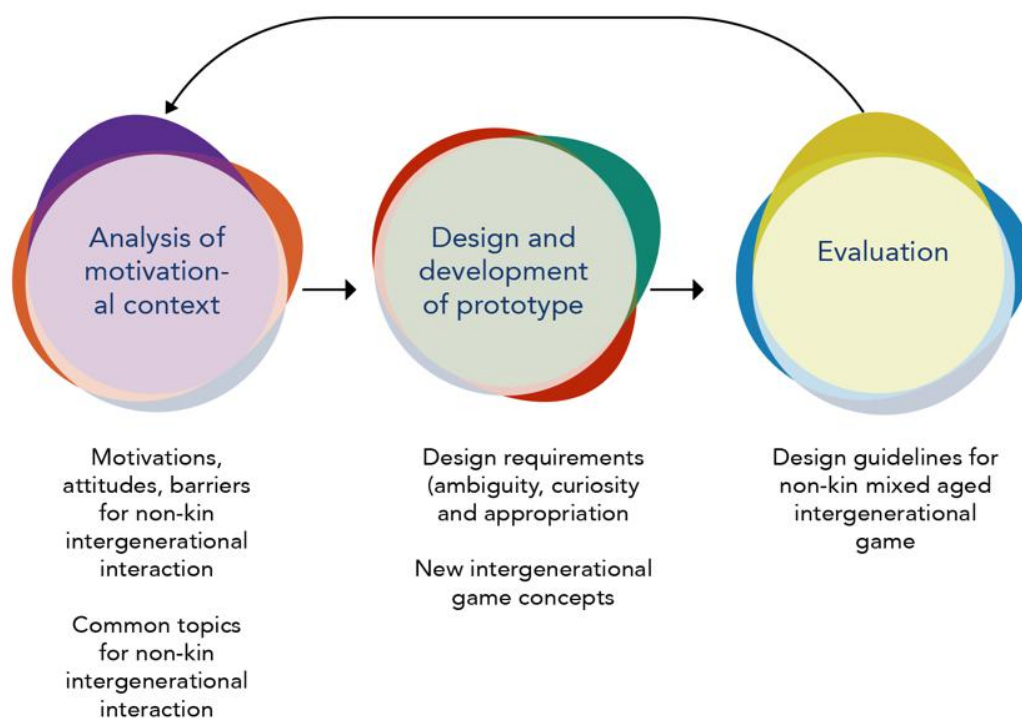
Figure 1: Research process

Following the research through design approach, the research contributes the following:

- Expand and explain seniors' attitudes and motivations for non-kin intergenerational interaction
- Explaining seniors' conceptions and perceptions of video games
- Describe the design and evaluation of ambiguity, curiosity and appropriation in a co-designed intergenerational game (Klang Verbindet) prototype
- Guidelines for the design of non-kin intergenerational games in public contexts

1.4 Limitations

This thesis has several limitations which need to be taken into consideration when generalising results for intergenerational groups, they are mainly concerned with a strong focus on the perspectives of healthy older adults, time constraints and a small sample size.

Older adult-centric perspective. The research mainly elucidates the challenges of intergenerational interaction as articulated by older adults. While I had hoped to give equal consideration for younger people, their perspectives on intergenerational interactions was only explored in a limited capacity. Younger players were involved in the co-design and evaluation of the intergenerational game prototype. Furthermore, my decision to focus on older adults is motivated by the fact that seniors are less socially active than their younger counterparts (Nelson-Brown, 2006). Another reason is that younger people are regarded to be more receptive to technology, making them less favourable candidates to articulate the existing challenges of adopting intervention technologies. Finally, the research does not directly address social isolation among seniors, instead it investigates the potential for intergenerational games to create new connections for healthy older adults.

Demographics. Due to a shortage of research on the matter, and prevailing concerns of ageism in technology design, I focused on older adults who live independently and are in good health. Seniors from European ethnicities. While this criterion satisfies the purpose of my research, it overlooks the effects of variables such as nationality, gender and class on the intervention design. Another simplification this thesis makes is the difference between non-familial and non-familiar. It is possible to have non-familial familiar relations and vice versa but for the purpose of this research both non-familial and non-familiar are used to refer to interactions where mixed-aged groups are strangers who have no prior connections.

Evaluation. It is important to note early on that the goal of the research is not to bring about a change in behaviour towards non-kin intergenerational interaction but instead, to argue the central role of intergenerational games as a promising avenue where non-kin interactions may take root. In this way the research is similar to the justifications of information and communication technology (ICT) artefacts given by Wulf et al. (2011) that state that, "the research challenge is to design innovative ICT applications so that their appropriation leads to (desirable) impacts on the applying social systems" p1. Of course, such a challenge cannot be achieved unless the design of an envisioned system is understood through its interaction with the applying social system (Wulf et al.,2011). With this limitation in mind, evaluation of the developed system and its constituents are based on the intervention's perceived ability to encourage intergenerational interaction. While I can say that intergenerational play with the intervention occurred during public play tests, I did not specifically control for different relationship types, instead of pairing young and older adults, players were allowed to choose their own partners. This was due to the voluntary and explorative nature of the playtest and my interest to observe design features' effects on appropriation, ambiguity and other themes. In the evaluation of the system, players who engaged in intergenerational play answered from their experience while players who did not where asked to imagine the potential of an intergenerational experience through the artefact. Each play test involved a different sample size and demographic composition.

1.5 Thesis outline

This section describes the structure of the PhD dissertation. It charts the development of the research and how every chapter contributes to achieving the research goals.

Chapter 2: Related work

This chapter presents a review of relevant literature in senior practices and motivations for digital gaming, design of games for older adults, gerentololudology, senior practices and motivations for intergenerational gaming and the design and evaluation of intergenerational games. I present a state of the art in intergenerational games in the form of existing design strategies and how they informed the research. I explain the relevance of using player-centred design as a way to overcome issues of ageism in digital game design for older adults. I also present critical findings from the research that highlight the need to reconceptualise intergenerational games, not just as interventive artefacts but as experimental mediums that provide chance encounters for shared enjoyable experiences. I use this to ground the relevance of games as a form of enquiry to explore how to address the wicked problem of designing for different generations. With this I also present a few arguments on why designing for intergenerational interaction warrants renewed investigations on account of *familiarity* as a pivotal variable in intergenerational interaction.

Chapter 3: Methodology

I present and explain the research design in the PhD period. I introduce the approach of research through design and advocate for a theory-led and data-driven approach to understanding behavioural determinants, giving several methodological justifications along the way. I also explain the relevance of accounting for non-familial behavioural determinants with the Integrated Behaviour Model and go on to describe how the outcomes of the preliminary work informed the planning and execution of subsequent design activities. I also give more practical definitions of ambiguity, curiosity and appropriation and their relevance in meeting prosocial goals for intergenerational games meant for the public context.

Chapter 4: User studies

In this chapter I provide a description of user studies in the form of a series intergenerational interview studies carried out in Italy and Germany. From the results I provide an impression of attitudes and motivations towards intergenerational interaction and interpret the results through the Integrated Behaviour Model. I examine activities, barriers and opportunities for intergenerational interaction. I also provide a summary of seniors' attitudes, perceptions and conceptions of games and probe their perceived potential to encourage intergenerational interaction.

Chapter 5: Co-design studies

I summarize findings from participatory game design activities. I discuss the challenges I faced in empowering multiple stakeholders as game designers at a festival in the town of Lincoln, UK. I report on various prosocial game concepts produced in the workshops and how they pointed to relevance of age agnostic game concepts as an approach to catering to intergenerational social needs. In addition to this I also describe an intergenerational game codesign workshop I hosted in Berlin, Germany that helped elicit the bulk of technical and design requirements for an intergenerational game intervention. The chapter concludes with a series of design guidelines that encompass the learnings from preliminary activities and literature.

Chapter 6: Game Design of Klang Verbindet

Drawing from the previous chapters, I describe the implementation of guidelines in the design and development of two versions (playful, gameful) of a playful artefact for encouraging intergenerational encounters. I describe the evolution of the playful artefact into an intergenerational game intervention. I motivate the need for experimental game interfaces that use metaphors, ambiguity, curiosity and appropriation as design resources. I also give a technical description of the artefact as a system before detailing two public playtests that took place in two different countries.

Chapter 7: Evaluation

In this chapter I discuss the player experiences from an evaluation of the intergenerational game intervention supported by video and field observations, unstructured group interviews, and a post-game questionnaire. I relate the concepts of ambiguity, curiosity, appropriation and ambiguity to the results. I position enjoyable low threshold encounters as an appropriate measure for non-kin intergenerational interaction. I give a final summary of the artefacts potential to promote non-familial intergenerational encounters.

Chapter 8: Conclusion

In this chapter discuss the contribution of the research work towards answering the research questions. I discuss the extent to which research objectives were achieved and the limitations of the thesis work. I also comment on the performance of theoretical frameworks in understanding the behavioural determinants of intergenerational interaction. The chapter concludes with directions for future research and general commentary of my thoughts on ageing in current and future societies.

Related Published Work

Mushiba, M., D'Andrea, V., De Angeli, A. Persuasive Games for Intergenerational Social Interaction in Urban Areas. Proceedings of International Conference on Intelligent Technologies for Interactive Entertainment 2017, Madeira, Portugal. (2017)

M. Mushiba and H.M. Heissmeyer. 2018. Dérive: An exploration of critical play for urban placemaking. In Proceedings of AFRICHI2018 conference, Windhoek, Namibia, December 2018 (AFRICHI'18), https://doi.org/10.1145/3283458.3283525

M. Mushiba. 2018. Sound Play: An Interactive Installation for Playful Intergenerational Encounters in Public Areas. In Proceedings of AFRICHI2018 conference, Windhoek, Namibia, December 2018 (AFRICHI'18), https://doi.org/10.1145/3283458.3283506

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Cozza, M., De Angeli, A., Jovanovic, M., Tonolli, L., Mushiba, M., McNeil, M., Coventry, L. Understanding Motivations in Designing for Older Adults. Proceedings of COOP2016, Trento, Italy. (2016)

Willis, M., Adamo, G., Mushiba, M. Persuasion and Empathy in Computer Games, An Ontological Perspective. 12th International Conference on the Philosophy of Computer Games (2017)

2. RELATED WORK

This section reviews works from gerontoludic research, a term proposed by De Schutter and Abeele (2015) to describe the bridging of two nascent areas of research, gerontechnology and ludology. According to Bouma et al. (2007), gerontechnology is described as "a harmonization of demographic and technological developments, through the direction of technological innovation to the ambitions, purposes, and needs of ageing persons" p 1. Ludology is defined as "a discipline that studies game and play activities" (Frasca, 1999). Within this context, I grouped works according to four overarching themes, namely, works that i) investigate existing practice and motivations for senior gaming, ii) incorporate the senior perspective in the design and development of video games, iii) investigate existing practices and motivations for intergenerational gaming and finally iv) incorporate the user perspective in the design and development of intergenerational digital games. Overall, a review of the related work on intergenerational games revealed that many of the studies in the state of the art were qualitative exploratory studies limited to a short number of participants. Studies often focused on a single collaborative game intervention. Common methods used to evaluate interventions were observations, questionnaires and interviews.

In this section, the terms video games and digital games are used interchangeably to refer to games that are played on a computer or other gaming system that features a display and a controller interface. This is done to distinguish such games from more experimental platforms such as interactive installations that might have the same goals and also employ digital technology but mediate the human-computer interaction in an unconventional way. I contend that conventional video games are only one of many digital formats in which play and game aspects can be instantiated in order to promote prosocial behaviour. With this it was my hope that a more pluralistic and expansive vision of game interventions could broaden current understandings of game and play and contribute to a more complete picture of how alternative mediums such as playful installations and other experimental platform can help to meet seniors' needs.

2.1 Digital games for seniors

Digital games have become a dominant industry, according to Entertainment Software Association (ESA, 2018), 2.6 billion of the world's population plays video games. In more developed economies like the United States of America, 60% of the population plays video games daily, with 25% of gamers being seniors (ESA, 2018). In a UK study by (Pratchett et al., 2005), it was found that 18% of seniors aged 51-65 years played digital games, with two thirds of that number playing at least once a week. A Finnish consumer study by Kangas and Lampila (2006) on exercise games (Exergames) found that every pensioner over 65 years old (52%) played computer games, while (22%) or every fifth pensioner admitted to playing games on a daily basis. Video games have also become an established topic in academia, with numerous studies (Gerling et al., 2017, Abeele and De Schutter, 2009, McLaughlin et al., 2013) on games for physical exercise, cognitive training, behaviour change and other health-related goals. Pearce (2008) and De Schutter and Abeele (2015) posit that while the growth of the gaming industry has produced many offerings for youngsters and adults, games for seniors have not experienced the same growth. There has particularly been a meagre growth in commercial or research-related games for seniors that focus on hedonic aspects such as enjoyment, fun and relaxation (Pearce, 2008, De Schutter and Abeele, 2015).

The dominant view is that young players, especially young men, are the most prevalent gamers, even though trends are starting to show that over-40 players have been the main contributors to recent growth trends in the gaming industry (Pearce, 2008). One of the reasons for the lack of games for seniors is that seniors are perceived as harder to design for. The game designer Jason Nelson-Brown (2006) asserts that older gamers are a more challenging demographic to design for because unlike

younger players, this group of gamers is more diverse and has more gaming experience. Nelson-Brown (2006) contributes that because of their long experience with games, older gamers are more responsive to games that use memory and nostalgia, motivating the need for more complex and experimental games outside the mainstream. Pearce (2008) also contributes that although in-game interactions have been sufficiently studied, real-life social interactions and contexts for gaming for seniors has not received much attention.

With the exception of Nintendo, the video game industry has been somewhat reluctant with considering older adults as a market for entertainment games, even though they represent a large population of an untapped market (Pearce, 2008). Much of Nintendo's success with older players can be attributed to their focus on the health-related needs of senior gamers (Pearce, 2008). For instance, for their Nintendo DS platform, Nintendo released and heavily marketed the game Dr Kawashima's Brain-training: How Old is Your Brain. In the game, players are engaged in series of puzzle, quiz, and number challenges. The player's progress is tracked and an intelligence level score is attained through attention and memory processes (Ijsselsteijn et al., 2007). De Schutter and Abeele (2015) support that mentally challenging games like Dr Kawashima's Brain-training: How Old is Your Brain provide cognitive benefits to players who want to mitigate the effects of mental decline. Another factor for Nintendo's success has been their departure from complex thumb-centric controller interfaces such as those found on Sony PlayStation and Microsoft Xbox game consoles. Nintendo uses more gesture-based controllers that give the players more confidence in interacting with game elements (Ijsselsteijn et al., 2007, Gaudiosi, 2007). A good example of this is their Wii-mote controller, a minimally designed wireless controller that captures hand gestures and translates them into game inputs. Even with the somewhat gerontological focus of Nintendo's games (e.g. Dr Kawashima's Brain-training), the gaming company has an excellent track record making games that are both fun and self-enhancing (Pearce, 2008). Unfortunately, commercial examples like Nintendo are rare.

Much like the games industry, De Schutter and Abeele (2015) assert that games research has also focused on usefulness, particularly around the rehabilitation and prevention of mental and physical decline. De Schutter and Abeele (2015) state that these themes of accessibility (ease of use) and usefulness have driven and dominated game design in at least two clear ways. Accessibility has resulted in an emphasises on the age-related constraints of older adults when playing games, and usefulness has prioritised the pragmatic qualities of games to improve the cognitive and physical capabilities of seniors. In its current state, the games research landscape frames games as tools for physical and cognitive enhancement, ignoring hedonic aspects that support non-instrumental senior needs. However, with all its shortfalls, games research has tried to push the agenda of games as tools for social interaction. Research by (Rice et al., 2013, Rice et al., 2012, Zhang and Kaufman, 2015, Abeele and De Schutter, 2009, Khoo et al., 2008) has outlined new directions for prosocial games, mainly by locating them as a means for older adults to maintain and make new social connections. The prioritisation of social interaction is justified by its ability to encourage both physical, cognitive and hedonic benefits for seniors (Mendes de Leon, 2005). Although itself plagued by a need to be useful, prosocial games serve a more broad-based advantage in that it is the enjoyment of social interaction through which all other goals of self-enhancement are channelled. This position is further strengthened by evidence that social interaction is the main motivator for why seniors play games.

2.2 Senior motivations for digital gaming

Even though video games are undoubtedly more popular with teenagers, the current and growing population of seniors represents both social and financial opportunities for game designers and those who would benefit from their work. Several researchers including (De Schutter and Abeele, 2010, Ijsselsteijn, 2007, Zhang and Kaufman, 2016) have argued for a more sustained effort in uncovering prevailing motivations for senior gaming. Motivations are valuable design resources because they give us an impression of the perceived benefits users seek to derive from gaming. In a comprehensive study by Melenhorst (2002), researchers found that seniors were more likely to adopt new technologies if they were able to perceive some benefit to their use. In some studies, researchers have developed more advanced theoretical frameworks for motivation-based design. For instance, De Schutter and Abeele (2010) carried out an exploratory study to investigate the different meanings senior gamers ascribe to playing video games in a psychosocial context. The study featured 35 participants aged between 50 and 72 who regularly played a variety of 2D and 3D video games. The results of the study are reported according to the Meaningful Play in Elderly (MPE) model (De Schutter and Abeele, 2010), a conceptual framework that expresses motivations for play through three aspects; Connectedness (facilitating social interaction), Cultivation (facilitating self-improvement), and Contribution (meeting collective goals). The Table 1 below gives a summary of motivations I encountered in the state of the art. The motivation types have been extrapolated into the MPE's categorisations.

Table 1: Motivations for senior gaming

Motivation	Description	Example	Motivation type
Social engagement	Games provide a means for social interaction and strengthening of familial bonds	*Collage* "allows families to express some of their traditional forms of collocated engagement over a distance. These forms of engagement include playful activities, but also extend to storytelling, gift-giving, and confirmation of social roles" (Vetere et al., 2009)	Connectedness
Mental challenge	Games provide cognitive training	*Brain Age* allows seniors to train cognitive abilities through puzzle and memory gameplay (Ijsselsteijn et al., 2007)	Cultivation
Physical exercise	Games provide physical exercise	*Gymcentral*, a gamified platform that encourages and instructs home-based physical training routines for seniors (Far, 2016)	Cultivation
Learning/technology support	Games provide a means for intergenerational learning	*Family Quest*, a multiuser 3D educational computer game (Siyahhan et al., 2010)	Contribution
Teaching/knowledge transfer	Games provide means to transfer own knowledge	*Blast from the past!* Quiz-based game that facilitates knowledge transfers between youngsters and seniors (Abeele, De Schutter, 2009)	Contribution

Social engagement

Literature (De Schutter and Abeele, 2010, Osmanovic and Pecchioni, 2016, Vetere et al., 2009) in senior games report a resounding motivation for social engagement, which was also found to be the most reliable predictor for the length of gameplay. Many seniors viewed playing games as a way of socializing with friends and relatives across great distances, although several studies such as Osmanovic and Pecchioni (2016) highlighted an overwhelming preference for physical co-located play instead of remotely mediated co-play. When seniors played with others it was mostly with grandchildren or children and in point-and-click adventure games (Pearce, 2008). In addition, games on platforms like Massively Multiple Online Role-playing Games (MMORPG) allowed seniors to meet and develop friendships with people from different cultural backgrounds (De Schutter and Abeele, 2010).

Mental challenge

It is well documented that the use of electronic media may influence health aspects (Eggermont and Vendebosch, 1999, Trepanier-Jobin, 2016), consequently senior games research has been exploring how to design and improve the uptake of video games by seniors. Osmanovic and Pecchioni (2016) reported that seniors enjoyed intellectually challenging games that followed rich narratives. Elders will play games such as puzzles and quizzes in order to enhance memory and attentional abilities (Ijsselsteijn et al., 2007). A review by Zhang and Kaufman (2015) gives a more comprehensive detailing on the cognitive effects of video games.

Physical challenge

Seniors view playing digital games as an enjoyable way to do physical exercise. In previous studies, seniors who played games were reported to experience general improvements in health and a higher success in completing physical rehabilitation programs (Ijsselsteijn el al., 2007, Jorgensen et al., 2012, Far, 2016, Awad et al., 2016). The emergence of new interactive technologies, especially those in motion capturing offer new ways for gamers to use their whole bodies to intuitively interact with game systems. These developments have particularly been more evident in exercise games or exergames, where the movements of gamers drive gameplay while involving seniors in physical exercise routines. Ijsselsteijn et al. (2007) note that it is in this way that games for seniors can take on the role of persuasive technologies; technology that encourage users to perform healthy behavioural actions.

Learning

Studies (De Schutter and Abeele, 2015, Siyahhan et al., 2010, Zhang and Kaufman, 2015) also found that playing video games was a way for seniors to indirectly learn and receive technical support from children and grandchildren. Sometimes games also provided a feeling of independence and autonomy. De Schutter and Abeele (2010) contribute that these feelings were related to the fact that some games allowed seniors to have fun without requiring the involvement or physical presence of other players. As part of the learning motivation, seniors have also been reported to derive confidence from playing video games. In a historical video games study of seniors in a long-term care home, McGuire (1984) state that seniors that played video games showed greater improvement in self-esteem than the group that did not play video games. Ijsselsteijn et al. (2007) offer a possible explanation for this effect by stating that after interacting with video game systems, seniors showed increased self-efficacy and computer literacy in relation to other modern technologies.

Knowledge transfer

Previous research by Osmanovic and Pecchioni (2016) also showed that seniors played games that allowed them to feel useful by sharing their experiences and knowledge. Studies (De Schutter and Abeele, 2010) support that solving game challenges with young relatives allowed seniors to feel like they were contributing to a shared goal. It also allowed them to demonstrate their knowledge to younger players, especially with challenges that required more cognitive skills which were not fully developed in their younger counterparts or games that required historical knowledge (Abeele, De Schutter, 2009).

2.3 Challenges for video game adoption

Video games represent a wide range of possibilities for self-enhancement and other health benefits. Most importantly, they promote social bonding and thereby have the potential to fulfil the social needs of seniors (Ijsselsteijn et al., 2007). Even with these benefits, seniors have not yet fully embraced these experiences (Osmanovic and Pecchioni, 2016). While convincing when presented in research interventions, it is not clear whether the broader population of seniors are aware or in agreement with the perceived benefits that digital games offer. This creates a need to account for attitudes and seniors' motivations for adopting digital gaming technologies. Ijsselsteijin et al. (2007) write that "A perceived lack of benefits may be more detrimental to the adoption of digital games, than perceived costs associated with usability problems, we need to design rich and rewarding experiences, combining low-threshold interaction styles with content that will directly speak to and engage elderly users". P1. Several other challenges to the adoption of digital gaming are explained below.

2.3.1 Usability

So far research has taken physical and sensory limitations as the characterising feature when developing technologies for seniors. While this undermines the well-developed and diverse preferences of seniors, this model is founded on concrete evidence. Ageing is generally related to well-documented changes in sensory-perceptual processes, motor abilities, response speed and cognitive processes (Pratchett et al., 2005, McLaughlin et al., 2013). When we age, we will experience at least some kind of decline in the abovementioned functions. It should not be a surprise then that most designers for game interfaces abstract their requirements from these perceived limitations. Furthermore, Pratchett (2005) posit that present generations of seniors only encountered computer technology in the work setting and may have lived much of their lives without sufficient exposure to these technologies. This suggests that many seniors may understandably be missing developed conceptual models of how new computer technologies work. To explain this, Docampa (2001) posited that apart from the ageing effect, there is also a technology generation effect that may influence the adoption of new technologies. During the formative stages of their lives, computer users adopt certain dominant conceptions of human to machine interaction. These conceptions are developed over a long period of time and become difficult to change. Docampa (2001) found that computer users from the "electromechanical generation" (born before 1960) incurred more errors in computer use than those from the so-called "software generation" (born after 1960". Pratchett et al. (2005) contribute to this point by stating that functional and experiential limitations of seniors from different generations could impact the confidence seniors will have when playing digital games. Despite usability related adoption challenges, it should be noted that a large part of seniors (55-75 years of age) have demonstrated the ability to learn and master new ICT skills (Bouwhuis, 2003).

Rogers et al. (2014) offer an opposing account that seniors are getting on with technology better than we think. The researchers posit that not only are seniors becoming more active after retirement, they are also increasing their technology use (i.e. Skype, Facebook, and Email) as they become more motivated to maintain social ties outside of work. Some seniors found that having struggled to acquaint themselves with technology towards the end of their work careers, they now had ample time and opportunities to learn and embrace technology into their private lives.

While the above-mentioned limitations by no means justify solely focusing on usability aspects, it is important to acknowledge and be aware of the usability constraints of seniors. At the same time, it is important to note that interfaces, which have the potential to accentuate limitations, are only a small part of interacting with computer systems. The content, processes and aesthetic appeal of these systems, especially games, are just as important if not more. Melenhorst (2002) affirms this point by stating that more than challenges of adopting new interfaces, it is the perceived lack of benefits that is most inhibitive of adoption. For seniors, usability alone is not a sufficient enough motivation to use a software (Ijsselsteijin et al., 2007). Superflux (2015) created a humours video to show the importance of creating engaging assistive technology that prioritises enjoyment over usability and self-enhancement. The video tells the story of Thomas, a 70-year-old man who finds himself extremely annoyed by smart devices that remotely tracks his behaviour for his son. One of the devices, a smart fork, continuously monitors what Thomas eats and sends high pitched notifications when Thomas is not eating healthy. To enjoy his fried fish and fries in peace, Thomas tricks the fork into "thinking" he is eating health by leaving it in a plate filled with vegetables. Thomas does not eat the vegetables.

Figure 2: Uninvited Guests (Superflux, 2015)

2.3.2 Attitudinal barriers

According to Boot et al. (2018), there is a consolidated agreement in society that older adults do not play digital games. These perceptions are borne out of societal stereotypes that video games are for young people since they require mental and physical abilities seniors no longer possess. Others have also noted this outlook, Van Leeuwen and Westwood (2008) draw out this biased attribution of play to youth by stating that it is peculiar that play is regarded as essential in early life but then denigrated or even looked down upon in later stages. In some cases, this outlook has been further reinforced by a resistance of older adults to adopt new gaming technologies (Boot et al., 2018). There is initial evidence that there may be conflicting motivations in playing video games. Although generally regarded as a positive activity, Boot et al. (2018) mention that participants in several game studies felt that sometimes digital games undermined the social experience. For instance, none of the participants in the aforementioned studies indicated playing video games as a passion, instead stating that they preferred outdoor activities that lead them to connect with people. This disconnect between expectations of seniors and offerings by designers signals the existence of a self-fulfilling bias, one in which designers continuously focus on making the "wrong" games which are not adopted by

seniors which further engenders the perspective that seniors are particularly resistant to digital games. In real it would help to point out that while seniors are not a homogenous group, they are repeatedly asked to adopt a homogenous group of games.

Seniors also reported to be sceptical about whether video games really led to self-improvement, instead some felt that playing video games negatively affected connectedness and cultivation aspects when players got addicted (Boot et al., 2018). There are some cases where seniors expressed a preference to playing digital games alone, but even in these cases, seniors held the reservation that playing video games alone often led them to feel disconnected from real life (De Schutter and Abeele, 2010). Seniors who preferred single-player games cited online abuse and ridicule from younger players as the reason why they were reluctant to play online multiplayer games. Even with this impression, some seniors admitted to playing online games to form cross-generational friendships (De Schutter and Abeele, 2010). In other studies, participants felt that newer games were too reflex-oriented and called for more offerings that focused on adventure, story and intellectual challenge instead of graphic intense violent shooters (Pearce, 2008, De la Hera et al., 2007). The strong aversion to violent video games is pronounced. Other researchers have recorded similar negative sentiments about video games. Marston (2012) reported that senior players had a particular disinterest in computers games as they found it to be an unproductive use of their time. This makes sense when considering Ijsselsteijn et al. (2007) thesis that "perceived lack of benefits" could be an inhibitor for digital game adoption. Nevertheless, this link between seniors' time and perceived lack of benefits requires further investigation.

Popular studies by De Schutter and Abeele (2010) and Marston (2010) showed that seniors preferred traditional analogue games, such as Mah Jong, Cards and Sudoku, which they considered as a more effective way of maintaining "mental fitness" than digital games. Puzzle and strategy were the most popular game genres among participants and seniors stated that they enjoyed games from their past. The correlation between popularity and past time has been the object of interesting speculations. Nap et al. (2009) posit that seniors may be retaining a preference for traditional games due to a lack of electronic equivalents on digital platforms. Again, although negative attitudes were prevalent in the previous studies, a lack of spare time seemed to be the most salient reason participants gave for not playing video games (De Schutter and Abeele, 2010, Marston, 2010). Participants simply did not see playing video games as the best way to spend their time, further adding credence to the lack of perceived benefits from playing video games.

Despite overlaps in experiences, seniors are a widely diverse group and differences in gaming preferences and motivations are bound to exist. Reported barriers to video game adoption sometimes contradict reported benefits. I offer that the source of this conflict is due in part to the focus on self-identifying senior gamers and improving the adoption of video games. Focusing on self-identifying senior gamers risks skewing impressions of video games among the general population of seniors. Previous research by Nap et al. (2009) support that while seniors might not always associate with the term "gamer" or play video games, they have a life-span's experience of playing a diverse selection of games. The focus on self-identifying senior gamers has perpetuated a notion that only seniors that play video games can be considered as gamers, creating the illusion that current seniors enjoy video games while senior sentiments on video games hardly reflect such. Ijsselsteijn et al. (2007) maintains that, being a heterogenous group with different experiences, abilities, interests and tastes, a typology or categorization of senior gamers might not be useful. For the broader society of seniors who play games, it could be that while video games provide much desired mental challenge, the often-solitary activity of playing conventional digital games undermined seniors' needs for social interaction. It is worth noting that in a large number of studies, co-located social interaction was identified as the most critical determinant of senior gaming behaviour. This signals that while digital games facilitate desired benefits, the medium itself does not always support how seniors want these benefits to be

delivered, which may be described as a disengaged and impersonal way. The research landscape is lacking the perspectives of so-called non-gamer seniors, which this thesis aims to provide. Furthermore, there is a generalised lack of research that interrogates senior-centric descriptions of games (Nap et al., 2009). Therefore, HCI research could benefit from work that interrogates broader older adults' perception of games, which entreated me to ask this particular group the question "what is a game to you?"

2.4 Designing games for seniors

Reviewing the literature reveals that bulk of the efforts around digital games for seniors have been centred on interfaces and not content. Interfaces have mainly aimed to accommodate seniors' reduced ability in spatial memory, working memory and motor functions. Several studies in senior's games research including Marston (2010), Blythe et al. (2015), Awad et al. (2016) and Ijsselsteijn et al. (2016) have all called for a more appropriate design of senior games through reflective research.

2.4.1 Player-centred design for senior games

Involving users in the design process is often cited as a way to create products that fit their needs (Awad et al., 2016, Ijsselsteijn et al., 2007, Wilkinson and De Angeli, 2014). Although a large part of HCI employs user-centred design methods to develop games, these methods are often used later in the design process when crucial decisions like story type, character and game mechanics have already been decided (Abeele and Rompaey, 2006). Marston (2012) asserts that there is scant research that involves seniors in game design. Previous studies (Ijsselsteijn et al.,2007, Awad et al., 2016, Marston, 2012, Abeele and Rompaey, 2006) argue that incorporating the user perspective in the design process helps to create more engaging games. This is particularly important in the creation of games intended for purposes other than entertainment or as they are commonly known, serious games (Michael and Chen, 2006). An example is games that provide an enjoyable means of doing physical exercise and rehabilitation- exergames. Exergames typically operate in a system comprising of a sensor and a display. The sensor captures player movements and translates them into signals for controlling on-screen game elements. Awad et al. (2016) add that because exergames rely on the player's movements to create an engaging and enjoyable experience, it is particularly important to factor in the user perspective. The user perspective accounts for the abilities of the player, the context in which the game is meant to be played, meanings derived from gameplay and the motivations for playing the game.

The manner in which the user perspective is incorporated has been a subject of interesting discussion for the senior games research community. In their work on designing a game for older adults, Awad et al. (2016) elaborate on the concept of affordances: the opportunities for action provided to players in a given context (Greeno, 1994). These opportunities are induced by the mutual relationship between the player and the game characteristics. For instance, graphical elements in a game give cues to players on the actions they should perform and an impression of what would happen afterwards. Awad et al. (2016) call this *the perceived affordance or opportunity of action*. Exploiting the concept of affordances, Awad et al. (2016) developed a movement-based game Butterfly Catch (see Figure 3) that required older players to catch virtual butterflies using specific hand movements. To develop this idea, the researchers first tested a host of commercial Microsoft Kinect and Nintendo movement games in a focus group involving older adults. The group was then involved in iteratively testing different versions of the game until such a level that the game's features were deemed enjoyable for them. The main recommendation from this study was that the visual presentation of the game should guide the actions of the player, consider the player's motivations and abilities, and use different rewarding systems in order to secure engagement.

Figure 3: Butterfly Catch game interface

In a similar study, Abeele and De Schutter (2009) explored the design of a movement-based game for intergenerational interaction. The design was based on a set of design rationales elicited from a mixed-aged group's experiences with various physical mini-games. By iteratively testing ready-made games, researchers were able to identify certain features intergenerational games should have. One of these design features, designing for enactive interaction, stresses the importance of gameplay that utilizes the player's learned motor responses. These responses are acquired from repeatedly performing actions in the physical world (e.g. walking) (Abeele and De Schutter, 2009). For instance, instead of using complex controls, a game might use the player's mental model of hammering down a nail in order to get the player to perform a similar action in the game.

Similar to Awad et al. (2016) use of affordances, the graphical interface of the game communicates the possibility for actions available to the player. Although the researchers tested for game requirements related to the cognitive and physical abilities of the players, the concepts of the games themselves were scantily interrogated. A review of previous shows that in eliciting technology requirements there is often of a lack of research that involves seniors as a heterogenous population in mind (Rice and Carmichael, 2011). In some cases, the lack of inclusion of seniors in generating game concepts has been attributed to a lack of knowledge and or confidence to be able to articulate design possibilities with methods such as low fidelity prototyping (Rice and Carmichael, 2011). However, this claim has been challenged by other researchers.

Marston (2012) supports that involving seniors in generating game concepts has been shown to entice older adults to play digital games and that failure to do so might result in poor technology adoption. The activity of successfully designing games for an aging society is intrinsically linked to understanding preferences, attitudes, conceptions, and capabilities of older adult players (Marston 2012, Brown, 2012, Nap et al., 2009) and involving seniors in design fast-tracks this understanding. In a rare study involving 24 participants, Marston (2012) investigated the genres older adults would want to play. The research involved participants in the design of game concepts using worksheets that simplified an ad hoc game design process. I would later use this worksheet approach in my own

codesign activities. Although the study by Marston (2012) mostly featured older adults who had experience playing digital games, it showed that by using various participatory methods and design strategies as scaffolds, it is possible to involve seniors as amateur game designers.

Similar to Marston (2012), Blythe et al. (2015) propose the use of speculative design as a way to generate technological intervention concepts. The researchers developed a board game called "Solutionism" to enlist the creativity of fourteen seniors who identified as "happy". In the board game, participants were prompted with positive or negative topics which they had to overcome or enhance with fictitious technological interventions in the form of products or services. The topics themselves were inspired by deeply complex matters such as dementia or fun. While the outcomes of the playful exercise were design fictions, the authors urge that the results illuminated real psychosocial factors that effected seniors and therefore expanded the emerging design space. This study is particularly significant because it focused on flourishing seniors, challenging the perception of seniors as miserable and idle. Using the Solutionism game, researchers were able to effectively harness the creativity of potential end-users in the design space.

While not specifically aimed at the older adult-led design of games, Rogers et al. (2014) also elaborate on the use of toolkits and resources to tap into seniors' creative thinking for creating technological interventions. Using an amateur electronics tool-kit called Makey-Makey, seniors created different technology ideas for different uses, particularly for children. Researchers reported that seniors mastered the technology surprisingly quickly, proving that seniors can thrive in technology design when the topic is properly presented to them and the right participatory design tools are used (Rogers et al., 2014). This is a very important point because it emphasises that while seniors may sometimes fail to generate new concepts for technological interventions like games, or struggle with design tools, this is not always due to their age and it is something that effects people of all ages who are not familiar with certain technologies or processes. At times when it is difficult to emphasise the need to specifically address seniors' needs while simultaneously staying clear of age-related requirements, it is possible better assist them in shaping the design space.

In intergenerational games, Loos (2014) advocates for a human-centred design approach whereby both young and older generations contribute in design activities. This process elicits the input of mixed-aged end users to evaluate and shape increasingly complex prototypes. By doing this, designers can democratise the process that takes the unique requirements of both player types into consideration, resulting in a more appropriate and adaptable design. To conclude, I found that in most studies, games often took the form of preconceived technical artefacts that merely employ the older adult player to test them, in short, *game design for* instead of *with* seniors. With the exception of studies by (De Schutter and Abeele, 2010, Awad et al., 2016, Marston, 2012 and Abeele et al., 2007), I found that research involving seniors in the design of games did not do it to a sufficient degree, particularly when it came to utilising participant creativity in generating suitable game concepts. This is worrisome because it implies that commercial and academic game interventions may not fully meet the expectations, needs and desires of older adults. This general gap is further signalled by a limited focus on video game interventions aimed to achieve physical, cognitive or social benefits. Again, literature reveals that previous studies often focused on involving seniors in the design of game interfaces leaving out other critical aspects such as content and play mechanics.

2.4.2 Reconceptualising games for older adults

From the research reviewed, it is clear that high importance is placed on incorporating the user perspective, whether this perspective is incorporated to sufficient depth is uncertain. Most studies stopped short of interrogating senior conceptions and motivations for the broader activity of playing. In their study, Marston (2012) posited that current challenges in games for seniors were due in part to the scarce attention paid to the understanding of what older adults consider as games. Part of the criticism that games for seniors receive is that the ideas are too simplistic and often reduced to stereotypical abilities of the senior players (De Schutter and Abeele, 2015). Previous research by Ferri et al. (2017) and De Schutter and Abeele (2015) suggests that the challenge of overcoming ageist stereotypes in games may lie in reimagining what games could be outside of the usual movement-based and brain training variety. This is exemplified by the growing popularity of experimental offerings like empathy-driven games that promote a felt-experience of age (Ferri et al., 2017, Broken Rules, 2017). The failure to generate exciting game concepts may stem from designers conceiving game ideas based on their perceptions of limitations older adults have rather than of creative possibilities they may desire. This leads designers to only involve older adults in fine-tuning play interfaces and interactive modalities originally designed to fit their own expectations of declining physical and mental abilities. The absence of a sufficient user perspective in game design practices alludes to a much deeper case of the digital ageism that is endemic in HCI (Cozza et al., 2017, Ferri et al., 2017, Vines et al., 2015).

The importance of interrogating conceptions of play and game is perhaps most adequately invoked by Salen and Zimmerman's (2003) seminal chapter on "Meaningful Play". The chapter can be summarized by a single quote, "the goal of successful game design is the creation of meaningful play" p.3. Similar to De Schutter and Abeele (2010), I conclude that the success of game and play designs are linked to the meaning players ascribe to them. In addition to that, I argue that these meanings are inextricable from player conceptions and expectations of games. Suffices to say, any successful playful intervention targeted at seniors needs to be concerned with understanding the pluralisms of meanings that the population attaches to game and play, for the simple fact that this understanding helps direct us towards more appropriate designs. While gerontoludic research has made significant strides in studying senior player experiences, the majority of previous works have constrained games within the domain of tools for medical purposes. Games have been developed as ways to rehabilitate frail seniors in care (Gerling et al., 2011), offer mental and physical stimulation (Abeele and De Schutter, 2009) and connect socially inert senior to peers and youth (Zhang and Kaufman, 2016). While the results of these projects have largely been positive, a part of the HCI community including De Schutter and Abeele (2015), Ferri et al. (2017), Gerling et al. (2015), Giacardi et al. (2016) and Vine et al. (2015) have criticized HCI research, and much of gerontechnology, for being overly focused on the phenomenon of decline in older adults. In clearer terms, Blythe et al. (2015) criticise this view for being "solutionist" (as defined by Morozov, 2013) in that against better judgement, designers are often quick to try to solve problems that don't exist or offer quick-fix solutions for complex social, political and environmental problems. Nevertheless, these voices argue that an image of older adults as weak and passive consumers is not representative of older adults as heterogeneous groups. Adding that there are positive aspects and experiences in seniors' lives that call for a more empowering image of the demographic.

2.5 Intergenerational interaction

As growth in the aging population continues, the need for medical care is likely to increase. It is probable that growth in the segment of people over 60 will be accompanied by a rise in social isolation, a condition of minimal involvement in social life which can lead to feelings of loneliness, depression, and dementia (Naufal, 2008). Although most social isolation interventions have targeted seniors in care, there is a large number of seniors who still live independent and healthy lives (Osmanovic and Pecchioni, 2016), and who because of declining social ties are increasingly at risk of suffering health decline that would require them to be placed in care homes (Alaoui and Lewkowicz, 2014) . Since there are healthy seniors who live independently, we can assume that some might live alongside young people, especially in cities where we are likely to observe people of all ages living in the same areas. This beckons the question, why are intergenerational connections not more common? Thang (1992) posits that in many societies, intergenerational segregation is considered as a natural phenomenon by both old and young, highlighting the complexity of addressing intergenerational disengagement. Ageist attitudes whereby older people view young people as unruly and young people view older adults as frail and strict, have also been implicated as a barrier to intergenerational interaction (Curtis et al., 2015).

Developed research has mainly addressed social isolation through interventions that increase communications between older adults and their younger relatives or same age peers. Intergenerational communication and interaction have been shown to provide benefits for both groups (Hawkins, 1996). Intergenerational interaction allows for older adults to assume the responsibility to nurture younger generations thereby giving them fulfilment (Hawkins, 1996). Seniors also benefit from interactions with younger people, who often facilitate soft introductions to new technologies, helping mitigate anxiety and improving confidence (Zhang and Kaufman, 2016). Most importantly, intergenerational interaction provides an opportunity for both groups to decrease feelings of social isolation and through that, reduce harmful ageist attitudes (Williams et al., 2012). Previous research in intergenerational interaction by Williams et al. (2012) contribute that older adults reported a more positive attitude towards younger people and vice-versa after intergenerational engagements. As mentioned in earlier chapters, social interaction has been reported to be a stronger predictor of successful aging than physical and cognitive conditions (Lloyd, 2015, Lewis, 2014). Intergenerational interactions within families have been shown to have positive effects on the psychological wellbeing of both younger and older people (Zhang and Kaufman, 2016). Intergenerational interactions give grandparents the opportunity to shape the development of their grandchildren while grandchildren can benefit from long-term psychological support and care (Zhang and Kaufman, 2016). While these benefits of intergenerational interaction in the familial context are widely elaborated on, there is very little research that elaborates on how intergenerational interaction can be improved in the broader society. Studies suggest that there seems to be a diffuse problem of social disengagement between older and younger people of no relation (Zhang and Kaufman, 2016), where the motivations to create or maintain social attachments are less obvious. This breakdown is likely to be more prevalent in urban areas that include larger populations of unrelated individuals (Arup, 2015).

The intervention space for intergenerational interaction is dominated by information and communication technologies such as email, social networks and video chat features (Parra et al., 2013). These technologies have mainly been used by older adults to maintain communications with relatives who might live in distant cities or even countries. While these technologies may support more purposeful forms of communication, they are often limited when it comes to promoting social interaction, particularly in facilitating new meetings between non-familial persons. Kaplan et al. (2015) posit that "no matter what types of technology are used; the promotion of meaningful intergenerational relationships is the core of intergenerational programs and new ways of stimulating conversation and understanding and maintaining long-term interest and engagement should be

created" p5. From the literature, there is a push for facilitating long-term intergenerational relations. Outside of the familial context, this agenda may become problematic. Motivations for non-kin intergenerational interaction are still not well known and might not support the long-term meaningful relationships the games community hopes for. I elaborate more on this point in the following sections.

2.6 Intergenerational gaming

The increase in older adult players and technology use has prompted experts to consider the use of digital games as socio-technical interventions for intergenerational interaction. In a literature review on the benefits of intergenerational digital game-playing practices, authors De la Hera et al. (2017) identify the main benefits of intergenerational gaming as reinforcing family bonds, enhancing reciprocal learning, increasing understanding of other generations and reducing social anxiousness. Researchers claim that intergenerational digital games promote prosocial values by providing players with a platform where they can act together to achieve a common goal. This kind of positive interdependence leads players to be aware of each other which in turn gives rise to instances of social interaction (De la Hera et al., 2017). A good example of this is the game Xtreme Gardener (see Figure 4) by Rice et al. (2013), an intergenerational gesture-based game where mixed-aged cohorts of players must devise strategies of collaboration to tend to plants. The game uses movements of player silhouettes to manipulate and control various weather elements. Players have to control environmental effects in order to nurture a small set of garden plants. The game encourages cooperative play between mixed age players by requiring coordinated efforts from two players to advance the game.

Figure 4: Xtreme gardener social game
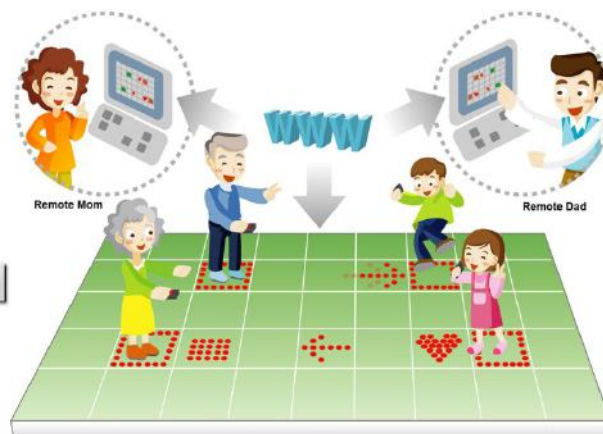
Figure 5: Age invaders

Intergenerational interaction has been repeatedly instantiated through play. Playing is a central activity to all animals, between generations it provides an opportunity to safely learn and make mistakes without harsh consequences. Zhang and Kaufman (2016) posit that due to the benefits of intergenerational interaction, intergenerational games offer older adults a means of building and maintaining intergenerational relationships that have the potential to reduce stress, promote relaxation and encourage positive attitudes in mixed-aged groups. For instance, for many grandparents, a simple game of hide-and-seek allows them to develop relationships with young relatives while creating pleasure and enjoyment for both parties. Chua et al. (2013) conducted a study to evaluate the effects of playing video games on intergenerational perceptions between youth and older adults. The study featured two groups, distinguished by a non-video game (n=28) and video game condition (n=25). Each group consisted of pairs of one older adult and a young person. Over a period of two months, the video game group played Nintendo Wii games while the non-video game group interacted through routine intergenerational activities at senior centres. At the end of the study, researchers tested for attraction, intergroup anxiety, attitudes, and game enjoyment through pre- and post-test evaluations. It was found that the video game group reported more positive results on intergenerational measures, although researchers advised that positive results may have been because of a novelty effect. Another

example is Blast from the Past, a Nintendo Wii-based digital game developed by e-Treasure research project (Abeele, De Schutter, 2009) using play-centric ethnographic and participatory design methods. The game supports gameplay for up to four players in a living room setting. It encourages intergenerational play and knowledge sharing using quiz-like game mechanics addressing popular culture from the past 60 years. It also features a physical mini-game (Atomium) that can be played by four players (Abeele, De Schutter, 2009).

As stated throughout this thesis, it has been found that interacting with younger relatives is a core senior motivation to play digital games. Seniors often observe grandchildren as they play casual games or join in on the fun through many of the collaborative playstyles digital games provide. A good example is Age Invaders (See Figure 5) by Khoo et al. (2008), a mixed-reality age game that uses a floor display to facilitate gameplay between pairs of one grandparent and one grandchild. The floor display reveals a pattern which young players (invaders) must follow successfully or lose health points. Patterns are designed to be increasingly complex for younger players and easy to follow for older players. In addition to the patterns, players can fire laser beams at each other but those launched by younger players are significantly slower than seniors. Seniors also have the added advantage of being able to move freely across the play space. Parents of children can participate via a remote link that allows them to manipulate player-specific difficulty from a distance. Save for a patronising name ("Age Invaders") and its aim to compensate "disadvantages" of seniors, Age Invaders is one of the few games that rely on a human agent to mediate play between different groups. These kinds of intergenerational digital games provide a playful context of shared goals, cooperation and equal status (Zhang and Kaufman, 2016). The goals of intergenerational games have been summarised by Zhang and Kaufman (2016) as (i) promote intergenerational connections between grandparents and grandchildren over distributed distances, (ii) connect older people with younger people, (ii) build meaningful intergenerational relationships, (iv) facilitate knowledge sharing and transfer between young and older people, and (v) improve the quality of life of older people.

Research on intergenerational gaming reveals a number of significant points. Up until now, research has focused on gaming in the familial context, involving relatives. Moreover, many of the games produced in studies have a common interface. With the exception of Age Invaders by Khoo et al. (2008), many of the games required seniors and younger people to be in a context like a room, playing through a television or similar interface. A development of non-kin relationship type games may define a different context and modes of interaction. For one, non-familial mixed aged groups are more likely to encounter each other in a public setting. This highlights a key challenge to design intergenerational games that can support the constraints that the public context presents. Public encounters have a more rapid pace (often brief) and likely to occur between strangers. The word "stranger" highlights an element of distrust and disengagement, a description that characterises the barriers of negative attitudes, disengagement, cultural difference, and technological generation difference that exist between current groups of older adults and young people (Mushiba and Heissmeyer, 2018).

Other aspects such as the quality of intergenerational interaction that gaming is somewhat well established for the familial context yet little is known about the opposite. In a comprehensive review on "intergenerational play for facilitating interaction and learning", the researchers Zhang and Kaufman (2016) affirm that, while there is great potential for intergenerational digital games, there are still open questions on the extent to which digital games can promote social goals (social interaction and learning) in diverse contexts. The researchers aimed to answer these questions with more specific inquiry into the nature and role of intergenerational play, the design-elements of digital games for facilitating intergenerational relationships, and the impacts of intergenerational digital gameplay on the lives of young and older people. After reviewing a total of nineteen studies, researchers reported a wide range of information, three of which are relevant to this thesis. These are,

the effects of (i) relationship type (i.e. grandparents-grandchildren or non-familial older adults-young people), (ii) context (i.e. physical environment or online, public or private) and (iii) game type (traditional or digital game) on the efficacy of intergenerational games to promote prosocial goals. In the following section I use these categories to extrapolate their relevance in the state of the art.

Relationship types

Most studies showed that relationship types played a significant role in motivation to interact. With regards to intergenerational familial relationships, interaction was mainly motivated by a sense of familial duty. Zhang and Kaufman (2016) elaborated that grandparents often took on roles as caregivers, instructors, organisers, and family historians when interacting with younger relatives. Grandparents sometimes took on a more playful nature as they became entertainers, teasers or surrogate toys, often encouraging them to take on more child-like behaviour. Zhang and Kaufman (2016) further contribute that the level of communication and participation facilitated by intergenerational games was not symmetric or reciprocated. When playing digital games, older adults were often observed to take on a more passive role leading to disproportionate participation. This was attributed to grandparent's dominant motivation to encourage thinking in grandchildren (Vetere et al. 2006, Vetere et al. 2009). In a similar study by Voida and Greenberg (2012), researchers found that when playing digital games, grandparents often gave priority to younger relatives. Another interesting finding is that in familial intergenerational gaming, parents or adult children were often the main facilitators of gaming, making sure that gameplay progressed fairly (Voida and Greenberg, 2012).

There is a shortage of literature on intergenerational non-familial relationships, more so for interactions that involved digital technologies. In a study by Williams et al. (2012), researchers investigated whether weekly exposure in a playground would improve intergenerational communication between eight seniors from a care home, and children from ten families. The study found that for several weeks, older adults were reluctant to interact with younger people. Older adults were resistant to the idea of interaction due to ageist motivations, one participant stated "this is an old age home, kids shouldn't be here". Other seniors had concerns about perceptions in the wider community, they were afraid of what others might think about visiting a playground in a residential senior care facility. It was also shown that prior to interaction, many of the seniors felt that children would not be "well behaved". Although seniors initially showed reluctance towards interaction, seniors came to see the interactions as positive over time, primarily because it provided enjoyment to see children playing happily. Other studies (Zhang and Kaufman, 2016) have also reported an important relationship between time spent and relationship quality. Due to their relatively young age, parents reported positive attitudinal changes on behalf of their children.

In relation to the effects of relationship type, current research might overstate the suitability for intergenerational games to create deep meaningful connections. Older adults might not be fully ready to embrace these opportunities. Seniors have been reported to strictly value existing relationships instead of seeking new ones, this is because the quality of the existing relationships are cultivated over a long period of time. While we cannot dispute that older adults would like to pursue new friendships, we must not underestimate the possibility that they may not be particularly interested in young people. Contrary to the existing imperative for games to foster and strengthen deep connections, we must adjust our expectations to be open to the possibilities that some older adults are only looking for brief encounters with young people. This might be another oversight research has neglected to highlight due to its focus on familial relationships, which are already meaningful by nature of kinship. In their popular review of intergenerational gaming, Zhang and Kaufman (2016) only included studies involving play between young and older people communities in familial contexts.

Context

While it may not be uncommon to find a context with elements of both, intergenerational gaming is divided into two categories, intergenerational play in online contexts, and play in the physical environments. Zhang and Kaufman's (2016) study showed that most analogue intergenerational games took place in playgrounds while digital play took place in the home setting. For both familial and non-familial groups, when looking at the broader contexts, research suggests common activities converge around activities related to nature and sport (Loos, 2014, Räisänen et al., 2014), which often took place in outdoor contexts. It is important to note that this somehow maligns with many contributions from games research, which seem enthusiastic about pushing for remote and digital play over hybrid or analogue methods that promote co-presence. Awad et al. (2016) confirms the importance of context by stating that designing a social game meant for a nursing home will have different requirements than a game meant to be played alone at home. In a study on co-designing games for intergenerational games, Rice et al. (2012) identified the need for games that "transform places for play". This sentiment is captured in their conclusive statement that states:

> *"The concept of an in-transit bus game suggests there is value in exploring opportunities within public spaces for community engagement. This brings into question the role of games in fostering relations with strangers, and the extent they differ to a family context. Likewise, the results indicate design opportunities in utilizing attributes of familiar outdoor environments within an exploratory game space, using portable devices to set and monitor challenges between players."* p377

Game type

Game types of analogue (traditional) or digital have been shown to invert leadership roles in intergenerational interaction. While older adults were the leaders in traditional intergenerational interaction, the roles tend to reverse when dealing with digital technologies. Younger players often take charge of gaming activities due to their early exposure to new digital technologies (Voida and Greenberg, 2012). Zhang and Kaufman (2016) contribute that this one-sided participation was common in digital intergenerational games, except when gameplay involved the contribution of knowledge topics such as in Blast from the Past (Abeele, De Schutter, 2009), here young players showed a lower participation. Seniors were also reported to have a preference for co-located cooperative games (De Schutter and Abeele, 2010). Seniors prefer to play games where they can support other players to accomplish game objectives (Davis et al., 2002). So far previous studies make two common recommendations that dictate game type, i) leveraging on differences in ability of players and ii) drawing on relevant expertise. These recommendations make sense in attempting to equalize power dynamics in intergenerational play, however, these game types are heavily influenced by a dimension of familiarity, leaving the effect non-familiar relationships on game type open for investigation. There is need for a fresh look at other design opportunities for intergenerational games.

2.7 Senior motivations for intergenerational gaming

The following section summarizes results of studies of known motivations for older adults to participate in intergenerational games extracted from the literature review. Due to the fact that there is little known research on how motivations differ between familial and non-familial context, and some of the known motivations are common between both contexts, motivations are discussed under one heading and familiarity is not differentiated.

Social connection

Zhang and Kaufman (2016) assert that it is the desire to interact and communicate with family members that is the primary motivation for seniors to participate in intergenerational play rather than play itself. This is especially pertinent to instances where family members live apart. Seniors may also seek out connections with non-familial persons on online and offline platforms.

Reinforcing familial bonds

Intergenerational games are seen as a way to strengthen familial bonds. When mixed-age relatives played the same game, the mediated experience has been shown to improve relationships and generate new topics of conversation (Vetere et al., 2009, Pappa and Pannese, 2010). Games also provide a safe environment to diffuse tension and discuss sensitive topics like sexual education (D'Cruz, 2015)

Intergenerational learning

Intergenerational games facilitate an exchange of skills and wisdom between family members. Older-adults may also seek to exchange knowledge with non-familial youth in intergenerational games (Zhang and Kaufman, 2016).

Increasing mutual understanding

Playing intergenerational games is a way for older adults to better understand younger relatives and vice versa. In some cases, this has led to a reduction in ageist notions (Chua et al., 2013).

2.8 Designing intergenerational games

Intergenerational games require a different design approach to games intended for a single age group. This results from the fact that often designers have to account for two perspectives, depending on the design goals, these perspectives are usually not investigated to the same degree. Younger and older players vary in experience and physical ability and although these categories do not cover the vast differences within both demographics, they inform the majority of gameplay requirements for designers. Another glaring category to cluster intergenerational game design is relationship type. It might be safe to assume that there are no stark differences but as we have seen, intergenerational gameplay of familial and non-familial cohorts can be markedly different. These differences may be thought to exist in two distinct categories, player centric and game centric differences (De la Hera et al., 2017). In defining and explaining these categories, I draw inspiration from Dela Hera's et al. (2017) study on the "benefits and factors influencing the design of intergenerational games". Similar to when designing games for seniors, player-centric approach accounts for the unique requirements of two generations while game centric differences account for the inter-player dependencies and settings of games. According to Dela Hera et al. (2017), player-centric factors in intergenerational gaming are influence by 1) the nature of interaction between younger and older 2) their motivation to play digital games and 3) differences in abilities, which is commonly viewed as the most important dimension. Table 2 gives a summary on design factors to consider for intergenerational games. The factors have been extrapolated from literature and further elaborated on by my own reasoning.

Table 2: Design factors for intergenerational games

Design factor	Description	Type
Old-young interactions	Intergroup variations and the relationship one generation has with the other. (Dela Hera et al., 2017)	Player-centric factors
Motivations to play and game preferences	Drivers for play and difference game preferences between generations. (Dela Hera et al., 2017)	Player-centric factors
Differences in abilities	Influence of age in the physical and cognitive abilities of players. (Dela Hera et al., 2017)	Player-centric factors
Goal-related forms of interaction	Preferences of cooperative vs competitive gameplay between generations (Dela Hera et al., 2017)	Game-centric factors
Space-related forms of interaction	Remote vs collocated preferences of different generations (Dela Hera et al., 2017)	Game-centric factors

2.8.1 Player-centric factors

Old-young interactions

Dela Hera et al. (2017) explain that there are differences in how different generations relate to each other. For instance, we might observe that older adults may find it easier to socialize with adults than with teenagers. The specific relationship between older adults and younger people may influence design in a more concrete way. An example is the intergenerational sex education games by D'Cruz et al. (2015). The content of this game might not be as suitable for primary age toddlers as it is for teenagers, highlighting the need to pay attention to nuances in young-old age groups. Furthermore, due to the asymmetric nature of familial intergenerational gameplay, games might try to facilitate more role-exchange whereby older adults can take leading roles to demonstrate their experiences and knowledge (Vetere et al., 2009, Davis et al., 2009). Since adults have been reported to serve the intermediate role of driving gameplay between older and younger generations, intergenerational games should make an allowance for them to assume this role in digital gameplay (Voida and Greenberg, 2009).

In the valuation of Age Invaders, Khoo et al. (2008) noted that cooperative play was more prevalent between dyads of younger and older players than same age pairs. Older adults were usually slower at understanding the mechanics of the game. It has been observed when that playing together, younger and older players often overcame technological challenges by "younger people intervening" resulting in older people being relegated to a more passive role of playmates (Zhang and Kaufman, 2012). At the same time, in their review of eight intergenerational games, Zhang and Kaufman (2012) contest this by noting that while younger players served as tech support in many of intergenerational games, technological challenges relating to competence were rarely discussed. An explanation for this is that the design of the game in the studies were designed with both perspectives of young and old in mind.

It is true that many studies take a player-centric approach to the design of intergenerational games but there is still a lack of nuance on characterising who the player is. The terms "young people "and "older adults" are both very broad ways to describe a rather nuanced demographic. Within the general definition of old and young, varied motivations for intergenerational interaction may exist, carrying different implications on how ready one age group is ready to interact with the other. This level of detail is missing from intergenerational studies. Just as most previous studies discuss challenges of intergenerational interaction in a familial context, there is also a tendency to focus on ages 4-12 and 50-80. Due to the lack of research, it is not entirely understood whether different ages of youth or older adults present more or less of a challenge for elders to interact with. This line of enquiry is especially relevant when discussing the state of interactions between non-familial youth and older adults in the public context; teenagers and young adults are usually more likely to encounter older adults in public settings since they are allowed to move around unaccompanied.

Motivation to game and game preferences

Another factor that requires consideration is the difference in motivations for playing games. For instance, younger players are known to play games mainly for entertainment and to connect with other young people. On the other hand, older adults will likely play games to connect with younger relatives. There are also differences in the types of games different generations like. It is well-known that young people prefer to play digital games, especially those on the console, personal computer (PC) and recently mobile phone platforms. Conversely, older adults prefer to play traditional or analogue games like bingo and chess. There are also varying differences in the genres of games different generations like to play. Young people play a variety of first-person shooters, real-time strategy, racing and MMO games. Seniors on the other hand are known to have a preference for

intellectual and narrative-rich games while staying clear of violent portrayals. An intergenerational game that uses themes of violence is likely to suffer some resistance from seniors. Designers should also be mindful of difference in motivations and game preferences.

Social play

It is perhaps prudent to foreground the importance of social play when talking about games. We should not forget that play has widely been cited as an intrinsically human (even animal) activity (Huizinga, 1983). Games research has been fascinated with the effects of social and solo play, the debate as it were is whether games should always have a social component. There is a consensus that games have the potential to create and maintain relationships and while many of today's digital games have been developed for soloplay, social play and social games are enjoying a growing prominence. The role of social interaction in how games are experienced has particularly become of interest (Gajadhar, 2012). Gajadhar (2012) posits that when you have multiple players, play is transformed into social play. Gajadhar (2012) is right in pointing out that many traditional games are social, e.g. card games, hide-and-seek, chess and that digital games have found interesting ways to make play virtual, disembodied and non-social. Perhaps this is why digital games are often perceived as being anti-social or encouraging anti-social behaviour.

It is intriguing that the presence of other people influences the experiences of players. When we play with others, we communicate different cues inspiring humour, fun or competition in ourselves and our coplayers. Gajadhar (2012) posits that it is then reasonable to conclude that when playing with others we are capable of influencing their thoughts and feelings (social influence). This highlights the natural position of coplayers as motivational agents. Although research often state that social play promotes feelings of belonging and happiness, it could also be that some people find social play nerve wrecking or enraging, for instance being nervous of losing to someone you do not like or wanting to impress a friend. In their PhD work on the effects of social interaction in play, Gajadhar (2012) states that in digital forms of social play like online multiplayers, feelings of belongingness are greatly diminished. It is not entirely clear the extent to which social play promotes negative or positive feelings but I am certain that it depends on the players, their motivations and intent in the game and towards each other.

Differences in Abilities

Due to age-related decline of motor and sensory abilities discussed in earlier chapters, differences in the abilities of young people and older adults are bound to exist. While they may not be as useful as previously thought in driving gameplay, seniors are likely to be more receptive to interfaces that account for differences in abilities. Designing interfaces that require complex motions and long button-combinations expose the limitations of the player, eroding their confidence to interact with the system and other players. Borrowing on Docampo's (2001) theory on different technology generations, seniors might not be well versed in operating newer technologies. It is important to minimise the effects of the technology generational gap. Particularly with input devices, it is more beneficial to use embodied or gesture-based controls instead of hard plastic controllers that require multiple button combinations to perform an action. These adjustments have been shown to not affect gameplay for younger players while boosting the confidence of senior players. However, specifically for teenagers and young adults, players might be more enticed by games that require them to master complex controls (Rice el al., 2013, Chiong, 2009].

There are many ways which designers can use to account for differences in abilities. Abeele and De Schutter (2009) make recommendations to support co-located physical play by i) designing for enactive play (see play-centred design section) ii) designing for competition and iii) designing for

acceleration (fierce movements). The last two may seem somewhat contradictory to existing research (Rice et al, 2013, Al Mahmud, 2009, Gajadhar et al., 2010) that suggests the older adults prefer cooperative over competitive play. The use of "fierce movements" is also discouraged. Nevertheless, there is a consensus that intergenerational games should allow both types of players to play according to their abilities. Another recommendation is to consider additional roles involved in intergenerational game play. For instance, Age Invaders by Khoo et al. (2008) uses the intermediary role of parents as game facilitators between old and young by allowing parents to remotely balance out player abilities in order to drive gameplay.

2.8.2 Game-centric factors

Goal-related forms of interaction

Goal-related forms of interaction have an effect on how multiplayer actions interact within the gaming system. A game like Xtreme gardener (Rice et al.,2013) requires players to collaborate to achieve a common goal. This has been called positive interdependence (De la Hera et al., 2017). Older adults have shown a preference for this type of multiplayer style of cooperative play where both generations have the same objective (De la Hera et al., 2017). Younger players are more competitive and will likely respond to games that promote adversity and competition. In intergenerational games these two perspectives can be balanced out by providing different levels of cooperation and competition. For instance, a game might require an older-younger pair of players to collaborate to achieve a score. Different groups of these pairs might then compete for the highest score.

Space-Related Forms of Interaction

Older adults have shown a preference for physically co-located gameplay. While there are seniors who have been reported to enjoy the independence of playing alone on a social gaming platform (De Schutter and Abeele, 2010), the majority of seniors tend to shy away from remote play experiences. Co-located play has special implications on the environmental settings of play. Familial play mostly takes place in the homes of seniors, sometimes they might be staged in care homes for seniors with severe health impairments. The setting of play is determined by relationship type (familiarity) of who you are targeting for intergenerational gameplay.

2.9 Evaluation of intergenerational games

The evaluation of intergenerational games is a very pertinent topic. Due to the relative novelty of the field, intergenerational games do not have well established methods for evaluation (Rice et al., 2012). As mentioned in earlier chapters, the extent to which intergenerational games have promoted design goals is not entirely clear, there is inconclusive evidence on the efficacy of intergenerational games to impact health and physical wellbeing (Owen et al., 2010, Rosenberg et al., 2010). Most studies are short and involve a small number of participants. The most common methods of evaluation were observational and qualitative user studies, video analysis, and post play questionnaires. Furthermore, addressing generational differences in the inclusive design of intergenerational games has also proved to be a challenge (Rice et al., 2012), signalling a need to evaluated inclusive methods. We can arrive at an impression of state of the art by looking at the some of the widely cited studies' evaluation methods and compare them to their intended impacts.

The designers of Age Invaders (Khoo et al. 2008) aimed to create a social and physical intergenerational entertainment system that can connect family members at home and at a distance. The system's goals were social, physical, cognitive and psychological. In their evaluation of the game's goals, the researchers carried out an initial user study involving five university employees (45-60) and a young group of five students (16-20) in twenty fifteen-minute playtests. Researchers then held a second playtest with a group of ten participants, 50% aged 45-60 years and the other 50 % aged 16-20 years old. The research was concerned with measures of participant's enjoyment, usability and liking. A question and answer survey and interviews were used for evaluation purposes. The study revealed that players mostly enjoyed the social and physical nature of the game. Apart from showing the promise of experimental games that fuse artistic and digital elements, it was not sufficiently elaborated on whether the game accomplished its goals (Zhang and Kaufman, 2016).

Xtreme Gardener is another intergenerational game that is widely cited in the literature. In their study (Rice et al.,2013) involved 60 young and older players to evaluate communicative and cooperative behaviour of same-age and mixed-age pairs while playing a multiplayer intergenerational game. Participants were divided into three groups (Young-Young, Old-Old, Old-Young) of 20 participants each divided into 10 pairs. Each pair had a single play session of 90 minutes. Participants did not know each other before the study. The researchers evaluated for perceived ease-of-use and used a mix of direct observation, video analysis, post-game questionnaires and paired semi-structured interviews. Despite reporting contradicting and stereotypical results at times, Rice et al. (2013) empirically showed that interactions between non-kin intergenerational cohorts were better than those of same aged groups.

There is a particular way in which measures such as enjoyment or usability are operationalized in most intergenerational game studies. Researchers tend to use more subjective methods of collecting data, such as questionnaires. For instance, in order to test for usability, researchers simply asked participants if they thought the game system was easy to use. This is a short departure from traditional usability studies, where measures may be operationalized and approximated around methods such as the time it takes a user to complete a task (task analysis). While the more casual style adopted by the intergenerational study is suitable for the dynamic "field experiment" conditions of playtests, we must be aware that this approach is likely to produce idiosyncratic answers that do not guarantee objectivity. Nevertheless, when the current evaluation instruments of intergenerational games are used together, they offer a somewhat reliable impression of the impact of intergenerational interventions. In real the challenges discovered during designing interventions for such a complex thing as promoting intergenerational interaction may prove to be the real value in doing research in the field.

Conclusion

Intergenerational games as a field of study and market is still in its infancy. The lack of commercial and research intergenerational games are a good indicator of this. The low number of intergenerational games studies is also testament to the diminutive state of the field in academia. From the literature, I summarize a set of key reflections to be practically addressed in my design and development of an intergenerational game for non-kin interaction in the public context.

"Conduct empirical studies to examine the impacts of relationship building and learning using different types of games and research methods in different contexts". This is one of the conclusive recommendations made by Zhang and Kaufman (2012) in their seminal review of intergenerational games. Despite the lack of practical examples, popular works by both Rice et al. (2013) and Zhang and Kaufman (2012) have called for short, easy to get in and out games that can be staged in diverse contexts. Following my own research, I capture this new direction as the need for low-threshold encounter-based digital games for non-familial intergenerational play. My decision to focus on the design and development of such games are explicated in four themes explained in the sections below.

Playfulness over usefulness

"Games for elders need to be played for their own sake, everything else is merely a side-effect" - De Schutter and Abeele (2015), Towards a Gerontoludic Manifesto

In the seminal work on a Gerontologic manifesto, De Schutter and Vander Abeele (2015) spell out the need for senior games to put the act of quintessential play above all other objectives. Many of the studies on digital games for seniors prioritize pragmatic qualities instead of more hedonic aspects like fun and enjoyment. Much like other areas of serious games, there is a lack of focus on the hedonic aspects (Menestrina, 2016). This has serious implications on the efficacy of intergenerational games to achieve design goals. It has widely been reported (Zhang and Kaufman, 2012, Rice et al., 2013) that intergenerational games have struggled to keep players engaged. For example, in a study (Derboven et al., 2012) on TranseCare, an intergenerational game designed to encourage young people (relatives) to do grocery shopping for seniors, it was found that younger players became quickly disengaged in gameplay, citing that the game was too simplistic and boring. Zhang and Kaufman (2012) further confirm that due to a strict adherence "ease of use" requirements as a core guiding design principle, games were often very simplistic, requiring no prior technological competence from older adults. It beckons the question; how does this simplistic direction of games reconcile with seniors' motivation to be challenged by games? The literature revealed that most studies on intergenerational games focus on promoting social interaction as a primary goal. While this makes sense, the state of the art might benefit from age agnostic studies that prioritize hedonic aspect such as enjoyment and relaxation. There is initial evidence that suggests that similar to seniors, young gamers also prefer to be mentally challenged. There might be some benefits to looking at common gaming motivations for both seniors and younger people and leveraging them to promote hedonic aspects. In this thesis I make the case of using music as a common topic with universal appeal. My design of an intergenerational artefact builds on common interests in music to create an enjoyable experience through explorative styles of play and an increasing level of challenge typically expected from games.

Low-threshold

I use low-threshold as a term to denote a playful activity that makes minimal demands on players, offering them enticing fun activity without attempting to control their participation, interest and long-term commitment. A balanced freedom from control supports more exploratory forms of play where a set of rules and mechanics exist but the player is not required to comply to them to enjoy the activity, setting the stage for multiple styles of play with varying involvement. I instantiate this using ambiguous and appropriative design strategies that will be detailed in the following chapter. My approach exploits aspects of intergenerational games research that are currently viewed as constraints. For instance, Kaplan et al. (2015) posit that intergenerational games should utilise the older players ability to transfer cultural knowledge to younger players. Fundamental barriers of varying motivations and ageist attitudes (Curtis et al., 2015) suggest that it is not be to connect intergenerational groups. I take this realization to mean that intergenerational games are missing a formative start (connecting mixed aged groups), one that has to be overcome before more lofty goals of intergenerational learning, reducing ageism and fostering deep social connections can be achieved. More specifically, it is clear that previous intergenerational games have had challenges balancing pragmatic and hedonic qualities, therefore I maintain that games might first need to facilitate enjoyable low-threshold encounters between mixed aged dyads before other goals are met. Recommendations by Zhang and Kaufman (2012) and Rice et al. (2013) on making intergenerational interventions with shorter play times and the ability to for players to get in and out of gameplay with ease affirm my position for a low-threshold approach. Similar to designing for hedonic aspects, designing brief gameplay with mixed aged people provides a unique opportunity for creating new game concepts and interfaces. I add this development to the state of the art by employing mixed aged participants as game designers for fun-first games.

Previous studies have Zhang and Kaufman (2012) shown that the effects of long-term intergenerational play are still unclear, despite of some initial indications of improvements in quality, not much else is known about how long-engagement enhances intergenerational goals (e.g. relationship formation, mutual understanding and knowledge sharing and transfer). As a starting point, I believe that a low-threshold approach prioritises relationship formation more than anything else. I believe this can be of significant benefit for evaluation purposes. It is easier to measure how many mixed-age people shared brief encounters than it is to determine the quality of their interactions.

Encounters

Part of the strategy for adopting a low-threshold approach was inspired by a need to challenge the pervasive image of aging as a process of decline and debilitation. By studying motivations of healthy seniors that live independently, I position my work as a departure from themes of accessibility and usefulness that sees games as rehabilitation and training tools. I choose instead, to frame games as mediators for intergenerational fun and participation. I argue that healthy older adults are easier to reach than severely disabled and isolated seniors that live in care homes and therefore require high-threshold commitments. I hypothesise healthy older adults to inhabit a more public context. From the limited studies reported in Zhang and Kaufman's (2012) review of intergenerational games, only three contexts where investigated, (i.e. family context, community and organizations). Some design guidelines (e.g. "employ a variety of design elements and game mechanics to stimulate and deepen intergenerational communication and understanding and maintain long-term interests") derived from these contexts present several challenges when transferred into a public context. Firstly, the level of involvement required by family, community and organisational contexts does not match the pace at which public encounters occur. Secondly, when applied in the broader society, motivations for deep meaningful connections do not match seniors' dominant motivation for an enjoyable experience. I

use the term "encounters" in order to characterise the dynamic and fast-paced nature of interactions that are typical of a public context.

Setting the design space of public intergenerational interaction allows us to tap into new design philosophies such as promoting curiosity, uncertainty or ambiguity as design resources for encouraging intergenerational social interaction. I believe that these new directions have the potential to expand on existing design opportunities, which more importantly, can be informed by the creativity of older adults. This opens up a possibility for much needed new interfaces and game concepts that require no computer literacy. I further emphasise the need for new game concepts. Rice et al. (2012) caution that designers should "consider the scalability and motivation factors of games". They explain that previous studies tended to focus too much on simple game concepts, mistakenly thinking that simply because older adults preferred traditional games, that digital versions of traditional games would be easy and enjoyable to play. Rice et al. (2013) identified and posit that seniors have a need for complex and challenging game concepts, and are likely to embrace new gaming experiences that take on a more experimental edge to be socially inclusive.

Non-familial motivations

Rice et al. (2013) state that evaluations between different relationship types could impact established results. The research shows that previous studies predominantly focused on design aspects for familial relations and familial contexts such the homes and care homes of seniors. This has led to many previous interventions to be informed by the motivations and attitudes of seniors towards familial young. The player-centric approach which is popular with much of the research in the field suggests that behavioural determinants for non-familial contact may be markedly different. With the exception of (Rice et al., 2013) I am are not aware of any studies in the literature that explicitly deal with designing intergenerational games for non-familial connections. As we have seen, contextual factors also influence the design of intergenerational games. An intergenerational game designed for a living room setting might not work well if deployed in a public area where non-familial people are likely to interact. My review of the literature suggests that the quality of intergenerational interactions improve over a long-period of time. Given constraints of time, safety concerns and motivation, intergenerational games designed to cultivate long-terms relationships might be challenging when designing for public use. Non-familial intergenerational play is missing from the literature, therefore as a first step I upend the dominant approach of designing for meaningful connections and instead design for brief and superficial encounters for the reasons mentioned above.

3. METHODOLOGY

This chapter gives a description of the research design and how its various elements are used to accomplish the research goals, first by presenting relevant conceptual and theoretical subjects and secondly by offering a brief description of how they were used. I adopted a research through design approach which integrates outcomes between research and practice. This section begins by explaining the research through design approach and thematic analysis as theoretical tools, this is done under the heading 4.1 Theoretical Development. I then continue to elaborate on the individual components of the research design, namely, i) Analysis of the motivational context with the IBM, ii) the practice-based development of a game prototype encompassing learnings from preliminary research, and iii) the evaluation of an intergenerational game meant for mixed age non-familial public interaction. In (i), I introduce a novel use of the Integrated Behaviour Model as an instrument for eliciting design requirements for motivational technologies. In (ii), I instantiate and discuss the design strategies of ambiguity, curiosity and appropriation as well as how intergenerational games support motivations. In (iii), I discuss the various methods that are used to evaluate the research outcomes. Using research through design as the overarching approach, Figure 6 shows how the different themes of theory, design and practice converge to chart the methodology of this PhD thesis.
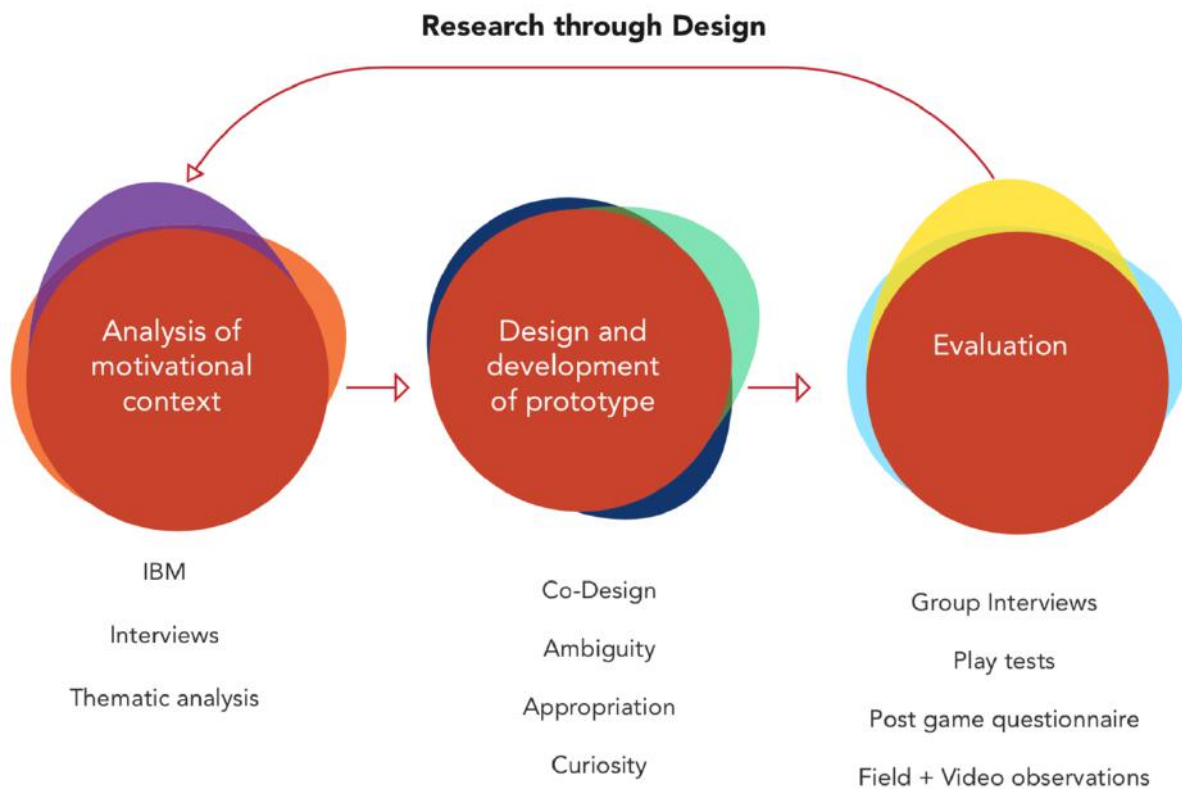
Figure 6: Research through design approach

3.1 Theoretical development

3.1.1 Research through design

I follow a research through design (RtD) approach, similar to Zimmerman et al. (2007) my intention was to produce design artefacts that create knowledge instead of a final commercial product. In the process I aimed to "investigate multiple perspectives on a problem; ideation-generation of many possible different solutions; iteration cyclical process of refining concept with increasing fidelity; and reflection" p3. I chose this approach of study because of the particularly challenging design space of intergenerational interaction. Intergenerational interaction, especially that of a non-familial nature, can be characterized as a "wicked problem", a problem which cannot be entirely solved because the often-conflicting perspectives of different stakeholders cannot be reduced to models that can be fully addressed using science and engineering (Rittel, 1973). Wicked problems have a multiplicity that is caused by a combination of phenomena, it is this combination that is the focus of design research and not a single isolated phenomenon (Zimmerman et al., 2007). A wicked problem framed in the context of intergenerational social interaction is the often-conflicting perspectives of young and older people. Lloyd (2015) posits that younger people tend to be resistant to engaging with older adults outside of their family, often harbouring ideas that older people are pessimistic and conservative. Likewise, older people may view young people as unruly and problematic (Zimmerman et al., 2007). A similar wicked problem has also been suggested to exists between adult children and their parents. Adult children want their parents to move to age old homes where they can be cared for, and elder parents, having invested greatly in their own identities as individuals, want to remain living independently even at this risk of great social isolation (Zimmerman et al., 2007).

Research through design is often criticized as lacking the standardisation and scientific rigor expected from other methods (Gaver, 2012). Mainly, it is said to attack the falsifiability paradigm that constraints conventional scientific research (Gaver, 2012). By this it is meant that a scientific theory is as good as its ability to survive experiments that attempt to falsify it. In defence of this limitation, Gaver (2012) posits that the notion that scientific theories are invalidated when contradictory evidence is found is inaccurate. He makes this proposition through two important characteristics that research through design is said to embody. The first is that of "theory under specifies design". Any conventional design activity deals with an interaction between a myriad of complex factors so to say that the application of X will lead to a successful outcome is disputable because subsequent applications of X may prove unsuccessful (Gaver, 2012). Instead, research through design posits that the application of X will sometimes lead to a successful outcome, prioritizing knowledge generated in the design activities instead of the production of a final artefact (Gaver, 2012). Gaver (2012) concludes this point by stating that "the synthetic nature of design is incompatible with the controlled experiments useful for theory testing" p4. The second characteristic is that "Design is Generative". While most scientific research focuses on comparison and refutation, and what is, research through design focuses on what might be, a distinction best emphasised by Zimmerman's et al. (2007) call for designers to "make the right thing". In their vision, Zimmerman et al. (2007) state that in order to engage wicked problems, research through design prioritises the production of design artefacts as research exemplars that serve as channels for important knowledge to permeate through HCI research and practice communities. In this way when the "right thing" is made, it transforms the world from its current state to its preferred state.

Like Gaver (2012), I concede that research through design certainly has its limitations, it lacks standards or a consistent methodology on how its projects should be implemented. Even though they are far from representing a single definition, RtD has common themes or assumptions such as a high priority for user-centred design, exploring multiple designs and discovery through making (Gaver, 2012). These themes ensure that a contextually rich description of the design space is attained at the end of the process. Given that intergenerational games are a relatively new field, it can benefit from the exploratory and constructive nature of research through design. Similar to other researchers in this nebulous field, I argue that due to its relatively small size and focus on wicked problems, intergenerational games for non-familial interaction is in greater need of conceptual contributions than quick solutions. Hence, I tie several concepts in behavioural science and game design to produce a number of key learnings on how the research goals can be approached.

3.1.2 Thematic analysis

Thematic analysis is a theory-flexible approach used for analysing, identifying and reporting patterns in qualitative data (Braun and Clark, 2006). Braun and Clarke (2006) posit that qualitative analytical methods fall into at least one of two broad categories. The first group features methods that are strongly bound to a specific theoretical framework and vary little in how they are applied. The second group, of which thematic analysis is a part of, are those methods that are not bound to theory and epistemology, and can be used across various theoretical frameworks. This characteristic of thematic analysis allowed me to search for patterns that illuminate salient aspects of senior gaming experiences and intergenerational interaction, and interpret them through relevant theoretical frameworks. I follow an essentialist and constructionist approach. By this I intended to both, reflect the personal realities of seniors and the ways in which societal influences impinge on those realities. Although my interests lay squarely with understanding game and play phenomenon, and intergenerational interaction, I was equally interested in how they are affected by the broader category of psycho-social factors. This description concludes the introduction of the more general theoretical tools, in the next section I describe more practical concepts concerned with making "the right thing|".

3.2 Analysis of motivational context through the Integrated Behaviour Model

In their seminal work on RtD Zimmerman et al. (2007) appeal to designers and researchers to "make the right thing", I offer the postulation that "a well-made thing is inherently a persuasive thing"

This phase describes a comprehensive investigation and examination of factors influencing motivations and how these factors interact in the motivational context. Factors include practices, activities, attitudes, norms, topics, barriers, and opportunities. This socio psychological focus is due to the intentionality of intergenerational games. By this I mean that intergenerational games make a deliberate effort to encourage intergenerational practices. This intentionality draws a close parallel with the design of persuasive systems.

The topic of motivation has been broadly studied. In technology and game design it is perhaps most developed in the field of persuasive technology, or technologies meant to change the attitude or behaviour of its users (Fogg, 2003). While the topic is primarily concerned with behaviour change, certain topics in early persuasive technology design adequately expand and offer tools for understanding motivations and consequently, behavioural determinants. Our present-day understanding of the topic has benefited contributions from philosophy, psychology, sociology, linguistics and artificial intelligence (Vargheese et al., 2008). This broad influence makes persuasion interdisciplinary in nature. Vargheese et al. (2008) assert that persuasive goals are generally based on a persuader trying to invoke a change in attitude or behaviour of a target participant. When dealing with a behaviour change challenge, Vargheese et al. (2016) point out that it is common for intervention designers to start by choosing a theoretical basis. This theoretical framework becomes the basis of empirical investigations that establish a clear relationship between determinants and the target behaviour (Vargheese et al., 2016). Michie et al. (2008) supports that behaviour enhancing technological interventions are likely to be more successful if they follow a theory-based approach. Investigations usually yield the design requirements that are than implemented to meet design goals.

Much of behaviour and attitude change theory seeks to explain how persuasive goals may be realized (Vargheese et al., 2008). To this end many theoretical frameworks have been developed and adapted to create models for persuasive systems design. The Theory of Planned Behaviour (TPB) is a behaviour change theory that posits that the ability and intention to perform a behaviour can be used to predict the occurrence of a behaviour (Vargheese et al., 2008). The TPB led to the development of the Fogg Behaviour Model (FBM), a behaviour change model that is widely used in persuasive technology design. In the FBM, Fogg (2003) contributes that for a target behaviour to be performed, three factors must converge simultaneously; the target user must possess sufficient motivation, ability and must be prompted by a well-timed trigger. Although the FBM is a powerful tool for identifying barriers to behaviour change, it risks oversimplifying the process of behaviour change by neglecting various socio-technical complexities. One of its other shortcomings is that it does not offer a practically feasible way of empirically validating its three components. Instead it relies on the assumption-led conceptualizations of designers who may fail to account for the variance in motivations of user groups (Ferron and Massa, 2012, Orji et al., 2013). The Integrated Behaviour Model (IBM) is another theoretical framework derived from the Theory of Planned Behaviour and the Theory of Reasoned Action (TRA).

We previously used the IBM in a study to understand the sociotechnical factors that influence older adults to use health intervention technologies (Cozza, et al., 2016). The IBM expresses a given behaviour to be a function of the attitude, perceived norm and personal agency (Montano, et al., 2018). The attitude is described as a person's predisposition to a certain behaviour. It is influenced by experiential, emotional responses (affective), and the beliefs about the outcomes (instrumental) associated with a given behaviour. The perceived norm reflects the social pressure one feels to perform (or not to perform) a particular behaviour. This is based on what others think one should do

(injunctive norm) and the perception about what others are doing (descriptive norm). The personal agency consists of two constructs: perceived control and self- efficacy. Perceived control is determined by the perception of the degree to which various environmental factors may facilitate (or prevent) carrying out the behaviour. Self-efficacy is the perceived confidence in the ability to perform the behaviour. The IBM extends the TPB and TRA by including knowledge on behaviour, environmental constraints, behaviour salience and previous performance of behaviour as determinants of a behaviour (Montano, et al., 2018). I am not aware of any research in persuasive technology that has used the IBM to understand the challenges posed by this research. The IBM is commonly described as being distinct from the FBM in that firstly it is descriptive instead of prescriptive, essentially prioritizing the understanding of behavioural determinants over giving a rubric on designing for behaviour change. While the IBM also considers ability (personal agency) and motivations (attitudes), it offers a more nuanced treatment of a diversity of motivations. The second is that it considers the user's context and other sociotechnical determinants (knowledge and skills, salience of the behaviour etc.) as seen in Figure 7 (Montano, et al., 2018).
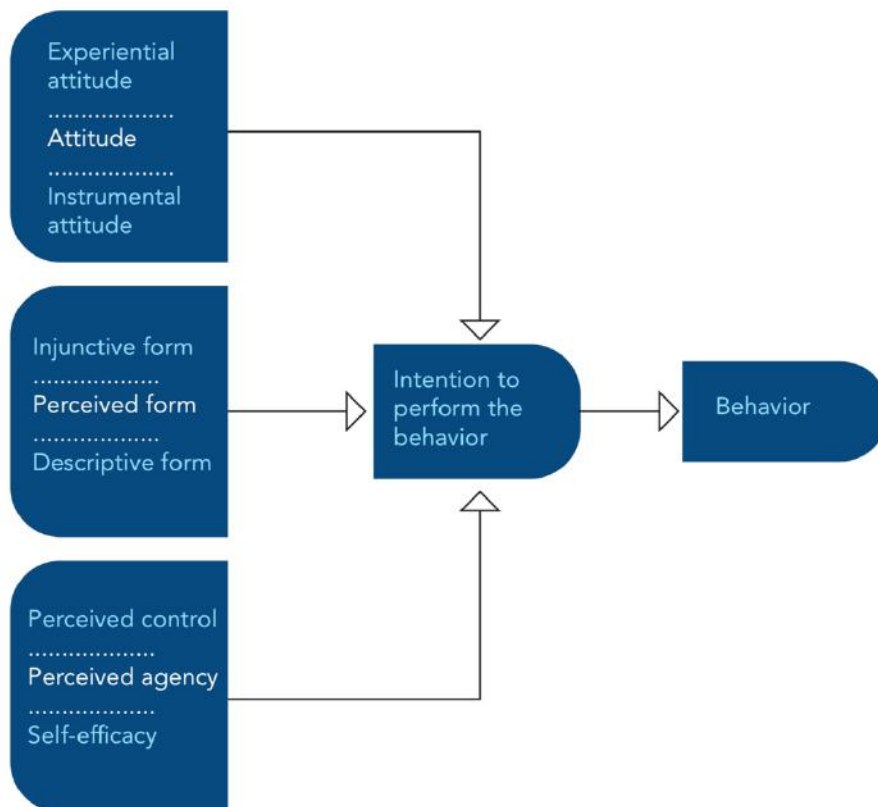
Figure 7: Integrated Behaviour Model

All the theoretical frameworks mentioned thus far deal with understanding the context of persuasion, or in my case, motivation. Consequently, through the use of interview studies I use the analysis of the motivational context to answer ***RQ1*** *What are the motivations driving older people towards non-familial intergenerational interaction?* With the guidance of the IBM, I conducted semi-structured interviews with older adults to investigate attitudes and motivations towards intergenerational interaction. I also interrogate senior conceptions of games thereby revealing their core motivations to play games. This also served the generative purpose of creating new game ideas that can meet older adult needs, hence providing new directions for intergenerational game concepts that are different from the existing video game variety. Using interview data together with existing literature, I also formulate a set of barriers and opportunities related to non-familial intergenerational interaction. These results are elaborated in the chapter User Studies.

3.3 Practice-based development of a prototype

At this stage it is pivotal to talk about the design and development of persuasive systems. There is no singular unified way of implementing persuasive design and there is little in the way of research that adequately demonstrates how theoretical frameworks can be modelled to support persuasive systems design (Oinas-Kukkonen, 2013). Oinas-Kukkonen and Harjuma (2008) offer a Persuasive System Development (PSD) model (Figure 8). It stipulates a stepwise approach of design methods and systematic analysis for developing persuasive software (Oinas-Kukkonen and Harjuma, 2008). The PSD is theoretically sound and gives a good overview of the key steps in persuasive design but it lacks any insights on how one might practically perform those steps. It is also reminiscent of older software development models such as the waterfall model that treat research (analysis), design and development as sequential processes. This has often been implicated as a process that undermines the integration of learning outcomes since one process is usually completed before the next process can begin. In this way it is not supportive of the iterative and integrative approach of research through design. Moreover, in RtD, the final product is not usually known, or valorised for that matter. Despite these discrepancies, the PSD provides a starting point for designing motivational systems in advocating for "analysing the persuasion context". When considered in the frame of research through design, the analysis of persuasion context is a useful guide on how to investigate behavioural determinants. I might also add that in this execution of RtD there is no singular intent, rather there are constellations of intent that emerge almost organically of the analysis of the motivational context. From an ecology of intentions negotiated between the designer (researcher), participant designers and participants, an intention such as "encourage more public intergenerational interaction among strangers" might come to prominence.

Figure 8: Development phases of Persuasive Systems

Since theoretical frameworks often foreground intention as a precursor to behaviour change, I will use it to distinguish motivational systems from persuasive systems. While persuasive systems promote behaviour directly, a motivational system is only concerned with creating a platform where behavioural determinants might interact to cause a transformation, I do not temper directly or pretend to be able to reliably manipulate factors that lead to behaviour change. While I prefer the idea of motivational technologies as interventions that support or enhance existing motivations, I borrow several key references from the field of persuasive games to describe how the goals of intergenerational games can be achieved.

3.3.1 Pro-social intergenerational games as motivational games

De Kort et al. (2005) offer that although persuasive technology was originally targeted at children and teens, it has the potential to impart benefits to the aging population. They add that the challenges older adults face can be overcome by adopting exercise behaviour, change in diets and sustained social engagement. De Kort et al. (2005) further contribute that based on these healthy behaviours, persuasive technology can play a role in convincing, stimulating and motivating users to engage in healthy behaviours. There are several studies that have used persuasive design to meet the needs of older adults, these include Vargheese et al. (2016), Far (2016), Baez et al. (2016), and Intille (2004), to name a few. For instance, the use of persuasive strategies is pervasive in the design of exergames (Far, 2016). Persuasive exergame provide timely and relevant notifications to nudge users to engage in exercise routines. Strategies also sometimes employ social influence strategies such as making the exercise progress of friends visible in an attempt to encourage competition and therefore, an increase in the target behaviour. These persuasive attributes are said to be applicable to gerontechnology that promote social integration and connectedness, especially for those interventions that facilitate social gaming among seniors and intergenerational contacts. De Kort et al. (2005) clarify that there is often a misconception that persuasive technologies are patronising and manipulative. They defend that this misunderstanding is based on a flawed premise that the persuasive nature of technology resides in the technology itself. De kort et al. (2015) explain that it is more likely that persuasion lies in the context of use and it is through the appropriation of technology under different users' intentions and contexts that a technology can be persuasive.

More practically, there are a number of ways that persuasive design can be useful in the frame of motivational technologies for older adults. For instance, given that injunctive norms stem from social pressures on what one should do, it is a useful line of enquiry to study who is the most persuasive person in an older adult's life. If for example this person is a senior's physician, designers can employ the assistance of the physician in helping a senior adopt a healthy behaviour. In the context of intergenerational games for public areas, this can be as simple as investigating which visuals or sounds are most effective at enticing players, placing persuasive design well in line with conventional design methods such as requirements engineering. It is with this line of thinking that I maintain that a well-made game is inherently a persuasive game. It is also not unrealistic to concede that design is not value-neutral, the designer's intent is omnipresent in their design and by this fact, carries a persuasive intent.

Earlier in this chapter I highlighted the relevance of several design concepts I borrowed from persuasive systems design. Strategies related to how certain design features may enhance intention and how that intention might go on to have transformative effects on attitude and behaviour. While similar in some aspects, this research describes an approach that differs from conventional persuasive design. Instead of setting the precedent that systems can be endowed with qualities that are persuasive or that persuade, I frame the system's role as one that through mostly the natural motivation to play, connects groups of potential persuaders. People are themselves the most effective persuaders and to me it makes sense that they occupy this role, whether it is convincing each other of the most fashionable sneakers to buy or whether it is that there is something to be gained from intergenerational play. Put simply, person to person persuasion over human-computer persuasion.

3.3.2 Use of appropriation, curiosity and ambiguity in free-open and structured play

In this section I present three emerging design strategies that have the potential to guide the design of prosocial intergenerational games. The strategies are articulated in relation to their ability to entice, engage, sustain, and drive interactive experiences in the design space under study. The relevance of the strategies is framed within a hybridised context of free-open and structured play. Free-open play refers to a more explorative style of play whereby the player derives enjoyment from their own style of play without strict adherence to rules. Structured play refers to more rule-bound ways of deriving enjoyment, such as deriving fun from mastering the rules of a game.

Ambiguity

"Ambiguity can be frustrating, to be sure. But it can also be intriguing, mysterious, and delightful". Gaver et al. (2003), p233,

When used as a design resource, Gaver et al. (2003) define ambiguity as the admitting of multiple interpretations. Using a series of installations and critically designed HCI applications, Gaver et al. (2003) demonstrated the use of ambiguity as a tool for creating self-reflection and high engagement between the user and interactive systems. Put more simply, and framed in design terms, ambiguity is the abstraction of information in order to allow for actions borne out of speculation. For instance, Aoki and Woodruff (2005) make the example that in personal communication systems when person A makes a call to person B and person B does not answer, the lack of information of why person B did not answer creates an opportunity for person B to offer explanations later that account for their behaviour, potentially strengthening the social relationship. Gaver et al. (2003) define this form of ambiguity as the ambiguity of information. Furthermore, Gaver et al. (2003) posit that if usefulness and usability are the two goals of HCI then ambiguity is their counterpoint. Gaver et al. (2003) further explains that by "impelling people to interpret situations for themselves, it encourages them to start grappling conceptually with systems and their contexts, and thus to establish deeper and more personal relations with the meanings offered by those systems" p233. In the case of free and exploratory playful systems, the absence of clear instructions towards the purpose of interacting with the system creates multiple interpretations, thereby allowing players to explore any one of these interpretations. Ambiguity has been linked to appropriation in that it encourages the use of systems in a way that they were not meant for, allowing players to derive and adopt strategies that might maximize their own sense of enjoyment (Boehner and Hancock, 2006).

Gaver et al. (2003) recommend three clear tactics for creating ambiguity of information relevant to this research, the tactics can be used to enhance the ambiguity of an interactive artefact. The first is *use imprecise representation to emphasise uncertainty*. This refers to the obfuscation of physical or conceptual information. The second is *over-interpret data to encourage speculation*. This relates to the ambiguous artefact's ability to make exaggerated but fairly plausible interpretations of the data generated by the user's actions. The third is *expose inconsistencies to create a space of interpretation,* which refers to the juxtaposition of incompatible elements in order to encourage users to create their own meanings. The last tactic is *cast doubt on sources to provoke independent assessment*. This refers to forcing users to question the validity of information presented by making it contradict their individual experiences.

The second kind of ambiguity this thesis is concerned with is the ambiguity of context. Gaver et al. (2003) offer that this kind of ambiguity stems not from things being unclear but from things being understood differently in different contexts, ultimately loading them with different meanings. The example of this can be the appearance of an automatic teller machine (ATM) in the middle of a nature park. Seen in a shopping mall, the ATM would hardly attract any attention but in a nature park, such

a thing would be the centre of copious speculation. The mismatch between the artefact and context sends a strong signal that it is a thing to be explored.

To implement ambiguity of context Gaver et al. (2003) suggest *implicating incompatible contexts to disrupt preconceptions*. This suggests deliberately introducing an artefact-context mismatch in order to create tensions that users will gravitate towards. Another strategy for this is *adding incongruous functions to breach existing genres*. This could be something as simple as adding a fan to the cover of a book to arouse speculation. Conversely, *blocking expected functionality to comment on familiar products* can also instantiate ambiguity. For the fan on book idea, making all the pages in the book blank would most likely cause users to speculate as to the function of the fan and other constituents of the artefact. In the absence of strict guidelines on how to implement ambiguity, I assume that these strategies can be implemented in an ad hoc manner suited to the nature of artefact, context, and designer's intent.

Ambiguity's more interpretative relationship between the user and the system contrasts that of traditional HCI, which prioritises practicality. Ambiguity instead advocates for a more evocative experience driven by mystery and not over explication (Gaver et al., 2003). Gaver et al. (2003) offer that ambiguity is different from fuzziness or inconsistency in that it is not an attribute of a thing but rather an attribute of our interpretation of them, adding that it is this pluralism in interpretation that encourages people to engage in meaning making. In other words, creating their own meaning in play as opposed to accurately perceiving the meaning intended by the designer. The use of a metaphor in this sense is not to define the meaning of the interaction but instead to provide a clue that guides the user to the designer's intended meaning even though in the end it may not be interpreted as such. For instance, in case of the scenario of interactive systems for social interaction, even though it is the designer's intention to encourage people to interact, this conclusion may not be directly attributed to the designer unless a specific behaviour from the system affirms this assumption. Gaver et al. (2003) explain that this sense of meaning-making gives the user agency in determining the comprehensibility of the situation, which can lead to a pleasurable experience or a "deep conceptual appropriation of the artefact".

My use of ambiguity as a design resource is based on these three advantages. Firstly, ambiguity allows designers to solicit the participation of users without limiting how users respond. Concretely this means providing different people with a platform to interact without dictating how they should interact. Secondly, ambiguity allows the designer to express themselves while allowing a sort of pluralism in the interpretations of users from different sociocultural backgrounds (mixed-age strangers). While the developed prototype seeks to promote intergenerational interaction, the obscurities of its design easily enable and support different meanings of play to different users, essentially making it age agnostic to a degree. This slightly contrasts Zimmerman et al. (2007) concept of designing for meaningful play, instead *deliberately designing for multiple meanings to play*. Thirdly, ambiguity capitalizes on the technical limitations of the interactive system by allowing people's interpretations to justify those limitations. In practicality this means the unrefined nature of a prototype creates interesting ground for speculation which turn into the artefacts next requirements. On designing for ambiguity, Gaver et al. (2003) states that ambiguity is likely to be an interpretive and can be brought about by attributes of artefacts or the attitudes of people. Gaver et al. (2003) further add that artefacts with imprecise or contradictory are likely to be more ambiguous than those that are clear and consistent.

Appropriation

Like ambiguity, appropriation often conjures up a contradiction to the intentionality of traditional HCI design. In most cases, designers hope that their designs are used as intended, making it seemingly counterproductive to design for the opposite (Dix, 2007). Despite the lack of perceivable benefits of designing for the unexpected, appropriation is often regarded as the sign of user's acceptance of a system (Dix, 2007). Described more formally, appropriation refers to the act of adapting and adopting technology in a way its designers did not intend (Dix, 2007). Dix (2007) explains this with a more analogue example; "perhaps you have used a screwdriver to open a paint tin, or a heavy textbook to prop open a door...or tried to open a bottle of wine without a corkscrew". This broader definition can be contrasted to the one offered by Dourish (2003) that "appropriation is the process by which people adopt or adapt technologies into their work practices" p1. Firstly, this definition describes a different degree in manipulation in so far as it refers to the "customisation" of software. Secondly, it situates these manipulations in the context of collaborative work practice. When you ignore the fact that both definitions refer to adapting and adopting technology, my interpretation of Dix (2007) definition is that appropriation happens in embodied interactive behaviour (i.e. play styles) instead of direct changes to software. Furthermore, the manipulations happen in a context of play where the definition of the *designer's intention* translates more easily. In the context of free-open or structured rapid encounters facilitated by an intergenerational game, references to work tasks would not be suitable, neither would customisations to software since the core functions of the system would be fixed. Nevertheless, parallels may easily be drawn when the two specific implementations of appropriation are ignored.

The use of appropriation is reported to have several advantages. The first is *situatedness*, an artefact designed for appropriation has the advantage of changing the environment in which it has been deployed in an unpredictable manner (Dix, 2007). Dix (2007) supports that while this can potentially be destructive, it can also invert contextual constraints to give way to new opportunities. Design embedded with elements which facilitate appropriation allow for more dynamics, making them adaptable to a changing environment Dix (2007). Lastly, appropriation can enhance feelings of ownership, leading users to feel positive feelings from feeling that they are doing things their own way Dix (2007).

Designing for appropriation is challenging. Dix (2007) asserts that there is considerable difficulty in designing for the unexpected. However, there are strategies that may be adopted to increase the chances that people will use what you have created in an unexpected way. Dix (2007) suggests a series of principles that assist with encouraging reflection. *Allow interpretation*, similar to ambiguity, appropriation benefits from encouraging multiple interpretations. This produces a sense of versatility for users to use artefacts in different ways. *Expose intentions,* refers to providing information on the functioning of the system in order to inspire users to subvert it by playing by their own rules. Provide *support not control* refers to providing the necessary functions for the user to complete a task but not guiding the user through every step towards their goals. This is exemplified by the statement "Instead of designing a system to do the task you can instead design a system so that the task can be done". P3, Dix (2007). Another strategy is *learn from appropriation* which refers to observing users' appropriative behaviour and designing new specific features in line with them. Dix (2007) contributes that the common feature among these strategies is openness, allowing artefacts to be used in unexpected ways. The application of appropriation needs to be selective and tailored; it would seem that appropriation is usually more beneficial for systems that already allow for some form of explorative behaviour such as games, hence the opportunities of providing a hybridization of free-open and structured play. Appropriation would for instance not be useful or perhaps even catastrophic for safety critical systems where systems need to be used exactly the way they have been designed.

Curiosity

There has been growing interest in HCI on how curiosity can be used to promote gameplay, engagement, and enjoyment (Deterding et al., 2018, Mushiba and Heissmeyer, 2018, Tieben, et al. 2011). Curiosity has been defined as a strong intrinsic motivator that all living beings have towards knowing or learning something (Tieben, et al. 2011). In another, more widely cited reference, Loewenstein (1994) define curiosity as a person's predisposition to uncertainty and their enduring ability to relish gaps in information. Itself an intrinsic motivation, curiosity has often been known to drive exploratory behaviour (Silvia, 2012). This reputation is leading research in HCI to explore the use of curiosity for the expressed purpose of driving gameplay and "playful behaviour change" (Tieben, et al. 2011). For instance, one application is the use of artificial intelligence (AI) to create artificial curiosity to anticipate player experiences and create more realistic non-player characters (NPC). The games F.E.A.R and Metal Gear Solid are well known for having interesting NPCs who react intelligently to clues. F.E.A.R is a hugely popular first-person shooter where enemy NPCs respond with tactical precision when they discover the body of fellow soldier. Metal Gear Solid is an espionage franchise that mixes themes of militaristic elements and psycho fantastical realism. In the game's earliest edition Metal Gear Solid One, I and undoubtedly many of the fans of the franchise were highly entertained by the bemused reaction of a patrol NPC that discovers the player's footprints in the snow. The enemy's curiosity led to a response of widening the patrol area and sometimes calling in reinforcements. This gave me a lot of pleasure to watch. While these reactions are all powered by AI, the game reactions exploit the use of curiosity to create interesting interactions between the player and the game system.

Figure 9: Metal Gear Solid 1   Figure 10: Huh? Whose footprints are these?

Figure 11: Shooters Never Matched F.E.A.R.'s Legendary AI

Figure 12: Piano Stairs

Figure 13: Light Musical Swings

Practically, curiosity has been used been used in interactive systems in public spaces. Tieben et al. (2011) explain how the interactive installation Piano Stairs by Funtheory (see Figure 12) elicits engagement through curiosity. "Imagine that you leave the subway, on your way to the exit of the station. When you reach the escalator, you see that the staircase resembles one big piano. Curious, you climb the first step, and hear a musical note. Climbing onward, you play the piano with every step you take." p361. Tieben et al. (2011) further explain that it is the curiosity of seeing a giant piano overlaid on stairs that draws people to explore the installation, furthermore, the novelty of this and the system's response with musical notes is what retains the player's attention. This interactive experience has the added advantage of encouraging healthy behaviour, during the time the piano stairs installation was running, a significant number of people used stairs instead of the escalator.

Another example of using curiosity in public interactive systems is the installation Light Musical Swings (see Figure 13) by Daily Tous Les Jours, an interactive system whereby pre-recorded sounds from a xylophone, piano, and other instruments are programmed into color-coded swings that play various notes when used. When users swing together, the system has the ability to create complex and harmonious sounds. I use the following scenario to illustrate how the system uses curiosity; *unassuming passerby walk past the installation and are drawn in by the sounds emanating from people using swings. There are clues but vital pieces of information are missing, they do not understand the systems functions nor how it operates. Curious to find out how the system works; players proceed to try the interactive experience. Discovering that they can collaboratively make music with other players, they invite friends or nearby strangers to join in the fun.* The designers explain that "The Swings allow participants to make music with their entire bodies, to connect to one another and to have a sense of ownership of public space due to the music they create. The result is a giant collective instrument that brings together people of all ages and backgrounds." While curiosity is widely cited in playful design, Tieben et al. (2011) rightfully point out that there is a lack of research that shows how curiosity as a core feature can be used to encourage explorative behaviour in interactive systems.

Our only enduring hint is that curiosity is evoked by exploiting gaps in our knowledge, this gap should be just of sufficient size that it can trigger inquisitive action (Tieben et al., 2011). Building on this Tieben et al., (2011) summarise that there are at least five main principles that can evoke curiosity, these are novelty, partial exposure, complexity, uncertainty and conflict. Figure 14 shows some examples of each principle.
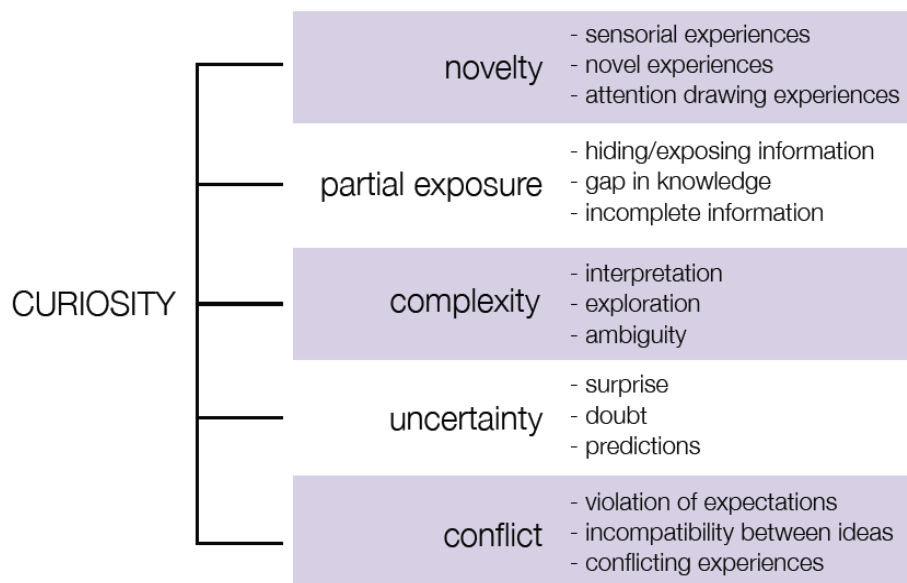
Figure 14: Curiosity principles

By looking at the examples given in Figure 14, we can see that ambiguity is a pivotal component in curiosity. We can also see that almost all examples coincide with ideas put forward by appropriation, namely, complexity in interpretation, hiding/exposing information, violation of expectations and so forth. The complexity principle of curiosity describes how the obfuscation of certain information allows for multiple interpretation and therefore exploration in filling gaps in knowledge. The conflict principle evidently bears some resemblance to the approach of appropriation. Providing conflicting experiences and ideas spur users to behaviours of subversion and eventually appropriation in use. Due to these relationships, I believe that designing for curiosity can benefit from similar tactics used

in the design of appropriation and ambiguity. To avoid rhetorical posturing, I am inclined to take the "novelty" principle as the characterising feature of curiosity, at least in the frame of this thesis. Curiosity can be cultivated with props that draw attention (entice) to an experience through sensorial lures.

3.4 Evaluation

According to the literature; group interviews, play tests, pre- and post-game questionnaires, video analysis, and field and direct observations are the most popular methods used in the evaluation of intergenerational games. All these instruments are used for their ability to report on the user's experiences with the system and other players. In the context of interactive installations which are often a combination of art and technology, Morreale and De Angeli (2015) affirm that evaluation is unique due to the system and inter-player experiences. In interactive installations of an artistic nature, the meaning and scope of the system is co-created between the designer and the participants (Bilda et al., 2008).

Using a mix of online observations, interviews, questionnaires and offline analysis of log data and videos, the authors Morreale and De Angeli (2015) were able to judge the level of enjoyment for an interactive system that supported collaborative music making. Similar to Dix (2007) thesis, authors Morreale and De Angeli (2015) judged their system's ability to foster creativity and enjoyment based on how users appropriated the original design idea. Morreale and De Angeli (2015) argue that in most interactive systems, there is an emphasis on evaluating the system's quality while the critical measure of user experience is largely ignored. While there may very well be differences in the evaluation of interactive art and intergenerational games, the two are bound by similarities in how they account for the public context. To engage strangers in a public context, interactive systems often have to employ some version of ambiguity and curiosity, it is within the frame of this initial point of contact that interactive art and public non-kin intergenerational games can benefit from the same methods. Put simply, it is hard to design for the use of a prosocial intervention if you do not design and evaluate that system's ability to entice, drive and retain a user's participation.

Morreale and De Angeli (2015) propose the use of qualitative and quantitative methods as a means of evaluating user experience and engagement. Viewing videos of participants experiences can be supplemented by questionnaires and interviews to provide strong impressions of the user's experience with an interactive system. Play tests as an avenue for testing are instrumental to understanding user behaviour since they allow for some level of control in evaluating player experiences. In the scope of intergenerational games, researchers (Rice et al., 2013) have also used the level of communicate behaviour as a measure for perceived ability to enhance social interaction. This can be easily ascertained from direction observation and video recordings. It makes sense that when two players display a high level of communication when trying to accomplish a shared goal, that the system is facilitating social interaction.

On the matter of evaluating curiosity, ambiguity, and appropriation, measures are almost always inferred from observation or other behavioural approximates. The design constructs are often described as situated and constructed, making it difficult to generalise one single way to evaluate the measures or the complex interdependencies between them (Aoki and Woodruff, 2005). However, researchers can mitigate these situational effects by making sure to sufficiently camouflage the inner workings of the system (Boehner and Hancock, 2006). Moreover, participants will likely evolve in their susceptibility to design strategies, with this in mind I anticipate that there might be some future provision to provide adaptive means of engaging players, I am tempted to suggest AI but for now I am more confident that a human mediator will provide a more vastly sophisticated adaptation strategy to changing user susceptibility.

4. USER STUDIES

The related work highlighted attitudinal barriers to intergenerational interaction and these barriers have been reported to be more prominent in non-familial contexts. Therefore, in order to illuminate this challenge, there is a need to investigate the prevailing attitudes of seniors towards these kinds of interactions. Secondly, there is also a need to probe the potential of intergenerational games to address these challenges. Through a series of preliminary studies, I aimed to provide an account of impressions seniors hold for intergenerational interactions and the benefits of games in this design space. The preliminary studies followed a sustained effort of enquiry that involved an interview study, several workshops and play test evaluation in a European and African setting. For the interview studies I used thematic analysis in order to identify constructs of interest in the qualitative data.

4.1 Interviews

This phase of the research details qualitative studies that were carried out in order to explicate behavioural determinants. The results of these studies were obtained through semi-structured interviews. This phase contributed towards understanding firstly, the attitudes and motivations towards intergenerational interaction and secondly, the motivational context- and the experiences of seniors with games, a critical analysis of conceptions of game and play. Results are divided into two sections, the first details and discusses the findings on behavioural determinants (attitudes, perceived norms, personal agency, motivations) for intergenerational interaction. The second results section presents and discusses behavioural determinants for play and games. My expansions on game and play may need further elaboration. Gerontoludic research field is a nascent one, requiring substantial qualitative research to scope. Consequently, and similar to previous studies by De Schutter and Abeele (2008), Brown (2012), Marston (2012) I adopt a player-centred approach to develop new perspectives and future design directions. To this end I investigate several factors that shape experiences and motivations for older adults to play games. In a wider scope I also capture the affordances that seniors attribute to games as tools that facilitate non-familial intergenerational interactions. I draw inspiration from the work of Brown (2012) in framing my goals as firstly, to develop an understanding of motivations for gaming through relevant theories as lenses, secondly to interpret the meaning of games to older adults, thirdly to record the appropriateness of current gaming technologies for senior needs and lastly, to inform a series of design considerations that can direct the future development of game and play interventions for social interaction. In presenting the results I first start by presenting results pertaining to intergenerational interaction, I then move on to results pertaining to senior perspectives on games and finally, I end with a general discussion on new directions to advance the field of intergenerational games.

Method

For the purpose of this study I recruited older adults within the age group of 60 years and older. The participants were older adults that still lived independently in cities and had no serious health impairments. This sample group conformed to the criteria I set out to capture the motivations of older adults who did not fit the themes of decline that often dominates age-related research. Eighteen of the participants were interviewed in Italy, 10 of these by a senior member associated to the research team and the other 8 by masters-level students at the University of Trento, Italy. The interviews were conducted in the participants' native language, Italian. In addition to this initial group, 4 seniors were interviewed in Berlin, Germany. the interviews were conducted at offices of the Technical University of Berlin ZTG (Zentrum Technik und Gesellschaft) and were conducted in English and German.

Interview Script

Interviews were conducted in a semi-structured style, relying on the interviewer's discretion to ask additional questions when the participants mentioned something relevant. More specifically, the line of questioning was loosely guided by the themes of the IBM (attitudes, perceived norms and personal agency) and used to understand the likelihood of intergenerational interaction. See appendix for style of questioning. In order to get qualitative rich data, interviewers refrained from asking direct questions related to the themes of the IBM (i.e. what is your attitude towards intergenerational interaction?) and instead allowed the themes to shape the interpretation of the answers. Interviewers kept the themes in mind when asking questions concerning play and game behaviour, and intergenerational interaction behaviour. Participants were asked questions in an open-ended manner that encouraged them to elaborate e.g. *Do you like to Play, what is a game for you?* To answer these questions, participants had to expand on their more idiosyncratic takes on what play and game are to them. Interviewers took care not to nudge participants into giving what they thought were favourable answers by seeming natural on the topic being discussed.

Procedure

At the beginning of the interview study participants were presented with an overview of the research, they were told that the study was primarily based on understanding the nature of intergenerational relations and the role games had in enhancing these relationships. Participants were then asked to review a consent form detailing the extent of their involvement and their rights to withdraw or refuse to answer questions they felt were too sensitive. Participants consented to the study by signing the form. At the start of each interview participants were asked to describe their typical day and highlight activities they performed from the time they woke up, to the time they went to bed. In addition to this, participants were also asked about their living status, whether they lived alone, with a partner or relatives. Participants were then asked if they played and what games they played. Following this, participants were asked to describe the friendships they had in their lives and how those friendships developed. These descriptions helped interviewers to establish an understanding of the presence of familial and non-familial relationships and how these related to engaging with kin and non-kin young people. When participants were unable to recall or did not have ongoing interactions with young people, interviewers asked them to think of friends or family members who might have these kinds of relations.

Participants

Twenty-two participants took part in the study with an average age of almost 72 years old SD =21 (ages ranging from 68 to 83). All participants identified as white and were nationals of Italy (18) and Germany (4). For the Italian sample, eight of the participants was recruited from *a* community centre for seniors while ten were recruited by a cultural association. The group in Germany were recruited from members of a seniors' community group. Interviews were primarily carried out by young researchers between the age of 22-30, in order to moderate the effects of a potential bias, 10 of the interviews were conducted by a senior person, the effects of which are detailed in the results section. Most of the participants lived alone or with a spouse. Ten of the participants were male while 10 were female. Although participants were not explicitly required to disclose health information, all participants expressed that they were in relatively good health and did not suffer from serious health issues. Participants did however mention suffering from some less severe health conditions like chronic back pain and depression.

Analysis

The interviews were audio recorded, transcribed and translated. In addition to theoretical themes contributed by the IBM, inductive thematic analysis was used in order to derive additional intergenerational topics present in the dataset (interviews). The deductive coding of the data was guided by the IBM, with the initial codes being denominations of attitudes (instrumental and experiential), perceived norms (descriptive and injunctive) and personal agency (perceived control and self-efficacy). Other codes on intergenerational practices, motivations and games behaviour were derived while coding the data openly after the researchers iteratively read the transcripts and identified points of interest. Codes were revised and restructured according to their ability to represent distinct constructs of certain themes. Coding and analysis were done in the Atlas.ti software.

Thematic analysis was performed by observing recurrent ideas in the dataset. For example, participants' descriptions of games were often related to a period in their youth. These comments were associated to the code "sentimentality". After an interpretive analysis of the comments under sentimentality I realised that they always referred to past experiences. This prompted us to modify the sentimentality code to "nostalgia". The revised code was then refined into a subtheme, which was subsequently attributed to a more general theme that pertained to participants' emotional responses (experiential attitudes) to games. In this way my analysis featured both a theory and data-driven approach.

A full list of codes is provided in the Table 3 below, the suffix (SI) denotes interviews carried out by the Senior Investigator while (YI) denotes those carried out by a Younger Investigator. Context group category relates to factors illuminating the motivational context, definitions for other code groups may be inferred from previous definitions.

Table 3: Codes for thematic analysis

Code	Description	Code group
Activities	Related to the daily activities of seniors	Context
Opportunities	Related to existing practices that hold potential for intergenerational interaction	Context
Barriers	Related to factors inhibiting intergenerational interaction	Context
Tech behaviour	Related to existing practices and behaviour around technology use	Context
Youth behaviour	Related to existing intergenerational practices	Context
Living status	Related to factors explaining domestic situation of seniors	Context
Intergenerational topics	Related to common topics between seniors and young people	Context
Past work experience	Related to past professional experiences of seniors	Context
Altruistic motivation	Related to intergenerational	Motivation

	interaction motivations to do good	
Personal motivation	Related to intergenerational interaction motivations for self-improvement	Motivation
Descriptive norm (SI)	Related to descriptive norms of intergenerational interactions identified by senior investigator	Perceived norms
Descriptive norm (YI)	Related to senior descriptive norms of intergenerational interactions identified by young investigator	Perceived norms
Injunctive norm (SI)	Related to senior injunctive norms of intergenerational interactions identified by senior investigator	Perceived norms
Injunctive norm (YI)	Related to senior injunctive norms of intergenerational interactions identified by senior investigator	Perceived norms
Experiential attitude (SI)	Related to senior experiential attitudes of intergenerational interactions identified by senior investigator	Attitudes
Experiential attitude (YI)	Related to senior experiential attitudes on intergenerational interactions identified by young investigator	Attitudes
Instrumental attitude (SI)	Related to senior instrumental attitudes on intergenerational interactions identified by senior investigator	Attitudes
Instrumental attitude (YI)	Related to senior instrumental attitudes on intergenerational interactions identified by young investigator	Attitudes
Perceived control (SI)	Related to senior perceived control factors on intergenerational interactions identified by senior investigator	Personal agency
Perceived control (YI)	Related to senior perceived control factors on intergenerational interactions identified by young investigator	Personal agency
Self-efficacy (SI)	Related to senior self-efficacy factors on intergenerational interactions identified by senior investigator	Personal agency
Self-efficacy (YI)	Related to senior self-efficacy factors on intergenerational interactions identified by young investigator	Personal agency
Games behaviour	Related to the gaming practises and	Games context

	behaviour of seniors	
Games definition	Related to seniors' conceptions of games	Games context
Experiential games attitude	Related to the senior experiential attitudes on games	Games attitudes
Instrumental games attitude	Related to the senior instrumental attitudes on games	Games attitudes
Games descriptive norm	Related to senior descriptive norms on games	Games perceived norms
Games injunctive norm	Related to senior injunctive norms on games	Games perceived norms
Games perceived control	Related to senior perceived control for playing games	Games personal agency
Games self-efficacy	Related to senior self-efficacy for playing games	Games personal agency

4.2 Results: Seniors' attitudes, motivations and practices on intergenerational interaction

During the interviews, participants described a wide range of motivations for intergenerational interaction. From my conversations with seniors, these interactions generally took the meaning of *"an exchange of ideas and views through participating in common activities"*. Moreover, seniors gave a comprehensive account of attitudes and prevailing intergenerational practices. Across answers, I observed favourable attitudes towards intergenerational relations, many seniors expressed an openness towards exploring relations with non-familial youth. Most accounts of intergenerational interaction featured either experiences with young children, presumably under 12 years old or people in the 20-40 range with sparse mention of teenagers. In some parts, participants expressed markedly different perceptions of interacting with children under 12 years and teenagers or young adults, those related to teenagers being of a more negative nature. Diverse attitudes towards a spectral definition of youth reflects the plurality of what participants considered as young people and the large space of intergenerational interaction.

Senior instrumental attitudes were divided into altruistic drivers (related to benefits for other people) and personal drivers (related to benefits for themselves). Instrumental attitudes around interactions were mostly attributed to co-learning. Altruistic drivers addressed the desire of older adults to provide guidance to and foster interest in less experienced young people. In return, older adults expected to gain knowledge of new technologies from relationships with younger people (personal drivers). Overall experiential attitudes were positive. I divide experiential attitudes into negative and positive experiences to paint a general impression of how they were perceived. Both descriptive and injunctive perceived norms appeared to favour intergenerational interactions although their influence on the core practice of engaging with young people wasn't entirely clear. Seniors' personal agency was expressed with confidence in ability to interact with young people, speaking towards their self-efficacy. On the matter of perceived control, negative attitudes towards relations with young people seemed to be barrier however, it appeared that the lack of common topics and activities between the two groups were considered as the more salient barrier to interaction between the two groups. A more detailed description of responses is presented in the following sections. Italicised quotes are from audio transcriptions and they have been anonymised by a participant number, sex, and age e.g. P10, F, 76 (Participant 10, Female, age 76).

4.2.1 Intergenerational practices and topics

An integral part of the research is to understand the broad range of activities, topics and contexts in which intergenerational interactions occurred. To this end I embedded questions in the interview guidelines to bring out aspects of intergenerational practices in participants' lives. This provided firstly, an impression of contexts where an intervention would be most impactful, secondly, a record of common discursive topics or themes that could serve as the core of an intergenerational intervention.

The most important dimension used to describe intergenerational interaction addressed the level of familiarity between younger and older people. Relationships between participants and familial young people were mostly centred around some form of informal caregiving, especially with grandchildren in their early childhood years. Participants stated that most of their interactions with non-familial young people were mediated by their grandchildren or children. This is echoed by a participant's answer when asked if she had any non-familial intergenerational interactions.

"...One of the reasons is that I certainly don't have children of my own, If I had children, they would have had friends and I would have known some." - P20, F, 73

Whereas familial interactions were based on caregiving and other family activities, many of the interactions with non-familial youth were fostered by professional relationships with younger people, particularly around activities that involved some form of volunteering or charity work. Answering on whether there were any specific activities that lead to acquainting with younger generations P8 answered:

"We can say doing fitness...and then, volunteering and nothing else." - P8, F, 70

Non-familial intergenerational interactions were at time the results of a long and rewarding engagement. Participants (18) who had a work history as teachers were particularly vocal on how enriching their experiences with younger people were. They spoke about how intergenerational interactions that started in school became long-term friendships which involved phone calls and sometimes, meet-ups. Past and current work occupations featured as a lasting source of intergenerational activity. While uncommon, some participants took on professional paid work after retirement. A 69-year-old participant confirmed this by saying:

"It's very nice, I like it very much, at the end of June I worked a little bit at a call centre for 10 hours per week and I have friends from there and they were very young and now I have friends from there." - P19, F, 69

Other participants pointed out that retirement contributed to a decrease in intergenerational interactions where relationships were more meaningful.

"I do not have because I'm outside of the work's world, so… I meet my old students, or some friends' daughters who became adults and I notice they like to talk with me " – P10, F,72

While some participants had intergenerational encounters from past careers, others managed to establish new relations through relationships with professionals they visited for services. This highlights an interesting potential for professionals who serve seniors to become proxies for intergenerational interaction. This kind of scenario is explained in the following encounter a participant had.

"It happened to me recently to talk with a twenty-year-old person, he was the nephew of my hairdresser" - P3, F, 72

A conversation between two older adult participants revealed that they characterized new encounters with younger people outside the work world as based on acquaintanceship and not friendship, as elaborated in the following excerpts

"But we cannot define them as friends, they are acquaintances" – PI
"Exactly, they aren't friends!" – P10, F, 72

On the wider matter of context, participants spoke about how intergenerational interactions are distinctively harder to foster in big cities compared to smaller towns and villages. For example, P11(M, 68) stated *"I think that in the city it's different to little towns, where you are closer…you know each other. In the city everybody goes independently, I do not know, It's my point of view."*

Questioning into the activities that participants engaged in revealed a wide swath of social activities, some of the most popular activities were gardening, playing music, attending church, bowling, sailing, language class, fitness class, water gymnastics and dancing. Participants affirmed that these settings had at some or other time fostered intergenerational interactions with both familial and non-familial younger people.

Life experiences and politics were amongst the most prevalent topics for non-familial interaction. More specific intergenerational topics that seemed to dominate engagement were mostly centred around gardening, sport and music. While gardening was an activity popular with familial connections, it seemed that music and sports had a bigger role to play for non-familial relations, particularly because they required both young and old to be physically present. When asked which activities were likely to improve intergenerational interaction, a participant had this to say, *"…about school, sports and music. Because Aristotle said that music and sport are the most important things."* – P18, M, 79

4.2.2 Attitudes towards intergenerational interaction

Attitudes towards intergenerational interaction reflected both positive and negative feelings, and perceptions that older adults held towards interacting with younger people. Attitudes are divided into two main groups according to the IBM framework and consequently, the coding scheme. *Experiential attitudes (positive or negative)*, which are concerned with the participants' valuations on intergenerational interaction based on emotional responses and past experiences and with younger people and *instrumental attitudes (altruistic or personal)* which are concerned with participant's expectations on the outcomes of their relationships with younger people. Table 4 shows the number of quotes reported for each construct, the emotional valency of the quote and the age of the investigator. Due to its comparatively larger size (18>4), this form of sentiment analysis was only performed on the Italian sample.

Experimental investigator effect

In order to investigate the effects of an interviewer bias, I divided the results of the Italian sample interviews into two groups. Namely, those carried out by a senior investigator (74) and those carried out by younger investigators (average 23). The results on behavioural determinants for intergenerational interactions for this sample are reported in Table 4.

Table 4: Number of quotes and valency (Italy)

IBM construct	(SI) Senior Interviewer	(YI) Young Interviewer
Instrumental attitude	N= 22 🙂 19, 🙁 3	N= 11 🙂6, 🙁 5
Experiential attitude	N= 48 🙂 32, 🙁 16	N= 21 🙂13, 🙁 8
Descriptive norm	N= 2 🙂 2, 🙁 0	N= 6 🙂2, 🙁4
Injunctive norm	N= 3 🙂 3, 🙁0	N= 2 🙂2, 🙁0
Self-efficacy	N= 11 🙂 8, 🙁 3	N= 3 🙂2, 🙁 1
Perceived control	N= 4 🙂 3, 🙁1	N= 6 🙂0, 🙁 6
Total count	**Total quotes** = 90 **Positive** = 67 **Negative**= 23	**Total quotes** = 49 **Positive** = 25 **Negative** = 24

Experiential attitudes

Positive experiential attitudes

Participants described contrasting experiences with younger people. A majority (45 of 69) of the descriptions were positive recounts under different circumstances. Perhaps unsurprising, perceptions of young people as a group were derived from experiences with young people. Overall, participants held fond perceptions of young people and interacting with them. This is signalled by statements such as:

"I get along with young people" – P1, F, 77
"I really like young people, I can talk, joke, we laugh together." – P16, M, 72

Participants described their admiration of the youthfulness of young people, this was captured by statements like *"Thinking about young people…I wish to still be young"* (P1, F, 77) and (P2, M, 77) *"first of all I think that young people have a physical force that we don't have"*. Other descriptions cast young people as full of potential and physical vigour.

Participants also described young people as "helpful", especially around volunteering activities. As previously stated, volunteering contexts were an evident source of positive intergenerational interactions. This is captured by statements such as:

"Everybody makes themselves available, young people went back and forth to pick up people who don't have cars or those who are wheelchair bound". – P1, F, 77

"One day I remember one of our teenagers was helping us out in our food cooperative and it was good, very pleasant." - P20, F, 73

Participants reported to enjoy particularly interactions where young people listened to them, this is echoed by statements like *"There are a lot who play bowling, we laugh and joke. I trained for two or three years with young people, they listen to me…"* - P11, M, 68

Some encounters seemed to be based on a shared experience or condition by a younger and older person. P1 recounts, *"For example the girls from Campagnano, the ones who are disabled, they are much younger than me but I feel that they understand me really well"*.

It is clear that intergenerational interactions are a source of satisfaction for seniors, especially when these interactions utilized their knowledge and skills. Speaking on teaching teenager neighbours how to prune, P14 (M,79) said, *"I like it a lot if I see that a young person is interested in something, I enjoy it very much to see that a young person is interested in how something works, this gives me great satisfaction"*.

Experiential attitudes varied markedly between familial and non-familial relations. Some participants even remarked on how they have an easier time interacting with young people that are strangers, for instance, referring to young people, P1 said *"actually, I can...talk more with unknown people than the ones I know"*.

Despite a perceived lack in life experience, participants felt that younger people had a natural aptitude for using technologies. This is even extended to adolescents, P20 said *"you know the computer, the whole computer thing was introduced when I was forty so it was a basic innovation and I will never become really familiar with it, the children which were born then, or after are born always with a laptop in the hand and this is what I'm missing. A little boy aged eight can do more about my telephone than I can do."*

Negative experiential attitudes

While most of the impressions of young people were positive, some participants voiced negatively accounts (24 of 69). For instance, participants made several remarks on the lack of emotional or social maturity and professional experiences of young people as evidences by the following quote:

"They have more information technology experience but they do not have a big professional training, they use technology as an instrument, but they lack basic preparation "- P2

In another line of quotes, participants made several references to young people as inattentive and directionless:

"Yeah yeah sometimes they are less orderly but sometimes it looks as though their head is full of ideas and then they forget what they have been doing and just leave it aside." – P20

"When I see young people... I see them as little...lost" – P8

"It depends on intelligence and their capability to listen, this is what I noticed, that young people do not understand" – P3

Participants also expressed concerned of a form of generational apathy. Respondents voiced that younger people seemed disengaged and did not understand the life experiences of older adults, even when the younger people were their own relatives.

"We had a better period than they did for sure, but our sons and daughters don't even understand our period" – P1

The presence of negative attitudes cannot be discounted; some participants recalled having negative experiences with young people. Negative experiential attitudes where captured in statements such as:

"They stole my wife's bag in Palermo, but a lot of people told us to keep calm because they steal everyone's bags" – P18, M, 79

Negative sentiments seemed to be more directed towards non-familial teenagers as is evidenced by the following answer when a participant was asked to recount a particular event where they had a negative experience with a young person. The participant makes a clear distinction between the behaviour of adolescents and older young people, presumably teenagers: *"When adolescents/young people are aggressive, in public or at events. At the events I attend there are little adolescents. But for example, at a sports event, you go to the snack stand and want to get a Bratwurst and then teenagers come up to you saying: "Hey old woman, move out the way a little". I only take public transport rarely but it's the same there that teenagers think they're particularly strong and they listen to music very loudly and have a full can in their hand, that's not so…but you have to look past that. You are not allowed to say anything."* – P22, F, 25

Instrumental attitudes

From a perspective of expected outcomes, this section describes drivers for intergenerational interaction. Motivational factors describe the various personal and societal reasons participants chose to partake in intergenerational interactions. While not directly implicated in the IBM framework, they were extrapolated from the dimensions of the IBM and expounded on here for clarity. The motivations are framed in two categories (see Table 5), altruistic motivations that involve participants' sense of duty to do social good and personal motivations that are driven by goals of self-benefit and self-improvement. The distinctions between motivations are not always clear but they help illuminate the source of intent, namely, whether motivations are external or internal. Needless to say, both altruistic and personal motivations were associated with participants being able to derive great joy from interactions.

Table 5: Motivations for intergenerational interaction

Driver	Description	Instrumental attitude type
Caregiving	related to seniors' motivation to fulfil familial role	Altruistic
Guidance	related to seniors' motivation to offer guidance and life advice to young people	Altruistic
Teaching	related to seniors' motivation to pass on skills they have	Altruistic
Learning (Technology)	related to seniors' motivation for learning and self-enhancement	Personal
Shared experiences	related to seniors' motivation to share common experiences and personal interests with young people	Personal

Altruistic drivers

Participants interactions with familial young took on an asymmetrical role. This primarily involved taking care of grandchildren out of a sense of duty. An example of this is shown by one participants' response to whether they interact with young people in their family

"Well…interaction with young people of my family…yes of course, surely with grandchildren but it is more a utilitarian relationship" – P9

"Yes, my nephews. We have to act like servants. Obviously, my 3 years old nephew always wins [laughs]" – P14

Although, many of familial relationships seemed to be motivated by familial responsibility, this did not exclude personal motivations as relationships were often described to give participants a lot of joy. While familial interactions seemed to be motivated by caregiving duties, motivations to interact with non-familial younger people were driven by a desire to do social good. This seemed to stem from the position that older adults thought of themselves as being in comparatively better economic and social circumstances than non-kin younger people. This position compelled some seniors to feel a sense of duty to impart guidance, generosity and understanding in their engagements with young people. This is exemplified by the following quotes.

"Yes, of course. We are keepers of a stock of personal and cultural knowledge for every one of us" - P4, M, 76

"If I find someone (referring to a young person) *going crazy, I try to give them him advice"* – P16, M, 72

"It happened to me recently to talk with a twenty-year-old person, he was the nephew of my hairdresser, he was disturbed by something someone had done to him and I offered some helpful advice" - P3, F, 72

"I'm friendly with everyone. I talk with everybody. Even if someone on the bus. Even we, as Italians…with young people begging on the streets asking for one Lira [old Italian currency]*, I ask them, where do you come from? What are you doing? Be careful okay? for me one word is more important than one euro…all these young people need that."* – P13, F, 83

The motivation to do good based on life experience was also present in participants' self-perceptions, when asked about what views they held of old people, a participant gave the following answer

"Well on the one hand, If I thinking about older people, we can say, a little, it makes me a little sad because, being old, they have little life to live, but, on the other hand, they are able… to guide, to give advice." – P8, F, 70

Other participants indicated doing well and helping each other as main motivations for intergenerational encounters. Challenging the stereotype of people in need, participants mainly described examples where they were the helping agents, emphasising their own agency and power.

"…For example, one time we were eating inside a restaurant and there was a young person outside looking at us. They prevented him from entering so I went outside and gave him a hand. Doing that made me feel helpful". P1,

Another participant (P20) mentioned how one of her friends was taking care of three children from Afghanistan whose father died soon after they emigrated to Germany. The mother of the children had died earlier and the participant's friend was helping the family in contacting governmental agencies to complete administrative tasks required to integrate the children into German society.

In some cases, participants mentioned that intergenerational relations are important for the preservation or continuation of valued traditions, for instance P18 (M, 79) said *"my father-in-law used to play music, I play music and my granddaughter plays music. Music is everything to me"*. Many participants felt that intergenerational relationships were an avenue for them to make use of their existing knowledge and that it brought them great satisfaction when young people were eager to learn from them.

P1 said *"...I'm not willing to make new friends, however with a young person I am always willing to talk, to discuss, especially about work"*. The previous point highlights a recurring trend, that participants were less interested about investing in new friendships with younger people but were happy to interact with them on the basis of acquaintances. It could be that relations between older adults and young people are rather motivated by the co-beneficial aspect than by "pure friendship".

Even with an overall positive impression on the benefits of young-old relations, some older adults felt that there is nothing to be gained from intergenerational interaction. This seemed to be due to a lack common topics and past negative experiences with young people. For instance, when asked if she would engage with younger people, a participant answered *"No no, I don't think so. What should I tell them? Maybe with someone around fifties, but less of this age, no. I don't have any interest in it. Because they do their business, they drink…and they smoke, I don't like it, no no."* – P12, F, 91

Some participants expressed a preference to interact with younger older adults, in this case, someone in their fifties. Other participants were eager to engage in intergenerational interactions as long as they were assigned a responsibility to younger people.

Personal drivers

Interviews revealed that personal motivation towards intergenerational interaction were mainly centred on learning, particularly learning how to use technology. This motivation seemed to be borne out of the perception that younger people have an intrinsic competency for technology use, due to how early they are exposed to it.

"...you know the computer, the whole computer thing was introduced when I was forty so it was a basic innovation and I will never become really familiar with it, the children which were born then, or after are born always with a laptop in their hands and this is what I'm missing. A little boy aged eight can do more about my telephone than I can do" – P20, F, 73

"Of course. I learn to use the computer from young people because it is like that." – P3, F, 72

For instance, when asked whether participants could learn something from younger people one participant replies

"Of course, this stuff [pointing at his smartphone], but I repeat, my brain refuses it" – P14

The exaltation of young people as "natural" technology users appeared to be the reason participants wanted to continue having engagements with young people.

"For example…I recently…there is computer technician, a friend who is a computer technician, I'm in contact with him, because I like this person and I try to contact him to obtain from him computer knowledge…otherwise practically I have to do a training course because I've never done a computer course" – P2, M, 77

Consequently, some participants also felt that not only would intergenerational interaction improve their mastery of technology use but that this skill would also improve their interactions with young people, hinting at the possible presence of a positive relationship between learning technology and intergenerational interaction. On this point a participant remarked on how technology serves as a bridge between generations and went on to give an example of WhatsApp and how a person can be completely excluded if they don't use it.

"The information technology knowledge should help me to better interact, better with [young people] …because with it we should have more common ground "– P2, M, 77

Intergenerational interaction seemed to be perceived as something of a positive exchange between technological ability that came with the early exposure of technology and life-long experiences and knowledge that came with having lived a long life.

"Yes, exchange of things…the experience of young people, that in this society they obviously take advantage because they born knowing a lot of things that we have difficulty learning… and in particular, we can only interact with them, from our experience and memories "– P9, M, 70

Other motivations to interact with younger people hinged of the mere incentive to share their personal and everyday experiences like good movies they had recently seen or ideas they had read. Participants pointed out that this motivation was based on the fact that like them, young people had similar desires to do fun things. Here participants made several references to a *"positive recklessness"* – P8, as adventurous and playful characteristics they shared with young people.

Intertwined with other personal motivations, some participants saw their continuing interactions with younger people as a continuation of their previous professional careers. Particularly with participants who held jobs that involve interacting with young people like teaching. These participants regarded themselves as being in a unique position to interact with young people.

"Yes, but in my case also because of my scholastic experience… I've always had a relationship with young people." – P9, M, 70

As mentioned before, personal and altruistic motivations where not mutually exclusive. Although the majority of responses painted engagements with non-familial younger people as opportunities to do good, some participants also cited these experiences to be a source of great joy. Describing an instance where he taught the neighbour's kids how to prune kiwi fruit, a participant said *"I like it a lot, because if I see a young person interested in it, I enjoy hugely. I mean, see a young person, interested on it and in how this work has to be done, for me it's a big satisfaction."* – P14, M, 79

The instrumental attitudes of participants described their expectations of the outcomes of intergenerational interactions. Participants' views on intergenerational interaction were mostly positive and painted a picture of co-beneficial relationships. The mutually beneficial relationship was expressed along the lines of intergenerational learning, especially where younger people were considered as a tether to the present and an aid to overcoming challenges that came with an ever-changing world. This casual reliance was captured in statement like:

"I think it is necessary to keep us in line with the times, it's important for both technological and mental development". – P15, M, 73

"There is a positive exchange between generations as long as listening channels are maintained". – P8, F, 70

'I think it's necessary to interact more…we, our generation…with young people because for me, they can learn something from us, and we from them". – P2, M, 77

Most of the participants' expectations of intergenerational interaction centred around seniors viewing a close relationship with younger people as a way to acquaint themselves with new technology. Although some seniors viewed young people as less experienced, many pointed out that young people are equally capable of advising older people on a number of topics, and that this was mainly dependent on the young person's *"education and civility"* – P17, M, 72.

4.2.3 Perceived norms on intergenerational interactions

Perceived norms reflected the personal and societal pressures seniors felt to interact with younger people.

Injunctive norm

Injunctive norms mainly reflected the social pressure participants felt to conform to the perceptions of others. Here the focus was mainly on whether participants felt their friends and family discouraged or encouraged social interaction with non-familial youth and the extent to which these judgments influenced willingness to interact.

A majority of the participants reported that their friends and family held a largely positive outlook on intergenerational interaction with youth.

"I think...some of them [referring to friends and family] *are even happy about it! Because, in addition to having interactions with sons, there is also a dialogue with strangers …they are happy I am not restricted from dialogue even with external people".* – P2, M, 77

Some participants also added that their friends and family felt relationships with young people helped to anchor them in life.

"It's positive because staying connected with young people keeps you younger. You always challenge yourself with other and different realities". – P15, M, 73

Salient opinions seemed mainly to be those of family members and physicians or personal doctors. It was also noted that in other areas, family members, particular children of participants seemed to have considerable influence on the activities that participants took part in. When asked whether they felt that other people could negatively judge their friendship with young people some participants voiced that relationships were viewed as P3 *"super normal relationships".*

Descriptive norm

Descriptive norms reflected the social pressure participants felt to conform to the intergenerational behaviour and perceptions of other older people. Descriptive norms also seemed to reinforce a positive outlook on intergenerational contacts. Perceptions were also extended to people outside of the participants' family. Although some statements did not allude to the extent to which descriptive

norms influenced their own behaviour, participants' demeanour in answering the questions implied a mostly positive influence from other older people. For instance, speaking on an exemplary experience of her sister, a participant had this to say:

"Well, I think yes, there are. For example, my sister who has a certain age, she always does beautiful trips with a young couple. For example, now they go to Finland." - P1

Another participant fondly remarked on experiences of a woman in his volunteering association

"I belong to an association where there is a woman who makes herself available for the recreation centre where young people used to go. She is open to dialogue. For me this is positive, even if I think that you have to possess particular virtues to do that, she has a dialogue with youngest children of primary and middle school". – P2

4.2.4 Personal agency

Descriptions on perceived agency were centred on whether participants felt that personal, societal and environmental conditions allowed for non-familial intergenerational interaction.

Perceived control

Participants gave an overall impression that there were not many environmental factors that barred them from engaging in intergenerational interaction. However, contrary to popular perceptions of seniors as people who have a lot of leisure time and who would freely invest in social interactions, the interviews painted a different picture. There was a resounding commentary of the "lack of time" as something that barred participants from seeking social interaction as reported by this participant:

"I try to handle my time with care and we (older adults) are not freely available. That is a misconception. Pensioners never have time, there is something to that. First of all, everything takes longer and then a big part of your time has to go into health and physical exercise. In addition, you now have time for things you didn't have time for before. You go to the theatre more or the museum, start painting or hiking. And there is some kind of old age egoism. Some say: I want to make use of what is left of my life. Normally there is nothing against that." – P21, M, 78

Time availability is perceived as not only a barrier for older adults but for young people as well. A key insight that one participant gave us is that young people and young adults, being as active as they are, rarely have time for social interactions with seniors beyond their educational, professional and familial obligations.

"I'm looking at my own sons and notice them having to work so hard that there is simply no time. If they are lucky, they get to play with their own children or go to the cinema with their beloved and stroke them." – P21, M, 78

"To make more it? I would say time but also you know, our young people are also very busy, they go to school, 6 or 7 hours a day and when they come home, they are tired. Make homework and then they play football which is not exactly my thing." – P20, F, 73

Participants also remarked that they felt that the fact that they were no longer employed severely limited their opportunities to meet people.

"...the limited amount of social connections, because I don't participate in working life any more. The communication possibilities range from my wife, to my cat and neighbours. Other than that, I have to turn on the machine. Otherwise I would work and meet people there and go for a beer with them." – P21, M, 78

Some participants also felt that there was not enough institutional support for intergenerational activities, particularly from educational institutions.

"In my opinion, the limit can come from the schools, which don't give the opportunity to make some experience with older people. When I finished primary school, I went to gather fruit boxes, those summer months were really useful for me. With people who looked after me and taught me how to do new things" – P18, M, 79

Responding generally to questions on communication in familial intergenerational interaction, participants also cited issues with accessing technology and apathy towards its use.

"Not everyone has a smartphone and some don't have the money for one while others aren't interested in it." – P21, M, 78

Some participants also attributed the lack of intergenerational interaction to apathy and negative feelings amongst young people. Participants added that this disinterest was the consequence of living in a society were the least economically productive people are viewed with disinterest. Others also cited economic pressures and an over-reliance on technology as a reason there is a growing distance between families and even strangers.

"They see us as consumers. But we are dismissed from the productive part of society, we do not contribute to the gross domestic product, except that we still buy things. Also, old people are mostly not pretty any more. And the obsession with being young and with fitness and that you have to look good and are not allowed to show any weakness, the thought of competition and that whoever is weak, loses." – P21, M, 78

Self-efficacy

Most participants were confident in their ability to engage with younger people, not just physically but they felt that they were sociable enough as this comment from P2 attests; *"I feel…I don't feel… uncomfortable. I don't feel…I like it, I can talk well and also joke well."* Another point that came out is the intellectual self-awareness that older adults have because it is often reified by society. For instance, P2 points this out by saying *"I recently read a book by a university professor, who says that older people are a resource for the country…he says that people have a lot of experience and they can be helpful to young people"*. Although many participants expressed their confidence to engage with younger people, some felt intimidated by them, especially when encountering them (teenagers) in groups.

"...I've noticed a tendency of isolation when I'm in a group made up of young people and not little young ones" – P2

Participants felt comfortable interacting with young people as long as this interaction did not involve any new technology. Answering a question on whether they felt comfortable interacting with young people of no familial relation participants made the following remarks.

"I do… well…as long as new technologies are not involved in it, yes" – P6, M, 83

"In my field, I feel more limited, because with all these new technologies I don't feel prepared. 30 years ago, there were no problems" – P14, M, 79

Some participants also mentioned that health problems got in the way of them interacting with young people. Others also cited their advanced age as reason they were not capable of interacting with young people.

"It's difficult, because the gap is quite high, I'm not 40 years old, I'm over seventy." – P15, M, 73

4.3 Results: Seniors practices, motivations, and attitudes towards games

Although the "gamer" or "non-gamer" status did not form part of the criteria for recruiting the sample, none of the participants identified as "gamers" in the conventional sense. In presenting these results, I therefore focus on the general gaming and playing habits of a sample group of presumable "non-gamers". This is done in order to address the lack of research on seniors who do not self-identify as gamers and to expand the understanding of the ludic experiences of seniors in the broader society.

4.3.1 Senior gaming practices

Almost all participants admitted to have experienced playing some kind of game. Cards, crossword puzzles and a variety of board games were popular. Examples of games that participants liked were extended to different types of sports and physical activities as well, although a generalised resistance towards video-games was identified. *"I don't like those kinds of games [referring to digital games]. I rather like sports, archery or studying at the computer. I don't like the digital games in itself"* – P7, M, 68, IT. Several participants echoed an aversion to playing video games, as evident in the following response when a participant was asked if they played any mobile or computer games: *"No, because they make me tired and I'm not a technological person"* – P8, F, 70, IT. Participants articulated their attitudes towards games according to two dimensions (themes) of the IBM [32]. The first one – instrumental attitude – described the beliefs about the expected outcomes associated with games and play. The second dimension – experiential attitude – elaborated on the emotional response and experiences with games and play. Sub-themes served as summary groupings within each respective attitude theme.

Instrumental and experiential attitudes were intertwined in the participants' narratives. They offered that sometimes they felt like games went beyond pure hedonic goals. *"Yes… More than to relax, it's a hobby, to allocate a part of your time to something. But I don't think it's always to relax. Because also the game… Even the game has its own care and it's not all about relaxing"* – P2, M, 77, IT. Contrasting relaxation goals, participants regarded game activities as something that could be used for self-enhancement and learning. These enhancements were not only mental but sometimes physical as well. Participants often extended the definition of a game to physical activities such as sports. *"A sport, for me a game is a hobby. Game means sport to me, like cycling, football, swimming"* – P14, M, 79, IT.

These interesting references to games as purposeful activities led us to probe the topic further. I asked participants to react to the words "serious game". As serious games currently represent a large interest in non-entertainment games, I was curious about how seniors' conceptions of a serious game fit with those laid out by researchers.

The majority of the sample indicated that the words "serious game" is an absurdity since it violates the non-serious quality "real" games promote. *"When you say serious game my first reaction is that it's a contradiction in itself!"* – P20, F, 73, DE. Whereas a conventional game was perceived to

require little cognitive effort, participants perceived a serious game as an activity that requires considerable mental effort. *"I don't know, the Ramino game is a serious game. Briscola is another serious game, because you have to think about it."* – P14, M, 79, IT.

Participants perceptions of the importance of rules were also contrasted in their conceptions of serious games. Respondents expressed that a serious game was more likely to be rule-bound and non-entertaining. *"Well, a serious game is when you have to respect the rules…related, for example to a card game match, should be when you have to know the rules well and everything, so that is a serious game, it's not an entertainment anymore"* – P8, F, 70, IT.

Some respondents also commented that serious games held different consequences for mistakes compared to conventional games. The most common consequence serious games held involved the player losing money. This loss was often associated to a gambling experience or playing a football championship were the chances of monetary gain or loss were high. *"…with Briscola, it is a serious game…they also play for money. Well, I have two friends that go once a month to play Pinnacolo… a bad habit…but sometimes I also go too and I exclaim: 'we bet 10 and nothing else, when it stops, we stop '. A lot of people go there. Also, young people. They go to the other room and they play with that stuff…that is a ruin…the slot machines…and you don't win there, it's not a game."* – P13, F, 83, IT.

Participants also indicated that serious games could potentially carry a more goal-oriented aim. This goal was expressed as clearly separate from fun. Respondents held the idea that serious games had the potential to communicate difficult topics. *"The other hand is that a game could be serious if it was like playing word games, communicating with people, to communicate something difficult or something serious, I try it in a nice way, also I make fun of it"* – P20, F, 73, DE.

Interestingly, seniors in the sample also made several references to life as a serious game. This was largely abstracted on the grounds of purpose and continuous effort. Effort was required to constantly seek out ways to improve oneself, especially in the face of physical and mental decline. This challenge was seen as something to beat the odds by remaining healthy for as long as possible. *"Serious game is… what you do to stay better, like physical activity…"* – P15, M, 73, IT.

4.3.2 Instrumental attitudes

Instrumental attitudes described the pragmatic reasons why participants played games. Table 6 gives a summary of such reasons by reporting the sub-themes of instrumental attitudes.

Table 6: Instrumental attitudes towards playing games

Sub-theme	Description
Socialisation	Games as an activity for social settings
Intergenerational relationships	Games engage younger relatives in interaction
Mutual Learning	Games are tools for teaching and learning

Socialisation

Games were described as an activity that facilitated interaction with friends and family at social gatherings. The social dimension was emphasized by a resounding preference for face-to-face interaction with other people, as one of the participants reported *"I mean when you are together with other people during a dinner and you play parlour games."* – P6, M, 83, IT. While co-located and collaborative forms of play were met with favour, remote digital play was seen as undermining the social experience. *"I like playing in company. Because together…they are games… they are made not for money but for the pleasure of playing, also for winning, but at least to spend time together, have a laugh…with the PC I'm alone in front of a machine!"* – P10, F, 72, IT.

Intergenerational relationships

Games were often associated with intergenerational relationships. Many of the participants mentioned the goal of maintaining a relationship with grandchildren or younger relatives as a primary motivation for playing both digital and non-digital games. Grandchildren were almost always cited in the playful events participants described. For example, when asked if they enjoyed games, a participant answered *"...with my great niece, yes, we lay out dominoes and these cards here. She has a tablet and involves me in that. Whatever there is on there for kids."* – P22, F, 75, DE. Children were often mentioned as the primary reasons for playing in childhood and later life *"I must say I do not play a lot of games, I used to play cards with my old aunt and uncle and now I'm playing some little games with children. Just to please them but it's just not my thing."* – P20, F, 73, DE.

Mutual learning

Education was identified as an important component of intergenerational play. Participants expressed that they invented playful tasks with grandchildren as a way to socialize them to a particular experience or to teach them a certain skill. One participant explained that they played *"With my grandchildren and my family, I live in the countryside with a lot of land and there is a lake as well. When we play with my grandchildren, there is always an educational layer underneath it."* – P21, M, 78, DE. The games older people engaged with younger family members often embedded older people's skills and abilities. *"I got a block of wood and drilled holes into it and then I put nails in it but not too far, so they wouldn't disappear yet. So, she learned how to guide the hammer and how to put the nails in. That was our shared game."* – P21, M, 78, DE.

Older people used games as an engaging way to pass their knowledge and skills to the younger generation. However, learning was not one-sided. On the contrary, participants reported relying on digital games with younger relatives to facilitate an experience where they could learn new technologies in a non-intimidating way. Playful exchanges between seniors and grandchildren often helped the older player to learn about technology. *"Then they send me pictures of dancing dogs. Beautiful!* [she repeats it three times]. *Also, with my grandchildren. So, I even learn to write… at the age of 83!"* – P13, F, 83, IT.

4.3.3 Experiential attitudes

Experiential attitudes described the hedonistic aspects of playing. Table 7 summarises the main sub-themes characterising this dimension.

Table 7: Experiential attitudes towards playing games

Sub-theme	Description
Fun	Games elicit feelings of enjoyment
Mindless relaxation	Games give hedonic sensations without the need for cognitive effort
Nostalgia	Games are objects of youthful memory
Annoyance	Games can be a source of frustration
Challenge	Games can invoke attention and intellectual action

Fun

Respondents described games as a means of having fun. Fun was elaborated as a feeling of freedom brought on by being able to enjoy an activity in the absence of any strict goals. *"Game has a different connotation for me. A game, to me, is connected with a high fun factor. If you can learn something on the side, it is still a game."* – P21, M, 78, DE. Fun as an objective was always placed before any other goals for games. Participants expressed that games should be enjoyable even when the player does not win. *"Game is an activity for having fun…to have fun…I see it like that. For example, in a tennis game…you can't always win…but you always enjoy."* – P11, M, 68, IT.

Mindless relaxation

Participants expressed that they approached games as an activity of mindless fun that did not require a lot of cognitive effort. *"Game? It's like passing the time with pleasure and without using your brain too much, just to relax.* – P20, F, 73, DE. The absence of strict goals was perceived as a thing that allowed for creative self-expression. *"Game is a break between duties that have to be done as obligations…because at the end everyone takes their responsibilities. With a game, you express yourself as best with your own imagination and with the desire to escape the mind"* – P3, F, 72, IT.

Participants also reported that they perceived games not as something where rules do not exist but rather where rules can be modified in order to cultivate fun. *"A game for me is related with laziness' rules, when someone has nothing to do and manages to grow laziness, grow it positively… you find many interesting things to do"* – P4, M, 76, IT.

Nostalgia

Most participants' viewed games as something associated with youth, many of their experiences related to times when they were younger and more active. These experiences were described with hints of sentimentality and nostalgia. The majority of games described were outdoor games played with groups of peers. *"Yes, that's it! When we were young, we did a track…cycle…with the chalk you create the track…we took the covers of beers…we used to call it scudelette"* – P11. Participants were acutely aware that the concept of games had deeply changed but remained loyal to

their time *"Then children's games. We played with a ball on the street; we played hide-and-seek, all this sort of things. Things of 50 or 60 years ago"* –P16, M, 72, IT.

Some participants admitted that they did not play games because they felt like they were too old. The social dimension of games was explicit, and while participants did not voice difficulties in finding people to play games with, some cited that they were not interested in the games that are popular with other older adults. *"Oh Yes, I would like to, but I don't have the company to play, because I don't like the card games much"* – P8, F, 70, IT.

Annoyance

While experiences with games were resoundingly positive some participants held negative attitudes about games. *"Mm no. Because I don't like games, I'm not interested in them either. I'm not interested in the activity of playing."* – P2, M, 77, IT. It was clear that in their negative opinion, many participants interpreted "games" as referring to digital games. They were cognizant of this popular interpretation when speaking with the interviewer. The negative opinions towards video games was perceived as a generalised age-related attitude. *"Well yes, videogames yes…I'm thinking about today games that are played in these apart places…but it's not a thing that pertains to me so closely, maybe because of my age…"* –P9, M, 70, IT. Even those people who were personally more positive towards video games emphasised that their friends had a negative opinion. *"I also have colleagues with whom I have been friends for several years. They also say 'no' to computers and 'naja'* (German term for 'oh well') *to cell phones. Partly, I was able to convince them. I need that for health reasons."* – P22, F, 75, DE.

The major critique related to the violent content which was often associated to video games, and elicited strong negative reactions. Comments seemed especially disparaging to the First-Person Shooter (FPS) genre of video games. *"With a game, to sit down at the computer and do some sort of games. I don't have time for that. To shoot some random people, I think that is a bit stupid."* – P22, F, 75, DE.

While participants did not report to play contemporary video game titles, they did mention playing computer games modelled after traditional games, such as cards or chess. *"…I don't use these games. However, I know they exist. The only computer game that I can play is the Solitaire card game. The only one, which I can play on the computer"* – P10, F, 72, IT. Digital games also drew out negative experiences because they were perceived as hampering socialisation. Several participants felt that video games exposed the younger generation to the risk of alienation. They complained that immersion in the game brings younger people out of reality, compromising opportunities for social interaction and good manners. *"Now they have this strange stuff on their hands, the mobile phone. Grandpa doesn't exist anymore; they say to me 'Bye' and nothing else. Then they are here with this thing in their hands 'ti ti titi'."* – P18, M, 79, IT.

Challenge

Participants expressed that games were entities that possessed some element of wonder and intrigue. The precise nature if this quality is not easily captured, however it can be approximated as a feature that sparks the play's interest to engage. *"A riddle, a chess match or with cards, something that make me curious."* –P17, M, 72, IT.

4.3.4 Summary of results

Here I describe the outcomes of the interview study. I start by giving a brief summary of motivations for senior gaming extrapolated from experiential and instrumental attitudes. As an addition to motivational types described by the Meaningful Play in Elderly (MPE) model by (De Schutter and Abeele, 2010), I introduced two new motivational types, the first is "Leisure" and describes seniors' desire to play games for no other reason than to relax. The second is "Nostalgia" and relates to seniors' desire to play games that remind them of their youth.

Table 8: Motivation for senior gaming

Motivation	Description	Motivation type
Relaxation	Games give hedonic sensations without the need for cognitive effort	Leisure
Fun	Games elicit feelings of enjoyment	Leisure
Nostalgia	Games are objects of youthful memory	Nostalgia
Challenge	Games can invoke attention and intellectual action	Cultivation
Mutual learning	Games are tools for teaching and learning	Cultivation
Intergenerational relationships	Games engage younger relatives in interaction	Connectedness
Socialisation	Games are an activity for social settings	Connectedness

Despite an emphasis on the cognitive and physical abilities, studies found that seniors sometimes played games to relax and escape stressors in everyday life. Ijsselsteijn et al. (2007) Digital game design for elder state that seniors are likely to interact with technology if it enhances the quality of their leisure time by facilitating low physical and cognitive effort enjoyment. For seniors, the high prevalence of watching television as a leisure activity indicates that playing videos games could eventually claim the same status (Ijsselsteijn et al., 2007). A large majority of the sample expressed that they played games for social motivations across a life-span. Games were seen as an activity that maintains and creates social connections. Gameplay was attached to sentimental feelings of social connections that seniors made with people since their youth, and as way to maintain meaningful intergenerational relationship in the present. Young relatives were perceived as lacking life experience and games were regarded as a way to facilitate their growth.

Since seniors did not think of themselves as needing life experience, they did not play games as much as they used to. Nevertheless, their experiential attitudes were largely positive and often included several hedonistic qualities such as fun, challenge and relaxation. A few participants cited
health concerns as a reason they did not play games, although this referred more often to outdoor games like hide and seek that required sustained exertion. Respondents were adamant that games were meant to be played with other people in face-to-face interaction, and this perception created

major tensions towards video games. A strong resistance to playing online multiplayer games and to a certain extent, digital games in general, was identified. When participants did play digital games, they were digitised versions of traditional analogue games like chess and solitaire. Digital games in general were perceived as something that undermines the social component of games. Contrary to expectations (Boot et al., 2018), participants were less vocal about their abilities to play digital games and were more expressive of the fact that the limited social aspect of digital games was why they avoided digital games.

While participants generally expected games to be a relaxing activity, it seemed that digital games were perceived as the source of a lot of frustration and annoyance. Engaging with younger relatives was one of the strongest motivations for playing games. Since younger relatives were more likely to play digital games, seniors preferred engaging them in traditional analogue games in order to preserve and strengthen social bonds. Participants felt that digital games made it easier for younger relatives to ignore reality. Since seniors felt that analogue games emphasized immersion, co-presence and cooperation, they often appropriated them for intergenerational education. Games were used to teach grandchildren valuable skills. This educational element was further emphasized in their expectations of games to communicate otherwise complex concepts to others. Similarly, a process of mutual learning was emphasised: when they were played, videos games were regarded as a way to learn to use technology while engaging with younger relatives. This spoke towards the expectations of seniors for games to not only be fun but to be purposeful as well, although the label of serious games was disputed. Games were expected to be purposeful but in an interesting way. A good purposeful game was expected to capture the player's interest and curiosity while covertly guiding the player towards self-improvement. This more purposeful aspect of games was signalled by how frequently seniors referred to sports activities as games. These interpretations of games showed that seniors were aware of the non-entertainment purposeful value of games even though they had never encountered the words "serious game" before. Although participants did not directly equate self-improvement to health benefits, there was an undercurrent desire for games to improve physical and cognitive wellbeing.

The study reported in this paper has several limitations, mainly addressing the sample size and intrinsic characteristics of qualitative user research. Thematic analysis relies on identifying patterned occurrences of narrative constructs (themes) in a dataset (Braun and Clarke, 2009). The development of themes is determined by its relevance to answering research questions and does not always rely on quantifiable measures (Braun and Clarke, 2009). In the analysis, themes were identified at a latent level, meaning the identification was informed by social theories on attitudes and sometimes their interpretation went beyond just what participants said. We subscribe to the proposition by Burr (1995) that meaning is socially produced and any interpretation of the individual's response must be conceptualized as derived from a dynamic interaction of social forces, and therefore we invite the reader to exercise caution in generalisation. However, we believe that the results of this paper can provide important directions for future research, which we have summarised as guidelines for game design.

4.3.5 Guidelines for the design of non-kin intergenerational games

With reference to the literature and the results of the interviews, we propose guidelines for designing games for seniors. These considerations are suitable for, but not exclusively applicable to prosocial game design that are meant to support seniors' existing motivations to engage in intergenerational interaction. Each design guideline presents an opportunity to enhance behavioural intention through understanding instrumental and experiential attitudes, which are important predictors of intention according to the IBM (Montano, et al., 2008). These guidelines are not prescriptive or exhaustive and would need to be considered within the context of specific user research.

Design for fun

Seniors regard fun as a central experiential goal for playing games. References to hedonic motivations like enjoyment were a recurrent theme in the interviews. Other research outside of senior research (Monk et al., 2005) have also confirmed fun to be a crucial design goal when developing interactive systems. Fun can be cultivated in different ways but it is important to match play mechanics to the abilities of the player. This allows for players to be engaged in the game long enough to experience fun.

Design for movement

Games must be designed in a way that promotes encounters, or chance meetings. Using an open space and overlaying it with structure enforced by digital elements encourages participants to move around and themselves solicit attention from nearby strangers. Similar to Bauhaus building, design for movement with open spaces, make it hard to withdrawal and solitude by making all areas easily accessible, it's not for privacy play

Design for relaxation

Seniors strive to improve their cognitive skills (De Schutter and Abeele, 2010). Over the years, they developed their own habits for keeping themselves mentally fit. Consequently, seniors do not always expect a game to challenge them mentally. On the contrary, player sensibilities point to an idea that seniors are equally interested in games that help them to relax, an activity where they can be engaged without having to think too much. Relaxation also calls for the application of "loose" rules in a game that do not require strict adherence, thus giving rise to creativity.

Design for enactment

Seniors are aware of their physical limitations but they do not want it to be emphasized in a game. Games with complicated controls are the source of a lot of frustration for older adults. Designers should try to employ input modalities that use natural body movements and do not require using complex manoeuvres. This presents serious opportunities for interfaces that make use of existing mental models. Graphical aids may be used to strongly signal the affordance of a game. Seniors want to play games that make use of concepts they already know. The use of gesture-based controls like Wii mote, Microsoft Xbox Kinect that allow for motion capturing are examples of good control interfaces. Computer vision may present added value by capturing full-body information that can be used to control game elements. It also easily disguisable in a public context to enhance ambiguous design features.

Design for co-presence over disembodied engagement

Seniors value face-to-face interaction. Both the interview results and literature point to seniors' preference for collocated play. Designers should aim to create experiences that encourage players to be in the same physical space. Moreover, these circumstances create an opportunity to use physical movements of participants as a play mechanic.

Design for cooperative open play over competitive structured play

Seniors prefer to feel like they are contributing towards communal goals, thus play styles that emphasize cooperation are likely to resonate with them. While a bit of competition can be good, it should be implemented in a healthy balance as not to promote adversity or emphasise limitations in the player. Some seniors also preferred lax rules that are typical of spontaneous and open play. An implementation of this could be to allow for multiple play styles that do not require players to conform to a single way of playing. I found this result to resonate well with design strategies of ambiguity, curiosity and appropriation.

Design for intergenerational learning

Intergenerational interaction is an important aspect of many seniors' lives. Designers should aim for experiences that allow play between familial and non-familial mixed-aged cohorts. Seniors also regarded intergenerational contact as a good avenue for intergenerational learning. Designers should consider experiences whereby players of different generations can share knowledge and experiences. Most seniors view intergenerational contact as an intimidating way to learn about new digital technologies so designers can leverage this motivation by designing experiences that encourage soft introductions to digital technology use.

Design for curiosity

Curiosity challenges the idea that seniors are only receptive to simplistic puzzle and quiz games. Seniors have multiple interests. It is important that designers account for this by coming up with original concepts that capitalize on their diverse interests. Designers should work hard to make these concepts appealing and engaging by relying on reflective user studies to uncover ideas that match seniors' interest. Older adults are time conscious and will likely not invest in games that do not capture their interest. Curiosity is a valuable resource, because like everyone else, seniors are naturally inquisitive and likely to be receptive to games that instil them with a sense of mystery and wonder.

Design for purpose

Seniors are aware that games can have positive "ulterior" motives apart from enjoyment. While they mostly see games as social activities, seniors are open to playing fun games that improve their mental or physical health. They are also open to being sensitized to complex issues through games. However, they reject the label of serious games as an oxymoron. Seniors prefer the purpose of the game to be covert, designers should avoid patronising designs that reify dependencies on technologies. Hiding purpose in design may be accomplished by relying design tactics for ambiguity, namely, obfuscating information on how systems work.

Design for ease of use

Seniors show a strong preference for tools that are reliable and easy to use (Ijsselsteijn et al., 2007). Seniors need to have their sense of control reinforced in the face of physical or cognitive decline, this essentially means creating tools that adapt to their lives instead of requiring them to adapt to the tool's functionalities.

Design for acquaintances, not friendships

Seniors are hesitant about casually making new friends, they are even more wary of games that outwardly purport to such aims. Designers should prepare to cater to senior gamers who are only interested in superficial interactions. Seniors are busy and will resist using technologies if they do not perceive benefits to outweigh time constraints. Likely to be retired, seniors spend their time doing things they never had time for when they were working, gaming interventions, especially those deployed in a public context should be prepared to demand low interest from seniors and allow them to quickly opt out from participating. This guideline sets the scene for low-threshold encounters.
Limitations

It is clear that the sample group does not fully represent the heterogeneity of older adults and the diversity of their behavioural determinants towards intergenerational interaction. The impressions captured from the interviews only provide a snapshot of participant sensibilities around intergenerational interaction and game behaviour. Furthermore, these impressions come from seniors who are from relatively well-off backgrounds. Perspectives may very well differ along cultural and class lines. Even with these shortcomings, the study provides a strong signal to some of the barriers and enablers of intergenerational interaction. Another limitation of the study is that it only considers the perspective of older adults, who would only be one target of an intergenerational interaction intervention. In order to fully account for the challenges of the kind of interactions under study, the same research process has to be undertaken with younger counterparts. Nonetheless, this first phase of the research seeks to explore the motivations for intergenerational interaction from the perspective of older adults, who can be said to be underrepresented in the discourse of gameful interventions for social participation. It is not uncommon for a study of this kind to focus on the perspectives of seniors for reasons mentioned in the literature. Younger people tend to show less resistance to adopting novel technologies, the design of games is also likely to be dominated by the perspectives of young people. While the topic of games is investigated in the interviews, no direct questioning on the potential of gameful interventions to enhance relationships is ever presented to the participants. Contributions on what can improve interactions were teased out using open-ended questions, allowing participants to make their own suggestions on how relations could be improved.

4.4 Discussion

Looking at the results of the interview bias experiment results, I observed that interviews carried out by the senior investigator were generally longer and had more talking (number of quotes) points than those by young investigators. This could have been due to the relatability towards the senior investigator that seniors felt like being more conversational. Seniors might have been more expressive of negative sentiments to young investigators because they felt patronised by young people asking them about their experiences with them. Experiential attitudes had the highest number of quotes illustrating the wealth of seniors' lived experiences. Instrumental attitudes had half the number quotes of experiential attitudes. This might have been due to the fact that seniors were clearer as to what they expected from intergenerational relationships, causing more brief accounts. The low number of norm and agency shows that seniors were firstly, not overly concerned about social pressure and secondly, they did not perceive significant barriers to their ability to interact with young people. This makes sense since the sample was comprised of healthy active older adults with no serious health issues. Responses on perceived ability also reflects this confidence.

From my analysis of the data it became apparent that seniors were more accustomed to interacting with kin and non-kin adolescents. Although participants recounted pleasant encounters with teenagers, negative experiences featured mostly around this group. Seniors often took the role of informal caregivers for adolescent children which could explain why they had fonder reflections of this group of young people compared to teenagers. Adolescents are also less developed and unlikely to be blamed for their behaviour. Seniors tended to interact with younger relatives in the family context while their interactions with non-kin young seemed to feature more prominently in professional and volunteering settings. Seniors were aware that it was more difficult to foster non-familial interactions in cities. Respondents seemed to favour activities which required people to be co-present, this is explained by their preference for gardening, music and sports as related common activities. Seniors also held that these activities provided opportunities for intergenerational interaction. Technology was also cited as an important encounter space, seniors often sought out friendships with young people in order to learn technology use or gain support. However, some contradictions were present. Seniors were sometimes reluctant to interact with young people when technology was involved due to a lack of confidence. Nevertheless, it seemed that seniors were more likely to derive confidence for technology use by interacting with young people.

Overall, seniors held positive attitudes towards young people. They regarded young people as people full of potential. Some positive accounts with younger people seemed to be anchored by feelings of admiration, often describing younger people as being full of "physical vigour" and having a "youthful appearance". This is no surprise since youth is seen as an attractive quality in many cultures, its importance in our society is evident from the size of the medical and cosmetic industries dedicated to preserving a youthful appearance. Nevertheless, youth is multi-dimensional construct and is likely to encompass a multitude of definitions and states across different people.

While seniors recounted some negative experiences with non-kin young people, they felt that interactions with them to be more interesting. A possible explanation for this might be the often-asymmetric nature of familial relationships. Seniors were motivated to interact with young relatives as part of their generational duty. It could be that seniors felt that they could share more non-kin young because they felt less pressure from familial duty when interacting with unknown young people. With non-kin youth, interactions seemed to be more motivated by a will to do good or shared experiences, in which case non-familial interactions offered more interesting encounters. Children, medical advisors and to an extent friends of seniors seemed to occupy the most influential role when it came to encouraging intergenerational interaction. This is supported by the research of Rice et al.

(2013) that posit that children of seniors had a crucial role in mediating intergenerational interactions and play.

Seniors were confident in their ability to interact with younger people. An interesting finding was that seniors felt that society underestimates how busy they are. Seniors were committed to performing activities they never had time for during their work lives and in some cases had no time to dedicate to making new friendships with unknown young people. Some seniors also remarked that they had no desire to befriend young people and would rather limit their involvement to interacting as acquaintances.

Exploring senior conceptions of games through an attitudinal lens had some notable advantages. Firstly, an attitudinal understanding of games helps to envision ways to enhance behavioural intention, an important psychological determinant of behaviour. This has strong implications on the design of digital games and other interventions that use game elements to improve senior adoption of digital technology. Secondly, attitudes have the advantage of drawing out barriers to adoption. Lastly, attitudinal considerations can be a start to anticipating new requirements for game interventions.

The etymology of the term "game" (Aarseth, 2011) or "serious game" (Trepanier-Jobin, 2016) have been the subject of much debate in the literature and this debate is evident also in naive conceptions. Overall the results of the interviews point to a diverse understanding of games. This is unsurprising since seniors are not a homogenous group. Despite these differences, there are common qualities seniors expect from games. The affordances that games hold seem to mainly move on an axis between fun and socialization, with intergenerational interaction and learning forming a critical part of the latter.

Some preferences of our sample of non-gamer seniors are different from those reported of gaming seniors. For instance, while some gaming seniors were reported to prefer competitive modes (Abeele and De Schutter, 2009), our sample voiced a stronger preference for cooperative play. The same preference was shown for games that allowed free forms of play. I postulate that seniors might respond negatively towards strict rule-based play and scoring systems, which are typical of the structural character of video games.

Despite the driving appeal of video games as a new cultural phenomenon, the platform still poses serious challenges to today's seniors. Video games are seen as highly unattractive due to their ability to cause social distance. As such, they are seen to be in direct conflict with the intrinsic
social motivation for senior gaming. While some researchers have slightly downplayed this result, it is widely cited in all previous studies (De Schutter and Abeele, 2010, Ijsselsteijn et al., 2007, Marston, 2012). Seniors seemed to value cooperation, co-presence, self-improvement and intergenerational learning when it comes to games. A well-informed balance of these features is likely to solicit the attention of seniors. Nevertheless, there is a need to investigate the importance of these factors empirically.

Instrumental and experiential attitudes provide a summary of seniors' experiences with games but more importantly, they outline limitations. For instance, while there are ongoing studies (Ferri et al., 2017) positioning empathy in games as a way to address ageism, results from the interview studies suggest that seniors do not think emotions like empathy can be conveyed through digital games, even when the player inhabits an older character, such as in Old Man's Journey (Broken Rules, 2017). Older adults in our sample believed that there are no shortcuts to empathy and that such outcomes come from face to face interactions with people. This is consistent with research that has been critical of overly positive visions of games as "empathy machines" (Loh, 2017). It is therefore important to reflect on older adults' critical sentiments about games, especially in light of the solutionism (Cozza

et al., 2017, Blythe et al. 2015) currently growing out of recent technological innovations such as virtual reality (VR) and augmented reality (AR).

The conceptions of games elicited from the interviews challenge the appropriateness of digital games in their current form. Reflecting this, I suggest that experimental games that take on a more hybridised playful character such as art installations provide alternatives for satisfying senior social needs. Most of these platforms often require the player(s) to be physically present and support different combinations of cooperative play. However, alternative games have their own challenges. Most anti-ageist games are usually aimed at non-senior players while playful interventions require a substantial amount of implementation and do not have the convenience of plug and play platforms like console, PC and mobile digital games. The results showed that when seniors played digital games, they were renditions of traditional games. This finding signals a need to provide digital interpretations of traditional games as a way to improve digital technology adoption. However, providing digital interpretations of traditional games has to be done with a close attention on how digital features can enhance play to further improve the appeal of such games.

5 CO-DESIGN STUDIES

In this section I present the co-design studies I carried out on the development of intergenerational games. I report on two separate design workshops with cohorts of younger and older people. The design activities allowed participants of various ages to reflect, negotiate and collectively create games they desired to play. Design activities were carried out with close attention to the design guidelines I described in the previous chapter. My analysis reports on game concepts envisaged from early brainstorming, group sketching and more refined storyboards. From the topics and interests involved, I endeavoured to investigate how these themes would impact the types of games designed.

5.1 Lincoln: Intergenerational co-design workshop

The Frequency Festival is a yearly event based in Lincoln, UK that aims to "harness the collective voices of the creative industries to help shape the future of digital culture; engages audiences and inspires the digital creative in us all." As part of the festival's civic creativity and engagement activities, I hosted a mixed-aged design workshop. The workshop's topic was centred around designing playful intergenerational activities for Sincil Bank, a low-income neighbourhood in the town of Lincoln. Several municipal entities had become concerned with the neighbourhood's state, it was experiencing problems of drug abuse, pollution, crime and other social ills. The problems were attributed to small tensions between native UK residents and the neighbourhood's immigrant population. Similar to other neighbourhoods, Sincil bank had a challenge of age and ethnic segregation. The aim of workshop was to explore creative techniques for facilitating participatory design of playful interventions in public places. By using game-based participatory design methods in involving both young and elderly residents of Lincoln, I had hoped to generate new game concepts that could promote intergenerational social interaction and a positive impression of the Sincil Bank area. Specifically, the design challenge was posed as "designing playful interventions to overcome social isolation at both an individual and community level by utilising open spaces for encounters for intercultural communities of different ages, abilities, cultures and familiar strangers". In addition to generating game concepts, the workshop was also meant to enhance my understanding on the game and play experiences of local seniors and youth.

Figure 15: Sincil Bank, Lincoln, UK

Method

Prior to the workshop, the research team created varying personas of people who might live in Sincil Bank. The personas described characters of various age, gender, ethnic background and abilities, one example being a young wheelchair bound woman who had moved to Sincil Bank to work as a software developer. The research team also prepared photos of various locations in Sincil Bank to help participants visualise where they could stage their game ideas. After setting up in a glass-walled room in the city centre, facilitators invited passerby into the workshop and explained the design activity to them. Several families, older adults, adolescents and teenagers participated in the

workshop. To help with brainstorming, I used the Playful Experience Cards (PLEX cards). The PLEX cards can be used for idea generations by presenting 22 categories of playful experiences that could be used by designers, researchers, and participants to design for playfulness. As a researcher affiliated with the local university, I was not allowed to collect any demographic data on workshop participants, which forced me to rely on field notes and pictures for the analysis.

Figure 16: Lincoln co-design workshop

Procedure

To entice passer to participate, I drew a hopscotch outline outside the workshop room. Members of the research team took turns to actively recruit people from the busy street in the city centre. Once participants were successfully recruited, they were given an explanation about the workshop and what was required of them. Participants were then invited to walk around the room which had different walls showing a diverse set of personas of people who might live in Sincil Bank, and significant locations in the area. The personas were modelled after descriptions provided by community stakeholders who had a rapport with inhabitants of Sincil Bank, they were archetypes of special interest persons (i.e. disabled people) and other personalities that could be found in the neighbourhood. After a brief tour of the room, participants were invited to sit down and a member of the research team proceeded in guiding them to complete a template sheet which was created to capture game design concepts. In order to structure the ideas produced by participants I prepared a template sheet with provision for a game name, where the game would be played, who the players would be, how the game would start and an extra space for participants to draw a storyboard of how the game would unfold. Participants who did not want to do the more involving design activity of completing the template sheet were invited to write suggestions or comments on the generated game ideas by placing sticky notes them on an idea wall.

Figure 17: Workshop items

5.1.1 Results

Due to strict data gathering restrictions given to us by the festival organisers, I was only allowed to record participants game design concepts. I was not allowed to gather demographic information from the participants. Game design concepts were supplemented by research observations from the design activities and informal conversational interviews with participants. Table 9 shows a summary of the game design concepts.

Table 9: Generated game concepts

Game name	Street games	Sincil Aware	History challenge	Window trail	Language monsters	Guess the emotion	Railway crossing game
Where	Sincil Bank	Sincil Bank	Cross street	Sincil Bank	Schools in Sincil Bank	Sincil Bank	Railway crossing
Who	Everyone	Anyone and everyone	Everyone	Anyone	School children	Anyone	Everyone
How to play	Get large versions of games to play on the street to get people together, XL Jenga, XL snake & ladders, XL Draughts	Explore Sincil Bank with app and spot the architecture, correctly identify buildings, locations by taking a picture and earn points	Four players on a team learn about the history of the area, start at the football field and see all the history of the area, get points by how many points of interest you capture	Players get a treasure map on an app and must find all special locations on the map and take pictures of special items	Location-based game whereby learners have to locate monsters on a map, when they find a monster it will ask you basic English language questions, high number of kids in Sincil Bank do not speak English as a primary language	One player plays a song and the other player has to guess which emotion the other is feeling under a 1 min time constraint	Stand on the right side of the crossing, get random true or false questions
How to start	Buy larger versions of games, buy score sheets, close streets for neighbours to see the games, get families play	Challenge is to go out and take a pic of significant location in Lincoln	Divide into teams, get A4 notepad, get a camera phone, obtain research	App prompt	Download app	Two players pair and start	Be there when the train comes

5.1.2 Discussion

The first intergenerational workshop was aimed at enlisting participants to design gameful intergenerational activities for a specific location, and in doing so revealed the challenges of facilitating rapid co-design sessions in public. The workshop presented several challenges to carrying out a public co-design session. I drew a hopscotch outline outside the workshop are in order to arouse curiosity and draw in participants, this worked very well. Although it was easy to recruit participants, they were more interested in finding out about what was going on in the workshop space than in the co-design activity. This reveals the importance of accounting for time constraints when facilitating public workshops, the benefits of investing time in the design activity need to be sufficiently emphasised. Running such a workshop also requires a considerable amount of scaffolding. Participants need to be supported and encouraged to work together. With the exception of participants that entered the workshop as a group of friends, they tended to work on their own instead of forming teams with other participants. This behaviour was observed from young people and older adults. In the case of families who joined the workshop, parents gave priority to the participation of their children. I observed that parents were more interested in watching their children working in the design activity then the design activity itself.

Although creative inspirations such as personas, locations and PLEX cards were provided in order to guide participant concepts, participants neglected to use these examples. The main aim of the props was partly for aiding the brainstorming process, an attempt to get participants to empathise with the unique characteristics of personas (e.g. disability) had mixed results. On the one hand participants seem to ignore unique needs among personas but on the other hand, they seemed to have created more general game concepts that applied to the most common Sincil Bank residents. This can be noted from the game design concepts participants offered, with the exception of the Language Monsters game concept, participants specified general player targets such as "Everyone and anyone" revealing a need to be age agnostic when designing intergenerational game ideas. At times, the PLEX proved difficult to use as some participants had a hard time following the inspirations on the cards. Nevertheless, they provided much appreciated design inspiration for participants. Choosing to carry out the workshop in the city centre also had an effect on which participants joined the workshop. Due to the considerably luxurious and uptown nature of the city centre, the workshop had likely only attracted more well-off citizens. Since Sincil Bank was a relatively low-income area, it was brought into question whether participants from the area would have contributed different ideas. Workshop participants all knew of Sincil Bank but none lived in the area and most had a bad impression of the neighbourhood as an area that cannot be rehabilitated. These perceptions were particularly difficult to address due to the limited time and interaction I had with participants.

The game design concepts contributed by workshop participants mostly featured location-specific gameplay that required players to move around and locate significant cultural items. This seemed to be driven by a motivation to use games as educational tools. For instance, the game concept *Language Monsters* encouraged learning through interaction with site specific educational items. While the game's target players were listed as "everyone", it seemed more targeted at the area's non-English speaking community. This highlighted the design space of designing for instead of with a targeted audience. While some ideas used the locations unique features to drive gameplay and create a more positive impression, other ideas tended to focus on how games could enhance the skills of the people that live there. This creates a delicate dynamic between creating interventions that empower their target audience and games that can create feelings of being patronised. The game design concepts all featured some form of social interaction that meant to promote contact between different people. Since I was not allowed to collect age data, I could not distinguish which ideas came from young people and which came from senior people.

5.2 Berlin: intergenerational co-design workshop

Following the qualitative study on attitudes towards intergenerational interaction and perceptions of game and play, I identified an intervention space whereby I would design an artefact to enhance intergeneration encounters. Due to the strong interest in music as a common theme between older adults and younger people, I decided to create an artefact that used music as its central focus. Music has a universal appeal that would serve as an interesting topic to engage participants. Another requirement brought forward by the interview studies was that the artefact would require co-presence of players. In order to conceptualize the first version of an intergenerational game artefact, I held an intergenerational co-design game workshop with a mixed aged sample group. The co-design workshop involved 4 youths (15-30) and 4 older adults (56-80). The aim of this intergenerational workshop was to involve older adults and younger people as co-designers for an intergenerational game based on music. During the Lincoln workshop, I realised that leaving the design space completely was not productive. Even though it generated to wide scope of ideas, crucial details were missing that would enable me to build on these concepts. In this workshop I decided to constrain the design space to music. This meant that participants were encouraged to create intergenerational game design concepts whereby gameplay would be driven by music. In addition to this I also decided to set a criterion for producing games that would support non-kin intergenerational interaction. The workshop was held in a university meeting room which allowed us to conduct the event in a more structured and controlled fashion.

Methods

The selection of methods for the workshop was inspired by participatory design and the work of Rice et al. (2012) and Marston (2012) in facilitating co-design workshops for intergenerational interaction. Particularly helpful were Rice et al. (2012) "100 pictures" and "fond memories" activity. The 100-picture activity involved compiling a hundred images based on themes which apply to the kind of gameplay you wish to facilitate e.g. fun, fitness and friendship. The images are sourced from various forms of media, formatted and printed. Groups of participants are asked to select three images they feel are most or least representative for each theme. Participants are then invited to describe how each image contributed to their conceptions of what was required for an intergenerational game. Fond Memories is activity whereby participants were asked to sketch a fond memory they shared with a grandparent or a grandchild. The memories were written on a A4 paper template which made provision for details on who, when, where and why the memory was memorable. This activity allowed participants to get to know each other better.

The workshop was facilitated by two experienced researchers (myself and a collaborator). Prior to the workshop, the researchers prepared 50 images that were themed on music, fun, location and activities. The activity was adapted and modified from the 100 pictures activity. Instead of 100 pictures, researchers decided that 50 images would be enough for a small group of participants. Images were based on themes of location, music and fun activities. A template was also created to capture participants' fond memories, with provision to record the who, what and where details of the memory. Workshop contributions were videotaped, audio recorded and photographed for analysis. The five-hour workshop was conducted over the course of a single day. No examples of intergenerational games were provided although the research team showed examples of gameful interventions such as "piano stairs" (Figure 18) that promoted public participation and interaction by allowing pedestrians to create piano melodies by stepping on steps.

Figure 18: Piano stairs; an interactive installation for behavioural change

Participants

With the help of research partners, I recruited 8 participants from a centre for seniors, a high school and a technical university. The sample consisted of 4 males and 4 females. The mean age of older adults was 74 years with a range of 71-76 while the mean age of the younger group was 22 with an age range of 15-30. The sample consisted one older male, three older adult females, three young males and one young female. Senior participants were recruited from a senior research group that was well accustomed to designing, developing and testing technological solutions for older adults. Younger participants were recruited from educational institutions, one female student and male from a university and two younger males from a local high school. Younger and older participants did not know each other before the workshop. Participants suffered no health impairments and were of white ethnicity. Three of the young participants admitted to play video games on multiple platforms (PC, console and mobile) on a regular basis while only one older adult played real time strategy games on PC.

Procedure

At the start of the workshop, participants were briefed on the research. Participants were informed that they would collaboratively be designing game concepts for intergenerational interaction meant for older adults and teenagers. In German, participants were made aware of what would be required of them and their rights to withdraw from the study should they wish. Participants were then asked to review and sign a consent form detailing the extent to which their likeness (videos, pictures) would be used in the research study. The co-design workshop was conducted at the Zentrum Technik und Gesellschaft Centre of Technology (ZTG) and Society of the Technical University (TU) of Berlin.

In the first segment of the workshop, participants were asked to listen to a 1-minute sample of a variety of music genres of music (classical, techno, country, opera, heavy metal) from a Spotify playlist. Participants were then asked to reflect on which music genres they preferred the most. After a round of discussions around genres of music, participants were asked to recount and draw a scenario whereby they had a pleasant experience with an older or younger stranger. This was similar to the fond memories exercise except participants were asked to recollect pleasant experiences with unknown people. Participants were then invited to present and discuss their experiences with the group. They were then involved in an intergenerational speed-dating styled activity in order to allow participants to get to know each other and feel comfortable. Moving clockwise around a table, participants took turns to conversate with members of the different generation groups.

After the speed dating game participants were then asked to form same generation pairs, 2 pairs of young-young and 2 pairs of old-old. This was done in order to later be able to distinguish the ideas contributed by the younger group from those contributed by the older group. Participants were provided with a template sheet and 50 samples of images portraying different young and old characters, locations, fun activities and musical styles. Participants were also given post-it notes, which they could use to record their additional ideas. The template worksheet was divided into four quadrants showing four different aspects namely Location (where the game would be played), Music (The kind of music that would drive gameplay), Interaction rule or game mechanics (specific rule in the activity that would require two or more people to get involved), Fun (aspect that made the game enjoyable). Participants were encouraged to use the different images for generative purposes and to help formulate explanations for their choices.

After creating the design concepts participants were asked to present their ideas to the rest of the group. Participants then provided feedback as to why the game concept would or would not promote non-kin intergenerational interaction. After this initial round of feedback, teams were asked to vote on two of the best ideas. Participants were then encouraged to join one of the two remaining groups to form two intergenerational game design teams. After a second period of group work, participants were asked to give a final presentation of their idea and reflect and discuss various aspects on how the workshop was facilitated.

Figure 19: Intergenerational codesign workshop

Data analysis

Workshop data consisted of video recordings, researcher notes, photographs, audio recordings and photographs of the design outcomes. Materials were grouped according to their respective activity i.e. fond memories. I then proceeded to annotate all paper materials with notes pointing out various important factors. Recordings were transcribed and translated into English. Since no structured interviews were performed and conversations unfolded spontaneously, I carried out open coding on the data.

5.2.1 Results

This section presents the main results of the workshop, namely; musical preferences, accounts and sketches of participants' fond memories, and game design concepts.

Music listening exercise

Participants held different preferences for music and although there were common genres that both young and old liked, overall preferences also varied. Popular music genres among older adults were Jazz, Classical music, Country and Folk while younger participants liked Classical, Techno, Heavy Metal, Hip Hop and Pop. For instance, commenting on Für Elise (Classical song by German composer Beethoven) a young participant made the following remark *"it makes you so emotional because it has the melody for it. And, of course, classical music is popular with all generations. With young people, but also with older people."* - P5, 15, M. Responding to the comment by the young participant another young participant said *"But there are also difficult classical songs, for most young people classical music is a bit antiquated, it does not keep up with the times."* - P6, 16, M. Seniors expressed that there were differences in their preferences for music and that these differences were dependant on context.

"Techno, for example, I wouldn't listen to that for half a minute at home, I'd switch over to a different radio station immediately. However, when I was in Bulgaria, an older gentleman took me to a concert where they played a mix of Wagner and Heavy metal, now I like Heavy Metal so much" - P4, 76, F.

Listening to the different music genres conjured up pleasant enjoyable intergenerational memories for some participants, for example, after completing the music listening experience an older adult participant said *"From a recent experience helping my daughter move I saw Waltz Night event at Cottbus, there were lavishly dressed young and old people, some old people even had their canes, even small children. It was so beautiful and uncanny to see all these people of different ages dancing in the night in the open market square"* - P3, M, 74. Other seniors had more negative impressions about techno and heavy metal *"Heavy metal and techno are very rhythmic and enter my body and my heart beat is forced into the rhythm, it creates physical tension in me that is very discomforting. But I am an absolute Jazz fan"* - P3, F, 76. This was more attributed to any music with hard rhythmic styles. *"I like jazz and classical but sometime with for example classical music on tragedy, it goes into these extreme loud tones and it gives me the same discomfort as heavy metal"*- P3, F, 76. Another senior agreed with her this by exclaiming *"yes, exactly"*. Participants offered interesting takes on music, responding to the first participant, a senior participant said *"We need to account for the evolution of music in different times, Waltz for instance was once revolutionary and frowned upon because people danced close to each other. I'm sure techno and heavy metal will be widely accepted in a hundred years"*- P3, M, 74. Another senior participant made another remark on how context influenced preference for music.

"Well, I like Techno. That's what I have to say. I was at the Love Parade; I was at the Love Parade [famous electronic dance music festival and techno parade] *the other day. We had demonstration against the AFD* [German right-wing party]. *So, I wouldn't have gone there like that. Because they make all these speeches and I don't like chitchat. But there were the ravers, they were there from Hansa-Platz to Brandenburger Tor. I walked with them. That's when I went. That was fun for me. That was friendly, that was peaceful, that was sweet and nice."* - P1, F, 71.

Participants were aware that society held certain music expectations of them because of their age. While reflecting on her music listening experience one senior participant said *"I'm not a music standard for my age."* - P1, F, 71.

Fond memories

I used the fond memories exercise to draw out common activities and contexts where non-kin intergenerational people were likely to meet. In their experiences, one young participant described a brief meeting with a senior on the way to the cinema.

"When I went to see the movie Every Monday in Dresden, I met an old woman who wanted to know where the cinema was so I gave her directions. After the movie I found myself sitting at the same bench as the old woman at the underground U Bahn station stop. As it turned out, we went to see the them same movie and we had a very interesting conversation about it. It was fun. We had the same thoughts on the movie. I couldn't believe it" - P6, M, 16.

A senior participant described meeting a young football coach at an airport after their plane was delayed. The participant said the young man provided company and good conversation which made the wait more pleasant for her. Many of the participants who had pleasant encounters with seniors or young people rarely met them again, often describing how both parties went to back to a state of disengagement after the encounter had passed. On this point a young participant said the following, *"We went to the station and talked about it. We didn't know each other before and still it was super interesting to talk about. And there was also no barrier or something, because we just had the same input. When we got on the Ubahn we got back to doing our own thing"* - P6, M, 16.

Senior participants mainly recounted stories of how young people helped them. One participant attributed this to cultural rules noting the fact the young people of immigrant backgrounds were socialized to respect older adults.

"Yes, well, what I noticed was positive. After my knee operation with crutches I had to use and was dependent on public transport. Because I had the strict orders from the doctor, not to be allowed to drive. I got into public transport, all seats were occupied, young people jumped up to offer me their seats. But hardly any German youth. Whether they were Vietnamese or not, I don't know, what shall I say now, Syrians or Turks or or or...? They jumped up immediately, they still have a completely different relationship to older people, I don't know, maybe from family upbringing. It was a positive "A- Ha-experience" to find that that still exists. That young people pay attention to seniors and pay particular attention to their physical disability." - P2, F, 76.

After a senior pointed out that German youth were less likely to give up their seat or assist older people, a younger participant responded by saying that altruistic actions gave him enjoyment. *"Yes, I do that too. That's what I enjoy most of all. Well, really, I like to get up. To give someone the opportunity to have a seat, so personally it gives me so much joy."* - P5, M 15. Even after this response the older participant maintained that German youth rarely assisted older adults they did not know, exposing a little tension between the two senior and young participants. This started a debate, with

other seniors offering that they had several encounters where German youth helped them however seniors ended up agreeing that these experiences were not so common.

Participants offered various stories on encounters with a different generation, while some were brief and superficial, others lasted for a long time with strangers sharing even private details. Recounting her encounter with a young man on a plane, a senior participant said *"and he told me that he had not had work in quite some time, but also many private things, like the difficult situation with his girlfriend and all those things. For me this was a great conversation. He obviously had the confidence to share those things with me."* - P4, F, 76. Other participants reported similar meetings with unknown young or older people in familiar contexts such as neighbourhoods or sport associations they were members of.

Participants had particularly pleasant experiences when younger people showed close regard for seniors', especially when they responded to this awareness by offering them help when it was needed. *"Very often there is positive feedback, even between the generations. And it's not just to say that, the boys are stronger or better or something. But it is also because they also show respect. That's nice."* - P3, 74, M. The pleasant experiences recounted by younger participants seemed to centre around older people sharing interesting knowledge with them.
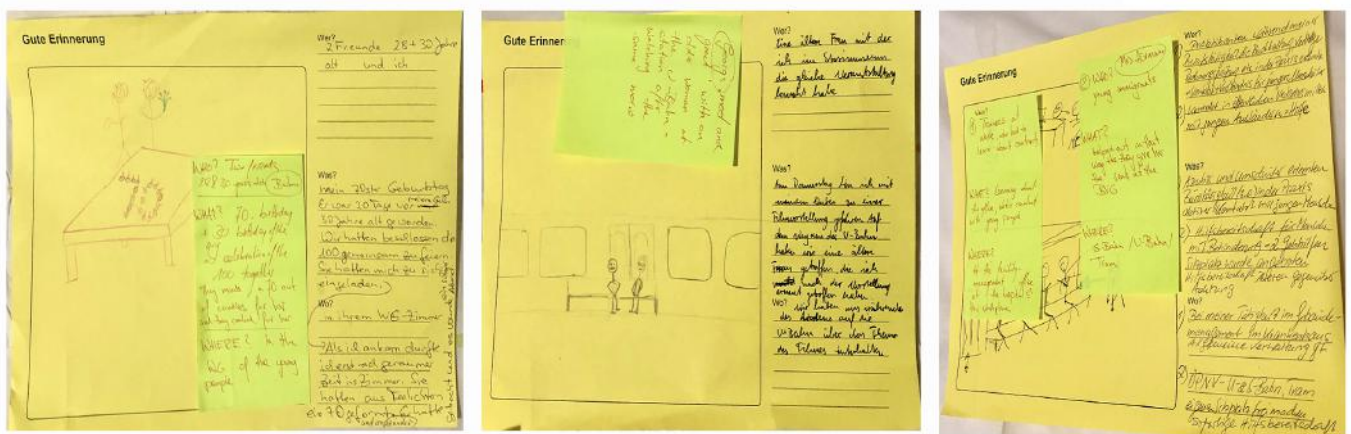

Figure 20: Fond memories sketches

Table 10: Fond-memories descriptions

Participant	Age	Who	What	Where
Participant 1 (female)	71	- Two friends aged 28 and 30 years	- Her two friends threw her a surprise party for her 70th birthday. One of the friends turned 30 and told the participant that because of their combined age they were celebrating their 100th birthday together	- In the apartment of her young friends
Participant 2 (female)	76	- Young immigrant - Young trainees at her previous employment	- Young immigrants often gave up their sits in the train to make sure she was comfortable - She taught the trainees about how the office operates and they remained friends for a long time	- On the train and the bus - Hospital where she used to work
Participant 3 (male)	74	- Young man at the rowing club - Young man at a political debate - His niece	- Helped by carrying desks and chairs at the club - Voiced strong opinion for the support of older adult rights and the need to respect them - Supported his niece with school work about Berlin	- Berlin rowing club - Political event
Participant 4 (female)	76	- Young Brazilian football coach	- Had a pleasant conversation with him, kept her company at an airport in Reykjavik when their plane was cancelled	- Airport
Participant 5 (male)	15	- Older man in his early 70s	- Lived in the same neighbourhood and would occasionally talk about their area	- Train station
Participant 6 (male)	16	- Older woman	- Brief encounter with an old lady at the train station after they watched the same movie	- Train station
Participant 7 (female)	28	- Older man	- Had a good discussion about sculptures with an older man who was an artist	- Train station

| Participant 8 (male) | 30 | - Older woman | - Older man invited him to his recording studio and showed him his guitar collection | - Older man's house |

Figure 21: Intergenerational game design concepts

Table 11: Intergenerational game design concept descriptions

Game name	Human Pinball	Musicians Karaoke	Airport games	Zumba music group	Museum VR game
Description	Human-sized pin ball game where two players each control a single flipper. Players sit on benches and control the flippers by pressing on small peddle devices. The game is projected on a large public display.	Players gather in front of an interface; they connect to the interface through an app & collectively select a style of music. One player only controls one instrument.	Introduce a play area after airport check-in, area must contain familiar games such as table tennis which are kid friendly and rules are already known	A Zumba game that can run during the holidays. Players organize each other in a WhatsApp group and meet in the park to dance.	A virtual reality application that guides visitors through different historical periods. Visitors are guided by an alien and robot avatar.
Fun aspect	Players have to keep the ball from moving out of the game zone. The longer two players can do this the higher their score. Their scored is publicly displayed	Players select their instrument and make music together for 5 mins. Players can download the music they make together	Players participate in playful activities with strangers and get to know each other	The collective movement of people in a group is fun	Immersive experience into significant historical events
Interaction rule	Flipper controls are controlled by physical pedals places some distance from each other making it difficult for one player to play the game alone.	There more people there are the more instruments, making an orchestra	Use familiar games that require two players	People will be motivated to join Zumba group once they see people having fun and dancing	The virtual reality tour is done in groups of visitors
Location	Game is staged at	Inside a mall	Airport	Public park	Museum

	the U Bahn (train) station.				
Music style	Starts with calming sounds and becomes more energetic as game progresses	Jazz, Classical, Techno, Rave, Percussion	Play classical music in the background	Latino and Salsa	Different styles of the street musicians in Berlin or music from the respective historical period
Intergeneratio nal group	Younger (male) - Younger (male)	Younger (male) - Younger (female)	Older (male) - Older (female)	Older (female)-Older(male)	Older (female) - Older (female)
Comments/fee dback	Game should not use quick movements because it might be harder for seniors to react, do not put the game close to train platforms	Add percussion instrument, use tangible objects instead of app, game should not be limited to 5 mins, allow pantomime movements of gestures, include children's instruments	Move game to an intergenerational house. Add tutorials of the games so people can learn them. Use real people to invite participants	Older adults feel more comfortable joining groups of people in playful experience	Base the VR tours on specific music cultures, educate young people with the virtual tour

During the feedback round, participants voiced objections towards staging the Human Pinball game at train station stop. An older participant remarked that train station stops (UBahn stations) were not visually appealing to which a young person replied that *"there are beautiful stations where it would be nice to play"*. Senior participants also remarked that a game like pinball requires quick movements and that older people might not react quick enough if the game required too many rapid movements. Older participants were also concerned with the safety of staging an intergenerational game in busy areas where the game might disrupt the usual flow of human traffic and potentially be dangerous for older people.

Participants were confident that any game staged in a public space would attract interactions between strangers. One senior participant remarked that she had no age preference for strangers*, "I don't care if I play with an old guy or a young guy"* - P1, F, 71. Seniors also voiced that older adults were likely to join games if there were already a group of people playing, adding that seeing people playing collaboratively would give older players the confidence to join. Although they were very receptive of public games, seniors expressed concern that socially isolated seniors who never left their homes would likely not benefit from such interventions. Participants proposed that in addition to staging the game, facilitators should actively try to recruit homebound seniors so they knew about the game. One senior also suggested a more targeted approach whereby intergenerational games could be staged in intergenerational houses would be effective. Intergenerational houses in Germany are community establishments where people of different ages are encouraged to live together. Two seniors stated that intergenerational games would be a good avenue to pass knowledge to younger people, emphasising themes of mutual learning.

Seniors were not concerned with game scores, expressing that they did not care very much about winning or losing as long as they had fun. For game concepts like *Musician's karaoke* that required players to make gestures, seniors voiced their concerns that interactive modalities that required hand gestures similar to air guitar to operate a virtual guitar would likely be lost on seniors. Participants suggested using tangible controllers that emulated the function of the represented object, in the case of *Musician's karaoke*, this meant using a tangible object that represented the virtual musical instrument. This has interesting implications on the use of in game virtual elements to communicate affordances, participants seemed to preferer tangible objects to communicate what actions to perform in a game. This is similar to the use of a physical guitar controller in the popular Guitar Hero game franchise. Participants also suggested giving players tutorials in order to improve their confidence. For many game concepts, seniors were not in favour of time limits and voiced that games should go on as long as the players wished. One younger participant was adamant that many older people had smartphones and it would be opportune to design an intergenerational game that incorporated smartphones. With the VR museum app game concept, two senior women were asked why they chose an alien and robot avatar as virtual tour guides, the senior women responded by stating that both seniors and young children were accustomed to aliens and robots. Children from playing and watching cartoons were both character types are depicted, and seniors were familiar with assistive robots from hospitals.

Participants' reflections of the workshop were largely positive, with some stating that it would be very interesting to create a game for different generations. Participant's also mentioned that the templates were especially useful, especially the four dimensions of fun, interaction, location and music. Participants expressed that these demarcations made it easier for them to conceptualize their game. One senior participant had this to say about the workshop "For me, it was really interesting. Otherwise I would have read the newspaper or helped my daughter with moving to another flat. It was really refreshing" P4, 76, M. Other senior participants expressed that they were particularly happy to be joined by younger people and that the workshop allowed for adequate time to think about game ideas without jumping to the "first impression". Participants also shared that the workshop gave

them many new ideas surrounding the topic of intergenerational games and tools for co-creating games.

5.2.2 Discussion

The first co-design workshop showed me the importance of structuring public workshops although some challenges were harder to overcome due to constraints that come with the public context. The location of staging such a workshop is very important, some measure has to be taken to ensure that the space is accessible and at least some participants from your intended target population are encouraged to join. This could mean providing wheelchair access or accounting for communicative differences by catering to various languages. While specifying a general design space such as "designing games for Sincil Bank" expands the possibility of eliciting a wide range of different ideas, it is sometimes necessary to confine the design space and also avoid patronising undertones. A general focus can prove to be unproductive, and sometimes the design space needs to be broken down so that participants address a small but manageable part of the design challenge. This requires careful thought in formulating a problem statement that can attract actionable results. It is also important to account for attitudes and misconceptions towards the design challenge itself. Give participants various modes of participation, for design activities involving people in a public area have a quick way to explain the purpose of the activity and how it works. In my case allowing people to simply put up post-it notes instead of sitting down for the design activities allowed me to capture some ideas which I otherwise would not have. I also found that props such as drawing a hopscotch game outside the workshop are played a crucial role in enticing participation. Needless to say, codesign workshops themselves could be benefit from curiosity and ambiguous design strategies.

The second co-design workshop followed a more structured approach. Prior to the workshop, participants were recruited from a target population of seniors and youth, and provided with a detailed plan of activities in the workshop. I also informed participants of how much time the workshop will take and what would be required of them. The workshop took place in a university meeting room which was a contrast to the field-styled setting of the first workshop. The first activity in the workshop featured a music listening session. Since I had identified music is a common topic for mixed aged interaction, I wanted to further probe music as a design opportunity for driving intergenerational gameplay.

I found that although older adults and younger participants had varying taste in music, these preferences were influenced by context and loudness of music. Seniors were more open to experiencing a variety of music genres especially if they did so in a social setting. This provided a contrasting vision to the stereotypical idea that older adults are people who are relatively conservative and uncompromising in their choice of music. In addition to context, seniors expressed a resistance to songs that had loud rhythmic sounds such as those expected in heavy metal or techno songs. More than the actual style of music, it was the biological effect of loudness on the body that seniors felt troubled by. While younger participants reported an overall preference for Hip Hop, Pop and Techno, older adults seemed to favour classical music and opera, with the exception of one older adult female participant who expressed a preference for heavy metal and techno. Seniors were aware of the expectations that society held for them when it came to preferences in music. Even within the age categories of young and old, participants expressed contradictory preferences for music. This led us to conclude that participants' preferences in music were too subjective and varied to produce an intervention that promoted only one type of music. Nevertheless, participants admitted to enjoy listening to the different music genres together. The participatory listening exercise worked well as an ice-breaker and participants appeared more joyful and open to interactions after the exercise.

The fond memories exercise drew out stories of non-kin intergenerational interactions. The past experience of respondents confirmed that people were likely to encounter unknown young or old people in public places. Areas for public transportation such as a train stations were popular places for intergenerational interaction, which coincidentally were also the most common location cited in participants recollections of pleasant intergenerational experiences. Seniors tended to appreciate experiences where young people assisted them with physical tasks while younger people appreciated experiences where older adults shared knowledge with them. It was interesting that one senior participants pointed out that cultural differences influenced the kind of interaction she had with unknown young. Cultural differences such as the high regard for filial piety in some Asian and African cultures have been the subject of interesting speculation in games (Khaled et al., 2009). These factors warrant serious consideration when designing interventions for intergenerational game interactions.

The game design concepts contributed by younger participants tended to be more technological. Overall younger participants were more well versed at incorporating functions of new technologies such as sensors and smart phones. Older adults on the other hand focused on more traditional game types, with technology only serving a secondary role of organizing where players would meet. Despite this observations, one group of senior participants incorporated the use of a virtual reality app in their game design concept. Younger participants were more articulate in spelling out how game mechanics would function. Seniors held that it was important to model new games on games that were already known. I assume that this was to avoid major difficulties in playing the game as senior participants also mentioned the need for tutorials that encourage confidence in players. Senior participants maintained that game interventions should account for some seniors' reduced ability to react to fast gaming inputs. Despite observing these concerns, game design concepts did not particularly account for generational differences and seemed to be targeted more towards a generational profile inclusive of both healthy older adults and young people.

Both older adults and younger people commented on how enjoyable the experience of co-designing games together was. Two of the older adults expressed how their perception of young people had been changed by interacting with the younger participants. One senior participant expressed safety concerns about staging a game in public and commented on the potentially disruptive effect that it might have on services such as public transportation. I found that seniors were more vocal in articulating challenges their own challenges in playing games, this is perhaps because the participants had prior experience stipulating requirements for technology design. It could also be that because the majority of games are designed for a younger demographic in mind, young people were less likely to demand additional features to make them playable.

The workshop setting presented several limitations. One was that seniors were overly conscious of time. Concerns regarding time were expressed before and during the workshop. The senior participants emphasized that they planned their time very carefully and needed to know exactly how much time the workshop would take. Younger participants were not so concerned with time. This asserts findings from the interview studies that contrary to common belief, older adults do lead busy lives and like to know the time requirements and perceived benefit of an activity before committing to it. Nevertheless, I did not have a problem convincing senior to participate in the workshop because many held the belief that there it is important to use technology to address challenges around intergenerational interaction and age segregation.

Another limitation was that both the young and senior participants belonged to a specific demographic, they were all relatively well-off educated people who had lived in Berlin for a long time. Berlin is known as eccentric city and seniors and young people of other places might have different views. Additionally, senior participants had prior experiences in technology design

activities, which made it appealing to consider them as expert end-users with insightful reflections. Our study is still one of the few studies in intergenerational games that contributes the design perspectives of both young and old generations. Rice et al. (2012) posit that of the few empirical intergenerational studies, it was uncommon for researchers to explicitly gather user requirements from both older and younger users together. Rice et al. (2012) further explain that "…the question of how to design intergenerational games based on the understanding of what both younger and older people want, or perceive to be important, remains largely unknown." p369. From my experience I found that due to varying skills of the two groups, it was particularly difficult to pursue design opportunities that accounted for these skills in perfect balance. However, due to the dominance of young people in the articulating more technical descriptions of game design concepts, it was more prudent for me to focus on seniors' perspectives on intergenerational games.

In both the co-design workshops, I explored a broad range of design opportunities which were outcomes of the interview studies. Among these were, common activities and topics, the difficulty of facilitating rapid playful encounters between strangers and the various drivers of intergenerational play. As is typical of research through design practice, the intention of the design workshops was not to create a final commercially ready digital game but to incrementally produce designs that had the potential to provoke intergenerational interaction. Many of the game ideas generated in the workshops illustrate participant's conceptions of how prosocial games function. The game design concepts also articulate challenges that I encountered in designing an intergenerational game probe. They highlighted challenges on recruiting, enticing and retaining players and therefore provided a design space for strategies of ambiguity, appropriation and curiosity. In the next chapters I report on how these themes influenced the design and development an intergenerational game artefact called Klang Verbindet.

6. GAME DESIGN: KLANG VERBINDET

This chapter describes the design and development of an intergenerational game artefact called Klang Verbindet. I begin by describing the use of metaphors as a useful method for sketching and imagining interactive modalities in public context. I then go on to detail the influence of a series of design concepts (ambiguity, appropriation, curiosity) that are meant to entice, drive and sustain player engagement. I describe the potential motivation enhancing qualities of interactive installations and finally conclude by describing the evolutions in the design of the intergenerational game artefact meant to encourage non-kin intergeneration encounters in public contexts.

Interaction design has a history of developing musical artefacts for social interaction. Piano stairs, Musical swings, Street pong are all examples of how musical interactive installations have contributed to understanding creativity and age agnostic social interaction in public. Some of the most foremost examples of these interactive systems have also been intergenerational games. Age Invaders, Extreme Gardeners are both examples of interactive systems based on sensor technology and a physical display. These features are well suited for robust systems that can be deployed in public contexts without any need for wired input devices such as those on video game consoles. The field of interactive music making is well developed when it comes fusing art and technology. My design draws inspiration from musical interfaces designs such as the Music Room (Morreale and De Angeli, 2015), an interactive installation that allows participants to control the emotional character of algorithmically generated classical music using the distance between two people. I also incorporate design heuristics from games like Xtreme Gardener and Butterfly Catch.

I present the iterative design of the interactive prototype in three distinct stages, namely i) Defining the interface ii) Prototyping and iii) Evaluation. While the numbering of these steps might imply a sequential process, the game was developed using an iterative, incremental and integrative approach.
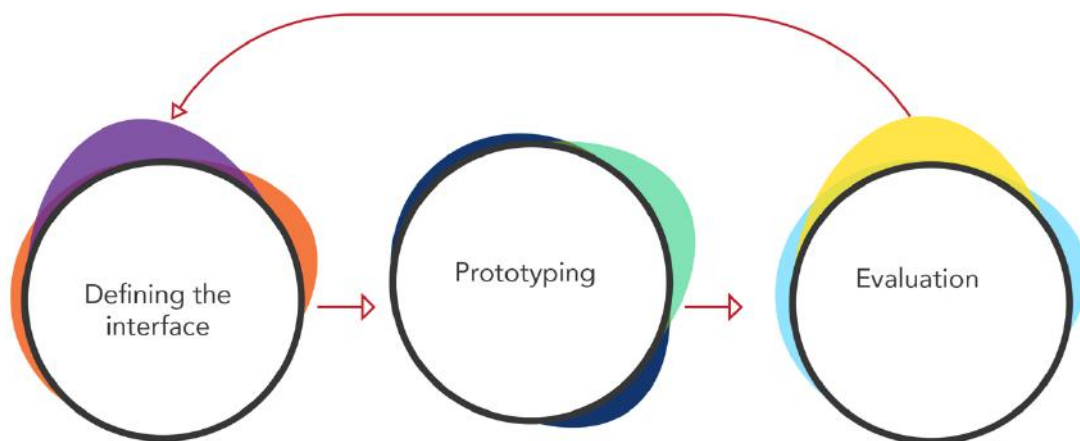

Figure 22: Game design process

6.1 Defining the interactive interface

6.1.1 The use of metaphors in interactive interface design

As a starting point for the design of my intergenerational game it was essential to define the interactive modality or interface through which players would interact with the system. At this point the system's technical requirements had not been outlined yet. In order to aid brainstorming I consulted the work of Fabio Morealle (2015) who developed The Music Room, an interactive installation for collaboratively making music whereby the distance between the composers influenced the emotional qualities of classical music. The technology was based on an algorithmic composer that changes properties of musical notation according to relative movements of actors to each other. The installation made use of a metaphor of intimacy; when actors were close to each other the music was more pleasant and romantic, and they faster they moved towards each other, the louder and faster the music became. This encouraged the movement and interaction of people in a room (see Figure 23).
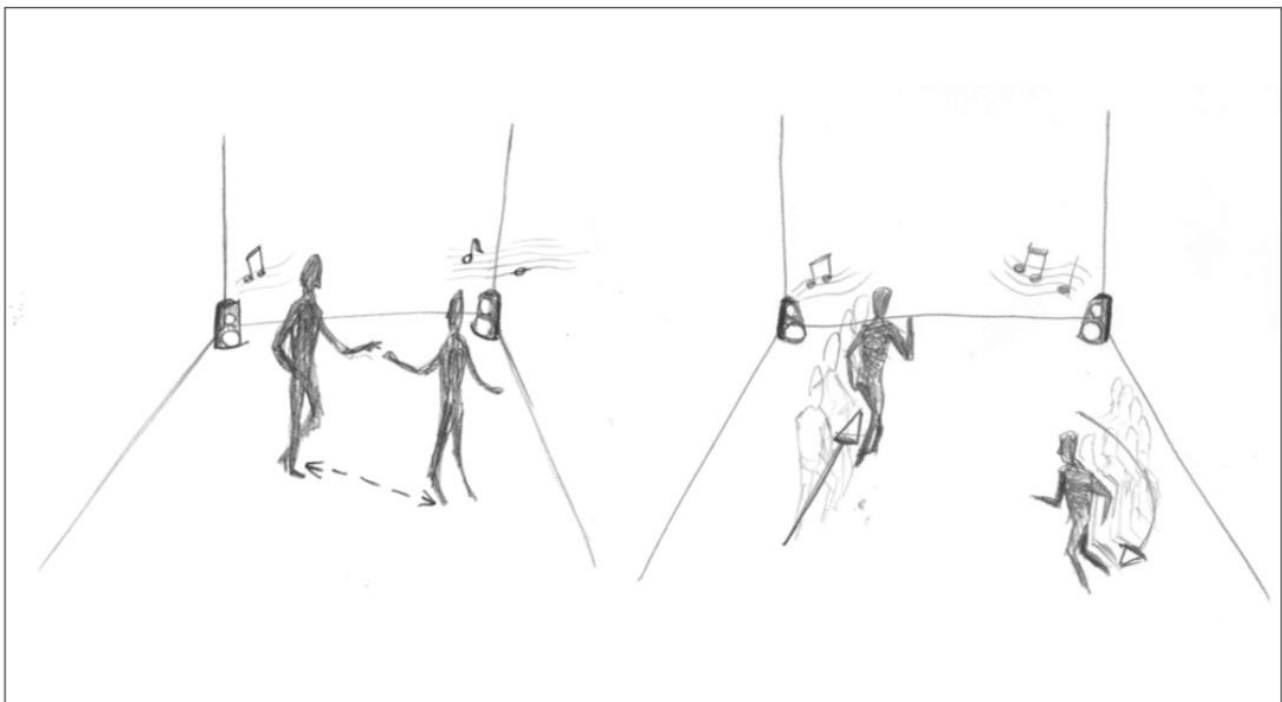
Figure 23: Sketched scenario of The Music Room

In their on designing interactive systems for music making, Morreale (2015) describe the use of interactive metaphors as a means of mediating abstract musical meanings to references that anybody can understand. Wilkie et al (2013) elaborate that interactive metaphors allow users to extrapolate how unfamiliar interfaces work by mapping existing knowledge from a familiar source domain. This conceptual framework is not unlike the use of enactive actions and affordance concepts recommended by Abeele and De Schutter (2009) in that it leverages existing mental models in order to guide and instruct interactive play. This approach of leveraging common conceptual model is particularly useful for a public context which often involves a diverse group of users with various levels of knowledge.

Considering the requirements of the installation to firstly entice interactions with the system and then with other participants, I developed the following scenarios and sketches. The scenarios describe the user's interaction with the system from the beginning to the end and how implicated design strategies are envisioned to entice, engage, sustain and retain player engagement.

Height as a metaphor for non-derisive differences.

During this interaction modality, participants interact with a musical interface by positioning their bodies in front of a camera sensor. The system produces different sounds depending on the variations in height of recognizable figures captured by a Microsoft Kinect sensor. The greater the differences in height, the more pleasant (tonal) the sound generated by the system becomes, promoting an ambient orchestral atmosphere. Smaller variations in height produce an opposite effect, a cacophonous and discordant collection of sounds. The mode of play is open-ended but the design rationale for creating variations in sound is based on the system's interpretation of height. This is to encourage people of different heights to arrange themselves in order to produce the most tonally "pleasing" sounds; the most nuanced variations in height producing the most "pleasant" sounds. Here height is used as a metaphor for the non-derisive differences between people. An anecdotal experience with the installation is provided in the following scenario. *Target solo playful activity* describes mappings to appropriative actions while *target interactive activity* describes the intended social interaction behaviour. The anecdotal description describes the instantiation of ambiguity, appropriation and curiosity.

Scenario:

*Jurgen walks past an **intriguing** display and **notices instructions** for him to stand in a square drawing on the floor. He notices that there is a **strange sound playing** that immediately changes when he enters the box outline on the floor, he also notices that **the sound changes** depending on whether he is bending down or standing on their toes. **He realizes** that the system is able to perceive someone's and **influences** the sound accordingly. He realizes that **the sound might sound more interesting** if the **system detected multiple people with different heights** so **he invites people to join him**, creating an orchestra of different sounds.*

Target solo playful activity: Player notices system and explores different ways to manipulate it (e.g. jumping, kneeling).

Target group interactive activity: Players invite other players to play with them to make more interesting sounds.
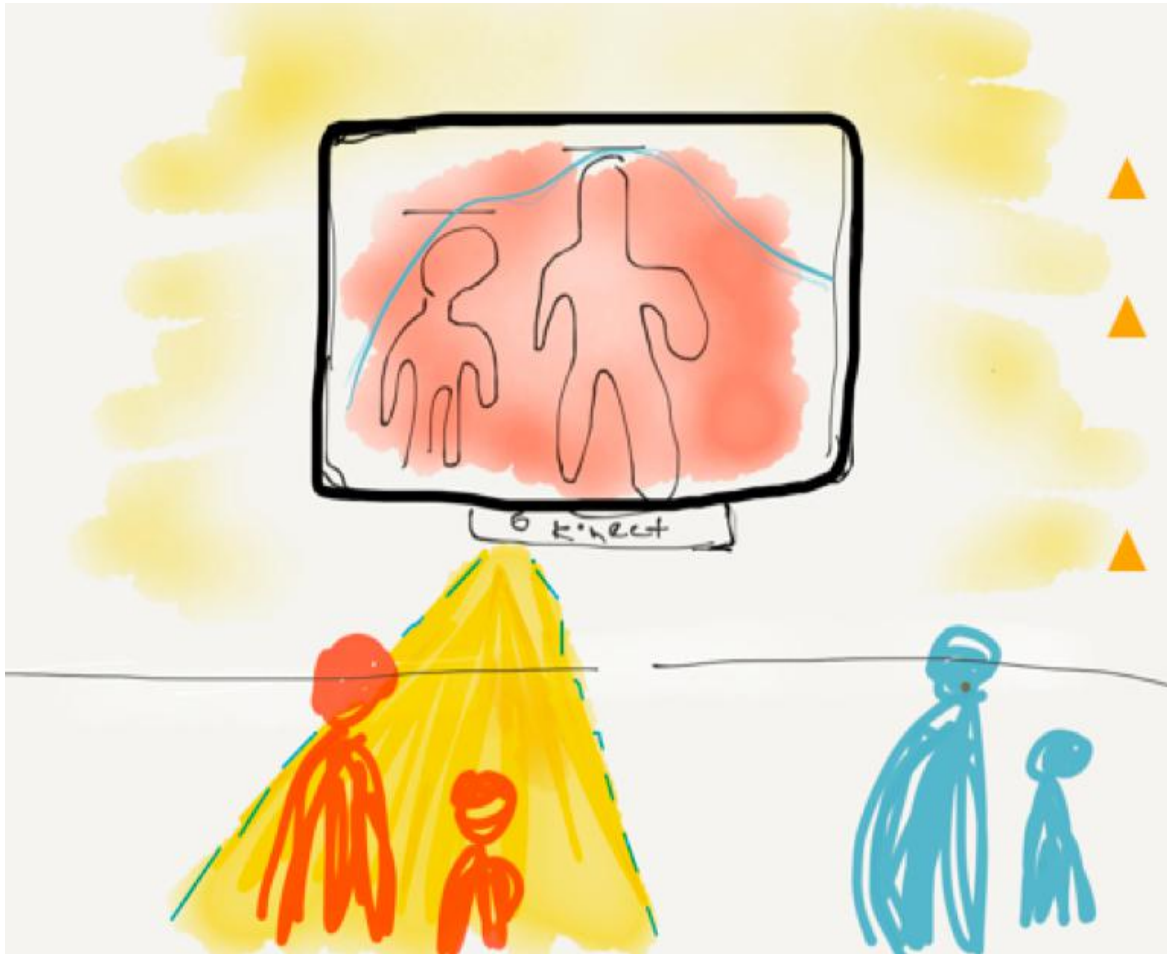
Figure 24: Early concept drawing of height interactive modality

Solitude as discordant noise.

During this interaction modality, participants interact with a sound interface by using their presence in a room. Using a camera in an overhead position, the system generates increasingly complex sound as more people enter the room. Conversely, the sound generated becomes less complex as the occupancy of the room diminishes. The lowest occupancy causes the system to output a discordant noise (white noise) that may be regarded as "unpleasant." Here solitude is controversially presented not as a peaceful state, as is a common understanding in many cultures, but as a state of confusion. This confusion of a small group is metaphorically presented as noise: a stand-in for the metaphorical confusion of disconnected communities in an echo chamber (the room). An anecdotal experience with the installation is provided in the following scenario.

Scenario:

*Sonia enters the installation and **is intrigued by the distorted sound** emanating from the room. Shortly after, **someone joins her** and she notices that there is an additional sound. A group of people enter the room and **the multiple new tones makes the sound more complex**. **Participants soon start interacting, communicating to change the room's occupancy** in order **to hear different sounds**. Some participants **try to hide in the room** as a way of subverting the unwritten rules of the system.*

Target solo playful activity: Exploratory manipulations of changing room occupancy (hiding, running in and out of the room).

Target group interactive activity: Players communicate to change the occupancy of the room
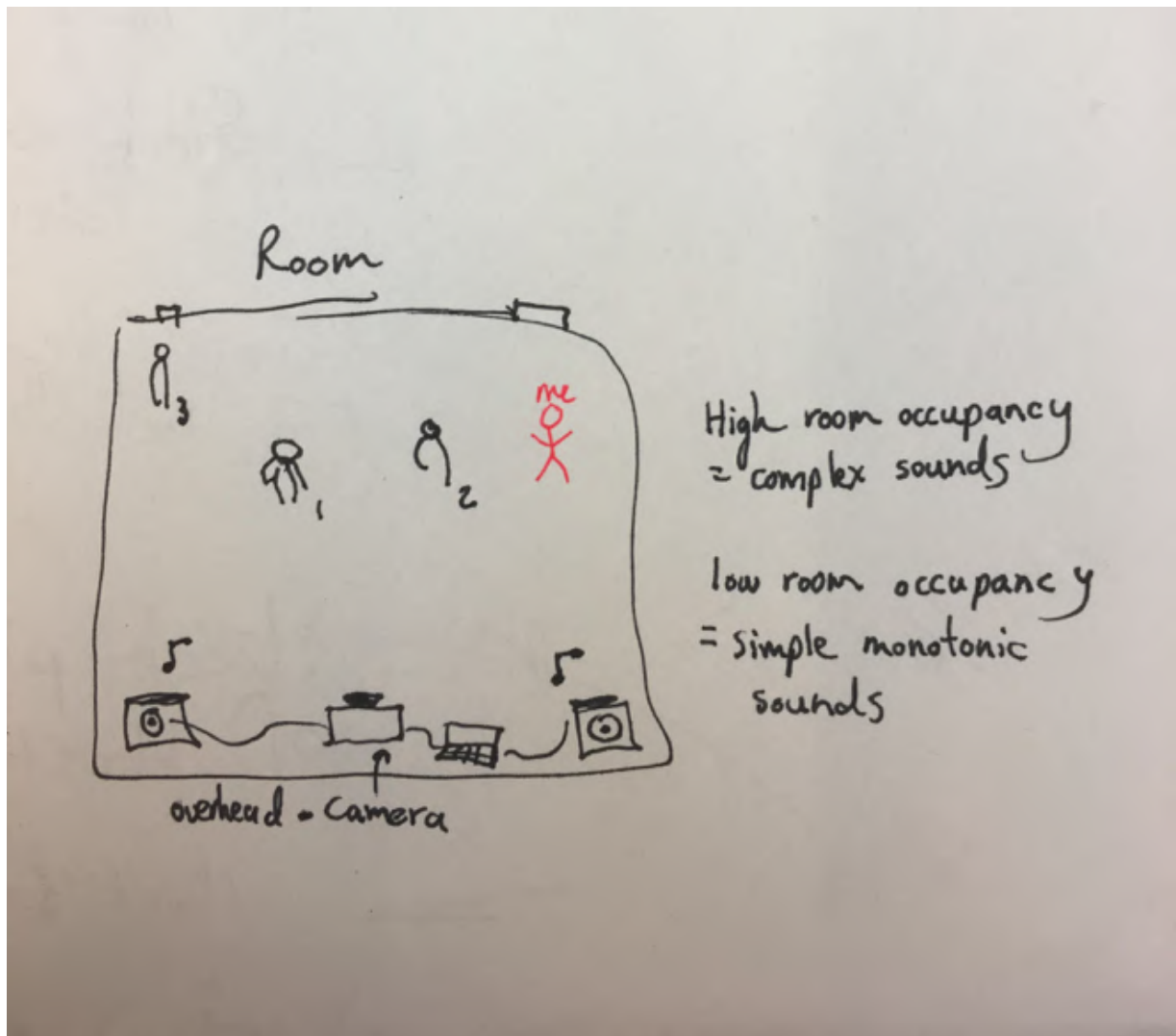
Figure 25: Early concept drawing of room occupancy interactive modality

The above-mentioned scenarios create a concept of metaphors which become the context of varying interpretations that users encounter when interacting with the system. Using these early conceptualisations with three related themes of ambiguity, appropriation and curiosity helped me to conceptualize the first version of the prototype. The "solitude as discordant noise" would later become the dominant metaphor for the intergenerational game.

I make use of the scenario *"solitude as discordant noise"* reported above to illustrate how ambiguity is used. In the example scenario, the technical system is abstracted. While the user realises that their movements in the space are responsible for the experimental sound they hear, they do not see or perceive how exactly the system works, improving curiosity. The multiple interpretations (ambiguity) the user is likely to experience leads the user to perform various actions to prove or dismiss their speculations (appropriation). The obvious absence of a comprehensive interface leads the user to speculate further (curiosity), transforming the technical limitation into a design rationale based on the user's own speculation. Once the user establishes that their actions influence the behaviour of the system, this understanding is disrupted by the entry of another user into the room leading the two actors to speculate together and spark communication or in other terms, social interaction.

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6.2 Prototype study

The challenges of enticing and engaging mixed aged groups from the co-design studies define the design space for concepts of appropriation, curiosity and ambiguity and how they can be used to stimulate enjoyable encounters. In order to test assumptions around the design, I developed an interactive prototype. This section reports on the design and development of the prototype and the results of an initial pilot or playtest evaluation involving three seniors and two youth. The outcomes of this study were used in creating the final prototype for encouraging social encounters in public contexts.

At this stage the prototype can be described as a sound-based interactive system whereby the movements of passerby triggers sound output. Not unlike the conceptual sketch of the room occupancy metaphor (See Figure 25), the prototype consisted of a webcam using computer vision technologies that translated participants' movements into algorithmically generated sound. Due to its prominence in formative studies and its popularity in previous research, I decided to use sound as the interactive medium between the system and participants. At this point the prototype did not contain any gaming logic and only presented a minimal interactive experience in order to collect participant feedback.

Initial prototype features

The prototype reacted to the presence of a participant by generating a unique sound. Participants could change the tonality of this sound according to discrete adjustments to the pitch and tempo. Because the sound varied in different places in the room, no two participants had precisely the same sound. However, standing in proximity to another participant created two overlapping sounds that could be perceived as a single louder sound. Players could change tempo by moving up and down in the room and the pitch by moving left and right. Table 12 gives a list of features for this version of the prototype

Table 12 : Prototype version 1.0 feature list

Number	Feature Description
F1	Unique sound is created for every person in the activity space
F2	Each player is able to change tempo of her/his individual sound
F3	Each player is able to change pitch of her/his individual sound

Method

In order to develop the prototype, I created a scenario where the interactive behaviour of the system supported exploratory play. This scenario was considered as a blank canvas whereupon play testers would be allowed to give feedback on existing features and articulate new features for the next iteration of development. Figure 26 shows an adaption of Tieben et al. (2011) curiosity process. Based on this process, I developed an initial scenario whereby the actions of participants would be translated into sound output. Sound output was dictated by two distinct algorithms. Due to older adults' preference for classical music the first algorithm generated the sound of a violin influenced by the movements of participants in a room. Moving left and right changed the pitch of the violin sound while moving up and down changed the tempo of the sound. The second algorithm featured a more experimental approach that generated a very complex sound, resembling those of "melodic droplets

falling into an ocean" as one participant would later describe it. This algorithm similarly had features of pitch and tempo that were manipulated in the same way as the violin algorithm. The two algorithms were discussed with two different members of the research stuff and an expert sound composer, these people then assisted with selecting the most suitable algorithm to be evaluated by a mixed aged group in a play test. The experimental algorithm was chosen due to its ability to create a variation of different sounds based on the spatial movements of participants in a room.
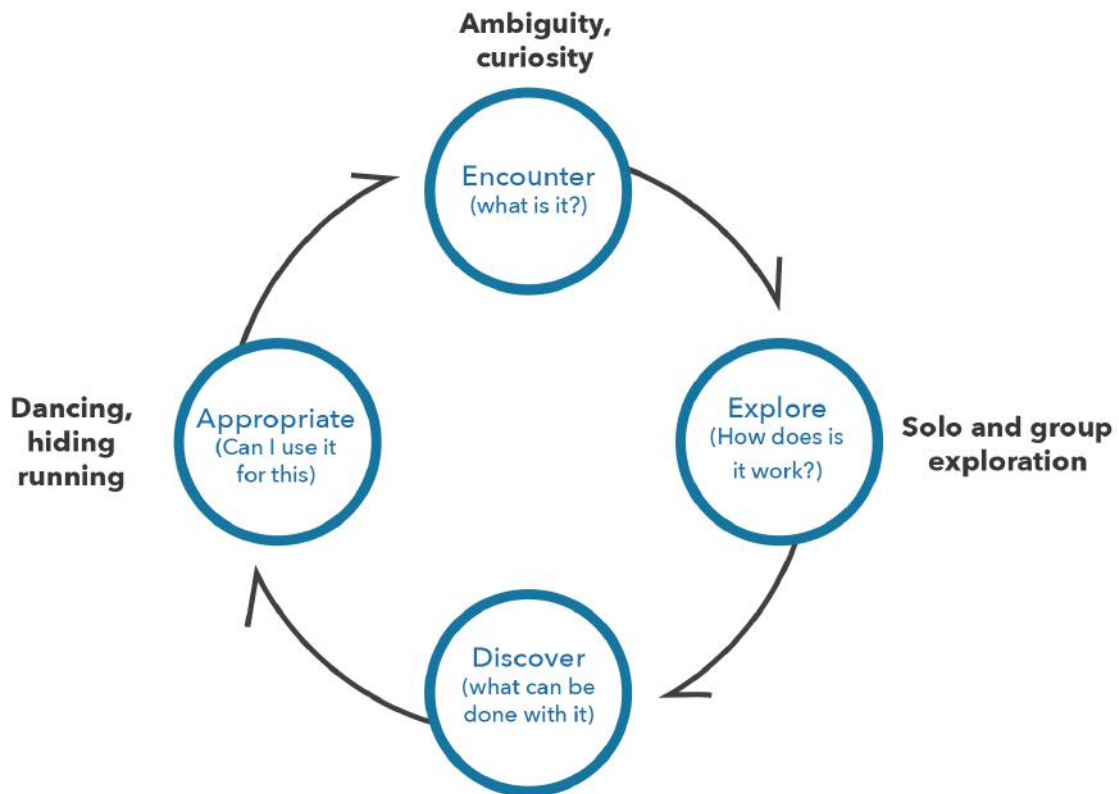

Figure 26: Curiosity process

The method of iteratively testing a mid-fidelity prototype has been used in a number of similar studies (Morreale, 2015, Awad et al., 2016 and Tieben 2011. Awad et al. (2016) offer that the purpose of this is to understand the needs of the users and evaluate how specific features fit their physical abilities. This is not only true for older adult users but youth as well. I was especially interested in users' evaluation of the prototype from both an individual and group experience. In order to achieve this, the play test evaluation was structured into two sessions, five minutes for individual explorations of the prototype followed by a collective group exploration. Participants were invited to fill out a post-play questionnaire and given a chance to elaborate on their views in a discussion with the research team. A post-game questionnaire was created and reviewed by the research team and modified to evaluate usability and several constructs based on prototype's ability to foster physical engagement, enjoyment and social interaction. Physical Engagement (PE) measured the perceived level of exertion participants experienced, this was necessary to gauge the potential to encourage physical exercise. Perceived Ease of Use (PEOU) measured how appropriate the prototype was in relation to participant physical and cognitive abilities. Ambiguity (A) measured the perceived level of ambiguity the prototype promoted. Curiosity (CU) measured the prototype's perceived ability to encourage curiosity. Appropriation (AP) referred to the perceived level to which the prototype fostered multiple interpretations of use. Fun (F) measured the prototypes ability to promote enjoyment. Using multiple items, Social Interaction (SI) construct measured the prototype's perceived ability to promote social

interaction based on familiarity and age. Sound Appeal (SA) measured the appropriateness of the sounds generated by the system. For questions that seemed unrelatable because of the respondent's age, participants were asked to imagine the perceived quality.

The constructs were presented in the form of 16 questionnaire statements (see Table 13) on a 5-point Likert scale (1= strongly disagree, 5 = strongly agree). The questionnaire was reviewed by three HCI researchers who were part of the research team.

Table 13: Post-game questionnaire items

Post-Game Questionnaire	
Physical Engagement (PE)	1. I was physically immersed in the activity 2. I feel the activity could help me move more regularly 3. I feel that the activity made me move more than I usually do 4. I found doing the activity to be physically exhausting
Perceived Ease of Use (PEOU)	5. I found the system simple to use
Ambiguity (A)	6. I quickly understood how the system worked
Curiosity (CU)	7. I felt curious to find out how the system worked
Appropriation (AP)	8. The play activity made me think about different ways it can be used
Fun (F)	9. I enjoyed the activity
Sound Appeal (SA)	10. I found the sounds to be enjoyable
Social Interaction (SI)	11. I would participate in the activity if I saw it in a public space 12. I would like to do this activity with my grandchildren or other children I know 13. I did not like doing the activity with others 14. Doing the activity with other people made it more interesting 15. I can imagine doing the activity with people I do not know 16. I can imagine doing the activity with young people (or older adults) I do not know
General	Please use this section to make any suggestions on how the game can be improved

Participants

Six participants took part in the prototype evaluation, four males with an average age of 73 (from 68 to 82) and two young people with an average age of 28 (from 27 to 29). Four of the participants were male seniors while the two young participants were female. All participants identified as white and German. Seniors were recruited from a senior's community group while the two young participants were recruited from a local university. Participants did not report suffering from any serious health issues.

Procedure

Prior to the play test participants were informed of the time the workshop would take place. On the day of the workshop participants were invited to a waiting area of a university meeting room and briefed on the playtest activities. Each participant was informed that they would individually enter a room and explore an interactive prototype. Participants were then asked to fill out a consent form. Once in the room participants were guided into the play space and asked to explore the system as they wished. Five minutes was allocated for each participant for solo or individual exploration. After the solo exploration was complete, participants were then asked to join other participants in the waiting area and not disclose any information on their experience in the room. A member of the research team was present in the room to observe participants' behaviour. Once all the participants had completed their solo exploration, they were all invited to enter the room and explore the system together. No instructions were given as to the specific actions required from them. After the group exploration, all participants were asked to fill in a post play questionnaire, after which I invited them to have a group discussion where they could elaborate on their experiences with the prototype.

Figure 27: Group exploration of prototype

6.2.1 Results

In this section I present the results of the evaluation of the first prototype. Results are presented along the constructs identified earlier and complemented with findings from video playback observations of participants' behaviour. Constructs are reported according to mean averages of the respective items in the questionnaire. Items that made up a construct were averaged in order to report a single index figure; however individual item scores are reported where necessary.

Table 14: Mean scores of constructs

Item	Mean
Physical engagement	3.0
Physical exhaustion	1.17
Perceived Ease of Use	3.83
Ambiguity	3.5
Curiosity	3.5
Appropriation	3.5
Fun	3
Sound Appeal	3.17
Social interaction	3.75

(1 is strongly disagree and 5 is strongly agree)

Physical Engagement

The post play questionnaire results show that participants found the prototype system to be physically engaging. An average of 3 reports that participants felt at least moderately immersed in the activity. While some participants felt that the prototype could help them move regularly, their experience with the prototype was not entirely convincing, illustrated by the very low exhaustion mean of 1.17.

Perceived Ease of Use

Participants generally felt that the system was easy to use, average 3.83. Video observations revealed that participants wandered the full size of the room without asking any help or information to the facilitators.

Ambiguity

Video footage review suggested that participants felt that the system encouraged a considerable amount of ambiguity (mean 3.5). In particular their facial expressions instantly changed when they heard the experimental sounds of the system. This was often followed by several moments of experimentation as participants continued to try to make sense of the relationship between their movements and the system's behaviour. Running, dancing, jogging and waving arms were the most

common behaviours, suggesting that participants developed multiple interpretations of the system's behaviour.

During the group exploration I frequently observed participants talking to each other. Many of these discussions featured participants expressing to each other what they thought was driving the system's behaviour. Participants realised that the presence of other participants produced additional sounds. Therefore, I observed participants communicating with each other to test their hypothesis. For example. One senior participant started coordinating the group's movements by asking others to occupy different positions in the room. From this point, participants continued their interaction trying to dismiss or build on one another's speculations.

Curiosity

Participants reported that the system encouraged some level of curiosity (Average 3.5). Similar to ambiguity, this was confirmed by participants making several unusual gestures. Participants often displayed a puzzled look on their face when first entering the activity space, this happened on cue with being greeted by an experimental sound. Facilitators encouraged the participants to explore by stressing that they were free to do whatever they like. They probed the system by performing random gestures. Participants also often glanced at the windows, laptop and ceiling. Curiosity reported an average of 3.5 out of a scale of 5.

Appropriation

I observed several participants making quick dashing movements from left to right and up and down. Most of the participants also made quick jogging motions, and performed a range of body gestures. When these movements created sudden changes in the sound, participants often followed it up with dancing. Dancing was the most commonly observed behaviour in both the solo and group explorations. When participants explored the activity space as a group, one participant coordinated their movements. In other cases, participants moved erratically in all directions in order to change the sound. In particular it was observed that often when the system had a mixture of high tempo and low tempo sounds, participants reacted to this orchestra of sounds by dancing together. Participants reported an of average of 3.5 out of 5 for the potential for the prototype to support the exploration of different ways of use.

Only one participant displayed visible annoyance during the solo exploration. He seemed overly concerned with whether he was doing the right thing. He got particularly annoyed after standing in one place while moving his arms vigorously without any change to the system's sound. On numerous occasions, seniors tended to group up together to have discussions. During this time the younger participants went off on their own to do individual explorations. During these individual explorations, one young lady had a pensive look on her face for several minutes as she puzzled over how her individual movements were affecting the group sound. Seniors did not seem to care about this and seemed more concerned about how to coordinate movements of the entire group influenced the sound.

Fun

While participants seemed more focused and curious during their individual explorations, they were joyful during the group exploration. Participants laughed and smiled with each other, often performing interpretive gestures to one another. These actions were met with laughing and smiling as each participant offered a physical demonstration on of how the system should be used. Participants reported an average of 3 out of 5 for the system's ability to encourage enjoyment. The participants' sentiments on their experience with the prototype is captured by the following event. When one of

the seniors asked other seniors whether he was still alive he responded by saying "yes, and I feel better than I felt before entering the room". Although participants reacted positively to the experience, one participant was visibly annoyed in the solo exploration, however, the participant quickly changed to a more positive demeanour when he was joined by others in group exploration.

Sound Appeal

Participants always seemed intrigued by the sound at their first encounter. As seniors explored the prototype further, they became increasingly confident in their movements and their relationship to the sound, often making small gestures to influence the tonality of the sound. Participants often grimaced when approaching the direction of the activity space that created high pitch sounds and tended to stand at one place when the sound had a low tempo and a thumping drum. Participants tried different configurations when they were in a group, often moving to make the most nuanced sound, a collection of different mixtures high pitched, low pitch, low tempo and high tempo that had some resemblance to a melody. Participants intentional made quick movements to momentarily disrupt the melody. For when participants explored the system alone, they commented that the sound supported the themes of exploration and mystery, adding that they felt the sound design resembled that of "…small drops of water in an ocean of sounds". Group exploration seemed to have the most positive reaction to the sound as participants laughed and smiled more to the sounds when they were in the company of others. Participants reported an average of 3.17 towards the prototype's sound.

Social Interaction

Participants seemed convinced that the prototype would do well in a public setting, an average of 3.75 demonstrates a positive outlook towards the prototype suitability for a public setting. Participants expressed an equal willingness to perform the activity with familial youth and non-familial youth with an average of 3.5 on individual items. Participants reported a preference for doing the activity with other people, an average of 3.67 on individual items. This is contrasted with the average of 2.5 for a preference for doing the activity alone.

Prototype challenges

Table 15 presents a list of critical challenges raised by participants in the evaluation. The solution column details resolutions that I implemented during the next design iteration. The most significant change was the introduction of a game challenge. I conceptualized the challenge to involve a set of rules which participants would have to reflect on in order to accomplish the challenge. This made the existing prototype take on more of a game like character, as rules are often described as the unique feature that sets play and game apart. The introduction of new rules saw the playful interactive prototype evolve into a gameful system that had features of structure and free explorative play that matches the low-threshold requirements stipulated at the end of the interview studies.

Table 15: Prototype challenges

Challenge	Solution
High pitched sound was discomforting	Set a lower maximum frequency
Free exploration of the prototype was fun but would be better if there was a challenge	Introduce a game challenge connected to players movements
The sounds were pleasant but it would be better	Introduce a reward system connected to the

if some music was introduced at some point so people could dance	game challenge
System was sometimes slow in changing sounds in response to movements and this delay made it difficult manipulate the music	Improve action-to-sound response time for algorithm
No instruction on how to use the system	Provide participants with a short tutorial on the game

All participants but particularly seniors expressed that although the experimental sounds provided interesting building blocks to create a mixture of sounds with other players, the high-pitched nature of the sound caused discomfort to their ears. This could be resolved programmatically since pitch was determined by frequency parameters in the code. Figure 28 shows a sample of the code that controls the pitch.

```
37          z=  if (msg[2] >= 100, {
38      p.put(pid, {|age= 0, cx= 0.5, dx= 0|
39              var freq= pid%8*100+200;  //8 ppl in cycle
40              var feed= (age*0.005).min(0);
41              var pan= cx.linlin(0.35, 0.65, -1, 1);
42              var mod= dx.linlin(-10, 10, -1, 1);
43              Pan2.ar(SinOsc.ar(freq+mod, feed+SinOsc.ar(mod)), pan);
44          }.play(fadeTime:3);  //fade in time
45      );}, {p.put(pid, { |age=0, cx=0.5, dx=0, cy=0.5|
46
47    var clockRate, clockTime, clock, centerFreq, freq, panPos, patch;
48
49          clockRate = cx.linlin(0.35, 0.65, 1, 10);
50          ("The clockRate"+clockRate).postln;
51    clockTime = clockRate.reciprocal;
52          clock = Impulse.kr(clockRate, 0.4);
53
 1          centerFreq = cy.linexp(0.35, 0.65, 100, 1500);
55    freq = Latch.kr(WhiteNoise.kr(centerFreq * 0.5, centerFreq), clock);
56    panPos = Latch.kr(WhiteNoise.kr, clock);
57    patch = CombN.ar(
58          Pan2.ar(
```

Figure 28: Pitch control parameters

One major complaint was that the experience with the prototype quickly became boring after a short while. This was due to the fact that there was no specific challenge that participants had to achieve and while collaboratively composing experimental sounds was fun it was not enough to retain the engagement of the participants. This would be remedied by the introduction of a game mechanic and a set of rules.

Participants expressed an overwhelming desire for music, they felt that while some musicality could be interpreted from the mixture of different sounds, the prototype would be more engaging if they had the opportunity to dance to some popular music at some point. One senior participant suggested that music could be incorporated in the rewards structure of the game. Another challenge voiced by participants was related to the synchronisation between movement and music, which was deemed to be delayed. Instead of a gradual change in sound, participants wanted to have a more immediate change in the sound so they would be able to perceive which sound was theirs, participants stressed

that this sense of agency was particularly important when there were groups of people in the play space and players wanted a clear representation of their involvement.

6.2.2 Discussion

The prototype provided me with a sandbox in which I used to test the potential of design concepts to promote social interaction. I made a deliberate effort to produce an experience that was ambiguous and open to suggestions, as recommended by Gaver et al. (2003). Not defining the what the purpose of activity helped participants imagine what it could be. This could be said to be a good example on the use of appropriation to direct the next features of an artefact, or more precisely what Gaver et al. (2003) calls *learning from appropriation*. The interconnectedness between curiosity, appropriation and ambiguity were clear in participants' behaviour and in their responses to the questionnaire. All three constructs scored an average of 3.5. While not always clear, literature elaborates on how these constructs are connected. Ambiguity is a central driver of curiosity and appropriation, which may be used to draw participation in the case of curiosity, and provide crucial learning in the case of appropriation. because ambiguity allowed for multiple interpretations on the use of the system, I was able to identify that dancing and therefore music could be used within the reward structure. This form of integrative experimentation is typical of the research through design approach whereby making *a thing* and evaluating it provides more value in terms of learning than the utilitarian value of the thing itself, a promising signal towards what Zimmerman et al. (2007) call making the right thing. The design constructs of appropriation, ambiguity and curiosity are useful when they are used in good balance, sometimes this balance is hard to achieve. For instance, while the ambiguous nature of the prototype promoted explorative behaviour, not knowing what to do created feelings of frustration in some seniors. What I learned from this is that although abstracting certain information from the player's inspires some level of curiosity, the presence of some form of instruction can provide less adventurous users with the confidence to interact with a system.

Age influences were evident in the group exploration, younger users were more likely to group up with other young people. This phenomenon has also been reported in similar studies Rice et al. (2012). This requires specific strategies that exploit the skills differences between users of different generations. Another finding was that ambiguity was a pivotal feature to promote social interaction. Because no user had complete information of the system's function, this promoted communication among players as they tried to uncover the systems functionalities. The use of a wide-open space also promoted interaction as users arranged themselves into different configurations in order to understand the prototype. My choice to use sound instead of music added to the system's ambiguity, supporting such interpretations as "it sounds like small drops of water in an ocean of sounds". I believe that this more open-ended design allowed users to imagine the play space as a physical and digital area that had things to be discovered, adding to the participants' sense of wonder, exploration and discovery.

Participants reported a relatively high perceived ease of use, but this might be because there was no specific way to use the system. This point relates to Gaver et al. (2003) postulation that sometimes ambiguity can enhance a system's technical limitations. Nevertheless, the system's design employed a very simple enactive action (Abeele and De Schutter, 2009) of walking, an action all participants did well. While not directly influential on the interaction between a single user and the system, my earliest conceptualisation of the room occupancy metaphor allowed users' actions to be imbued with a certain sense of meaning. Participants noticed that when there were few people in the activity space, the sounds were less textured and monotonic, with the entry of more people into the play area the sound became more complex and music-like. While abstract, participants were able to deduce meaning in playing collaboratively. When the items of the questionnaire that tested for physical engagement are taken together, the prototype showed some promise of encouraging physical activity which lead me to wonder whether the results would have been clearer if participants were allowed to

play a challenge without time limitation. I limited the solo explorations to five minutes and ten minutes for the group exploration.

Appropriation, ambiguity and curiosity are all new themes that have a long way to go before they can become established strategies in interactive system design. Previous research also does little in the way of providing validated methods of evaluating these themes. Despite this shortcoming, research has shown that designs meant to engage public participation can benefit for exploring appropriation, curiosity and ambiguity as design resources. Studies research have been careful not to offer exhaustive and prescriptive strategies to design for the factors, instead leaving their exploration and use to the discretion of the designer. Themes also overlap and sometimes oppose each other. For instance, the *expose intentions strategy* somehow contradicts the need to obfuscate information suggested by the *ambiguity of information*. In order to avoid unwanted effects, designers need to investigate the interactions between each theme and implement a balance that helps them achieve their goal. It makes sense to implement these themes iteratively, collecting feedback on how the themes influence engagement until a satisfactory level of the design goals are met.

The results of my evaluation come some limitation, like many previous studies my evaluation was brief and utilised a small sample size. Due to the small sample I did not check for reliability and correlation between measures. However, I considered both seniors and youth as being representative of their respective demographic by providing a snap shot of impressions. While I hoped to get a more mixed gender composition, several seniors and youth did not turn up to the playtest on account of terrible weather. Results can be considered tentative by some degree; however, I believe they provided clear impressions on the prototypes ability to promote mixed aged non-kin social interaction. Moreover, the evaluation allowed me to collect useful feedback that I used to complete the conceptualisation of the prototype as a game and implement suggested features. Following several comments from participants about how the prototype could connect different people, I decided to call the system Klang Verbindet, German for "Sound Connects".

6.3 Klang Verbindet: System description

This section presents a technical overview of the Klang Verbindet system. The system is comprised of three major parts illustrated in Figure 29, namely i) a generative sound algorithm that runs in Supercollider, ii) a camera sensor component, and iii) The actions of participants that creates input signals for the system.
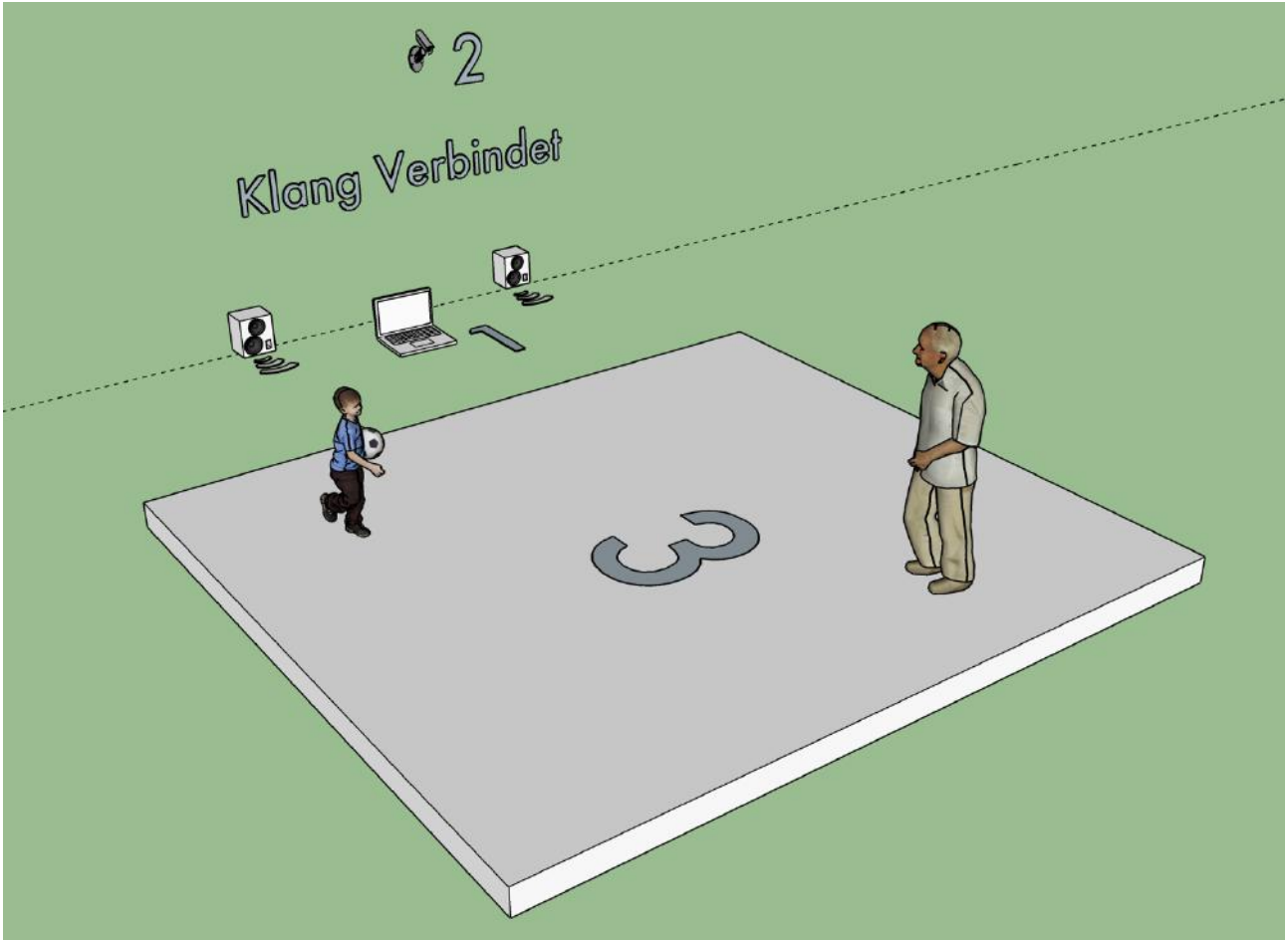
Figure 29: Klang verbindet system

6.3.1 Supercollider

Supercollider is a client-server system and programming language that can be used to generate sounds. It is especially popular for manipulating generative sound according to signals from external sensors that can transmit Open Sound Control (OSC) signals. Figure 28 shows a snapshot of the Super collider algorithm. The system receives OSC messages from a computer vision program, which defines several can parameters describing what a camera sensor sees. The Supercollider program runs on a Mac OS X machine connected to a pair of speakers. Figure 30 shows a depiction of the programming environment.

Figure 30: Klang Verbindet development environment

From the camera sensor computer vision algorithms divide the scene into a number of quadrants each with a unique id and status value. The status value varies from 0 to 1 depending on whether the computer vision algorithm detects a subject in the quadrant. The algorithm is also capable of reporting whether there is more than one subject in a quadrant at any given time.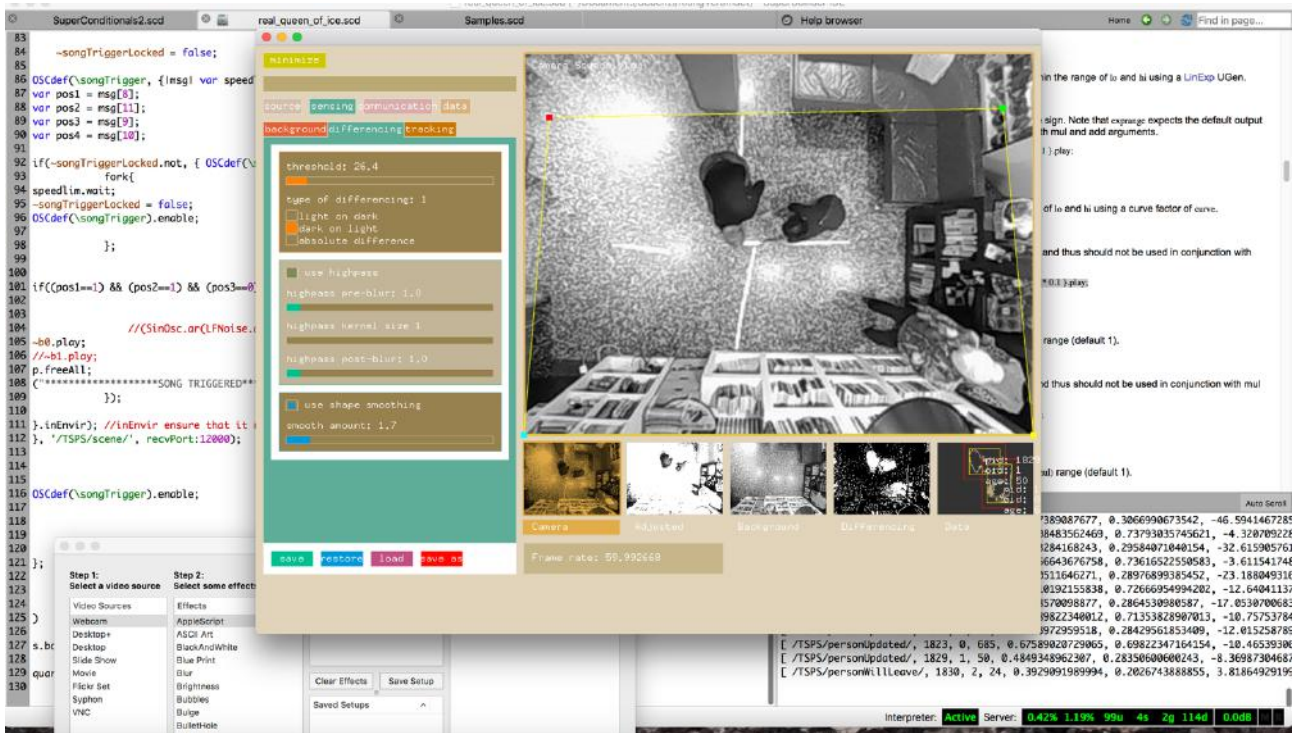 By transmitting scene information, a conditional statement enclosed in an OSC event function triggers a predetermined procedure. Using conditional statements, the algorithm triggers the playing of a song based on selected coordinates. For instance, in the first diagram, a song is triggered when there are subjects in the first and the fourth quadrant. The song will not be triggered if there are more than two people in the scene, this ensures a strict adherence to the predefined coordinates. Scene configuration can divide the scene area into any number of quadrants. The second diagram in Figure 31 shows what a scene looks like when divided into 9 quadrants. In this case a song is triggered when there are subjects into quadrant 1 and 5. The song is only triggered when this condition is met however, I could programmatically modify the algorithm to support multiple players.
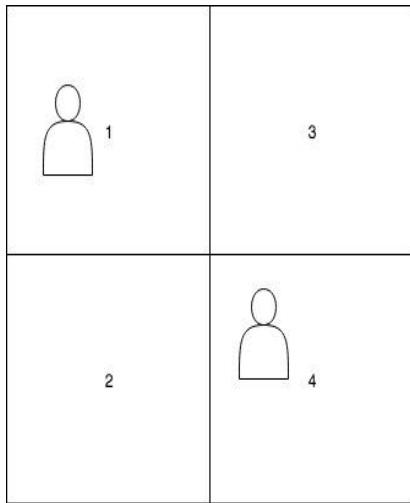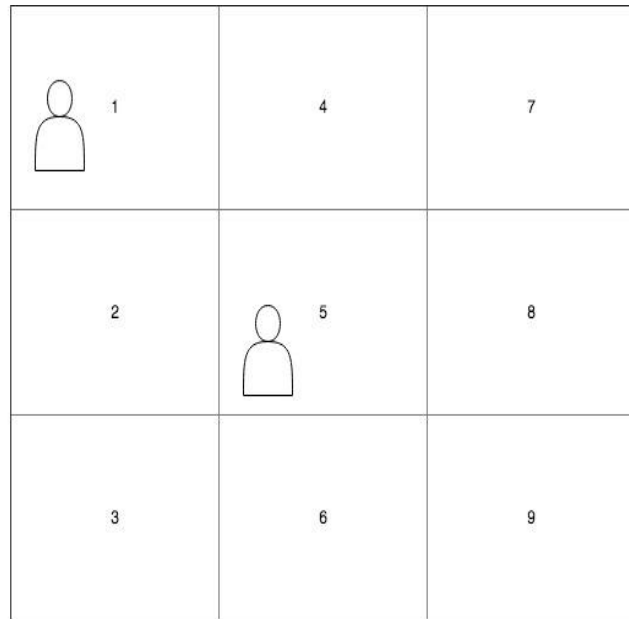
Figure 31: 2x2 and 3x3 scene division
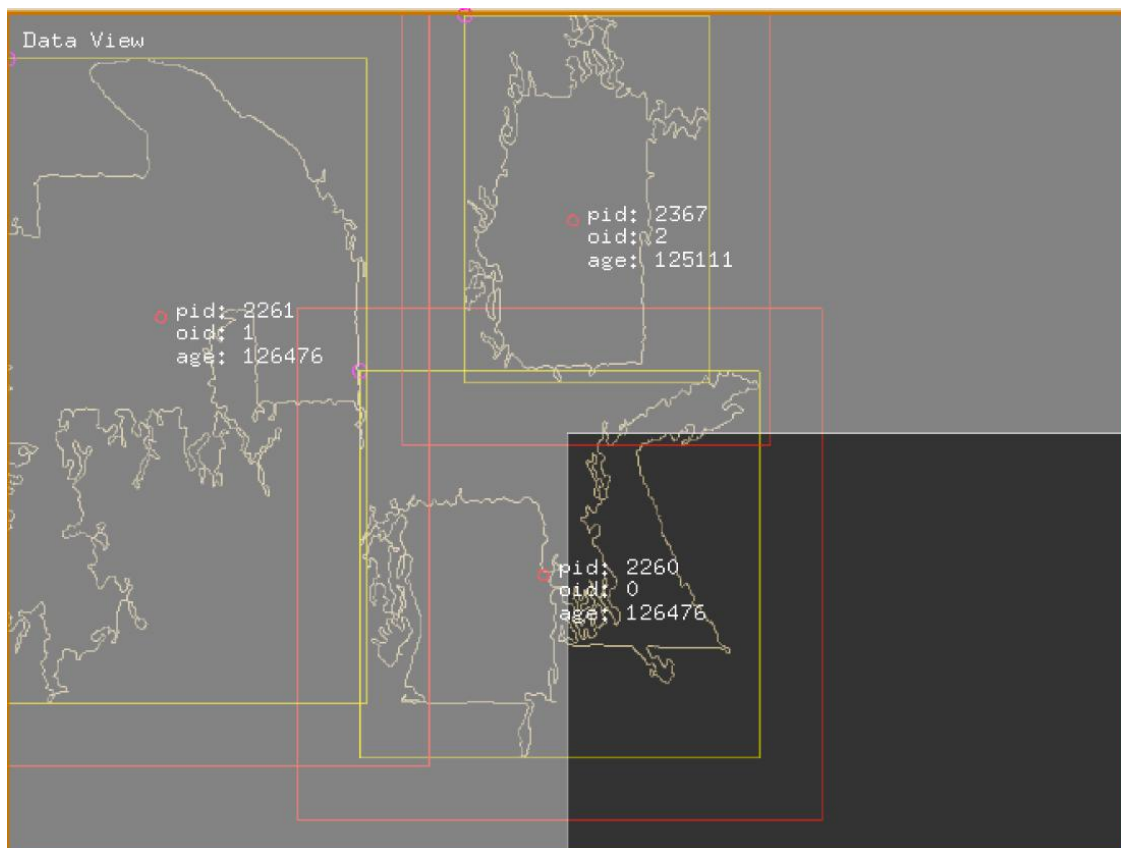
Figure 32: Multiple subject detection and tracking

6.3.2 Camera sensor

A camera sensor is used to determine participants' movements. The movements are interpreted by Mean Shift object detection and tracking algorithms that transmit OSC data to Supercollider. The signals are then used to manipulate sound parameters in real-time. The computer vision algorithm sends the following information event information. The entry of a new figure in the play space, real-time information on position, speed, shape and size of the subject is in the play space, real-time information on the position, speed, shape, size of the subject when it departs the scene. Each subject in the scene is assigned a unique id (see Figure 32, 33). In addition to real-time information of the subjects in a subject, the computer vision algorithm also sends information on the scene. This means it can relay information on the number of subjects in the scene and the specific position of these subjects.

Figure 33: Detecting subjects in places

6.3.3 Game challenge

Subjects are free to explore the play scene and individually or collaboratively make mixtures of sounds. Each subject is assigned a unique sound as detailed in the first prototype description. If subjects decide to complete the game challenge, they need to communicate with each other and coordinate their movements. Once subjects are standing on the right quadrants and event is triggered and a song starts playing. Similar to early scenario sketches, I provide details on the target playful and interaction activities.

Target interaction activity: Players communicate with each other to change their positions and trigger a song.
Target playful activity: Exploratory manipulations of system (e.g. hiding from the camera, using props to occupy more than one position in the play space).
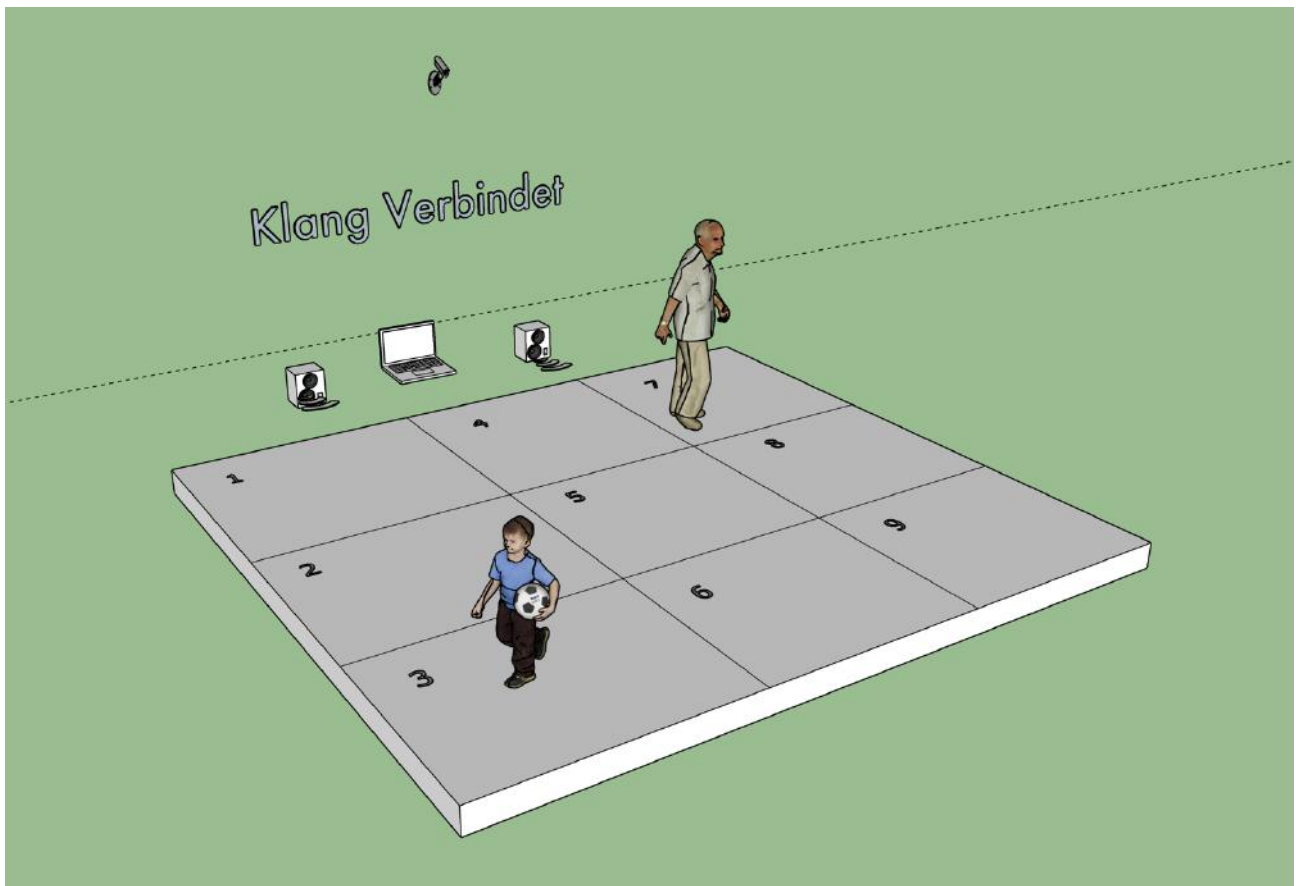
Figure 34: Game challenge, find the hidden song!
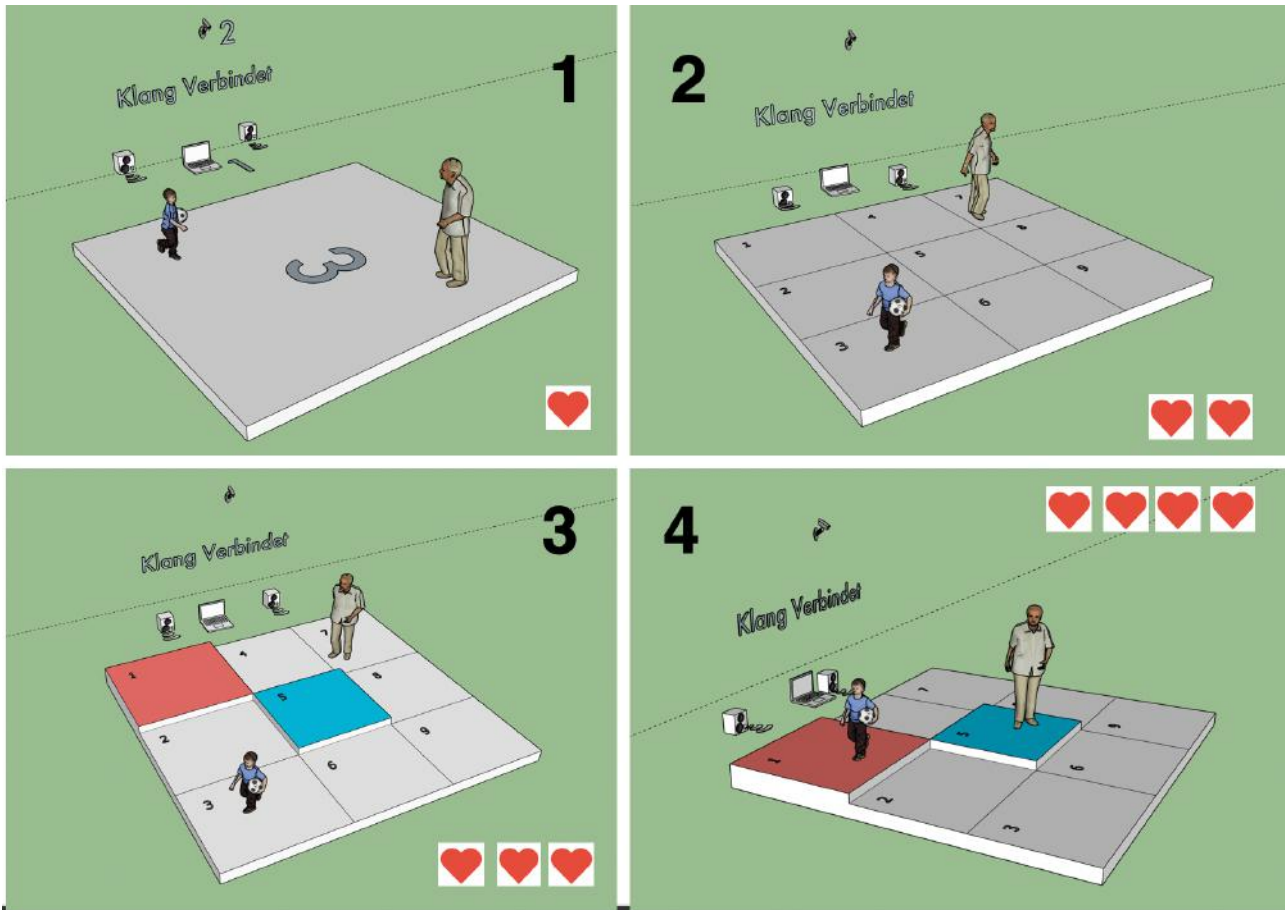
Figure 35: Klang Verbindet game process

Figure 35 illustrates the use of the different design tactics in cultivating enjoyment with different levels of challenge. In the first diagram (1), two participants playfully explore the system, they derive enjoyment from performing appropriative actions. At this point participants are more curious and have not maximised enjoyment. After discovering or being informed that the play space can contain of a hidden song, participants tell the facilitator which song they want to find and he or she (facilitator) programs it into the system. At this point (2) participants go on a purposeful challenge to find the song. They are more motivated and excited at this stage. Quadrants 1 and 5 in diagram 3 show where the song is hidden. Participants communicate and coordinate with each other to find the hidden song, at this point they have cultivated a good level of enjoyment. In diagram 4, participants find the song and celebrate by dancing, further enjoying the system. Having accomplished the challenge participants explore the system more using their own play styles.

Table 16: Prototype V1.1 feature list

Number	Feature Description
F1	Unique sound is created for every person in the activity space
F2	Individual player is able to change tempo of their individual sound
F3	Individual player is able to change pitch of their individual sound
F4	Computer vision algorithm divides scene into quadrants and detects subjects in quadrants. Adding more quadrants adjusts challenge difficulty of completing game challenge
F5	Supercollider algorithm triggers song when scene information matches winning condition

7. EVALUATION

This section describes the evaluation of various iterations of the Klang Verbindet prototype. Evaluations were carried out in the field in order to examine the prototype's gameful and prosocial features in real public contexts. The initial prototype was designed with a public context in mind, this requirement was operationalised through different strategies of ambiguity, curiosity and appropriation. Even so, the original prototype was developed and tested in a lab-like setting, therefore, it was necessary to stage evaluations in real public settings to gauge the system's ability to adapt to the contextual constraints posed by a public context. As mentioned earlier, these constrained are mainly highlighted by the public rarity of interactions between non-familial persons. Having identified the unique motivations of non-familial interaction in my preliminary studies, it was my aim to observe how these motivations and other constrains interacted outside a controlled setting. Two evaluation studies were carried out in order to examine the protypes ability to enhance non-familial interaction and to draw out other contextual factors that were not anticipated in the early design phase. This chapter details, compares, contrasts, and discusses the research findings and how they were leveraged to enable a more complete understanding of gameful intergenerational interactions in public areas.

7.1 Case study 1: Player experience evaluations (Trento, Italy)

For the first field evaluations of the Klang Verbindet artefact, I staged a play test involving participants in the Social Stone, a community bar in Trento (Italy), which often hosts cultural and artistic events. Social Stone is a location where both young and old people meet and the establishment is known for hosting inclusive social events. The objective of this field test was to deploy the interactive artefact in a setting where it can be evaluated based on the constraints of the public context. This specifically meant paying careful attention to aspects of low-threshold, encounter based and non-kin social interaction. The play tests were carried out over two days in order to capture the responses of a diverse audience. At the end of the play test I refined the prototype to reflect the features listed in Table 17, new features are marked as "NEW".

Table 17: Prototype V1.2 feature list

Number	Feature Description
F1	Unique sound is created for every person in the activity space
F2	Individual player is able to change tempo of their individual sound
F3	Individual player is able to change pitch of their individual sound
F4	Computer vision algorithm divides scene into quadrants and detects subjects in quadrants. Adding more quadrants adjusts difficulty of completing game challenge
F5	Supercollider algorithm triggers song when scene information matches winning condition
F6 (NEW)	Participants can select their own song to be used in the challenge
F7 (NEW)	Adjust amount of time subjects should remain in winning quadrants to trigger song. Allows for modification of challenge difficulty

Methods

In order to evaluate the player experience, I used a post-game questionnaire. The questionnaire was similar to the one used in the first prototype evaluation, however because of the relatively faster pace of public interactions, I decided to shorten the questionnaire to make it more efficient. Table 18 shows the questions I used in the survey. Due to the limited time I anticipated participants would have, the research team adapted the questionnaire to focus on questions that were more relevant to assessing the artefacts ability to promote social interaction. Furthermore, it was decided that constructs such as curiosity and perceived ease of use could be noted on the basis of observations, making it unnecessary to include it in the questionnaire at the risk of making the evaluation procedure cumbersome for participants. Due to the relationship between appropriation, ambiguity and curiosity, I also believed that I could infer the artefact's curiosity aspect from the two remaining constructs (appropriation and ambiguity) since curiosity has been previously described as formative to ambiguity and appropriation. I also added Non-kin intergenerational interaction (NI) as a grouping. NI described the system's perceived potential to promote non-kin intergenerational interaction. Physical Engagement (PE) described perceived potential to encourage physical activity, Ambiguity (A) described perceived level of ambiguity, Appropriation (AP) described perceived level artefact supported multiple interpretations, Fun (F) described perceived level of enjoyment, Sound Appeal (SA) described level of appeal of the sound and Social Interaction (SI) described perceived ability to encourage social interaction. Once again, questionnaire statements were presented as 5-point Likert scale items ranging from strongly disagree (1) to strongly agree (5). The questionnaire was reviewed by five members of the research team and standardised for all remaining evaluations.

Table 18: Revised-post game questionnaire

Post-Game Questionnaire	
Physical engagement (PE)	1. I feel that the activity made me move my body more than I usually do
Ambiguity (A)	2. I quickly understood how the system worked
Appropriation (AP)	3. The play activity made me think about different ways it can be used
Fun (F)	4. I found the activity to be fun
Sound Appeal (SA)	5. I found the sounds to be enjoyable
Social Interaction (SI)	6. I did not enjoy doing the activity with other people around 7. Doing the activity with other people made it more interesting 8. I would participate in the activity if I saw it in a public space
Intergenerational interaction (NI)	9. I can imagine playing the activity with people I do not know 10. I can imagine doing the activity with old people I do not know 11. I can imagine doing the activity with young people I do not know
General	Please use this section to make any suggestions on how the game can be improved

In order to further investigate the importance of game instructions as indicated by the first prototype evaluation, I organised the play test into two days. The first day featured minimal instructions, participants were required to deduce from markings on the floor that the different squares held some larger challenge. To make this discovery easier I only used four squares, a scene division of 2X2 as shown in Figure 31. During our own internal playtests, I observed that after moving around the play space for a short time, participants were able to trigger a song in a relatively short time. On the second day the play space was more scaffolded to support instructions. Instructions were put on a wall next to the play space. These instructions, demarcations of squares on the floor and assistance from members of our research team insured that participants were more aware of how the challenge worked although the artefact's sonic response to participants was still left up to their individual interpretations.
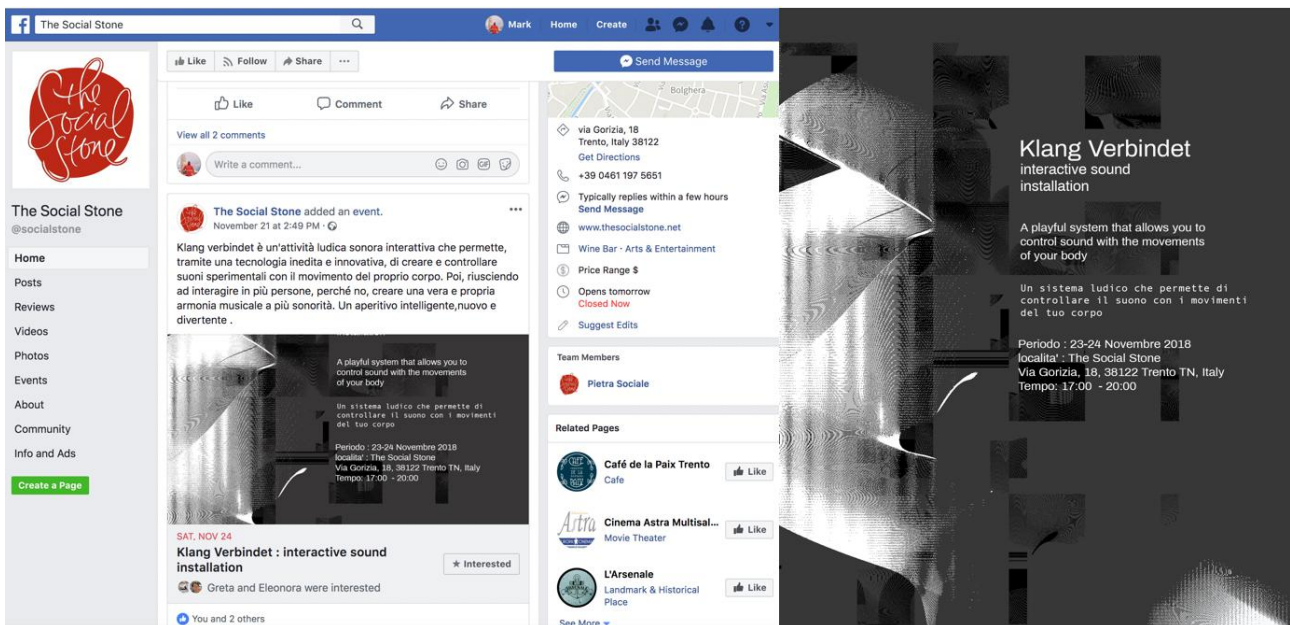
Figure 36: Facebook event and promotional poster for play tests (Trento, Italy)

Participants

Twelve participants took part on the first day of the evaluation. The group was comprised of 7 females and 4 males with an average age of 38 (31-68) SD 12.73. Participants were Italian patrons of the Social Stone bar. None of the participants reported any serious health issues. On the second day of the evaluation 14 participants took part in the evaluation. The group was comprised of 7 female and 7 male participants with an average age of 41 (26-57) SD 10.80. This new group of participants was also from patrons of the Social Stone bar. Again, none of the participants reported any serious health issues.

Procedure

Prior to the play test session, members of the research team helped me to prepare staging the game. The setup was relatively minimal, I used a small camera which I hung from the ceiling. I also made an effort to conceal wires and other components that would make the systems functions obvious. The device which the programs ran on was a MacBook pro attached to the camera by a long cable. The machine was disguised as the computer of an ordinary patron sitting in the bar. An agreement was reached with the owner of the bar that members of the research team could come in before opening time and arrange the play space. The owner assigned the research team to an open space close to the bar area where I set up the camera sensor and the audio system. A roll of white tape was used to demarcate squares on the floor of the play space. In order to observe how participants would respond

to the ambiguous appearance of the system, no instructions were put up. It was planned that while wandering around in the bar, participants would inevitably walk into the play space. This was because the play area was a space between the bar and the restroom. Once participants wandered into the play area and noticed the curious sound adapting to their movements, a member of the team stepped in to give them a brief explanation of the interactive experience. Participants were informed that there was a system responsible for generating the sound and then encouraged to explore the play area individually in order to see if they could deduce how their movements were altering the sounds. After 3 minutes of exploration, participants were given more information about the functioning of the system. Participants were further informed that the play area contained a hidden mystery in the form of a challenge. The challenge involved finding a hidden song and this required the help of a second person to accomplish. After completing the challenge participants were invited to quickly complete a consent form and questionnaire. I then had a brief conversation with participants during which they elaborated on their experience with the system.

The second play session took place at the same venue and utilised the initial setup. For this session the research team created posters with instructions. These posters were then put up on various walls of the bar to be used as props that would attract attention. Instructions showed that within the play area, patrons could use an interactive system to make sounds. It also stated that the sound was influenced by participants movements, up and down movements across the squares controlled the pitch while left and right movements controlled the tempo. I changed this configuration arbitrarily to suit the play space. In addition to this, I also created a poster that described the challenge of finding the hidden song. All instructional material was written in Italian. Once again participants were encouraged to wander into the play area and interact with the system. They were informed that they could explore the play area alone or with a partner if they wished to complete the challenge. After this experience participants were asked to complete the questionnaire and consent forms.

Figure 37: Setting up Klang Verbindet

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Figure 38: Players puzzling over system ambiguity

Figure 39: Playing Klang Verbindet

Results

The following section presents results of two evaluations of an interactive musical game designed to enhance encounters between non-familiar mixed-aged groups. Responses were recorded with a post-game questionnaire of 11 items assessing 7 constructs. While Figure 40 reports on the comparative measures of the two evaluations. Table 19 reports the averages of each item related to a 5-point Likert scale scores ranging from 1 for strongly disagree and 5 for strongly agree. The scores of each item were computed by obtaining an average of all responses for that item.

Table 19: Results of evaluation (Trento)

| Item	Play test 1 (μ), N=12	Play test 2 (μ), N=14	Measure
Q1 I feel that the activity made me move my body more than I usually do	3,67 SD= 1,03	2,86 SD= 1,12	Physical engagement (PE)
Q2 I quickly understood how the system worked	2,00 SD= 1	2,64 SD= 1,11	Ambiguity (A)
Q3 The activity made me think about different ways it could be used	3,75 SD=1,15	3,43 SD= 0,73	Appropriation (AP)
Q4 I found the activity to be fun	4,00 SD= 0,82	4,00 SD= 0,76	Fun (F)
Q5 I didn't enjoy doing the activity with other people around	1,58 SD= 0,64	2,14 SD= 1,12	Social interaction (SI)
Q6 Doing the activity with other people made it more interesting	4,50 SD= 0,5	4,00 SD= 0,93	Social interaction (SI)
Q7 I found the sound to be enjoyable	3,08 SD= 0,86	3,71 SD= 0,45	Sound appeal (SA)
Q8 I would participate in the activity if I saw it in a public space	3,75 SD= 1,09	3,50 SD= 0,82	Social interaction (SI)
Q9 I can imagine playing the activity with people I don't know	3,50 SD= 1,12	3,79 SD= 1,01	Social interaction (SI)
Q10 I can imagine playing the activity with older people I don't know	4,25 SD= 0,43	3,79 SD= 0,86	Intergenerational interaction (NI)
Q11 I can imagine doing the activity with younger people I don't know	4,17 SD= 0,55	3,64 SD= 1,11	Intergenerational interaction (NI)
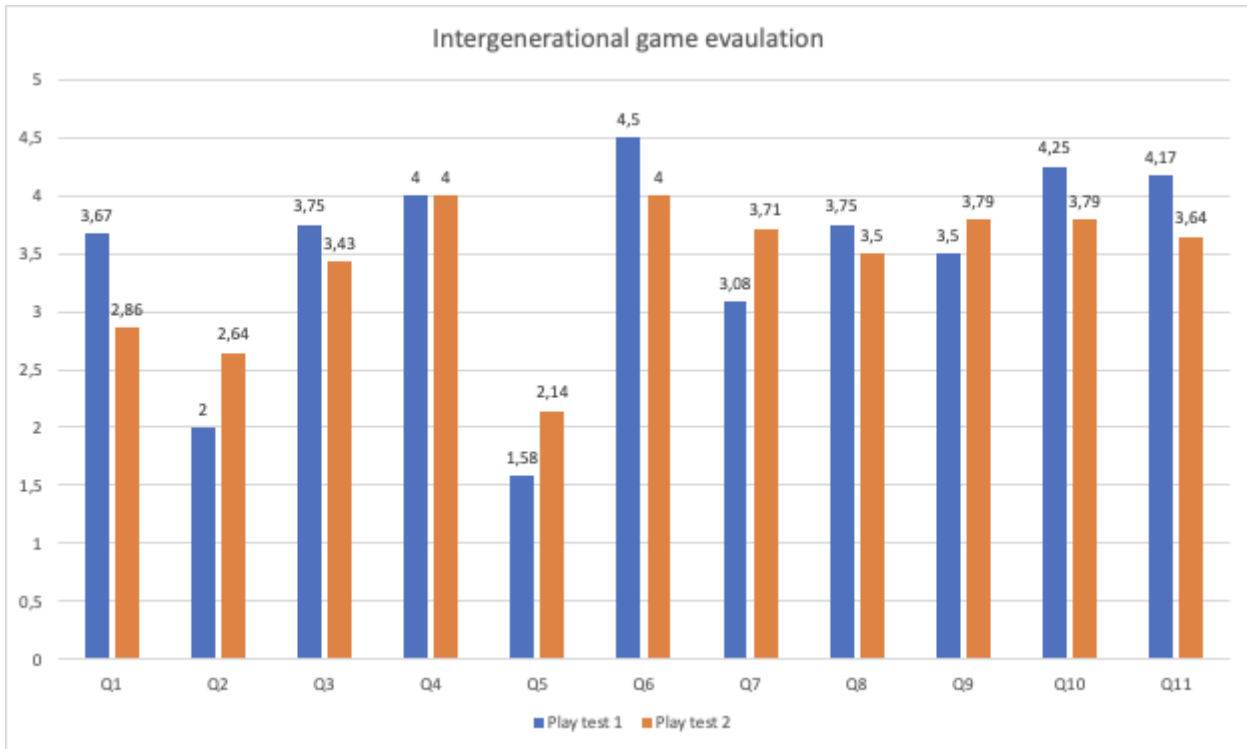
Figure 40: Play test 1 and 2 comparative scores (Trento)

Physical engagement: On both evaluations, participants reported a high perceived potential for the game to encourage movement. Its highest was on the first day with 3,67 and a lower score of 2,86 for the second day. I observed that participants were energized once they discovered the response of the system to their movements, this vibrance in physical action was even more apparent during the challenge stage were two players cooperated.

Ambiguity: By considering the average score of 2,00 we can believe that participants did not immediately understand how the system worked. Comparatively, the second evaluation score on ambiguity is slightly higher with a score 2,64. Upon entering the play area, participant displayed inquisitive behaviour. Participants were puzzled by how their actions were generating sounds and this led them to make several curious actions in the play area to confirm their assumptions. I observed that after these curious encounters, participants engaged the bar owner to find out what was going on which eventually led them to participating in the song finding challenge. Participants frequently glanced at the ceiling in an attempt to ascertain how the system worked.

Appropriation: Participants reported a high score for appropriation, 3,75 on the first day and a slightly lower result of 3,43 on the second day. Participants displayed similar behaviour to earlier tests, with multiple participants running around in the play area in order to radically influence the system. I also made several observations of participants dancing to the generated sounds, this behaviour was common in the collaborative round. I observed that participants were more likely to dance and do other appropriative actions when they were experiencing the artefact together with other people. Participants in group exploration also adopted their own styles of play, several participants suggested that the system cycle through a series of coordinates in one game session. This meant that players would solve a certain combination, request a new challenge and ask us to restore the first combination in order to test participants' memory. This is an interesting example of appropriation, as participants created a new memory game out of their own experience and interpretations of how the system could function alternatively.

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Fun: On both days, participants reported a high rate (4.0) for the game's fun factor. During the observations, it was noted that all participants appeared to be enjoying themselves. They were often seen laughing and smiling. This behaviour was more notable in the cooperative mode where participants engaged with each other to solve the game challenge. The challenge provided a contrast in behaviour, players acted more frantic when exploring the play space to discover the song but once the song was triggered, participants had a shift in mood to a more joyful disposition.

Social interaction: All items on social interaction scored highly. For the negatively phrased statement "I didn't enjoy doing the activity with other people around", respondents reported low scores of 1,58 for day 1 and 2,14 for day 2. The positively phrased statement "Doing the activity with other people made it more interesting" scored an average of 4,50 and 4,00 respectively. Participants replied favourably to whether they would like to play the game in a public place, 3,75 on the first play day and 3,50 on the second play day. Several participants made suggestions about the potential the game would have if it could be played in a large space by a large group of people. One participant said "It would be nice to try it with large groups of people and enjoy small choreographies". Another participant suggested that it would be fun to stage the game in Piazza Duomo, the main square of the city centre of Trento, often used for artistic explorations.

Intergenerational interaction: Respondents reported a positive outlook on the system's potential to promote intergenerational interaction. In my observations of the play test I noticed that participants often invited friends or family to participate in the activity, familial people were often same age peers. In other instances, children played with other children while parents watched. One older adult couple also participated in the game after wandering into the play space. No differences emerged in reported preference on people they would like to play with. Participants reported a score of 4,25 and 3,79 for perceived preference to play with non-kin older people and 4,17 and 3,64 for playing with non-kin young people.

Sound appeal: Participants seemed to enjoy the sound design of the installation (3,08 and 3.71), however some players felt that the sound was too electronic and would have preferred a more classical music sounding sound design. Participants also felt that at times they could not distinguish their specific sound and suggested the use of different musical instruments so that players would be able to clearly differentiate the sounds. One participant said "The choice of sounds/noises is a bit weird. They are not really melodic; they remind me of electronic music so probably they might not be enjoyable by everyone (e.g. senior or children) but this is only a guess. Overall, I recall that I enjoyed to explore it with a person that I know a bit, but no so well." On the first day participants reported that they struggled to recognize preloaded songs in the system since they did not know them. On the second day the prototype was updated to allow users to select their own songs.

7.2 Case study 2: AfriCHI2018 (Windhoek, Namibia)

The remaining evaluations of the intergenerational game artefact took place at the African conference of Human Computer Interaction (AfriCHI2018) in Windhoek, Namibia. The AfriCHI2018 conference attracts an international audience of multidisciplinary academics. The playtests were staged in the open hallway area of Safari hotel, an international hotel resort located in the heart of the city. Participants of the conference and guests of the hotel were informed that a prototype of the game would be exhibited on the first day. For the second day the artefact was one of the interactive systems that were open to the public. The event and the system were also featured on a local TV news programme. Table 20 shows the prototype feature list at the end of the evaluations, new features are marked as "NEW".

Table 20: Prototype V1.3 feature list

Number	Feature Description
F1	Unique sound is created for every person in the activity space
F2	Individual player is able to change tempo of her/his individual sound
F3	Individual player is able to change pitch of his/her individual sound
F4	Computer vision algorithm divides scene into quadrants and detects subjects in quadrants. Adding more quadrants adjusts difficulty
F5	Supercollider algorithm triggers song when scene information matches winning condition
F6	Participants can select their own song to be used in the challenge
F7	Adjust amount of time subjects should remain in winning quadrants to trigger song. Allows for modification of challenge difficulty
F8 (NEW)	System cycles through different winning combinations and requires player to remember past combinations that triggered the music (memory minigame)
F9 (NEW)	System support for up to four players (introduced by teenagers)
F10 (NEW)	Competitive time challenge future; gives players a time limit to complete challenge. Increases difficulty.
F11 (NEW)	Hot or cold game assistance. Hide and seek type mechanic whereby game facilitator yells "hot" when players are close to finding the winning combination and "cold" when they are far

Participants

For the third evaluation, I recruited 15 participants from the AFRICHI18 conference goers and patrons of the hotel where the event was held. This group of participants was comprised of 9 females and 6 males with an average age of 32,2 (26-51) SD 7,87. I recruited 21 participants for the four evaluation, which included 14 females and 7 males with an average age of 32,24 (22-63) SD 11,44. For both groups, participants did not report any serious health issues. Participants of the third

evaluation were mainly conference goes and hotel guests. For the fourth evaluation I recruited a mix of participants from the public who had come to see the interactive systems exhibition on the designated public day of the event, and conference goers who had not had the chance to experience the system the previous day. Groups were composed of students, researchers, government officials and citizens.

Procedure

Prior to the play test session, I setup the system in the lobby of a hotel resort. Due to the fact to limitations of computer vision technology, I had to make several adjustments to the program to ensure that it reliably detected and tracked subjects in the play area. A large canvas of white paper was placed on the floor to mark the designated play space. I made red markings on the sheet to show quadrant locations. Once the interactive session of the conference was opened, participants begun to approach the installation. Participants were briefed that they had to first explore the play area individually and try to deduce how their movements were influencing the system's sound. Some participants voluntarily wandered onto the play area and begun exploring the installation on their own. After participants completed the solo exploration, they were given an explanation of the cooperative challenge and asked to recruit a second player to complete the challenge. Participants were only informed that the play area contained a hidden song and that they needed the collaborative efforts of a partner to help trigger the song. Participants were then asked to select a song of their choice and complete the challenge. Once completed, participants were given an explanation of how the system worked and asked to complete the questionnaire and consent form. Minors were allowed to play freely but their responses were not recorded. On the fourth day of the evaluation, participants were guided through a similar process. The exception was that on this particular evaluation the research team created a sign on a pin up board which was placed next to the installation. The sign described basic instructions to use the system, information about the challenge and details on the artistic inspiration of installation. Since the play space was comparatively bigger than the one used in the first two evaluations, the number of quadrants for the game was set to 3x3, essentially creating a higher difficulty for participants to solve.
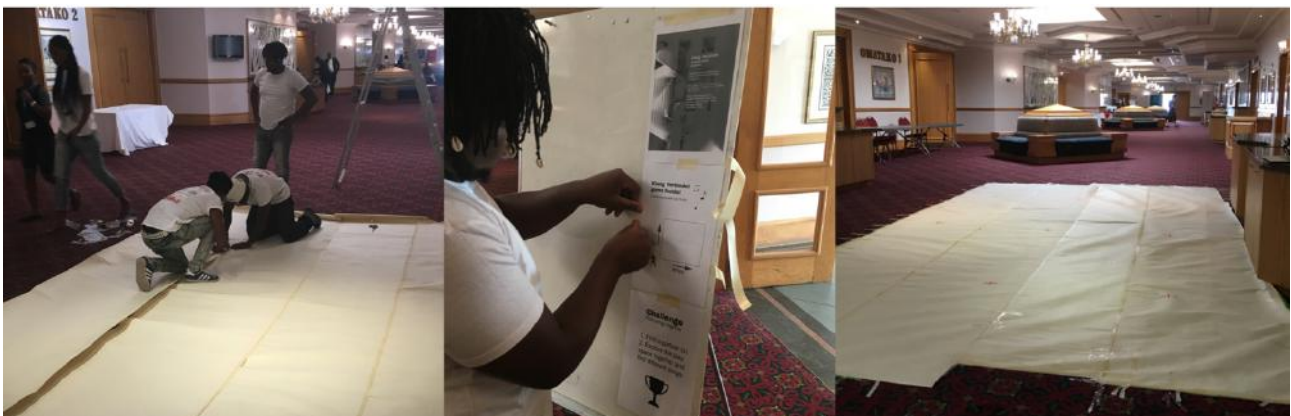

Figure 41: Setting up Klang Verbindet for AfriCHI2018

Figure 42: Curious, ambiguous and appropriative play

Figure 43: Playing Klang Verbindet

Figure 44: Discussion of Klang Verbindet game on a local news channel, One Africa Namibian Broadcasting Corporation

Results

This section reports on the results of the third and fourth evaluation.

Table 21: Results of evaluation (AfriCHI2018)

| Item	Play test 3 (μ) N=15	Play test 4 (μ) N=21	Measure
Q1 I feel that the activity made me move my body more than I usually do	2,93 SD= 1,33	3,71 SD= 1,16	Physical engagement (PE)
Q2 I quickly understood how the system worked	3,60 SD= 1,02	3,67 SD= 1,04	Ambiguity (A)
Q3 The activity made me think about different ways it could be used	4,13 SD= 1,02	3,95 SD=0,90	Appropriation (AP)
Q4 I found the activity to be fun	4,73 SD= 0,44	4,67 SD= 0,47	Fun (F)
Q5 I didn't enjoy doing the activity with other people around	1,53 SD= 0,88	1,52 SD= 1	Social interaction (SI)
Q6 Doing the activity with other people made it more interesting	4,67 SD= 0,60	4,19 SD= 1,26	Social interaction (SI)
Q7 I found the sound to be enjoyable	4,53 SD= 0,62	4,48 SD= 0,66	Sound appeal (SA)
Q8 I would participate in the activity if I saw it in a public space	4,47 SD= 0,62	4,33 SD= 1,17	Social interaction (SI)
Q9 I can imagine playing the activity with people I don't know	4,33 SD= 0,62	4,33 SD= 0,94	Social interaction (SI)
Q10 I can imagine playing the activity with older people I don't know	4,07 SD= 0,88	4,05 SD= 1,05	Intergenerational interaction (NI)
Q11 I can imagine doing the activity with younger people I don't know	4,33 SD= 0,80	4,19 SD= 0,91	Intergenerational interaction (NI)
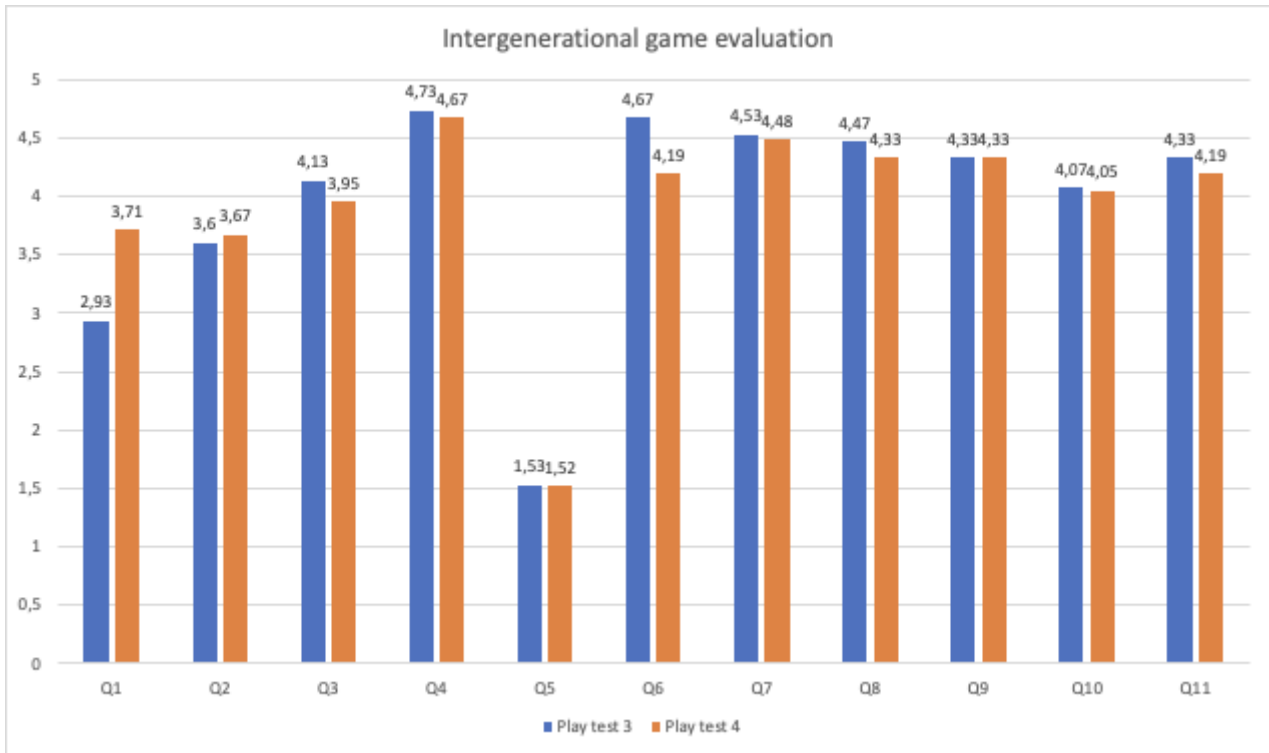
Figure 45: Play test 3 and 4 comparative scores (AfriCHI2018)

Physical engagement: I recorded physically active behaviour from participants, who would often made quick repetitive actions to dramatically affect the composition of the sound. Participants were also observed running in the play area. Most of the vigorous physical activity was observed during the collaborative part of the game, when participants had to guess the location of the song. Average scores of 2,93 (SD 1,33) and 3,71 (SD 1,16) confirmed that participants perceived the game as having potential to encourage physical engagement.

Ambiguity: The statement "I quickly understood how the system worked" was rated highly, with an average score of 3,60 SD 1,02 for the first play test and 3,67 SD=1,04 for the second play test. Participants exhibited several inquisitive behaviours. After unassumingly walking into the play area, participants often responded with a puzzled look when they heard the generated sounds. This was often followed by a short walk around the play area to try and establish the source of the system's computed sounds. Even without being invited into the game challenge, participants often sought out other players to satisfy their curiosity in acts of co-exploration. Some participants were observed testing the parameters of the system by moving on and off the play area sheet. Overall perceived ambiguity decreased on the second day. The second day featured an introduction with more clear instructions.

Appropriation: Participants rated perceived appropriation highly with a start of 4,13 SD =1,02 on the first day and 3,95 SD= 0,90 on the second day. Similar to the ambiguity construct, there was a slight decrease in ambiguity scores. Participants took appropriative actions when playing the game. One group of participants suggested the introduction of a three and four player mode whereby multiple players communicated with each other to solve the challenge. Participants also introduced a different playstyle by requesting that the research team inform them on how close they were to finding the solution by shouting "cold" when participants were not close to solving the challenge and "warm" when participants were closer to the solution. After trying the game once, several participants formed pairs and competed against each other to see which group could solve the challenge in the shortest time. This led to the introduction of a high score which I updated as different teams participated. One participant chose to play alone and used his bag in order to trick the system into recognizing it as

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another person. The participant then modified their own movement and threw the bag into different quadrants in search of the winning combination. After failing to achieve the desired result, the participant who was a male in his late 30s invited an elderly woman to play with him, this was an attempt to cover more quadrants since he thought having three subjects on the play sheet would increase the chances of discovering the combination which required two subjects. I informed the participant that the game was programmed to strictly recognize two subjects and would not trigger the song if more than one subject was in the play area. Other participants attempted to hide themselves from the camera sensor by putting a sheet of white paper on top of their heads (Figure 42). Nevertheless, the confidence players got from structured play might have encouraged more appropriation since they knew what the rules were in order to bend them. Participants also requested for a rotating winning combination to test themselves on whether they could remember previous combinations, a sort of memory minigame. Participants showed more appropriative actions in the cooperative round of them game. Appropriative actions of participants highlighted three main uses for the prototype. Firstly, participants viewed the adaptive change of the sound as a way to compose sounds together. Secondly, participants saw the adaptive change of the system as its own experience whereby they could explore an interactive system out of curiosity. Lastly, participants viewed the system as a platform to play a communicative game whereby they had to solve the challenge as well as a way to train their memory by having to remember previous winning combinations.

Fun: Observations showed that participant enjoyed the game. Participants made comments such as "It's a good game for exercise" P2, F, 41 (play session 2) and "I love the whole concept, it's something new and exciting, it is very unique" P10, M, 22 (play session 2). These observations and comments were reflected in the questionnaire scores (4,73 SD = 1,02 and 4,67 SD = 0,47 for play session 1 and 2 respectively. Participants made several suggestions to improve fun aspect. For instance, P17, F, 39 (play session 2) said "It is very interesting, adding colour to the different areas of the cube would make it more visual, otherwise it is a superb experience, include more squares". Some participants called for the reduction of squares, adding that the 3x3 configuration was too difficult and led to people giving up on the game. Judging from my own observations, many participants seemed to enjoy the game experience, especially when they played with another person. Because of their young age and ethical concerns, children under 18 years were allowed to experience the prototype but their experience was not evaluated. Parents of underaged children were reluctant to evaluate their children's experiences on their behalf. In the general feedback on the questionnaire participants also suggested having different difficulty for different people. "The system should have different levels for kids, younger adults, adults and seniors. There should also be a player mode for 2-5 players" - P21, M, 23 (play session 2). "The system should give you a time frame to find the song, to make it even more interesting" P16, F, 24 (play session 2). "It would be nice if there were several hidden songs" P6, F, 24 play session 2.

Social interaction: Items in the questionnaire scored highly for the social interaction construct. For the negatively phrased statement "I didn't enjoy doing the activity with other people around", participants reported average scores of 1,53 SD 0,88 and 1,52 SD = 1. For the positively phrased "Doing the activity with other people made it more interesting", participants reported averages of 4,67 SD=0,60 and 4,19 SD=1,26. Observations corroborated that participants were more jovial when they were interacting with other players. Participants interacted with each other by coordinating their efforts around the play mat, often communicating strategies on how they could solve the challenge efficiently. While participants reported a preference for cooperative play, one participant felt that it was necessary to provide players an option to complete the game challenge alone (single player). Participants also reported a high potential for the game to promote interaction between non-kin players. Responding on whether they could imagine playing the game with unknown people, participants reported mean scores of 4,33 SD = 0,62 and 4,33 SD = 0,94 for play test 1 and 2 respectively. Participants also expressed that the game would be a good fit for public settings such as

malls and underutilised public spaces. One parent voiced that they would be interested in buying a commercial version of the game for his daughters, adding that they needed a fun way to interact with each other at home. The perceived appropriateness of the game for a public setting is captured by a high average score of 4, 47 SD = 0,62 and 4,33 SD = 1,17.

Non-kin intergenerational interaction: Participants also recorded a high impression of the games ability to promote mix-aged gameplay. The first play test recorded an average of 4,07 SD=0,88 while the second play test recorded an average of 4,05 SD =1,05 for impressions on gameplay with older people. Asked to imagine the potential of the game to support mixed age gameplay with younger people, participants recorded impressions 4,33 SD =0,80 and 4,19 SD 0,91 for play test one and two respectively. In the open discussions, respondents reported that they felt the game was suitable for mixed aged groups because it must have been designed with different users and their abilities in mind.

Sound appeal: Participants had mixed impressions about the system's sound. Some participants found the sound intriguing and commented that its experimental character supported the explorative aspect of the game. Other participants felt the experimental sounds distracted from the compositional aspect of the game. Participants had it in mind that the game should support a compositional element whereby players could play for the sole purpose of creating music together. Participants were particularly happy with the fact that they could select the song that they wanted to find in the challenge. One participant said "the music finding feature works well because even if an older person plays the game, they can select the music from their time and this will make them happy" P3, F, 34 (play session 2). Four participants commented that they would have liked the experimental sounds of the system to work towards finding the song, "the change of the sound should give the player an indication of what's going on, for instance, if the sound tempo speeds up then it should mean that the player is closer to finding the song". P19, 22, F (play session 2). Some participants also called for a contextualisation of the music, "Use less annoying sounds, use African music, contextualize the game's sounds to the choice of music" P13, 35, F (play session 1). Despite mixed impressions on the system's sound design, participants rated the sound appeal highly with 4,53 SD=0,62 and 4,48 SD=0,66 for play session 1 and 2.

7.3 Guidelines for the use of ambiguity, curiosity, and appropriation in the design of public intergenerational games for strangers

In this section I present ten strategies related to curiosity, ambiguity, and appropriation and how they might be used for the purpose of increasing low-threshold encounters. Figure 46 illustrates the envisioned curiosity, ambiguity, appropriation process. Table 22 lists the strategies, followed by more detailed explanations.
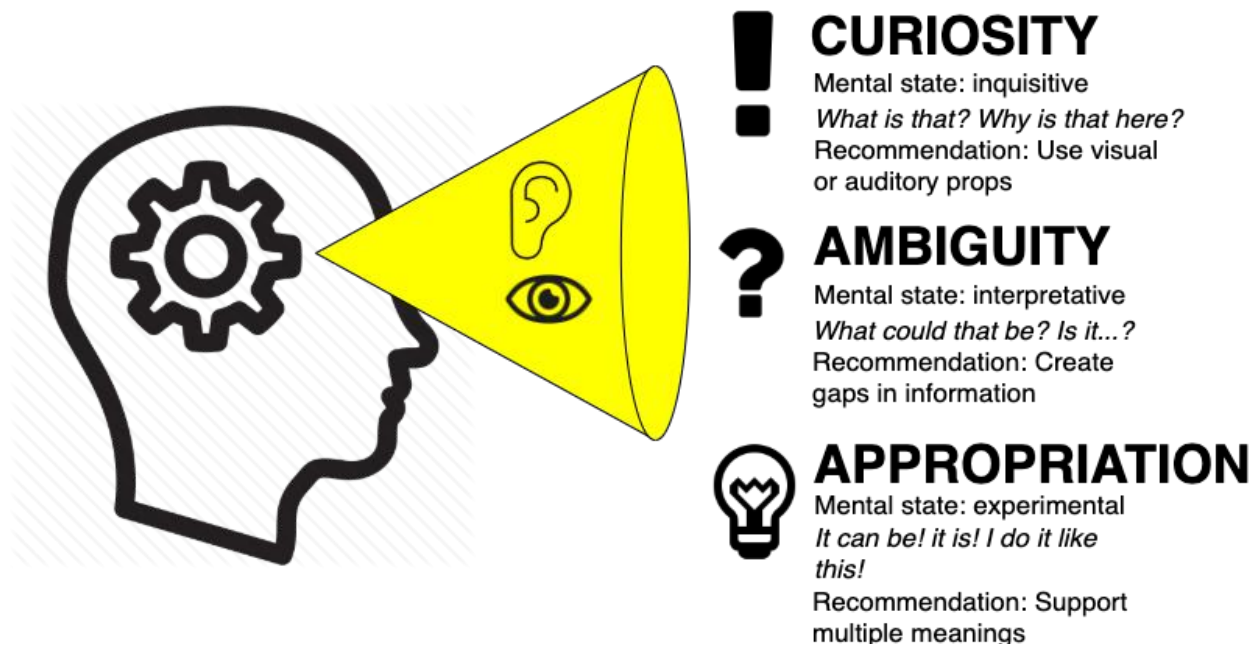

Figure 46: Curiosity, ambiguity, appropriation process

In order to meet the goals of the design space set out by this research. The process of how designing gameful low-threshold intergenerational encounters can be initiated takes the form of a step-wise process. Due to its importance in enticing participation, curiosity is implemented first. This creates the opportunity to recruit participation with minimal effort. Due to the nature of a public context, the process is likely to attract more than one passerby. At this stage players are in an inquisitive mental state as they are initial drawn to the interactive experience. Next, the player transitions into a state of ambiguity which is an interpretative mental state as they try to make sense of the interactive experience, hopefully enlisting the help of other people to demystify the game's function. Lastly, the players move to an appropriative stance where their speculations are tested through experimental action. A short move from this and players can become aware of the game's challenge but should be given freedom to choose to discovery other modes of play with the support of the system's design. The ideal implementation of the different states should be gradual so to harness different levels of certainty to sustain engagement but designers can opt to start with any stage of the process. I elaborate on these aspects of scheduling in the following sections.

Table 22: Curiosity, ambiguity, appropriation strategies

Strategy	Description	Strategy type
Design for partial familiarity (ice-breakers)	Design for pre-game ice-breaker events moments that bring players closer together	Curiosity
Design for the use of props	Props can be used as lures	Curiosity
Make enjoyable play visible	The enjoyment of players will likely attract participation from onlookers	Curiosity
Design for artefact-context mismatch	Deploy game artefacts in spaces where they would not typically appear	Ambiguity
Design for gaps in information	Leave artefacts intended purpose open to interpretation	Ambiguity
Design for multiple meanings to play	Frequently reward the player with feedback for random actions	Appropriation
Design for human mediation of play	People can be good adaptive agents for play, allow mediators to manipulate the system while others play	Appropriation
Design for both open and structured play	Balance of structured and open play gives players option to commit or reject, minimal demand so they feel they are not pressured	Ambiguity, Appropriation
Design for meaningful meaninglessness	Players should be made aware that system has meaning but part of that meaning is that player has liberty to define it, subvert it, build on it	Appropriation
Design for metaphors	Communicating rules communicates how to bend them	Appropriation

Design for partial familiarity (ice-breaker)

"Overall, I recall that I enjoyed to explore it with a person that I know a bit, but no so well." – Klang Verbindet player

In the play tests of Klang Verbindet, numerous participants approached the interactive system with the intention to strengthen newly established bonds. In public contexts, people are likely to strike up small-talk with strangers which initiates a type of gentle familiarity with a stranger. In this instance, while waiting to play a game, a participant might become curious about a stranger and want to further develop a relationship with them but might feel intimidated to initiate interaction. It is in this moment that the game may present itself as an opportunity to explore a new friendship in a safe environment. Designing for this might for instance entail creating a social atmosphere around the public game by providing area where participants can wait for a turn to try the system. In other instances, groups of newly acquainted people might already approach the game with the intention strengthen bonds. For example, two people on a date. In this case designers could orchestrate more minimal playful activities to ease tensions between participants, making the transition to more co-operative play or exploration more likely. This could also have the added effect of compounding curiosity as

participants might be more confident to be curious about the system and the opportunities for further interaction it provides.

Design for the use of props

Props are useful for arousing curiosity. They provide sensorial stimulation that draws the attention of participants. Designers might use visual or auditory lures to enlist participation. However, designers have to be careful how these lures are used to trigger an inquisitive response. In some cases, this can be done by painting footsteps leading up to the game space, this leverages the use of metaphors by allowing participants to infer a call to action, leading them to participation. In this way, props can be used like contextual triggers.

Make enjoyable play visible

The successful participation of a dyad is likely to attract the participation of a third person. Making enjoyable moments of play visible will entreat onlooking participants to try the game. Players will be curious to find out whether the game can impart the same enjoyment they have seen in others. Practically, this requires designers to think of ways to communicate this enjoyment to non-participants. Public contexts are typically open, meaning that play is always within eye sight of spectators. Greater visibility might for instance be achieved by broadcasting play sessions on screens in more secluded parts of the play space. This must be done with careful consideration for players' safety and privacy concerns. This point espouses the concept social influence and highlights the ability of participants to influence the behaviour of others around them.

Design for artefact-context mismatch

Deploying an interactive artefact in an incongruent setting is likely to create curiosity and the desire for exploration. With the aid of ambiguity of context, participants will start to form interpretations of why the artefact has been deployed in an unlikely environment. Designers should take care not to antagonise players, for instance, placing a biohazard sign in a food market might disrupt the environment causing participants to no longer feel safe and become sceptical about participation in a public game.

Design for gaps in information

Omit certain information about the system's functions in order to allow participants to form multiple interpretations.

Design for multiple meanings to play

Obscuring a clear purpose of an interactive experiences inherently makes it ambiguous. Making it even more ambiguous is designing for at least two or more meanings that can be experienced through the game. Players are more likely to be engaged if a system minimally conforms to at least one of their expectations. For instance, even though the designer's intention is to provoke interactions between participants, the game should have additional functions that cause the participant to think that their speculations are correct. For example, in the face of ambiguity, a participant might try to jump in order to interact with the system, as a secondary function, the system should give the participant feedback for this action but not so much that the participant concludes that that is all the system has to offer. The system might make a sound, and then progressively continue to change this sound as the participant repeats the action to satisfy their expectations. The game should progressively surprise the participant as much as possible.

Design for human mediation of play

While it is possible that designers can use adaptive methods like machine-learning to discern which strategies to prompt a player, it is more reliable to use a human mediator. People are experts at recognising when a particular play mode gets boring and how to adjust system properties to foster continued engagement. Like the example of Age Invaders given in previous chapters, a parent might be able to best judge the level of difficulty required to keep both a young child and a senior person engaged. This helps with real-time appropriation strategies, allowing the system to adapt to participants' needs without having to disconnect them from the interactive experience. Automating this task could breed suspicion of the system's motivates and cause players to abandon the experience. That said, opportunities to optimise the game's features through AI should not be ruled out completely but should be modelled and implemented with great care. It is easier for participants to forgive a mistake from a human mediator than a computer agent. Even so, designers should investigate the external appearance of this mediation, a wizard of oz technique could make for an interesting mix.

Design for both open and structured play

Ambiguity is more conducive to free-open play where the rules are not clear. Designers must recognise that players have different preferences and will likely be experiencing different constraints in interaction. A participant with a limited amount of time will not be responsive to a playful experience where they have to learn complicated rules, in fact, it is more likely that they would want to experience a quick preview of the system's capabilities before choosing to commit. It is important that the experience supports some form of quick interaction, making minimal demands from players to get enjoyment. This will also create sufficient intrigue which the participant can then choose to explore further. This more gradual progression of interest can complement structured play. Once a participant has sufficient motivation, they might be more interested in following a more rule-bound process that invites them to take on a challenge. Both open and structured play should be immediately accessible. Requiring a participant to first explore then tackle a challenge diminishes the chances of sustained interaction and will likely result in the participant rejecting the experience if it does not meet their expectations.

Design for meaningful meaninglessness

While the designer can endeavour to communicate to users that a system indeed has a purpose, it should not penalise players for exploratory behaviour. Participants should feel safe to make mistakes and be confident that those mistakes are themselves an additional future of the system. This will encourage players to adopt and adapt their own playstyles, fostering feelings of accomplishment when they subvert obvious rules.

Design for the use of metaphors

Some participants thrive when minimal instructions are provided. Metaphors are particularly useful for this purpose. A metaphor capitalises on the system's affordances by allowing participants to infer interactive modalities that the system supports. Not only do they provide usability benefits through enactive representation, they also give participants the confidence to derive multiple appropriative behaviours.

7.4 Discussion

In this section I provide a synthesise of collective scores obtained throughout all the play tests. Table 23 and Figure 47 show how measures differed. I offer explanations for variances in measures and relate them to the different constructs expressed by the Klang Verbindet system. I also provide an assessment of the system's perceived ability to promote intergenerational goals.

Table 23: Comparative scores for play test 1, 2, 3 and 4

Item	Play test 1 (μ), N=12	Play test 2 (μ), N=14	Play test 3 (μ) N=15	Play test 4 (μ) N=21	Measure
Q1 I feel that the activity made me move my body more than I usually do	3,67 SD= 1,03	2,86 SD= 1,12	2,93 SD= 1,33	3,71 SD= 1,16	Physical engagement (PE)
Q2 I quickly understood how the system worked	2,00 SD= 1	2,64 SD= 1,11	3,60 SD= 1,02	3,67 SD= 1,04	Ambiguity (A)
Q3 The activity made me think about different ways it could be used	3,75 SD=1,15	3,43 SD= 0,73	4,13 SD= 1,02	3,95 SD=0,90	Appropriation (AP)
Q4 I found the activity to be fun	4,00 SD= 0,82	4,00 SD= 0,76	4,73 SD= 0,44	4,67 SD= 0,47	Fun (F)
Q5 I didn't enjoy doing the activity with other people around	1,58 SD= 0,64	2,14 SD= 1,12	1,53 SD= 0,88	1,52 SD= 1	Social interaction (SI)
Q6 Doing the activity with other people made it more interesting	4,50 SD= 0,5	4,00 SD= 0,93	4,67 SD= 0,60	4,19 SD= 1,26	Social interaction (SI)
Q7 I found the sound to be enjoyable	3,08 SD= 0,86	3,71 SD= 0,45	4,53 SD= 0,62	4,48 SD= 0,66	Sound appeal (SA)
Q8 I would participate in the activity if I saw it in a public space	3,75 SD= 1,09	3,50 SD= 0,82	4,47 SD= 0,62	4,33 SD= 1,17	Social interaction (SI)
Q9 I can imagine playing the activity with people I don't know	3,50 SD= 1,12	3,79 SD= 1,01	4,33 SD= 0,62	4,33 SD= 0,94	Social interaction (SI)
Q10 I can imagine playing the activity with	4,25 SD= 0,43	3,79 SD= 0,86	4,07 SD= 0,88	4,05 SD= 1,05	Intergenerational interaction (NI)

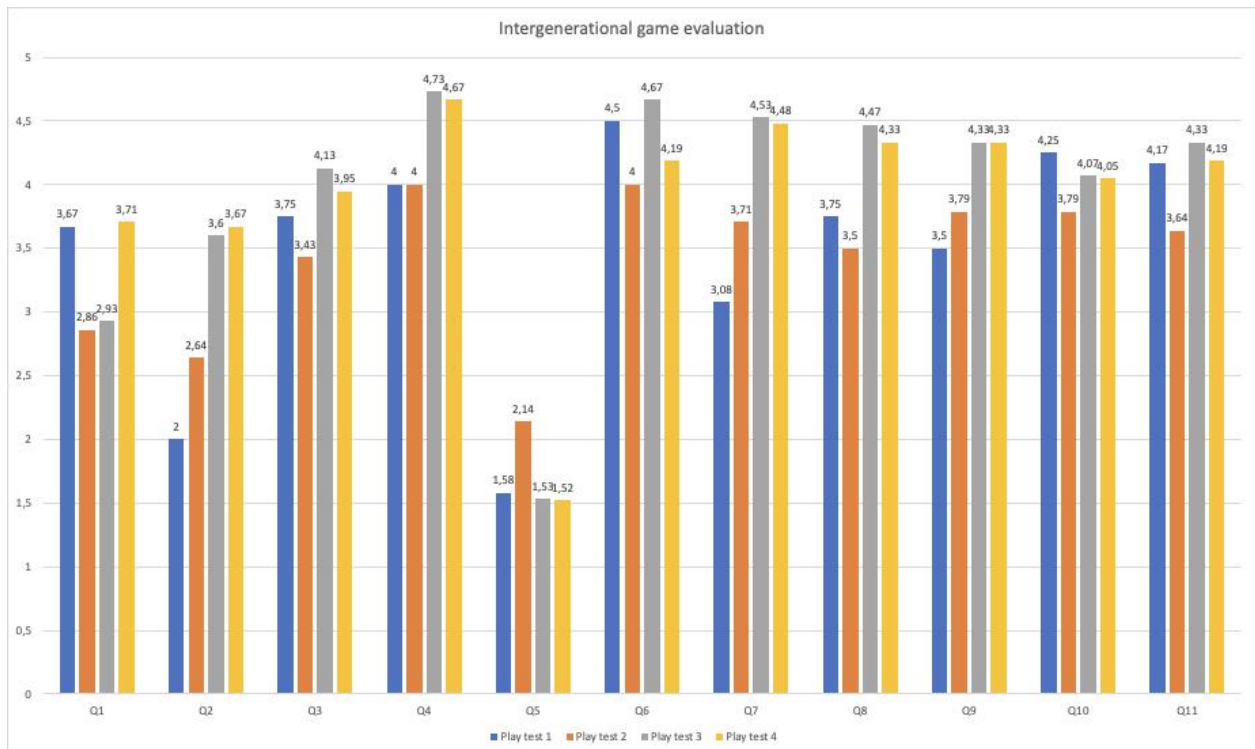| older people I don't know					
Q11 I can imagine doing the activity with younger people I don't know	4,17 SD= 0,55	3,64 SD= 1,11	4,33 SD= 0,80	4,19 SD= 0,91	Intergenerational interaction (NI)

Figure 47: Comparative scores for play test 1, 2, 3 and 4 graph (Trento + AfriCHI)

Curiosity and Ambiguity

The results of the evaluations showed that ambiguity has the potential to be a useful design resource for attracting engagement. Deliberately creating gaps in information about the system led participants to take on a more inquisitive demeanour from the outset. Perhaps the most useful function of ambiguity was that it allowed players the agency to define the next features of the prototype, therefore making it a useful tool to elicit future design and technical requirements. Several final features of the game including the game challenge, song selection, time-sensitive challenge, multiple player mode and clue-based exploration were all inspired by the participants' own interpretations of how the game should function. However, it must be stated that ambiguity must be accompanied by an adequate provision of instructions. It was more useful for participants to explore the system when they were made aware, to some degree, of the system's core functionalities, such as in play test 2 and playtest 4. The presentation of the game as an artefact that supports interpretive play helped to give players the confidence that their actions were acceptable and would not jeopardise the functioning of the system. Using an embodied interface that did not require physically handling input devices like gamepads gave participants more freedom to explore the system evidenced by the confidence with which participants performed experimental gestures. This quality specifically connects to how a mix of structure and rules can be harnessed to provide a guided and yet safe environment for playful action, a central requirement for intergenerational games.

The function of the song finding challenge for instance was too difficult for players to discover without direct knowledge, and so I provide clues (props) by drawing squares in the play area with red dots to nudge participants to understand the key game mechanics. I believe that this level of abstraction led to participants feeling more fulfilled when they discovered the song because up until that point, they could not ascertain as to how the system was able to detect their positions with such accuracy. While the results are not conclusive, I noted a correlation between the decrease of ambiguity and the provision of instructions on the second day of the evaluations. This provided some meagre evidence that omitting information might be a reliable way for designing for ambiguity. Another design choice that contributed to the ambiguity of the system is the choice of technologies that can be covert. The overhead camera and speakers were set up to blended into environment. Computer vision was instrumental to achieving a covert setup. Computer vision allowed me to detect and track several features of subjects in the play scene. Features such as the size of the subject, direction, position and movement speed could easily be used to support multiple play modes. For instance, the corporeal mass of a subject could be used to control some element of the sound. Computer vision offers a promising platform to create multiple interactive experiences for collocated strangers.

Appropriation

I believe that the relatively open style of play contributed to the high rating of the appropriation construct. Results showed that participants believed that the system design encouraged them to think about the multiple ways it could be played. The most popular interpretation of the system's adaptive sound generation feature was dancing. Across all play tests, I observed that upon hearing the system's sounds, participants started making dancing motions, which is expected as dancing is the prototypical response to music. This perception was even clearer when multiple persons were in the play area. In this case, the generation of multiple sounds supported speculations that the system was meant for composing sounds and dancing. Participants believed that the choreography of different player actions created unique compositions and often asked if they could download their own compositions. Due to time constraints, I did not implement this feature. Participants often made accelerated motions in an effort to drastically affect the system's sound. This implies that they might have believed the more accelerated actions led to different sound output, which was indeed true but this did little to speed up which sounds changed and did not affect the volume (amplitude) as one participant believed.

Compared to the earliest play tests, play test 3 and 4 had higher scores for appropriation. One possible reason for this is that the later play test was carried out in a larger play area. Behaviours like running and dashing might have been more prevalent since the space allowed for it. It could also be true that because some of the participants at the AfriCHI conference where academics, their familiarity with interactive systems caused them to be more appropriative in their interactions. I can only hope that the composition of public attendants provided some reliable measure to compensate. Results of the Italy case study comprised almost entirely of public citizens and they reported similar measures, albeit lower values.

Physical engagement

The game's perceived potential to promote physical actions is highlighted by the above average scores of the construct in the questionnaires. Coupled with the observations, the outcome of the evaluations makes a convincing case for the further developments of a game mode that supports a motivation for physical exercise. The scores of play test 3 and 4 are relatively higher than those reported in earlier play tests. Again, one explanation for this is that the play area for the AfriCHI2018 studies was relatively larger compared to the one in earlier play tests. Having a bigger area supported more cooperative play. Participants from the earlier play tests made suggestions to use a larger play area that supported more players and more quadrants. Participants in the later play tests showed more of a propensity for running and other more physically engaging actions. Although these actions were generally observed in most of the players, it is the younger people who seemed more likely to make vigorous actions, which is understandable because the sample groups of all play tests predominantly featured young people. Even though most seniors were observed to make more calming movements, I cannot reliably say this way due to their age because some young people also adopted calm behaviours.

Fun

Observations of participants along with their self-reported evaluation make a case that participants enjoyed themselves. Participants enjoyed speculating about how the system worked, in individual play this created communication between the player and the facilitator. In cooperative mode the system's open-ended character created considerable interaction between players. Participants showed higher levels of enjoyments when they were playing with other people. The different phases of the game worked in an orchestrated manner in order to gradually build enjoyment. The first phase of the experience was dominated by intrigue as players tried to demystify the interactive artefact, some participants enjoyed this mystery. Having their speculations confirmed or debunked also provided enjoyment for players.

The second phase paired players with other players which also contributed to enjoyment. The challenge of the game harnessed this prebuilt enjoyment by allowing all these actions to culminate in an achievement whereby players could collaboratively dance with their game partners. Participants also enjoyed the fact that they could select which song to find, creating a moment for them to celebrate together when they found the song. This gradual build up towards player enjoyment appears to have contributed towards sustaining play, since the system provided different levels of enjoyment at different stages of the interaction. For instance, I observed that players made celebratory gestures with the completion of every challenge. Participants were happy when they were able to guess how the system worked. They were even more joyful when they and their partner managed to complete the song challenge. Once complete, participants made their own suggestions on how the difficulty of the game could be modified by increasing the number of quadrants or setting the winning position to a past position which challenged them to recollect exactly where they stood during that winning combination. Even when they did not complete the challenge, players often came back to try the

challenge, sometimes with other partners that they were more familiar with. These findings demonstrate the importance of cultivating challenge to ensure greater engagement.

Sound appeal

The evaluation of the sound appeal was controversial. On the one hand, the use of experimental sounds created an atmosphere of ambiguity which stimulated exploration. On the other hand, some participants found the design of the sound discomforting, this was mostly related to the fact that the sound had no recognizable structure such as that often associated with music. When it came to the system's ability to support composition, there was no strategy to creating music. This caused disengagement for players who did not understand that the sound design was only one component of the system. In later play tests this was remedied by providing players with sufficient information that the sound was meant to have an ambiguous quality that supported their discovery of how their movements were used to generate the sound. Sometimes participant's preferences of the system's sound were based on cultural sensibilities, demanding that the sound design be more adapted to culturally relevant styles. This was particularly true when African players played the game. This finding is further supported by the fact that European users compared the system's sound to "electronic music", a style of music which is not particularly well established in the African context. Expanding player freedom to select the song they liked placated players' concerns to some extent. Players were happy to endure the experimental sounds as long as they got to enjoy their music of choice once the challenge was completed.

Social interaction

The three social interaction constructs in the questionnaire scored highly. Participants were convinced that the game has the potential to promote social interaction. From their observed behaviour, participants appeared to enjoy the game more when they were in the company of or playing the game with other people. One of the points that emerged from the results is that people mostly played with people they had some familiarity with. In the case of the Social Stone evaluation, some players were familiar with each other before playing the game. Granted that social stone is a local bar, the chances that people would be acquainted before playing the game were quite high. Despite this I did observe some people who met for the very first time playing the game. In the AfriCHI2018 evaluation, I noticed that many of the players who played the game met at the conference. I discovered that many of them brought these new acquaintances to play the game as a way of strengthening new bonds. This promotes the role for public prosocial games as activities that help cement new friendships from situations of minimal familiarity.

In the case of the AfriCHI2018 conference, some people were there to attend the conference while others came to see the interactive systems on display. This common purpose creates a stage of some level of familiarity. Due to the fact that I did not record the familiarity of the players in the post-game questionnaire, it is difficult to state what kind of relationship players had prior to the play experience. An encounter-based approach exploits the benefits of exposure. Putting players in collocated contact for a brief moment provides a platform for them to gauge each other's interest for friendly relations without the pressure of having to commit to a new friendship. I believe the game's flexible design allowed players to opt in and out spontaneously, making chance encounters more likely. Using an encounter-based approach potentially improves evaluation methods for prosocial games. Unlike prosocial goals such as fostering meaningful friendships, encounters are much easier to measure. This creates space for future work to study whether increased encounters are a reliable way to predict the formation of long-term friendships.

Intergenerational interaction

Participants seemed convinced that the system has the potential to promote social interaction independent of age. All the intergenerational interaction items in the questionnaire scored highly on the system's perceived ability to foster non-kin intergenerational interaction. While perceptions certainly support it, it is hard to judge the real impact of the intergenerational game on encouraging mixed-aged non-kin interaction. Most of the people in the evaluation studies were young people or adults.

There are certain constraints that come with deploying this kind of intervention in a public context. Firstly, for interactions between strangers I could increase the likelihood of encounters by enticing people to interact but there was no sure way I could specifically target mixed-aged groups. In order to access the system's ability to draw attention through curiosity, ambiguity and appropriation I had to allow people to participate voluntarily. I could not specifically recruit older adults and young people to interact because it undermines how challenging it is for these interactions to happen in a real-world setting. While I mentioned recruiting participants in all case studies, this only represents the number of people who signed up for the evaluation. In real there was a significant number of people who explored and played the game but opted out of the evaluation process. There were also a large number of primary aged children (minors) whose responses I observed but could not capture to a sufficient degree. This is unfortunately another drawback to the low-threshold approach as it accommodates rapid play and sometimes this interferes with more comprehensive evaluation.

By allowing a random sampling style of recruiting players, I had hoped to capture the real sentiments of non-kin mixed aged groups. However, from all of the evaluations, I noticed that people preferred to interact with same-age peers. Furthermore, their behaviour indicated that they also preferred to engage with people they had at least partial familiarity with. I also noticed that indeed older players tended to give preference to young users, especially to toddlers. Teenagers and younger players experienced the game but again, due to the constraints of the public context I was unable to record their evaluations of the system. Some teenagers that played the game were often unaccompanied by adults so it was not possible to acquire consent from their parents. Parents were reluctant to report on the experiences of their children and often said it was better to just allow the kids to play. In order for participants to evaluate the system, it was required that participants be of legal age (18 years old). Despite this shortcoming, I observed that teenage and adolescent aged players had an enjoyable experience with the game.

In the interview studies, I identified teenagers to be the more often cited demographic in older adults' negative experiences. Thus, it would have been insightful to record their perceptions on the game's ability to encourage non-kin mix-aged interaction. Nevertheless, some of these perceptions were captured from the point of view of seniors. In designing specifically for intergenerational interaction, I found that save for a few features it was more productive to design an age agnostic system to promote intergenerational interaction. The reason for this is that there are few reliable requirements that can strictly be applied to the diversity of older adult and young players. It can be said that it is true that seniors suffer from a deterioration of perceptual and motor abilities but I found these to be of little relevance when designing the system.

Senior players rarely commented that the system's functions exceeded their abilities. This may very well have been the result of the target audience who were healthy seniors. I aimed to design an intergenerational game artefact that healthy seniors could play. In saying that, there were no overtly glaring differences in the physical and cognitive abilities of senior and young players. However, I am aware of the limitations brought on by having short evaluation times involving small samples of participants. More longitudinal evaluations may produce wildly different results. While the results

do not exhaustively capture, nor can they capture the vast contextual differences in which non-kin intergenerational encounters happen, participants self-reported measures lend some confidence to the system's ability to promote intergeneration prosocial goals.

8. CONCLUSION

This research is concerned with how the benefits of game and play can be extended to new demographics and new contexts, and how an accounting of the constraints that surround them can be used to enhance chances of success. The new demographic is non-familial and intergenerational, the context is public, and the design goal is prosocial behaviour through the prioritization of enjoyment. While the aforementioned parameters have been pursued from various points in games and interaction design, there are still very few practical examples that show how analysis, design, development, and evaluation of the design space can be carried out. It is not surprising then that there are few projects that have directly concerned themselves with the study of non-familial intergenerational games; the process requires multidisciplinary skills employed over a long period of time. Though these challenges are not trivial by any measure, through this research, it becomes clear that there is a lack of sufficient descriptions that illuminate methods for the purpose of non-familial intergenerational game design.

This research provides a practical example of how understanding motivations and attitudes, harnessing player creativity and incremental design can be used to bring us closer to realising prosocial design goals. Furthermore, I build on previous research that promotes public places as platforms that can foster the gentle introduction of strangers using a low-threshold approach, requiring only that players be true to their nature, and play. Through a series of iterations, I developed an intergenerational game. Firstly, I place the potential user of this intervention at the centre of articulating design requirements. To this end I carried out user interviews with a senior focus group and then later on, involved mixed age groups in codesign workshops where they generated concepts from early requirements. I prioritise seniors as primary users because of their marginalised status in technology use and design, however through the co-design workshops, I capture the multiple and sometimes opposing perspectives of younger users.

I use the Integrated Behaviour Model (IBM) as a comprehensive framework for eliciting behavioural determinants. The importance of the IBM is captured by its ability to stipulate several dimensions that enhance intent, which consequently has been established as a strong predictor for change in attitude and behaviour. It is in the articulation of these dimensions that the IBM creates value in understanding behavioural determinants for non-kin intergenerational interaction. This is a crucial first step in developing an understanding for the design space. This initial phase led to important results which have informed the design of an intergenerational game artefact. Firstly, music was identified as an important topic which can be of interest to different demographics. Secondly, the importance and the difficulty of non-familial intergenerational encounters in a public context are expressed as limitations on time for engagement rather than differences in ability. Thirdly I found that due to the diversity of motivations for non-familial intergenerational interaction, supporting enjoyment as a primary motivation shows important potential for non-kin intergenerational interaction. In addition to this, results revealed that participants bore a strong association of games with a leisure activity. This adds to the growing position that both academia and industry would greatly benefit from games that focus on hedonic aspects, as articulated by the seniors of various ludic realities.

Borrowing multiple inspirations such as analysis of persuasive context from persuasive design and player-centred design from game studies, I designed and developed an intergenerational game prototype. To arrive to this result I engaged mixed-aged sample groups in co-design workshops where young and old explored common activities, topics, factors for disengagement, and intergenerational concepts that promote prosocial goals. These design activities were carried out in two main co-design workshops carried out in two different European countries (United Kingdom and Germany). Workshops revealed that when recruited to design prosocial game concepts, participants created game

concepts that meet the social needs of a general target audience. This strengthens the position of seniors as a valuable creative resource, and while the game concepts can be described as age-agnostic, their implementation definitely show a careful consideration for seniors' social needs. I further expound on this by pointing out that requirements for non-kin intergenerational interaction are partially defined by the public context, which has several implications on the technical character of intergenerational interventions. Firstly, I confirmed that the public context is often predicated by rapid encounters between strangers, necessitating the need for technologies that can covertly blend into the urban landscape, require minimal technical abilities and employ strategies that can entice, engage, sustain and support cooperative gameplay whereby the means of interacting with the system require coordinated action. Coordinated action is implicated as the main source of communication between different players. This also revealed the importance of a human mediator in facilitating gameplay by controlling such things as difficulty with respect to player preferences.

The importance of design strategies is expressed more specifically as implementing open play as a way to elicit new design requirements. From this framing, ambiguity is identified as a means of supporting multiple interpretations, curiosity as means of drawing player engagement and appropriation as a means of drawing alternative modes of play that drive player-to-player engagement. From these outcomes, a game artefact is produced using an iterative and integrative approach. It is continuously evaluated to produce the next version of enquiry into behavioural determinants. Playtests were used to get feedback on the prototype's ability to be foster enjoyment and perceived ability to encourage social encounters ultimately illuminating the design space of *How can we use curiosity, ambiguity and appropriation in the design of games that support non-familial intergenerational interaction?*

The evaluation of the evolving artefact did not follow a comparative analysis approach. While certain comparisons and justifications are made for the different measures across the sample groups, it is only done to explain why these differences might have occurred. Comparisons are not made to draw differences between different versions of the prototype but for the different contextual factors. The prototype was developed in a research through design approach, feedback from each iteration of the play tests was factored into the facilitation of the next, working towards improving the quality of the artefact rather than specifically evaluating which feature of the prototype was most effective at promoting social interaction. The overall responses from players in the form of the 11-item questionnaire, observations and video analysis gave the impression that the game has the potential to encourage non-familial intergenerational encounters. Challenge was identified as the central factor for driving engagement, with participants positively appraising a gaming approach that facilitates a low-entry and intimate exploratory interaction with the system. This feature was complemented by a gradual progression to a more structured form of rule-based play involving multiple players and increasing in difficulty.

Despite a relatively positive assessment of the intervention, evaluations revealed several challenges in evaluating prosocial intergenerational games for the public context. Mainly the importance of using a mix of short post-game questionnaires, field observations and unstructured interviews. Most importantly, that designing for non-kin interaction yields the most promising results when participants experience at least some partial familiarity with each other prior to participating in the intervention. In future, the study of intergenerational games could benefit from a formalized framework for design. Curiosity, ambiguity and appropriation were operationalised to meet design goals. Future work on this might look to automate the very complex interactions between these constructs. The links between ambiguity enjoyment warrant more investigation. However, it was clearer to me that ambiguity was one of the causes of inter-player communication with co-ordinated action playing a close second. Similar to persuasive game design, researchers may seek to model different player

profiles for varying levels of each strategy but I am still confident that relying on human to human influence through interactive systems can be more productive.

Throughout this thesis, I have made several references to age-agnostic games. I clarify here that interfaces should be age agnostic (to an extent) but game concept and content should be the subject of subjective investigations. Perhaps in my own way, alluding to age-agnostic games is my admittance that age may no longer be a relevant parameter to design for. In the face of a changing ageing landscape that will no doubt be influenced by biotechnological developments like CRISPR (gene-editing program), ageing will likely warp into an absurd construct, if it is not already. Research in games for seniors often refers to seniors as people in the >55 category (sometimes >60) but any reliable characterisation of this cannot possibly continue to depend on ability and retirement age, for the reasons that I mentioned before. Throughout the interviews, I was saddened to hear seniors talk about how society is dismissive of people when they are no longer productive, is there a meaning in what is "old age" outside of capitalist conceptions? Perhaps this denigration will change with the character of what we call work, a thing that is already happening at an alarming rate. People are living longer, working longer, and staying healthy longer and keeping up with the times. The seniors of the future will look very different from the ones of today but they will most likely still play, but perhaps within the shells of different interfaces.

At the core this research is the desire to revitalise the position of the public domain as a crucial element of socialization and an avenue where relationships are formed and performed. The public domain is the binding agent of a society and through time, one of the crucial determinants of a society's character. It is then important that those of us who are concerned with designing in these spaces are cognisant of the influence we possess and more importantly, how that influence may be directed towards a more nurturing spirit. For me this spirit has been one of inclusivity and the reduction of social distance within the safety of open play. Amidst all the fervent optimism that precludes hyper digitisation through Internet of Things, Ubiquitous technology, and smart city concepts, it is especially important to declare an agenda committed to reflective design that espouses our most valuable resource, our ability to be social. The anthropocentric desire to live, learn, and build together has propelled the survival and advancement of humanity. But now this same desire is at risk of being lost under the rising tide of sensors, robotics, and datapoints. However, the proliferation of these technologies need not be the harbingers of a fragmented human society, as long as there is still a commitment to make things that cause us to pause and give attention and awareness to each other. It is a daunting task, as every particular instance of human connection seems to be competing with a repelling force engendered by old cultural norms and at times new socio-economic differences. I cannot offer nor am I able to devise a complete solution for these kinds of problems. I had only hoped that by studying the complexities of intergenerational interaction that I might offer a sliver of a new insight or at worst, a reminder of the importance of social interaction. As a black African man living in Europe, I often felt saddened and annoyed by the social distance that exists between people like me and Europeans, especially older Europeans who are often said to be "conservative". While in some aspects it may be hard to judge the scientific quality of this research, it was a work that I did with passion and it ultimately allowed me to access some of the stories and experiences of older populations of this society, experiences and stories I can now say, with the confidence of academic practice, are important for all societies of the world because they are a part of it. Indeed, it may be considered in bad fashion to give such thoughts in an academic text, I feel that there are very few other places where the message is not bound to be lost.

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APPENDIX

Interview script

I: Would you briefly introduce yourself? How old are you? What does your daily life look like?
I: Are you still involved with and interested in your previous employment?
I: Let's quickly go back to your association and how did you become involved?
I: Are you a member of any other associations, clubs or groups?
I: Are there regular meetings in your association?
I: From this point on, we want to talk more about new technology. Do you use a smartphone or computer? In what way have these new technologies entered your everyday life?
I: How else would you relate your experience with technology?
I: Do you like to play?
I: What does game mean to you? What associations do you have with it?
I: Are there any other games you use?
I: Does the term serious game mean anything to you and what connections can you make to it?
I: Are you a grandparent?
I: Concerning your role as a grandparent. Do you get involved in playing there often?
I: Does your family get together regularly?
I: Are you or have you been dealing with many younger people through your work?
I: Do you tend to be an instructor or do you work with younger people on an equal level as well?
I: Where do the communication problems between the generations lie? In everyday life?
I: Is one of your friends and relative in contact with any younger people?
I: How is your contact with younger people, who are not part of your family?
I: Do you observe interactions between younger and older people? Within or outside your family?
I: According to these projects and experiences in your private social environment, can you report rather positive and/or negative experiences with younger people?
I: Can you think of any joint actions with younger people who are not part of your family? A joint project or something?
I: Apart from that, would you wish to spend more time with younger people?
I: Where do you see difficulties which prevent younger and older people who are not related, to come together?
I: Regardless of whether you're related or not?
I: Do you think it makes sense to install something from the outside, in order to bring young and old people together?
I: Do you have an idea within what framework that could take place and including what sort of activities?
I: What aspects make it difficult for you to interact with younger people? In different contexts. Are there any obstacles that complicate interaction?