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Astaire, a Collocated Physical Virtual Reality Game

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Abstract

Astaire, a Collocated Physical Virtual Reality Game

Zhuoming Zhou

Virtual reality is a new medium slowly getting popularized that introduced a new form of merged play: hybridized reality. Collocated physical virtual reality games are an interesting and diverse design sub-space of this that offers a wealth of improvements over traditional virtual reality games. This work tries to probe only a small facet of this area to demonstrate its potential for more technology-supported and hybridized reality games that lead to increased interpersonal relationships and experiences for both the spectators and the players.

Acknowledgment

This project was a collaborative effort and everyone will be credited appropriately. My project advisors, Professor Katherine Isbister and Professor Michael John have always offered me direction, unconditional support, expertise, and inspiration. I could not have completed this without their assistance. Elena Márquez Segura was critical in the ideation phase and beyond, always there to lend an ear to my ideas, guide me through unknown techniques, and objectively give me feedback. A very special thanks to Jared Duval for working with me in the beginning of the project and assisting me in whatever I needed help with. Thank you to Charles Somerville as well for directing me in the early steps of the quantitative analysis.

Chapter 1 Introduction

The introduction of commercialized virtual reality (VR) has presented a design space similar to the one that resulted from the period when the Wii, Kinect, and Playstation Move were popular. It is an intriguing circle of play that mixes physical movement with an entirely separate experience from physical reality. Due to the novelty of the field, many designers and researchers are solely focused on advancements and creations based on only one limited aspect of what VR potentially offers: simulation (Smith et al. 2014; Sucar et al. 2014; Cho et al. 2015). This is understandable, as VR's prominence has always stemmed from its ability to simulate realistic sandbox environments for players to roam around. This focus on simulation naturally means that when designers think 'multiplayer' for VR, they immediately consider networked VR instead. However, this neglects rather than explores the aspects of physicality possible within VR games. The space of play comprised of the amalgamation of physical and virtual realities, better labeled as hybridized or mixed reality, offers an accessible and fascinating area of study that enables developers to take advantage of the positive effects of physical play that many modern games are unable to. To be direct, collocated physical play within the context of VR is a vast field to explore and offers a new and interesting design space.

1.1 Conflicting Visions of Virtual Reality

The idea that VR has become too socially isolating has amassed a rather large following these days, with many news sites and even some university blogs referring

to VR as “too isolating” for it to be popular (Metz 2017; Schober 2017; Freeman 2017; Hills-Duty 2018). While these sites may not necessarily have the proper research backing their claims, it is not difficult to grasp why people see VR in this light, considering the structure and set-up of modern VR. It comes with a headset with a screen that only the player can see, a space of play dedicated to that person alone, and controllers that only have recognizable consequences within that space. Players seemingly have little ability to consciously interact with what is around them, limiting collocated social play.

Video games and other forms of visual media have telepresence, described as the ability to see from the viewpoint of a virtual character and perceive what they perceive (Durlach & Mavor 1995; Schroeder 1994). Once players put on the helmet, their current version of reality is replaced by something else entirely, and this experience extends beyond telepresence because players also genuinely embody the characters they play. This heightened sense of presence and attachment to player character may increase player identification and increased usage of VR which, in turn, could reduce face-to-face interactions (Calvert 2001). However, despite being seen by so many as an isolating medium, there have been many modern attempts to use VR to alleviate social isolation and facilitate social training (Didehbani et al. 2016; Bouchard et al. 2017; Falconer et al. 2016). This raises the question of why people keep subverting what many see as its limited natural affordances. There are more instances of these unexpected occurrences in the form of spectators. The central reason why VR is popular among spectators is likely the actions vs reactions. It is enjoyable for audience

members to see players in VR fiddle with and flounder against objects that they cannot see. At the same time, the acknowledgment that both parties are unable to see what the other can adds to the ideas of isolation and social limitations. That is why so many works on spectator experience with virtual reality focus on bringing in the spectators to enjoy the VR experience as well (Geisner et al. 2016; Marks and Osman 2018; Werry and Schmidt 2014).

These social limitations are just another facet of how modern VR actively promotes hybridized reality play through an exploration of its potential. VR is simultaneously isolating and not isolating, as its setup and ability to utilize movement within 3 different planes compared to previous digital circles of play that, at most, used 2 planes means that there is a stronger focus on physicality and collocated physical play. It does not undermine how we think about collaborative play using the tools presented, but challenges us to consider designing through a new lens. Hybridized reality accords researchers and designers a new design space based on its conflicting nature that really allows developers to capitalize on the benefits of collocated physical play. My thesis work is an exploration of this fascinating design terrain.

1.2 Astaire, Purpose, and Research Questions

Astaire is an asymmetric collocated virtual reality (VR) game designed with the intent to encourage pro-social play in festival/home settings and provide a better spectator experience than other games. The overall goal of the game is to get the highest score possible by tagging musical notes and footsteps as quickly as you can with your

controller, as they appear on beat with the music. Players are rewarded with more points the faster they tag the notes, and each interactable object within the world has a generous hitbox to create a more fluid experience, in that players should not have to struggle because the controllers are not attached to their feet or hands. It is designed to allow for 2 players to use 1 system simultaneously to play, both with different objectives and roles to consider (hence the asymmetry). The players have distinct sources of information. The player with the controller attached to their leg uses the television for guidance, as the view there is from an overhead camera above the map that shows notes that are only interactable with the controller attached to the other player 1 second before they spawn. The player inside VR can see both players' notes, but not with the foresight or breadth of the other player. They see the footstep notes only interactable for the player outside VR, which they can then guide them to.

Figure 1: Controller setup

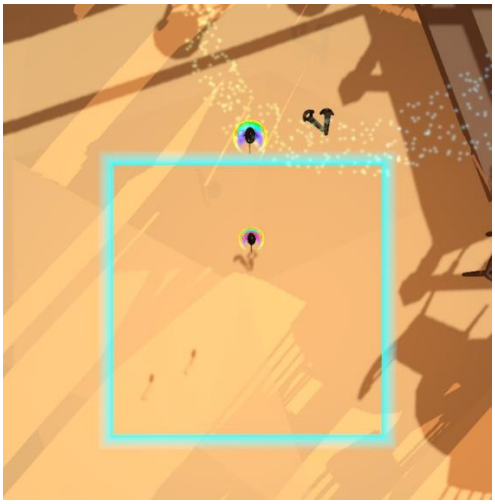

Figure 2: Overhead view

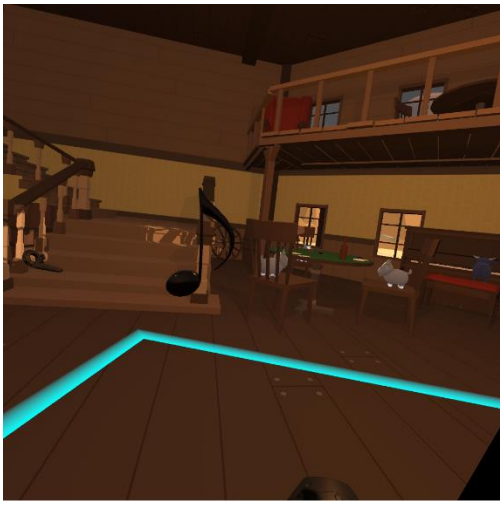

Figure 3: In-game view

Players are disincentivized from straying too far from each other as they lose points based on time spent apart. This decision was made to encourage more physical play and reflect actual partner dancing. Previous user tests of earlier iterations of the build showed that players naturally drifted towards physical interactions to guide each other anyways because of the fast-paced nature of the game and the limited value of verbal assistance when both players are essentially blind to some aspect of the other player's world. Due to these findings, and how some partners would occasionally only try to unsuccessfully verbally direct each other, it felt apt to concretely establish this as a rule within the world.

Nonverbal communication (guiding one another through physical cues rather than just by talking it through) was cemented within game as a rule for dual purposes: as was mentioned above, it greatly enhances the communication and success between players, but it was also encouraged due to the concept of proxemics. Hall, who originally created the term, defines proxemics as "the interrelated observations and

theories of humans use of space as a specialized elaboration of culture." He also introduced the 4 zones of interpersonal spatial distance to determine the relationship that that distance suggests: intimate distance, personal distance, social distance, and public distance, ordered from closest to furthest (Hall 1966). While this interpersonal distance normally directs and defines the parameters of social interactions (Lloyd 2009), the magic circle of play (Salen et al. 2004) suspends the established norm of interpersonal distance. The magic circle is a metaphorical circle within games that enables players to follow special rules while potentially suspending disbelief and some traditional ideas of interaction (Juul 2008). Even though players take up the magic circle as a suspension of real life rules, they still feel the positive effects of engaging in rich nonverbal interaction. We know that nonverbal interpersonal communication has the benefits of increasing overall positive feelings, assisting in leading or guiding, and structuring certain elements of interaction so that both players feel as if they had a better overall experience (Knapp et al. 2013). We can see the magic circle, in the case of Astaire, as allowing players to reap the benefits of closer interpersonal interactions under the guise of playing a game.

The aim of Astaire is to create a collocated play experience using the natural affordances of the HTC Vive. As mentioned previously, there have been numerous attempts to use VR to reduce social isolation by drawing upon its immersive atmosphere. *Rec Room* places you online in a networked VR environment to engage with other players from around the world in activities like dodgeball, chess, table tennis. *Keep Talking and Nobody Explodes* places one person into a simulated room with a

bomb they can manipulate and describe to teammates who have manuals used to give instructions on how to defuse the bomb. *Keep Talking and Nobody Explodes* is also one of the games I compare *Astaire* to most often because it is one of the few collocated experiences available for VR.

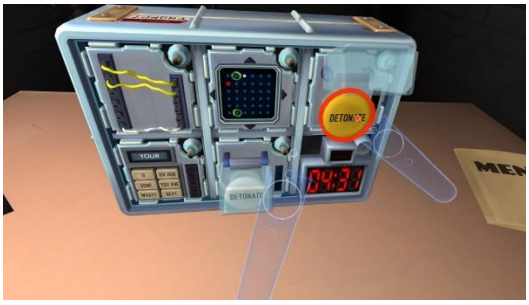

Figure 4: Keep Talking and Nobody Explodes

Figure 5: Rec Room dodgeball

In particular, *Astaire* takes inspiration from the game *Audioshield*, a mostly stationary games resembling a VR version of *Dance Dance Revolution*, with different colored notes drifting towards players which they have to tag with the matching colors**.** The notes are meant to coincide with beats of the music playing so it simulates a form of dancing for players. *Astaire* works from *Audioshield*'s gameplay loop and expands that into a hybridized reality experience.

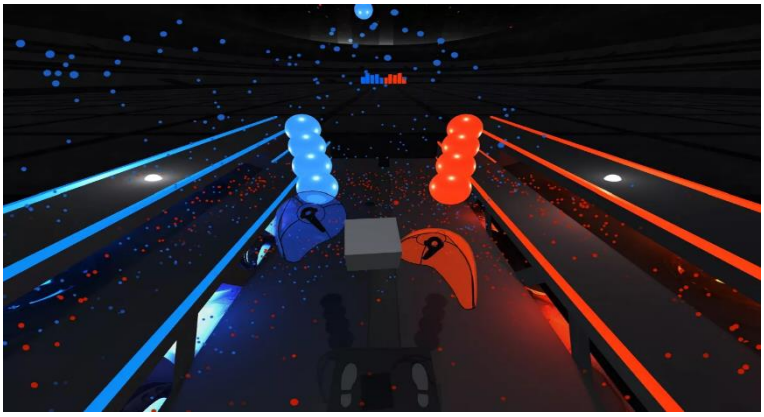

Figure 6: Audioshield

There has been work done on integrating parts of reality into VR through engagement-dependent context (Boland 2015) to create a more immersive mixed reality environment, but it misses the context in what VR lacks. His version of engagement-dependent context is essentially simulating real world materials into the virtual world whenever a player reaches for it, but this is not a mixed reality approach, rather, a more intensified virtual experience. Given VR's nature of shutting out one's local environment's sights and sounds, how would one ground the player within VR and also create a collocated social experience? Pursuing this line of thought created an entirely new strategy for approaching this problem of socially isolating VR. Astaire went the route of touch, adopting nonverbal communication as its main form of interaction. This quickly became an essential part of Astaire, because it not only invited the necessity of another person, but also utilized areas of study that VR typically could not adopt before, such as social proxemics. Distance between people hardly matters when one person has no way of distinguishing the other.

This led to another inquiry: how does this duality affect the spectator experience? One of VR's most notable strengths is its potential to draw a crowd--wearing a VR headset and moving about in response to a virtual environment is an entertaining sight, offering the potential to turn a solo experience into a performative collaboration. Usually the most enticing part of games comes from the screen, where the consequences are flashy and notable. However, this is not necessarily how VR games are seen. Part of the enjoyment comes from seeing how visceral those consequences

can be for players, such as their physical reactions to in-game events. The idea of social isolation accounts for the visual aesthetic of the system itself and the consequences it produces but fails to consider the kinesthetic element unique to VR and few other systems in media. Aarseth, in 2004, mentions that video game studies run the risk of being colonized by other disciplines whose terms are unable to capture the richness and depth of games. Specifically, he calls attention to the kinesthetic dimension that transforms the medium into a focal point on embodied motions and actions (Aarseth 2004). Due to the nature of *Astaire* and games as a whole, it is appropriate to view it through the lens of performance studies in addition to the typical ways we scrutinize VR. With embodied motions, each player brings their past traditions, actions, and encounters, and displays parts of themselves through these motions to those watching (Behrenshausen 2007). Can it really be said, under this context of performative experiences, that VR is an isolating experience?

Stemming from these reasons, the purpose of *Astaire* is to use technology that people normally consider isolating, and convert it into a fun, collocated experience that uses the system's natural affordances, and potentially probes further into the idea of converting VR into hybridized reality. Overall, there were 3 hypotheses tested:

- *Astaire* is a better spectator experience than *Keep Talking and Nobody Explodes* (KTNE) and *Audioshield* (two VR games that also support hybrid VR/in-person interaction),
- *Astaire* is more enjoyable to play than *KTNE* and *Audioshield*,

- *Astaire* is better at furthering interpersonal relationships than *KTNE* and *Audioshield*.

1.3 Thesis Structure

The thesis is composed of 5 sections: the introduction, the literature review, the design process, the results, and the discussion section. The literature review will examine the changes that design for collocated play has gone through over time, as well as explore concepts mentioned in the introduction such as proxemics and performativity. The design section covers the design process, from conception of the idea to the final product. The results section discusses the exploration of the hypotheses described above, based on user tests of the final version of *Astaire*. Finally, the discussion section elaborates upon possible effects seen from the results and how to interpret them, as well as possible future work.

2.0 Introduction

Whenever new technology for play emerges, there is usually a period of time before researchers and developers begin utilizing the system's full potential for play. Instead creators focus on designing and developing experiences that revolves almost fully around the technology itself, creating technology-sustained outcomes (Waern 2009). A technology-sustained game would be a game that is maintained and supported by technology in all of its aspects, from control of outcome, rules, and feedback. Virtual reality (VR) technology has been lingering in this part of the system lifetime cycle for quite a while. In part, this could be attributed to the focus that many developers have on the simulation part of VR rather than the design space, as well as to how effective the headset that accompanies all modern VR systems is at isolating its users from the physical world, by taking over the auditory and visual channels of the user. These twin focal areas on the part of developers creates a counterintuitive cyclical pattern in which our technology improves, and VR becomes more effective at creating entrancing, realistic simulations, but simultaneously worsens its image in the public eye. Collocated social physical play seems almost an impossibility given this frame. I feel

the, problem lies in how developers and researchers design for VR, not in the systems themselves. Current variations of VR have affordances similar to the Wii, which does encourage an asymmetrical form of gameplay that branches across different realities.

This literature review aims to provide insight into why it is important to consider collocated physical play now more than ever, and secondly, how designing for collocated physical play within the context of VR has more potential for beneficial and exciting results. Firstly, this review will describe a brief history of collocated social play that elaborates on its benefits and importance. Secondly, it will address the phenomenon that the Wii created when it was introduced: it signaled a change in people's perceptions of physicality interlaced with technology and the introduction of more collocated physical games that were less technology-sustained than predecessors. Finally, this literature review covers the significance of collocated VR using concepts of proxemics, performativity, and the transition to a mixed-reality design space.

2.1 The importance of Collocated Social Play

Collocated social play has been an area of focus for many researchers, over the last decade. Initially, researchers found that the positive effects social play offered includes increased levels of positive emotions, engagement, and arousal (Mandryk et al. 2006; Ravaja et al. 2006). People also tended to enjoy the play experience more if they perceived that the other players were real people rather than if they were playing solo or against computers (Ravaja et al. 2006). Mandryk showed that this perception of an increased social experience resulted in players experiencing more fun, perceived

competence, and challenge, without negative side effects like heightened levels of aggression (Mandryk et al. 2006). This suggests that "the social cues and opportunities or social interaction directly shape player enjoyment in social play" (Gajadhar et al. 2008).

As video games rapidly spike in popularity, the focus on and interest in collocated social play in the context of digital games has also grown. And as new technologies for gaming have appeared and spread, research interest in the nuances of design for this kind of play has grown. In 2017, 67% of US households owned a device that they used to play video games, with 53% of gamers saying that they played multiplayer games (Entertainment Software Association 2017). Social games have always been extremely popular, with 9 out of 10 of the top selling games in 2007 and in 2017 having some form of multiplayer mode. Collocated play has become less mainstream within that decade gap, with 8 games in 2007 having some form of local multiplayer compared to only 5 games in 2017 (Schiesel 2008). Many players and reporters have noticed this trend as well (Noah 2018; Johnson 2017; Gartenberg 2015). Part of this decrease in presence within mainstream games could potentially be attributed to the layer of difficulty that collocated social play adds not only to the game development process but the evaluation process (Isbister 2010). However, this does not show that collocated play has become less popular, but potentially too timely or costly for many larger companies to invest in. Collocated digital games can, instead, be found in other areas where smaller developers sell their wares.

Steam, the popular digital game distribution platform, shows that between the period of 2010-2015, less than 250 games with the tag, “local multiplayer” were produced. However, from the shorter time span of 2016-2018, more than 400 games contained that tag. Nintendo has been gradually shifting towards more collocated play as well, with the introduction of the Wii in 2006 whose top 10 best selling games all had local multiplayer (Nintendo 2018a). Nintendo’s latest console, the Nintendo Switch, actually comes with 2 controllers attached to allow for multiple people to play in the same area using the same console. While collocated digital games may have become less popular for consoles like the Playstation 4 or the Xbox One, indie game developers and Nintendo have taken it upon themselves to further develop more local multiplayer games and due to the concerted efforts, collocated social play is more popular than ever.

2.2 The Wii and the Spread of Collocated Physical Games

2.2.1 Brief History of the Wii

The last period of mass distributed forms of social physical collocated play came in the form of the Wii, with its most popular game, Wii Sports (Nintendo 2018a). The Wii was advanced for its time, coming in a relatively small package, with a sensor bar for its controllers, the Wiimotes. Each Wiimote was a gyro-based motion controller that came equipped with an accelerometer so it could detect fast and slow gestures, as well as position. Wii Sports, the Wii’s driving force, was a collection of different minigames composed of fencing, bowling, boxing, tennis, and more. Those games all had different ways of utilising the Wiimote, transforming it into whatever is necessary to play the

activity. For example, the Wiimote acted as the racket in tennis, the boxing gloves in boxing, and the foil in fencing. The Wii has sold 101.63 million units to date, and over 20 million units more than both the Xbox 360 and the PlayStation 3 as early as 2012 (Nintendo 2018b). So what was the driving force behind its massive popularity? The main appeals were the physicality of play involved and the overall accessibility of the system. For one of the first times, digital games began to become more physical in nature, something rarely seen before save for rare exceptions in the forms of games like *Dance Dance Revolution*. This new level of physicality not only produced a more interesting design space and style of gameplay, but also a different spectator experience compared to the norm for the time. Whereas most console games within that period could be labeled 'Magical', the manipulations (player actions) and effects (resulting consequences) become exaggerated and amplified to the point where many of the popular Wii games would be better aptly labeled 'Expressive' (Reeves et al., 2005). The results of effects and manipulations range from hidden to amplified, which means audience members can notice quite readily, or have the results obfuscated.

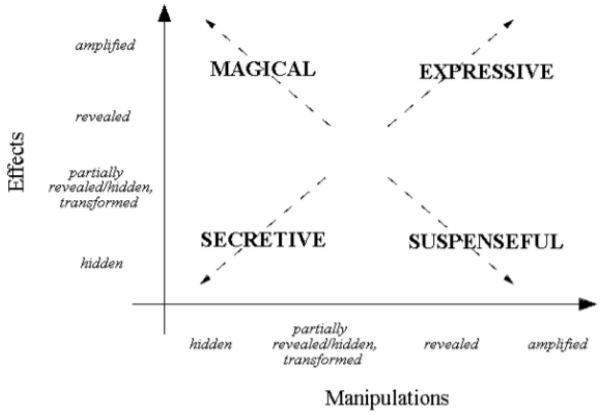

Figure 7: Secret, Expressive, Suspenseful, and Magical approaches to designing for the spectator experience

2.2.2 The Physicality of the Wii

Players had to act out their commands for many of the games, which usually translated to energetic flailing to ensure that the system caught out their actions and repeated it. The act of playing the Wii became the spectacle along with the resulting effects that showed on the television set. The console demonstrated the idea of 'gestural excess,' which means that the fun of these games lies in performing funny gestures and moving the body, leading people to perform movements that were actually beyond what the game could truly detect and process (Simon 2009).

Thus hybridized digital and physical 'magic circle' of play (Huizinga 1955) began to move away from their initial, stationary limitations set by home digital game platforms previously (Márquez Segura 2015). Designers and researchers have begun to emphasize social presence and physical interaction within the circle as technology further supports it.

Bennett Foddy from NYU describes the strength of collocated physical play and how it affects people:

> *"Wii Sports makes the most of what is great about local multiplayer. It lets you laugh at your friends striking silly poses. You find yourself teaching your grandmother or your kid sister how to play. It ropes people in as they walk through the living room. When you get together to play games with friends, the space you're in becomes a ritual space, like the stage at a concert or the*

altar at a wedding. It's a space where you can trash-talk your friends or howl in defeat, where you can trick people, where you can laugh at their expense and dance on their grave. It's a space where you have permission to look foolish in front of your family members. Importantly, it's a space where you can look up at your opponent's face, lock eyes and dare them to make the first move before your split-second counter-attack." (Foddy 2014)

Kirk describes the Wii as "[bringing] people together in a way that video games had never done before, and in numbers never seen before" (Kirk 2012). The Wii created a space that everyone could join in on, and the main draw of this immersive space wasn't in what appeared on the screen, but in the people themselves. It was a phenomenon that Microsoft and Sony later tried to copy with their Kinect and PlayStation Move respectively, both in 2010.

It was initially curious how these new waves of physical, 'Expressive' games (Reeves et al., 2005) took the gaming world by storm, and it becomes apparent that a good portion of the praise leveled at the Wii can be connected to the positive effects of movement. Movement has been connected to higher levels of arousal (Isbister 2011a), engagement, presence (Bianchi-Berthouze 2007), energy (Isbister 2011b), and even social interaction among players (Lindley et al., 2008). The Wii managed to embrace positive qualities of social play and physical play to become a driving force behind the popularity of collocated physical play.

2.2.3 Technology-supported Physical Games

Researchers have observed, that with each new introduction of a piece of technology, the first few to develop rarely fully explore the affordances and capability of what they develop on (Waern 2009). What results is technology-sustained results; games or art that focuses on the technology itself. Part of this is due to what people perceived as the technological limitations of the device. For many consoles, games were developed for fun initially, but researchers explored new areas, focusing on creating immersive simulations that could push people towards affecting social change (Swain 2007; Chung et al. 2007). This is a familiar song and dance, with every new piece of technology. The Wii, however, had people quickly realizing that movement afforded by technology could be adapted to other purposes. Movement and physicality were natural part of the game that was evident to anyone playing or watching, after all, and naturally led to games that encouraged movement for its own sake, such as exergames.

We began to see innovative usages of the Wii in forms of therapy, teaching, and even play (Miller 2007; Pearson et al. 2007; Schou et al. 2007) only a year afterwards, which focused on using various aspects of the Wii like its motion sensing, and later on, balance detection. Games soon began to innovate and become more technology-supporter rather than technology-sustained. Technology-supported games are games that use physical space as a design resource to consider or have broad implementations that allow players more freedom in interpreting and creating rules within the game rather than sticking close to the technology's obvious affordances and constraints (Márquez Segura 2013). Yamove is an example of technology-supported games. This mobile-phone based game used the on-board accelerometers to track synchrony of

movement between dance partners. The design of this game utilized the dance space as well as the unique, reflective roles of the players themselves to create an interesting and complex game that focused more on body interactions rather than on the technology itself.

Since the Wii, wireless and embedded technology have progressed rapidly enough to drive the development of more interactive toys and games that allow for more open-ended physical play (Bekker et al. 2010). The enormous success of games like Pokémon Go, the high expectations for VR devices, and the ubiquity of devices like FitBits, all point to how technology is increasingly being merged with physical activity. The constant presence of technology within our lives and the growing tide of portable devices – laptops, tablets, phones, and even watches now – afford us new opportunities for exploring play within mixed reality and augmented reality settings. Our society is now far more likely to accept and even encourage the addition of more physical and social playfulness into how we interact with our technology on a daily basis (Fernaeus 2012).

2.3 An Overlooked, but Significant, Design Sspace

2.3.1 Isolating VR

Oddly enough, our embrace of playful, technology-supported endeavors has not quite extended to VR, despite its similarities to the Wii. They both tend to encourage more expressive play to the point of gestural excess, use motion tracking within a limited space, and provide a stronger spectator experience because of a high level of physicality.

The main differentiator that VR has that the Wii does not, is the headset, which transports the player through auditory and visual means out of the physical environment. The helmet projects an entirely different screen for the player that other players may not be able to see, depending on the developer of the game, and can come with headphones attached to the headset which blocks out noise from physical reality and provides the player with sounds only from the system.

This creates an isolating experience, one that very few researchers acknowledge. VR has been categorized as isolating by a portion of the community (Wilson et al. 1997), some say its greatest strength and its greatest weakness are simultaneously the isolation it provides (Boland and McGill 2015). To begin with, I would argue that this isolation is not VR's greatest strength. Boland and McGill say that "in shutting off reality, we can become extremely immersed in VR without distraction," but this implies that reality is the distraction, which many researchers have found contrary results to. If reality were a central detriment to the immersion, this implies that collocation takes away from the engagement or presence within a game that the game space creates for players. Referencing above to Mandryk et al.'s paper on collocated play, engagement with a game is actually increased in the presence of others. One study found that while they were unable to detect an increase of immersion comparing playing online with playing locally with a friend, there was no decrease in immersion found either (Cairns et al. 2013). Another study found that collocated co-play actually increased the immersion experienced by players (Gajadhar et al. 2010).

VR's social isolation has mostly been an unspoken issue for researchers, but a significant one for the general public and media (McEvoy 2018; Pringle 2017; Metz 2017; Schober 2017; Richards 2017). And, despite all of the criticisms and fears about social isolation and VR, some researchers attempt to use VR to address issues such as social cognition training, and the very same social isolation that VR seems to invite (Kandalaft et al. 2013; Anderson et al. 2013; Didehbani et al. 2016; Park et al. 2011).

2.3.2 Collocated Physical VR

The basis of isolation within VR is that no other physically collocated[1] person is able to intrude into the game space that the system creates, but this stems from a limited viewpoint that VR can only create technology-sustained games based on its nature. ShareVR, a project created last year, shows that it is entirely possible to create a collocated experience that allows 2 players to share in the world and has the potential to increase the sense of presence for the person within VR if the physical proximity of the other player is made a part of the virtual experience (Gugenheimer et al. 2017). It involved a set-up using multiple projectors, a tracking space on the floor, and mirrored view on the television to project different games along the ground and screens. Some of the games they designed involved having one player lead another using their controller as a simulated flashlight, and having to duel each other with lightsabers, with the player outside of VR using the projections along the ground.

[1] My thesis does not focus on *networked* social VR, so I am not including that in this analysis. However, I would argue that networked social interaction is fundamentally different than physically collocated interaction.

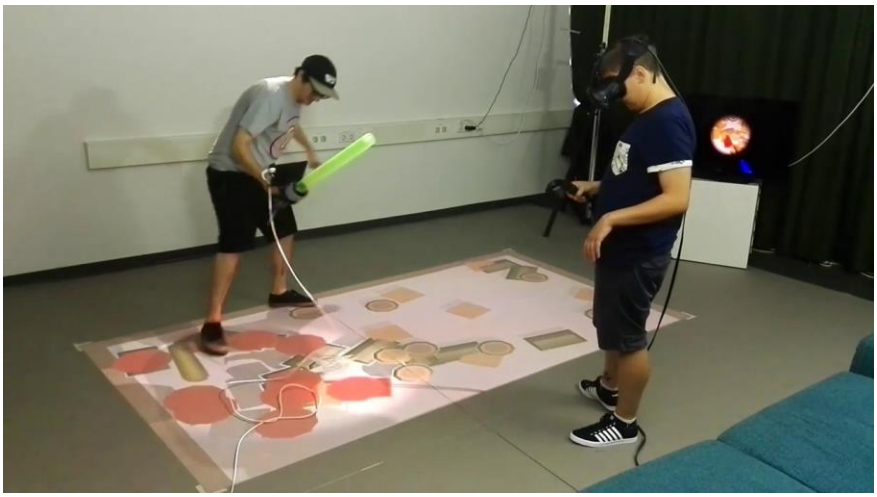

Figure 8: 2 players playing a ShareVR game

However, ShareVR does have the disadvantage of needing more technology than readily available to support the game which, even though it is a technology-supported game rather than a sustained one, means that it is still focused a little too much on the technical aspect of it all. ShareVR takes the traditional VR experience and creates a hybridized reality experience that instead utilizes the advantages of VR's natural affordances that many overlooked in the ideation process. It is valuable to consider that for players in VR, the physical space does not disappear or have to act as an obstacle but can be a valuable resource to create hybridized realms of play that allow for more social play contexts.

Wii Sports proved that you could have a popular simple game that did not require players to learn a series of complex controls and could utilize their basic muscle memory from previous experiences to have a lasting impact on players. Wii Bowling had seniors forming bowling leagues within retirement homes, while Wii Tennis had

people forming large-scale tournaments like the “Wiimbledon” with over 128 competitors, and another tournament in Australia that had the winner competing against professional tennis players (Mao 2007; Shea 2007; Wischnowsky 2007). Wii Tennis only used the motion detection capability, while Wii Bowling only used an additional button to grab and release objects. Part of the drive of developing within VR is to seemingly use everything that it offers, which means all of its convoluted control schemes. My own previous informal user studies on the usability of the HTC Vive showed that users were continually confused by the icons on the buttons, their purpose, and the naming scheme. When developing for VR currently, it seems simplicity might be the best option. Not forcing a player to use all of the controller opens up the design space to more body-controlled interactions, instead focusing on simple physicality as Wii Sports did.

2.3.3 A Hybridized Reality Game

Voida describes the console game as a computational meeting space for social interaction, with porous boundaries, games with varied levels of skill, and support for interpersonal relationships (Voida et al. 2009). I would argue that the same description could be used for VR games. One significant aspect of VR is that developing a collocated physical game naturally creates two settings in which the game is played: asymmetry and mixed-reality. To have more than 1 player using the same VR system for a game implies that everyone else is likely to be playing within the physical reality, using the physical space around them as the context for play rather than the virtual space. This creates both asymmetric gameplay due to the differing goals and nature of

the player within VR, and because some player(s) are outside of VR, also creates a mixed-reality setting.

2.3.4 Performativity

Numerous studies and papers have examined the prosocial effects of arcade games. Some of those have considered arcade play using performative studies, because traditional game studies were seen as contextually inappropriate as Aarseth argued before (Healey and Light 2007; Stein 2013). Performativity in this context is tightly tied to community, social identity, and player interests (Crawford and Rutter 2007; Harper 2010). VR has always had the strength and advantage of being able to attract a crowd and create a more social atmosphere, but it has recently been gaining popularity through another unforeseen route: arcade VR rooms (Stackable 2018). In hindsight, of course, this development should not have been surprising, due to both VR and arcades capacity to draw a crowd. The popularity of VR currently, means that we should establish better ways to interpret how play exists within these bounds and how to design for these experiences.

There is a surprising dearth of research on how performativity in games overall affects the spectator experience. Performativity research has focused on online role playing games and how people establish their online identities or personas, as well as the space of arcade games (Herman et al. 2008; Higgin 2009). There is a strong argument to be made here that the spectator experience is a more valuable design space to consider than ever before, due to the rapidly expanding nature of eSports, Twitch,

and the games industry as a whole. I would further argue that performativity is so heavily intertwined with these areas that it is inescapable to consider when trying to develop for the spectator experience in modern times. Performativity, as a creation of players' self-expressions of their experiences and identity, naturally connects them to their audience members. *Yamove* explored this in a way, through its free form dancing and expression of player identity, which allowed players to adapt to the crowd (Isbister et al. 2016). It is valuable to further explore how to consider this relationship between bystanders and players now more than ever before.

Players naturally lean towards a more performative behavior with an audience, established in multiple studies with a varying age and gender group (Walkerdine 2006; Crawford and Rutler 2007). They will act differently in acknowledgment of being watched, but a game's circle of play actively encourages these performative aspects without anyone else. Behrenshausen's study on performative play within *Dance Dance Revolution* shows that these players take on personas when they play. One participant recalls traditional dance techniques through the game, and begins to naturally integrate these more performative and less efficient movements into his playstyle, while another mentions that she never felt as if she were being railroaded, instead, being given suggestions to express herself in different ways to reach the end-goal (Behrenshausen 2007). There exists something within these digital spaces of play that pushes players to become someone else, to adapt personas and try out different methods to reach their goals. While not all games encourage performativity to the extent that *Dance Dance*

Revolution did, the physical nature of it is a strong contributing factor, one that *Astaire* also makes use of.

Astaire's collocated, physical circle of play leads to interesting questions about how physicality between multiple players affects the overall spectator experience. I suspect that the 2nd player adds a bridge between the VR player and the audience based on performativity. These players not only must keep in mind the manipulations and consequences of the game itself, but also how they manipulate the environment and the consequences in regard to their audience. I attempt to simulate *Yamove*'s flexibility of dance style to allow the players of *Astaire* to dance with each other in a performative way that expresses the intentions and self-identity of both player,s to bolster the connection between the audience and the players, as well as elevate how enjoyable the spectator experience is.

2.3.5 Proxemics

Though the origin of proxemics theory lies in the study of human use of space and how it affects behavior, communication, and social interaction, many modern studies of proxemics with technology focus how people interact with technology in these areas, and not as heavily on how other people interact with each other through technology supported means. The intimate zone, described by Engleberg as a space normally inhabited only by lovers, children, close family members and friends, has been overtaken by how technology relates to people within this space and how the use differs with distance (Engleberg 2014). Proxemic interactions, heralded in 2011 as a new form

of ubiquitous computing, uses this distance between technology and humans as the focal point for study. I would argue that, in the case of *Astaire*, because the interactions and distance between the players are technologically supported, it operates right on the line between the subjects of proxemics and proxemic interactions (Greenberg et al. 2011).

Through the support system that technology creates, I would label this as part of proxemic interactions. This is important because of how popular proxemic interactions as a topic is recently, but how little has been done to tie into this through games and people because of how parallely broad the area is to technology. For example, the intimate distance between the HTC Vive controller in *Astaire* and the players is a core part of what enables the intimate distance between both players themselves as well. The effects of this physical proximity, as mentioned in the introduction, are supported by the proxemic interactions of technology and player. In fact, designing *Astaire* meant that I had to face many of the proxemic interaction design challenges that Marquardt and Greenberg presented: Revealing interaction possibilities, directing actions, establishing connections, providing feedback, and avoiding/correcting for mistakes (Marquardt and Greenberg 2012). While their challenges are designed more for ubicomp proxemic interactions, many of their challenges are universal ones relevant to anyone designing for technology-involved proxemics in general, as they pull from traditional proxemics theory, which is based mostly on human interpersonal interaction principles.

The discussion about proxemics as a whole is valuable because of two recent movements: the trend of games in the past decade or so, showing that there is clear interest in games with embodied movement and interpersonal bodily movement, and the rapid expansion and exploration of multiplayer games. This has resulted in interesting creations related to the area, such as *JS Joust* and *Musical Embrace*, both taking advantage of collocated physical play (Huggard et al. 2013; Wilson 2012). *Johann Sebastian Joust* better known as *JS Joust* utilized the Playstation Move's controllers to sense motion. When the music played slowly, players had to be careful not to jostle their controllers too much, but when it played quickly, players could rush at each other to try to knock other players' controllers around to get them out. *Musical Embrace* has 2 players embracing and applying pressure to a pillow controller using only their torsos to maneuver through the game environment and to their goal.

Figure 9: JS Joust

Figure 10: Musical Embrace

Much like *Musical Embrace*, *Astaire* aims to take any initial social awkwardness that being within each other's intimate zone presents and reduce it to something players can control and even manipulate. The game purposefully has times where you are

encouraged to drop down to the ground however you want, kick high, twirl, and do things you normally are not presented the option to do without social ramifications.

Mueller describes previous proxemics-based games such as *Proxemic Pong*, *Musical Embrace*, *Wardriving*, and *Jelly-Stomp*, but never dives deeper into the human aspect of it (Mueller et al. 2014). People tend to congregate in games, as it as seen in the arcade era, but it is no different now (Braun and Giroux 1989). It is important, here, to study the effects of proxemics and touch on play, enjoyment, and interpersonal relationships because those are fundamental aspects of all online games, regardless of collocation or not. How does the introduction of touch and intimate distance affect player enjoyment and interpersonal relationships within the context of play? Does touch still affect enjoyment as much as it has traditionally in different contexts explored by others in areas like health (Maggie 2000)? *Hotaru* addressed this question in a way, showing that many of their participants display clear signs of improved interpersonal relationship and enjoyment after playing the lightning-bug game (Isbister et al. 2017). It is valuable to further explore the effects of proxemics, especially in the context of a hybridized reality game involving modern VR systems.

Figure 11: Hotaru layout

Chapter 3 Design Process

In this section, I describe the design process used to create *Astaire*. I'll introduce the ideation phase first, then describe the usability test of the HTC Vive afterwards, and finally, the playtests I ran to evaluate overall player enjoyment, spectator experience, and interpersonal relationships.

3.1 Ideation Phase

The ideation phase for developing the game lasted 2 months, due to the nature of the methodology I implemented. I had to first evaluate what players could do with their bodies within this space under the contexts of both the virtual and physical play realms. I also needed to test what the system I chose would allow me to do and how players

interacted with it here. The usability test I ran to evaluate player comfort with the HTC Vive lasted a few weeks and gave valuable direction on what, within the given space, I should use to my advantage in developing the game.

3.1.1 Bodystorming

When I first began designing the game, it was overwhelming to consider the design features I could implement within VR and what affordances I could work with. Everyone participating in the initial ideation phase was unfamiliar with designing for VR as well, leading to initial difficulties on how to create prototypes. The goal here, at the time, was to create a game that would allow both players to take advantage of the realities they were set in and explore the effect that these different perspectives on play would create. We wanted to make a collocated physical game that was a better spectator experience than typical VR games. I needed to first test different concepts to see how VR allowed players to play, which led me to bodystorming instead of trying to develop loosely conceived prototypes over and over until I achieved the interactions that embodied collocated social physical play. Bodystorming is a form of embodied design that pushes designers to create the physical experience in order to establish experiential awareness for when we use the item we are designing (Schleicher et al. 2010). It permits activities that researchers are not familiar with and allows for immediate feedback for any ideas that are generated, all with the stronger understanding of contextual factors like the environment a game is meant to be played within (Oulasvirta et al. 2003). No one person conducted data collection and analysis, so every member was afforded first-hand experience with working in VR. It essentially acted as an equalizer for many of

the people participating in coming up with design ideas, and even those inexperienced with VR quickly adapted to the design method at hand.

There were 6 bodystorming sessions in total, each one recorded and analyzed later to keep in mind the context under which the ideas were created. The initial 3 bodystorming sessions included 5 graduate and undergraduate researchers, most of whom had never used VR before. We used these sessions to play around with the affordances of the headset and the controllers and how we thought players would want to use them. The final 3 bodystorming sessions involved only myself and 2 other researchers. These sessions transformed single player VR games such as AudioShield into a collocated social game to see how we could incorporate multiple people into a single-play ruleset, such as having two players handle a controller each, or having controllers strapped to different body parts.

3.1.2 Bodystorming Sessions for Headset and Controllers

The 1st bodystorming session focused on using established tools within VR to create simulated environments that would act as playgrounds for the VR user. The research question to answer here was how does the headset affect bodily experiences within the physical space. We wanted to see how the tools and headset would inspire players and what they wanted to do; this led to the creation of small games that involved 1 person outside of VR leading the person inside VR through a physical maze using an assortment of props we brought, as well as maneuvering through the simulated space that another person created within VR. We quickly discovered the difficulties of

guiding a person in VR around physical objects as well, but it gave inspiration on other fronts, for example, the simplification of the game mode: outside props could be used, but should be used minimally. Next we experimented with HTC Vive's option of using the headset to actually see the physical world through the small lens attached at the top. We turned this view on and off to create a kind of stilted frame-by-frame tag game. The controllers were attached to the hip of the person with the headset and other players would dodge in and out to try to grab a controller while the person in VR attempted to tag those players. The tension and mounting excitement, as players dodge in and out closer to the player with the controllers, led us to think about proxemics and how collocated VR play naturally encourages their presence in the context of play.

The 1st bodystorming session reminded some people of asymmetric physical games where some players were blindfolded. The comparison was accurate initially due to how we were using the headset, but it posed a question of whether or not this was the design decision that would best make use of VR.

The 2nd and 3rd bodystorming sessions resulted in more creative ideas about how the controllers fit into player perceptions and how they added to gameplay, stemming from the last idea in the 1st session. Understanding the headset required only 1 session because we encountered the idea that many have discovered before: the VR headset is very good at establishing believable simulations. That is why it has been used for serious purposes such as cerebral aneurysm clipping simulations and fire evacuation research (Alaraj et al. 2015; Kinateder et al. 2014). Nonetheless, I wanted to understand the bodily experiences that VR encompasses.

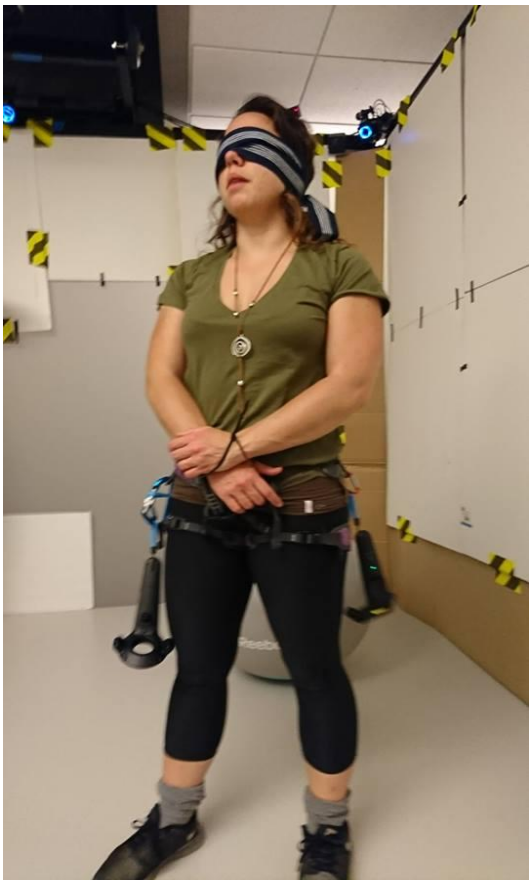

Figure 12: Testing how to manipulate controllers with other body parts

We focused solely on the controllers and how we can interact with them for these next two sessions. The controllers were what enabled the physical movements for our collocated physical game, after all. One variation of the game generated that day involved us blindfolding a person while attaching controllers to their waist and having another player guide them. The rest of the rules we created followed the previous game, in which other players would have to weave in and out to try to snag the controllers, but this time against the cooperation of 2 people. We found for those not playing, it was a more interesting spectator experience to watch people work together and

simultaneously attempt to achieve a singular goal through different means. We altered the game in different ways, giving 2 players separate controllers and having 1 guide per person, or having the person blindfolded try to track another person with controllers strapped to them, and even blindfolding both people with 1 controller each to test how the controller factored into enjoyment. After this bodystorming session, I understood more about how designers and players perceived the controllers as a part of the play experience in and out of VR. The addition of extra players outside of VR led me to also consider how having players who actively recognize that they are being watched affects the performative aspects of their actions. The performativity here, theoretically, should be more noticeable and fluid than if there were only 1 player inside VR who could potentially be unaware that they were being watched.

3.1.3 Bodystorming Sessions using Established Games

For the final 3 bodystorming sessions, a smaller group of us focused on trying to include collocation into traditional single player VR games. The goal here was to use these established rulesets to create interesting body movement between 2 people. We focused our attention on *Audioshield*, which, at the time, was one of the few games that included directed movement for players. *Audioshield* is a fairly simple game, where the main goal is to block colored spheres coming at you with the same colored shield. The spheres follow the low, mid, and high pitched notes from songs you choose and the movements that the simulations evoke seem almost ritualistic. *Audioshield* actually proved itself a strong foundational framework for a collocated socal physical game in that its simplicity allowed us to try a variety of multiplayer scenarios. We experimented

with how it feels to try to tag the notes with other parts of your body using the controllers, or having two players with the VR player shouting out instructions and general locations of notes to the person outside of VR. The iterations demonstrated just how difficult verbal communication was when both players could not see what the other player was seeing.

Figure 13: Mimicking dance-like movements

We also included props again to see if we could test more dynamic concepts, such as tying the controllers to the ends of a plastic rod, and supporting these bodily movements to see if we could make the game more engaging to players. By this point we had discovered that a dance theme would work best for creating a collocated physical game in VR, because this takes advantage of proxemic interactions, but we were unsure of how to design the details, such as why and how we wanted the dance to take place. As shown above, we attempted a version of *Yamove*'s gameplay, where 1 person outside

of VR had to copy the person's movements in VR (Figure 13). The iterations were getting closer to the final prototype for a fun collocated physical game and the sessions had brought up interesting points to consider, especially in how we wanted player movements to relate to each other (Figure 14).

Figure 14: Mirroring a dance-like scenario

The biggest realization I had during our bodystorming sessions with *Audioshield* was that it could have been done with a Wii controller. It did not require a vr system; it was more as if the system was an afterthought to the gameplay here. While that is not a critical fault, it was not enough to just have these gestures. The 2 biggest differences between the Wii and VR systems are the headsets and the space available for play. *Audioshield* utilized the same level of space that the Wii would use for its games, not really the environment that truly set VR apart from other modern entertainment technologies. I began to think about how to make 2 people really move within that space and utilize this hybridized realm to its advantage, which, according to proxemics

and the effects of physical play, could elevate overall enjoyment of games from both a spectator and player point of view. However, before I moved on to the 1st working prototype, I needed to consider what other affordances of VR were worth using and what were too needlessly cumbersome.

3.2 Usability Tests of the HTC Vive

3.2.1 Study Design

This section recounts and elaborates upon tests done to explore the hypothesis "The HTC Vive's hardware and UI are not fluid or intuitive to use." I looked at various reasons why users might feel that the HTC Vive was or was not accessible to people who have not used a virtual reality (VR) headset before. Various questions were asked of the users, ranging from questions about the responsiveness of the system, to questions about preferred methods of movement. After presenting analysis of the data, I will discuss implications for the design of my game.

The process to test my hypothesis consisted of 2 parts: think-aloud walkthroughs, and a survey questionnaire afterwards. All users were given a task for the think-aloud walkthrough. They had to turn on SteamVR from steam, move around physically and using the teleportation function for 1 minute, and then click Google Tilt Brush VR in the HTC Vive homeroom in VR. For each person, I gave instructions as they finished a part of the task, so if they turned on SteamVR, I would ask them to start moving around. I expected people to take around 3 minutes for this task, give or take 15 seconds. As an example, my own time for this task as someone who's experienced with VR was

1 minute and 28 seconds. The survey consisted of multiple questions, from “The HTC Vive’s UI was intuitive and fluid to use”, to “I preferred teleporting to move around in virtual reality”. Most of the questions had short answer follow-ups, such as “Of the two methods of movement mentioned above, which did you prefer more and why?” 5 users were recruited for the walkthrough and the questionnaire. 3 of those users identified as male, and 2 of them identified as female. Almost all of them were of ages 23-24 except for one male outlier who was age 34. All of them belonged to fields that commonly used technology and computer science, with a split of 2 computer science majors, 1 computational media major, and 2 bioinformatics majors. Wearing glasses was a physical quality that I believe affected their experience of the HTC Vive, which was noted but not asked about. Each participant had no other conditions that would affect their walkthrough of the VR headset, such as being prone to dizziness or motion-sickness. Also, all the users were completely unfamiliar with any VR headsets, including the Oculus Rift, Playstation VR, etc., and the walkthrough would have been their first VR experience.

Due to previous brief literature review, it was expected that teleportation was the favored movement compared to physical movement. Studies showed that this form of locomotion within the virtual space resulted in jarring transitions (Yao et al. 2014). The users overall had stronger positive opinions towards teleportation, while they were more neutral towards physically moving around. The fact that users did not negatively view physical movement showed that dancing was possible, if awkward at first.

3.2.2 Quantitative Analysis

Next, let's consider the amount of time that it took to complete the tasks (Table 1). This averaged out to be around 313.6 seconds, with a standard deviation of 110 seconds. Due to the small number of participants (n = 5), I used a one sample t-test to discover a 95% confidence interval of 176.95 seconds to 450.25 seconds, with the true population mean residing somewhere in that interval. I am unable to safely reject my hypothesis that the HTC Vive is unwieldy and confusing to use as it still falls between that range. However, the hypothesized amount of time resides close enough to the extremes of this interval, that I felt it was apt here to assume that even if I could not reject the hypothesis, it was enough to assume that the usability is worse than I considered, which would affect what features I implemented in the game. Where the literature review brought up the idea of simplicity being key when it comes to movement and gestures, the usability review established that to make *Astaire* a broadly satisfying game to play, I would need to focus on more minimalistic features.

Table 1: Time it took to complete the task

Players	*Times*
Player 1	339 s
Player 2	464 s
Player 3	354 s
Player 4	215 s
Player 5	196 s

Table 1: Players total times to complete task

3.2.3 Qualitative Analysis

Almost all participants mentioned the controllers as being the most clunky part of the setup. There was only one answer that abstained from mentioning the controllers. The

most interesting part of all this was that I had only asked for one piece of hardware that needed to be changed, but 2 participants felt the need to address that either the controllers or the headset also needed to be adjusted. All participants who mentioned that the headset needed to be changed wore glasses, though 1 of them did not mention that the headset should be more glasses friendly.

Almost all participants who mentioned the controllers had issues with the buttons, mostly because of how unintuitive it all was. A sample quote: “The buttons and controls on the controller confused me, because I couldn’t work out what the conventions were for interacting with things.” I compared the buttons on the HTC Vive to typical buttons across multiple generations of game controllers to see if the icons resembled anything done previously. However, there were no matches, indicating that very little technological literacy could have informed a user which button was the button to turn the controllers on. Every time a participant turned on the Vive, the headset would automatically turn on, and there was good feedback of that event, as you would be able to see through the headset into VR. However, it was apparent that Steam did not give sufficient feedback that the controllers were on, because although players could not see the controllers in VR, they assumed it was part of how the UI was intended to be. A content analysis of all the videos gave me the information I needed to confidently say that the portions that resulted in the longest time on task for players, had to do with realizing that their controllers were on. One player even abandoned a second controller because the first was already turned on and they assumed that was enough.

The think-aloud walkthroughs also brought to light one more glaring issue that the HTC Vive had that players did not mention: the wire attached to the headset. Players were stepping on it, or nudging it accidentally and adjusting how they moved because of that quite often. This was a small enough event that players did not notice, and the headset's/controller's problems overshadowed this. Simple actions, such as walking around the room, were made much more difficult with the presence of the wire. Once a player had stepped on it or felt it in any way, the issue was always in the back of their minds, and they were much more hesitant in maneuvering around the space.

3.2.4 Discussion

Using both quantitative and qualitative methods, I observed that people find the HTC Vive experience overall to be problematic. The think-aloud walkthroughs and surveys revealed a plethora of small issues that arose. At first glance, it seems as if the system was intricately designed enough to provide users with a satisfactory experience, due to the availability of different types of locomotion, the cameras to detect more subtle movements using the controllers, and the adjustable headset. However, it became clear that newcomers to VR had no idea how the controllers were supposed to function, or disliked the headset for how rigid it was. Many of them felt that the hardware and UI were responsive to their actions, but actually engaging in those actions was difficult due to buttons or precision.

The usability tests were valuable in establishing what parts of the HTC Vive could be used as an intuitive part of the gameplay experience. They supported my initial

intuition that the Vive would be too difficult for many players to use if I included too many input options with movement focused gameplay. As of 2017, only 11% of all households own a VR device, which necessitates an onboarding process, one that would take much longer if I had players attempt to use all of the controller's features (Entertainment Association, 2017). The wire was also a potential issue, but less of one if you had a player act as a 'guide' in the physical reality for the player in the virtual one. I had a prototype in mind afterwards, using the data collected from both the usability tests and the bodystorming sessions.

3.3 Prototypes

There were 2 major prototypes I attempted before settling on developing the final version of the game. Each prototype had movement centralized around different limbs, as well as different ways for players to interact with one another. The goal for the prototypes was to create an asymmetrical collocated physical play experience that gave both players agency and a sense of control over their interactions. I wanted players to feel as if they both took equal part in crafting the play experience for themselves, and not as if they were just there as extras put in for the sake of collocation.

3.3.1 First Prototype

I designed the first prototype as a more directed experience in which I initially thought that both players would have equal control. I created a basic environment that contained a platform and 4 colored pillars for reference for the players. The pillars were designed as landmarks that would support the limited verbal communication that players could

utilize here. The player outside of VR could mention that there was a sphere closer to the green pillar and the player within VR would immediately understand. Both players shared a scoreboard and they would have to move around the space and touch the balls that appear with their controllers for points. The longer it took to touch, the lower the score both players would receive for touching it. The balls appeared in time to the music and appeared in a fashion that would force the players to traverse the whole room and react quickly. The player wearing the VR headset would have controllers attached to their shoulders that would detect when they touched a ball. Each controller was only allowed to touch a certain kind of object, and they were color coded so the concept was easily understood by looking at the controller color vs the object color. The original intention was to simulate the feel of a conga line so that the person outside of VR could direct the person inside VR to a limited degree.

The player outside of VR had a camera attached to the headset's view in-game. It was displayed on the television screen so the player outside of VR could see it whenever they needed to. The notes, through that point of view, would appear 2 seconds earlier than they would to the view of the person within VR. The field of view for the headset was also purposefully reduced in order to create a need for the other person to guide them quickly to locations to grab the points.

Figure 15: First prototype

An internal playtest of this prototype showed that players had fun, but much of the agency was lost for the player within VR. Due to how early the notes appeared and the attention directed at the screen, physical reality players would grab the shoulders where the controllers were and drag the other player into the correct position. The person within VR became a glorified note detector and seemed to be helpless without the other person, scoring much lower if they did not receive instructions. It had the pull, but lacked the push for the push-and-pull style of gameplay that would be more interesting. The effects of touch such as increased affection and positivity were lost on the player outside of VR, as they were never touched by the other player (Fisher et al. 2017; Knapp

et al. 2013). Touch, here, was used too often to give information and direct, and not enough to communicate excitement or worry (Henley 1977).

It slowly became clear that I had focused too much on movement and the proxemic interactions without considering the balance of asymmetric gameplay. The previous bodystorming sessions focused on creating a collocated social physical game using VR, but prototyping demonstrated the need to consider player roles within the gameplay and how these movements and interactions affected them. The asymmetric gameplay needed to have both players enjoying the experience to really take advantage of the affordances of VR and the positive effects from theories such as performativity. In this case, it meant that I needed to give the players in VR more agency.

Despite the imbalance of player enjoyment, the first prototype succeeded in a few areas. It demonstrated that players could enjoy moving around in a frantic manner and were learning about each other's physical habits in that same time. What I tried here was a only a small facet of dancing, and it was evident that I had to narrow the focus more on couple dancing to really encourage equal participation. Dance is about the community and this first prototype showed that the concept was capable of looking past the daily inhibition of interpersonal communication and the activity approaches 'exstasis,' in which both members of the dance are delicately balanced with one another (Shoupe 2001).

3.3.2 Second Prototype

The second prototype kept many of the features of the 1st prototype, except for a few adjustments. The biggest change was to how the controllers were placed on the players. Now, the controllers were strapped to different parts of the body to encourage both players to lead each other instead. 1 controller was strapped to the ankle of the player outside of VR, while the player inside VR had the 2nd controller strapped to their wrist. In this iteration, spheres were lower to the ground for the player outside of VR to sweep their leg across to tag them. Due to the lack of direct visual information that the physical reality player had, the hitboxes were adjusted on those notes to be larger than how they looked, so that it required less accuracy to touch one of the spheres. The balls were more spread out here, because of the wider range of actions allowed to achieve the goal of touching them. In the 1st iteration, players generally had to shimmy their way to a point and use their shoulders to bump into the spheres, but as of the 2nd iteration, it was not unexpected for some players to have to kick in the air, or throw back their arm to tag them.

Another large change was how the camera was oriented for the player outside VR. Before, the camera was attached to the headset of the player within VR and displayed to the television set so that spectators and other players could see it. Then, the field of view was reduced for the player inside VR. Now, those players had an overhead camera, displaying the platform and pillars while also showing the notes that appeared. However, because the camera really only showed what seemed like a flat representation of the area, the player could not determine the height of the note, and so it was up to them to direct players inside VR to the general location but then pull back and let

themselves be guided. This included notes that only their controllers could touch. The player outside of VR also had reduced foresight time of notes, given only 1 second to notice when notes appeared. When either player touched a sphere with their controller, the controller would rumble and emit a small chime to let them know that they successfully tagged a point.

I ran another internal playtest to understand how people would arrange themselves around this new configuration of controllers. Players naturally drifted towards holding each other around the shoulders and waist, as shown below, during the 2nd half of the game when they both realized that verbal communication proved to be of little benefit.

Figure 16: 2nd prototype with more finalized controller layout

The result was a much more balanced experience that had equal participation from both players. There was a visible, frantic tension that had players bouncing back and forth

from area to area to try to achieve a higher score, but I noticed that the structure of the game was too wild. The notes did not appear in the style of a dance, but to the beats of the music. I spaced them out initially to push players to move around the whole room, and it seemed to succeed in creating a lively, movement based game, but lacked some of the spectator experience I wanted to provide. There was valuable feedback afterwards, with the reported main issues being the lack of visibility on the notes, satisfying reactions to having successfully touched a note, and structured dance movements.

3.4 Final Version

The final version of *Astaire* kept many of the features that the 2nd prototype had. The configuration of the controllers, position of the overhead camera, foresight timing, and goals of the game did not change. However, I rearranged the notes to follow certain dance styles, incorporating 2 in particular: line dancing and the can-can. The current version of the game starts off with a line dance segment and eventually transitions into the can-can after 2 minutes. The simplicity of line dancing made it a perfect choice to create a smooth onboarding experience for new players. It allowed me to utilize a smaller portion of the room, creating musical notes (Figure 3) along a 2 x 1 matrix line pattern, with 3 set variations of heights. This also maintained both players' need for the other person. Players outside of VR could spot notes spawning far behind the player within VR and would have to direct them backwards. The consistent spawn points allowed the player within VR to eventually fall into a certain rhythm that would still

need the other player for some initial guidance, but created basic movements that resembled 2 people dancing. Eventually, the line dance begins to only produce notes close to the ground that looked distinct from the notes that the player within VR had to touch for points. These notes are more distinctly visible with brighter visual effects due to their spawn position being lower than the VR player's usual line of sight. This separately introduced the mechanic that the player outside of VR needed to step along to tag these points, using the VR player's guidance.

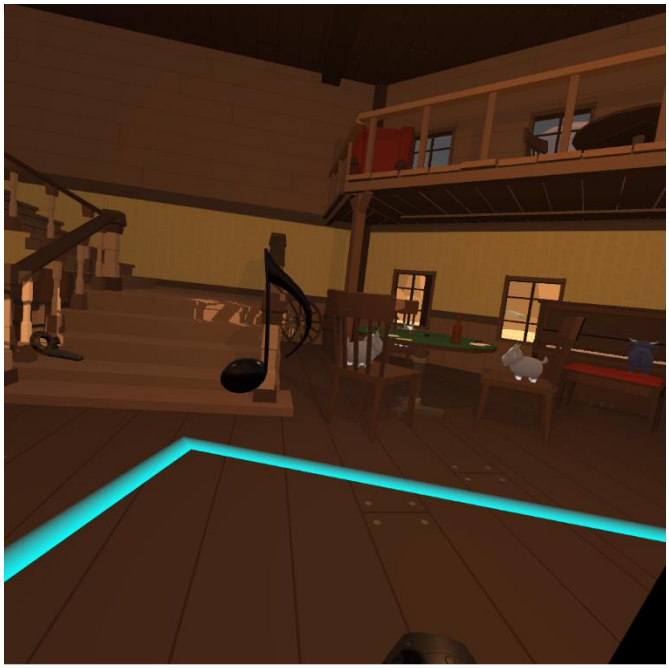

Figure 3

Whereas the line dance was used for an easier onboarding experience that would push players to traverse along the room across simple paths, the can-can was far more restrained in the area that players would move within. Instead, I focused on increasing

the diversity and freedom of actions that players could take while moving from one point to another. All of these efforts were to convert the more technologically-sustained gameplay of line dancing into something more free-form, or technologically supported play. This segment of the game retained typical movements expected of can-can dancers, such as waist-high kicks and flamboyant arm extensions. However, the version of these movements depended heavily on how the players positioned themselves, which resulted in more eclectic dance patterns and movements. The can-can segment focused on mixing notes within VR and outside of VR, pushing towards a chaotic and frantic style of play that would commonly result in a high intensity back-and-forth with players swinging each other around to face notes.

Figure 17: Players twisting in can can segment

Figure 18: Score HUD and can can walls

It also introduced the concept of obstacles, which came in the form of expansive walls, textured to clearly appear as something players should avoid. I added obstacles

here because it provided players with the freedom of how to dodge. Each obstacle could only be spotted by certain players; VR players could see reasonably tall, chest-level walls while physical reality players would see those same walls but at a much lower height as well as full-body walls that took up the left half and right half of the play space accordingly. This led to a large range of different motions with some VR players attempting to limbo under walls while others dropped to the floor completely. Physical reality players leapt over obstacles or even simply raised the leg with the controller attached upwards. The diversity of movements resulted in a self-defined player enjoyment. As results would later show, many players actually found enjoyment in a player established competition, in which both players would chaotically try to outdo one another, creating numerous situations where players inside VR would fall from the amount of within VR and physical reality manipulations.

Figure 19: Can can failed

3.4.1 Setting and Visuals

I redesigned all of the models and textures for the environment and objects according to the moods I wanted to establish: messy, chaotic, and fun. I converted the prototype's original platform map with 4 colored pillars into a saloon filled with small animals. The saloon not only captures all of these feelings, but also strongly resonates with the song choices of line-dancing and the can-can. The game takes place in the center of the saloon with no obstacles in the way, but with a clear view of the environment.

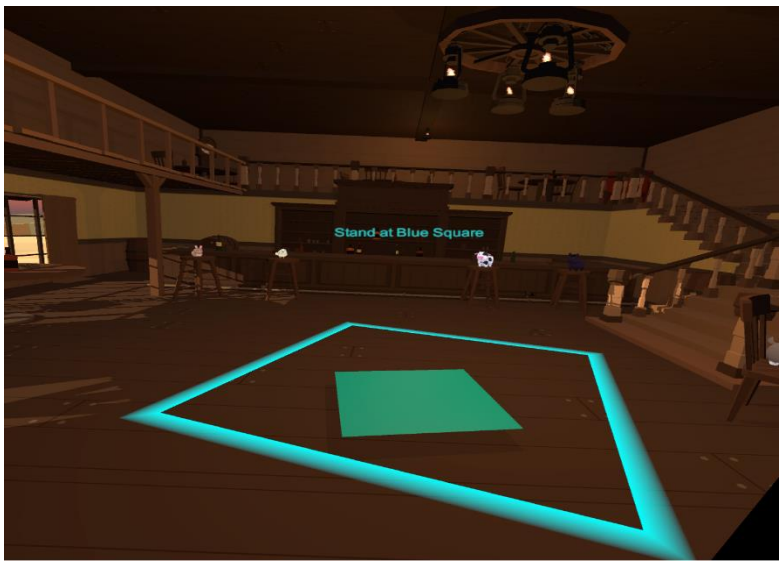

Figure 20: Initial view of the saloon when loaded in

I added another system within the game that deducted player points if the controllers strayed too far from each other as well, to ensure different variations of physical contact. Most players chose to hold shoulders and wrists in a 'ballroom-esque' style to give better control over movements. Points are consistently shown at the bottom left view of the person within VR once the game begins (Figure 19).

Visual effects were altered to be more noticeable, with the spheres for one player displaying glowing, shrinking halos that visually represented the remaining time before it despawned (Figure 22). The musical notes had wisps of color flying around their general area because of the variability of their spawn points compared to the spheres. On the overhead map, rainbow colors were chosen to clearly differentiate the notes from the environment and allow players to quickly determine where to move (Figure 2).

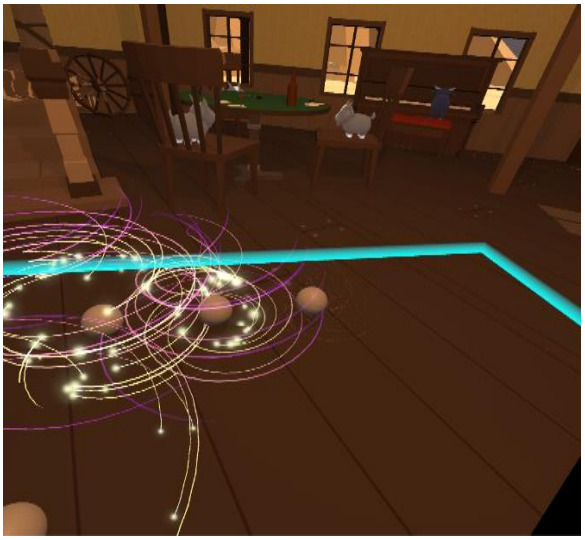

Figure 21: Shrinking halos

The haptic vibrations from controllers for successfully obtained notes were increased due to previous feedback of lacking noticeable consequences. I chose only to use vibrations here because auditory feedback had the potential to obstruct players who were using the music to try to predict note spawns. Previous prototypes used Unity's in-built haptic feedback, but had to be strengthened with each iteration. Though the players inside VR could feel the vibrations against their wrists or hands, players outside

of VR could not feel it against their ankles or legs, especially those not wearing shorts. In the end, I set the haptic feedback to max and even this was barely passing my minimum expectations for feedback.

Chapter 4 Study Section

The overall goal for this game was to create a collocated social, physical experience because of the potential positive benefits this design context provides for relationships, general enjoyment of the game, and the spectator experience. I tested 3 hypotheses, comparing *Astaire* to a popular mixed reality game, *Keep Talking and Nobody Explodes (KTNE)*, and the VR game that inspired *Astaire*, *Audioshield*. *KTNE* was chosen due to its background as one of the few existing hybridized reality games using a VR system and the more widespread popularity it had. If *Astaire* could prove to be a more enjoyable experience that also better improved interpersonal relationships than *KTNE*, it would be an enormous achievement. The 3 hypotheses are listed below:

1. *Astaire* is a more enjoyable play experience than either *KTNE* or *Audioshield* are.

2. *Astaire* is a better spectator experience than either *KTNE* or *Audioshield are*.

3. *Astaire* is better at forming interpersonal relationships between spectators/players and players/players than either *KTNE* or *Audioshield* are.

4.1 Procedure

I ran a total of 5 sessions of user studies for the final build to evaluate the hypotheses listed above. For each session, I had 3 people participate as a part of the experience: the spectator, the player outside VR, and the player within VR. For *Audioshield*, I also had the player outside of VR take the spectator role in a second round of play. Each participant was given information about the length and components of the overall test, as well as a survey before the session started. They were all told to expect 1 hour of testing, with 3 games being tested. At the end of each game, they would answer 2-3 short surveys depending on their roles in gameplay (spectator, VR player, non-VR player), and undergo a brief interview to elaborate on their answers as well as get their overall reactions about the playtests. After I set expectations for the user study, I asked each participant to fill out an initial Inclusion of Self (IOS) scale that would help ascertain starting perceptions of relationships among the participants. The IOS scale was designed to measure the structure of interpersonal closeness, ideal for my attempts to measure how the various games affected participants' subtle relationship shifts during the session (Aron et al. 1992). The IOS scale was later validated to be replicable and significantly positively correlated with other measures of relationship closeness

(Simon et al. 2015), and has been used in other social game research (Isbister et al. 2017).

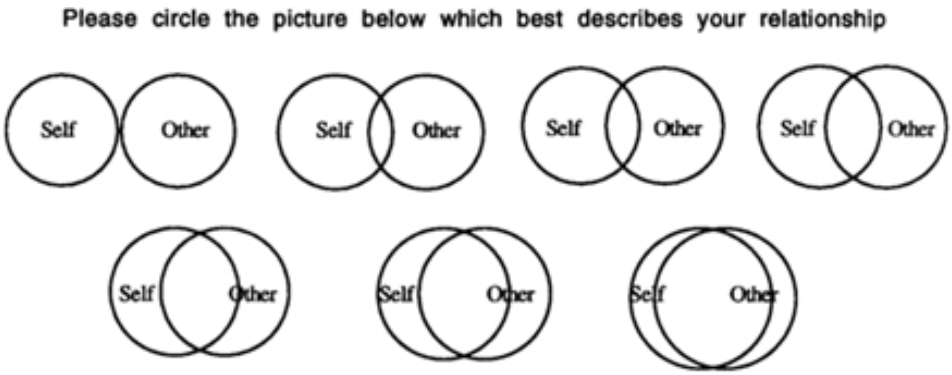

Figure 22: Inclusion of Self in Other scale

Each participant completed the survey in separate locations, so as to not affect their decisions on what picture to circle. They were told explicitly to not share or reveal the choices they selected so that they did not bias any of the other participants.

I wanted to determine how close spectators felt towards the players overall, and whether player interactions elevated how connected the spectators felt to the players. Due to this, the spectators filled out 1 of these scales initially for the pair of players. The players, instead, filled out these scales for their partner. All participants were given the same instructions on how to fill out the scale and what 'Self' and 'Other' designated under the circumstances, so that none of them misinterpreted the scale.

After they finished the initial survey, each group of participants were given a randomly selected game to play (*KTNE*, *Astaire*, or *Audioshield*) to reduce carryover bias. It was necessary to ensure that any interpersonal relationship changes were not

due to an amalgamation of the effects of playing or spectating all the games. Following each game, participants were given the IOS scale again as well as the self-assessment manikin (SAM) survey.

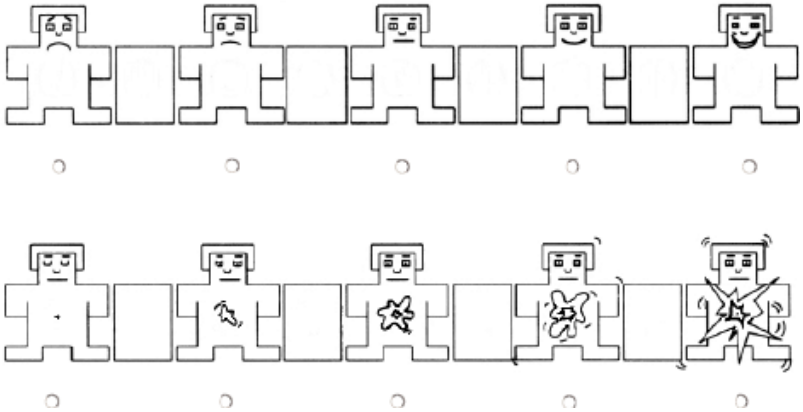

Figure 23: Self-assessment manikin survey

SAM is used to measure emotion, which in this case, signified unhappy to happy feelings from the top line and bored to excited emotions on the bottom line. Both of these ranges and the survey itself were taken from the results of its original study (Bradley and Lang 1994). I chose not to use the last line of SAM, because it is focused on dominance, which was not a concept I was interested in for the research. I was confident using SAM because it has been validated to be an effective tool in recognizing emotions along valence and arousal dimensions (Handayani et al 2015).

After the surveys were completed, participants were asked semi-structured interview questions, with some questions generated in the moment to follow up about certain reactions or actions observed during their gameplay. For the IOS scale, I determined that I must use the following questions regardless of the scenario:

- Can you elaborate on any change in relationship? What caused this?
- (If participants answered no change) Can you elaborate on why this is the case?

For the SAM survey, a question was developed to uncover which aspects of the game caused players to feel bored/excited or unhappy/happy. This question was used for every interview to further elucidate the qualities of each game that informed participant answers on the SAM survey.

- Can you elaborate on what aspects of the game made you feel _____?

Players were also asked to fill out a short online survey afterwards that consisted of adapted questions from Agarwal and Karahanna's cognitive absorption paper (Agarwal and Karahanna 2000). While originally intended for information technology usage, many have adapted the questions for games and play as well (Jennett et al 2008; Qin et al 2008; Hsu and Lu 2004). The purpose of this survey was to determine player enjoyment, so I adapted a few questions from the heightened enjoyment section of the cognitive absorption paper. I chose only a select few questions because of my smaller sample size and qualitative nature of the study. Each question utilized a 5-point likert scale from Strongly Disagree to Strongly Agree.

- I had fun playing this game
- Playing this game provided me with a lot of enjoyment

Finally, I recorded each playtest with their permission under the conditions specified by the IRB exemption to conduct content analysis on them afterwards and destroy the videos once I obtained the necessary information.

4.2 Results

The coding from the interview answers as well as the numerous likert-scale questions used within the tests called for a mixed methods approach to analysis.. Due to the diverse number of roles and methods used here, I will split the results section into smaller subsections composed of spectators and players, as well as the analysis methods used for each. 15 participants were recruited for this user test, 8 female and 7 male, all between the ages of 24 and 30. Those 15 participants were recruited in groups of 3, so there was always 1 person for each role. Each of those participants had little to no VR experience but all regularly used and engaged with technology either through work or entertainment.

4.2.1 Player Results for Inclusion of Self in Other (IOS)

For this section, I will be addressing the player results, leading with the quantitative analysis to demonstrate that there might be a significant result worth exploring further, and concluding with the qualitative analysis for a deeper dive. The overall goal for IOS here was to examine hypothesis number 3 from player/player relationships: ***Astaire* is better at forming interpersonal relationships between spectators/players and players/players than either *KTNE* or *Audioshield* are**.

10 participants out of the 15 acted within player roles, and out of those 10, 6 were male and 4 were female. I looked at the differences in player answers for the IOS scale before the session started, for KTNE, and for *Astaire*. Because *Audioshield* is single player, I had 2 spectators and the player within VR could not fill out an IOS scale without a partner, so I excluded the game out of my IOS scale analyses for players. A non-parametric Friedman's test of differences among repeated measures was conducted and rendered a χ^2 value of 8.75, which was significant ($p < 0.05$). A sum of the ranks for each section seemed significant at first glance as well, with *Astaire* having a sum of 28 compared to *KTNE* and pre-test rank sums of 16 each. I can conclude here with confidence that the observed differences among the mean rankings for all 3 IOS scales taken reflect more than just random variability or coincidence. This result suggests that there is something further to be discussed and analyzed within *Astaire* that seems to be leading to increased interpersonal closeness among players.

Table 2.1 Friedman's test for IOS

Table 2

The comparison of IOS values for pre-test, KTNE, and Astaire using a Friedman's test.

	n	χ^2	*P*
Initial vs KTNE vs Astaire	10	8.75	0.0126

Looking at players' freeform responses, 7 out of the 10 players responded that the

physicality of *Astaire* made it stand out for increasing interpersonal relationships in a comparison among all 3 games. One player mentioned, "There's something really there for [*Astaire*] that isn't really in the other two games? For *Keep Talking and Nobody Explodes*, it was always really stressful and I never really knew what the other person wanted, but here, it's, like, if the other player really wanted to do something, you'd know immediately. I mean, it doesn't mean that you'll succeed, but at least you're failing on the same page!" This is supported through content analysis of some of the recordings as there were noticeable tensions and confusion for a few sessions for *Keep Talking and Nobody Explodes*. It was harder for both players to work together and be focused on the same objective when language can be so poorly utilized. This was further represented with another player's quote, "It actually felt like dancing instead of what other dance games usually make you do! There were moments when we're both leading and we know what the other person wants to do and it feels awkward and silly, kinda like if you were at your first winter formal." Pairs of people spoke up about the physicality in the game, but there was one pair that disagreed, with one person thinking that *Astaire* did a better job because of the physical communication and the other mentioning that they felt that *KTNE* did a better job at making him feel like they were a part of a team, regardless of how you had to communicate.

Balance also showed up fairly often, with 4 out of 10 players reporting that they really appreciated having a mixture of equal responsibilities in *Astaire*. Feeling like equals within a game provided those players with a more positive and confident view of their interpersonal relationship afterwards. In *KTNE*, not many of the people outside

of VR felt like they had much control or that the person controlling the bomb felt like they were too dependent on the skill of the person outside of VR: "[My partner] was really bad at giving me the right directions to defuse the bomb so we lost way faster than we should have. It probably made me more annoyed at him afterwards than it should have." Oddly enough, *Astaire* had the same dependence on skill, as players outside of VR were fairly dependent on the VR players to guide them towards the correct locations. The difference in both games, however, comes down to how easily the information is conveyed, and most likely individual scoring, but I was not able to pursue this route of questioning.

Other responses to questions about IOS answers were more vague, with players who put unchanging results from *KTNE* and *Astaire* remarking that they felt that each game addressed teamwork and relationships in different ways. *KTNE* seemed to really stress the more conceptual and theoretical challenges that had players working together in a high intensity situation while *Astaire* drove players to understand each other in a new way that does not happen often. Both had goals and objectives that challenged them and promoted teamwork in different but equal ways. One person who marked improvements in interpersonal relationships only said that, "[*Astaire*] seemed designed to make players like each other more afterwards." *Astaire* had no lower scores in IOS compared to *KTNE*, but 4 out of 10 players put the same IOS ranks for both games.

4.2.2 Player Results for Self-Assessment Manikin (SAM)

The layout for this section will be the same as the IOS section, leading with quantitative and concluding with qualitative. Due to SAM's multiple sections, I will address the enjoyment results first and then the excitement results. For SAM, we tested hypothesis 1 for players: ***Astaire* is a more enjoyable play experience than either *KTNE* or *Audioshield* are.**

A non-parametric Friedman's test of differences among repeated measures showed, this time, a χ^2 value of 4.9, not significant under typical parameters ($p > 0.05$) but significant under broader terms ($p < 0.1$) for player enjoyment comparison of *Astaire* vs the other two. With a higher sample size, I feel confident that this would have shown *Astaire* to have demonstrated itself more enjoyable than both *KTNE* and *Audioshield*. SAM survey results were trickier to evaluate due to the varying number of people playing a game and how participants were split. Only those within VR could properly evaluate how much enjoyment and excitement they were receiving from each game because they were the only players to be able to play all 3 games. Players outside of VR were excluded from playing *Audioshield*. With this, the size for each group for another Friedman's test was reduced to 5 each.

Table 2.2 Friedman's test for player enjoyment

Table 2

The comparison of player enjoyment scores for all 3 games.

	n	χ^2	*P*
Audioshield vs KTNE vs Astaire	5	4.9	0.0615

Comparing all 10 players of *KTNE* to *Astaire* showed more significant results. I chose not to run a Wilcoxon signed-rank test here because the data comes from small Likert-like scales, which would necessitate discarding many paired results because they were the same. A paired *t*-test was instead run to show if there were any differences in enjoyment and excitement between playing *Astaire* and *KTNE*. There was a significant difference in the scores for *KTNE* (M = 3.4, SD = 1.07) and *Astaire* (M = 4.3, SD = 0.48) in terms of enjoyment. There was a mean difference of 0.9 with a confidence interval of 0.04 to 1.76, the lowest number clearly showing that there's still an improvement. The results were significant, ($p < 0.05$) with a p-value of 0.041.

Table 2.3 Paired *t*-test for enjoyment

Table 3

The comparison of SAM scores for enjoyment for Astaire and KTNE

Source	*n*	*M*	*SD*	*P*

Astaire	10	4.3	0.48	
KTNE	10	3.4	1.07	
Comparison				0.041

For excitement, the results were more ambiguous. There was not a significant difference in the excitement scores for *KTNE* (M = 3.6, SD = 1.07) and *Astaire* (M = 4.2, SD = 0.49). There was a calculated mean difference of 0.6 with a confidence interval of -0.30 to 1.50, and the results were not significant ($p > 0.05$) with a p value of 0.1679. The interview answers later provided insight as to why there might not be a measurable difference for excitement beyond the lower sample size used.

Table 2.4 Paired *t*-test for excitement

Table 4

The comparison of SAM scores for excitement for Astaire and KTNE

Source	*n*	*M*	*SD*	*P*
Astaire	10	4.2	0.49	
KTNE	10	3.6	1.07	

Comparison				0.1679

After asking players, “Can you elaborate on the changes or lack thereof in your SAM scores?” players gave their responses. The enjoyment in SAM was affected by a different version of ***physicality***, more in tune with the physical world, which 5 out of 10 players felt. Essentially, they seemed to respond to being able to physically interact with others One player said, “I don’t usually get motion sickness from VR games but there [was] something about touching and turning the bomb in *Keep Talking and Nobody Explodes* that made me feel sick. There was no substance to it.” Another mentioned that, “It’s weird to say but it doesn’t feel like many VR games really make you move around the whole room that often.”

Playing with others was a central point that 6 out of 10 players mentioned. Surprisingly, despite the teamwork present in *KTNE*, some players were quick to mention that it felt like it was almost too cooperative in a way where their success relied on the ability of others too much. Playing with others meant that they also wanted a little competition, or a way to really interact with their partners taking different approaches. 3 of the 5 players who played *Audioshield* mentioned that they actually missed having someone to play with, either in the interview following *Astaire* or the interview following *Audioshield* depending on the order they played the games in. Unusually enough, 1 of those *Audioshield* players mentioned the lack of a 2nd player even though their enjoyment score did not change.

Mood was the final point that came up consistently in the interviews. 4 out of 10 players said that the feeling, song choice, and environment of the game created a scenario where they felt they could really do anything to achieve their goals. This was actually reflected in *Audioshield* as well, where I used the same song (Offenbach Can-Can) for consistency. After all the interviews, one person mentioned, "The song choice was amazing for the game." The ridiculous energy of the game encouraged people to try out new ways of reaching points that I did not even consider.

One aspect that seemed to really detract from *Astaire*'s experience was the wire from the back of the headset. A player said, "Once she almost tripped over the wire, I started to think about that more and I was more sensitive to whenever the wire even came close to our feet. It was stuck on my mind the whole time." 2 groups had struggled with the wire during *Astaire*, getting tangled during the end section of the line dance segment of the game. This matched the results from the usability test, one that was not possible to address due to the hardware constraints of the HTC Vive.

4.2.3 Spectator Results for IOS

Due to the lower number of participants, the data from a quantitative analysis on 5 spectators across repeated measures provides was too weak to evaluate, so I focused purely on the qualitative side, but note some of the trends. For IOS ranks, *Astaire* always managed to improve scores from their initial values and only ever tied in score with both *Audioshield* and *KTNE* once. Otherwise, the scores were all improvements over the other two games. The IOS scale was used to prove hypothesis 3 as well, but

for spectator/player relationships: ***Astaire* is better at forming interpersonal relationships between spectators/players and players/players than either *KTNE* or *Audioshield* are**.

The interviews showed 2 central points that came up more than once for why *Astaire* was potentially more effective at developing interpersonal relationships than the other games. 4 out of 5 spectators mentioned that **increased sense of participation** was a major factor. One spectator said "Even though I wasn't playing, it didn't feel like I was just watching either." It seemed as though for many of the spectators, being able to see what was going on through the overhead map on the television set and talking with a player who could converse with them and react had a strong impact on how close they felt to the duo who played the game. They could direct from the crowd view, exclaiming if they thought the player outside of VR was leading the other player incorrectly. For those who ranked *KTNE* as an ineffective way of advancing interpersonal relationships, they discussed not understanding what was happening because they could not see the bomb and also slightly frustrated whenever communication went poorly. One spectator commented, "If I wanted to see 2 grown men fail this spectacularly so often, I would have just stayed at work…"

The 2nd focus for higher IOS scores seemed to come from **the player outside of VR**. This is an important distinction to make aside from just participation; 3 out of 5 of the spectators really felt closer being able to enjoy the game on a similar level to the player outside of VR. This was notably missing from both of the other games. A spectator made an off-handed remark at the end of the user test to one of the players,

"It was really funny when you guys were late in grabbing that one point and you were trying to rush left while I was screaming for you to get the one on the right and [the player in VR] got really confused."

4.2.4 Spectator Results for SAM

Spectator results were also too few in number to conduct meaningful quantitative analysis on so I focused on qualitative here as well. For SAM values, *Astaire* showed itself to be as more or as consistently an enjoyable and exciting spectator experience as *KTNE* and *Audioshield* were. The hypothesis being tested here was the 2nd: ***Astaire* is a better spectator experience than either *KTNE* or *Audioshield are*.**

Spectators seemed to interpret SAM's excitement as a part of enjoyment as well. Many of the responses they gave in the interviews following questions about both were heavily interrelated. All 5 spectators agreed that part of the enjoyment and excitement coming from watching *Astaire* came from the **barely controlled chaos** that happened with every group. One spectator mentioned, "As soon as [player inside VR] fell, I was dying." Almost all the groups flowed through the line dancing segment smoothly, but when the can-can segment started introducing higher kicks in the air and having players duck and jump over obstacles, gameplay began to grow much more wild. Controllers almost came loose with the frantic player movements.

Chapter 5 Conclusion

5.1 Discussion

My initial hypotheses on interpersonal relationships and player enjoyment seemed to have been strongly supported by the results of the user test. However, due to the lack of quantitative data for the spectator experience portion, I am more hesitant to say the same. For the discussion, I will be further exploring the design aspects that might have led to these conclusions as well as potential future work.

In my earlier literature review, I discussed designing the game with the intent of adopting proxemic interactions and natural performativity for positive effects on the overall player/spectator experiences and interpersonal relationships. There were signs of both during the final rounds of playtesting, evident from the interview answers I analyzed.

'Physicality' was a major reason why many players felt closer after playing *Astaire*, but there potentially exists a deeper layer to this. I used 'physicality' as a tag because it was the closest to tying all their comments together, but there are other aspects to this too, such as trust, or the proximity of their physical interactions. Referring back to the quote I used above in the IOS player result section, it would have been far more difficult to understand the other player than if they had simply held hands to dance together. I purposefully designed the game so players had to stay within close distance to each other to see if that would affect player relationships and enjoyment, and it seems to

have had a strong effect based the results. Knowing your partner was a strong factor in how these interpersonal relationships developed, regardless of success or failure within the game. It seemed as if that level of trust and understanding that resulted from the proxemics was enough to enhance the experience. In the future I would like to be able to further test the effects of proxemics in VR play related settings. There has been little to no efforts conducted within that space, with a few exceptions (Garner et al. 2014; Isbister et al. 2017). Their results from I-dentity led them to recommend considering proxemics in future novel gameplay endeavors.

My original intention of adapting performativity to improve the spectator experience seemed successful but in ways that I did not anticipate. The key takeaway from the spectator interviews for the IOS section is that the player outside of VR was what influenced many of them to consider *Astaire* better at developing interpersonal relationships, not both players or the player within VR. From that, the difference between the two is also an aspect of why Twitch is so popular nowadays: interaction. Players outside of VR are able to readily acknowledge the audience viewing them and even interact with them. The acknowledgment of their existence might even push those players to be more performative than the players within VR. This could attributed to how visible the player manipulations and consequences were. The spectators could easily relate to the players outside of VR, as they are able to interact with them to a further extent and even have the same view they do.

The effects and variance of performativity within this modern game space are still unexplored, with most studies related to performance studies focusing on arcades and

large scale competitions. Due to the results here, I would be highly interested in further exploring performative players and the spectator experience. I expect VR to be a natural field for this to occur, with the speculation that the headset that comes with our most popular forms of VR today can actually serve as a performative facilitator that leads those who are naturally more reserved to a state where they feel comfortable acting for a crowd. Previous work bolsters this claim, with game designers mentioning that staring at the screen allowed people to become less self conscious about their movements than if they were looking at each other (Isbister and Mueller 2015).

Though performativity and proxemics seemed to have a significant effect on enjoyment and relationships, it unexpectedly did not noticeably affect excitement. *Astaire* was purposefully designed to be more chaotic, unruly, and active than other games to take advantage of the affordances of the HTC Vive, but the SAM values hinted that it may have only been coincidentally exciting for particular cases. This may have been a result from the lower sample size and excitement being more difficult to differentiate among the player groups, but I have a stronger opinion that it is due to how players interpret excitement. As mentioned above, many of the spectators were mixing excitement and enjoyment together and providing responses to cover both areas. It may have been that, to players as well, excitement and enjoyment are more similar concepts. I should have established firmer guidelines for the two in order to highlight the differences of the concepts more.

Overall, the main takeaway from the tests here should be that hybridized reality games are an interesting and worthwhile space to further explore. *Astaire* is an

unpolished game that still has some areas I hoped to have more time to develop and refine. Assets are still missing, such as replacements for walls in the can can section to fit the atmosphere, and I planned to have a disco segment as well to round out the segments. It did not have the time and manpower put into the games I compared it to, *Audioshield* and *KTNE*. However, the studies I conducted above showed there was a strong potential for a fun, enjoyable game that rivaled those games that are being sold. If I had the chance, I would implement those features and further test concepts such as how operating in a different realm compared to their partner and the audience members affected their performativity. Did it assist them in staying grounded in a circle of play that encompassed everyone?

I would argue that the results show what people really want from VR: an enjoyable way to experience it together. As I mentioned in the literature review, people still consider VR isolating, regardless of how advanced the network features are. Unless VR technology develops rapidly enough to be able to incorporate and simulate their surrounding space into the VR realm for them to see, or if VR becomes widely accessible to the public, it seems as if people will always see VR itself as isolating. However, hybridized reality takes advantage of what VR offers and more. I demonstrated in *Astaire* that giving both players different views and screens to play with can actually balance their interactions. They can still share the same world and feel equally involved. Designing for hybridized reality offers a way to incorporate interesting kinesic interactions and incorporate the sense of touch, something that is noticeably missing from current forms of VR.

Researchers are currently so focused on technology-sustained creations for VR that many are neglecting how freeform and flexible VR can actually be. There are still many concepts to consider for hybridized play. Unlike traditional games, both players are unable to perform the same role. Their context of play is different, but that does not hurt gameplay. In fact, it opens up the design space to really consider how these players can have different, physical interactions with each other and how these embodied motions factor into enjoyable gameplay. I only briefly touched upon kinesics here, focusing more on the proxemics and performativity, but there are still other relevant and applicable areas such as vocalics or haptics. My work is just a small facet of hybridized reality in general and I hope to pursue this further in the future, to dig deeper into player and spectator interactions within this space.

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