Leveraging Asymmetry and Interdependence to Enhance Social Connectedness in Cooperative Digital Games

by

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This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

Portions of the materials, ideas, tables, figures, and videos in this dissertation have previously appeared in the following peer-reviewed conference publications. The chapters which make use of the material are noted.

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Harris, J., Hancock, M., and Scott, S. D. (2015). *"Beam Me Round, Scotty!": Studying Asymmetry and Interdependence in a Prototype Cooperative Game*, in *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '15)*, New York, NY, USA, 2015, pp. 775-778. DOI:https://doi.org/10.1145/2793107.2810274 Material appears in chapter 3.
***CHI PLAY '15 Student Game Design Competition Peoples Choice Award & Judge's Choice Award**.

Harris, J., Hancock, M., and Scott, S., (2014). *"Beam Me Round, Scotty!": Exploring the Effect of Interdependence in Asymmetric Cooperative Games*, in *Proceedings of the First ACM SIGCHI Annual Symposium on Computer-human Interaction in Play (CHI PLAY '14).* ACM, New York, NY, USA, 2014, pp. 417-418. DOI:https://doi.org/10.1145/-2658537.2661311 Material appears in chapter 4.

Abstract

Play is a fundamental component of human development and is an important means of forming healthy relationships throughout life. Research has shown that the types of digital games people play, how they play them, and who they play them with can have significant impacts on players' social and psychological well-being. Playing games with preexisting social relations, such as family and friends, has been shown to help strengthen relationships, but it can be difficult to find games that provide both enriching social interactions and are able to accommodate the wide variety of player types, ability levels, genre preferences, and social roles that each player brings to the group dynamic. Asymmetric cooperative games—games that present their players with sharply contrasting aesthetic experiences in the same shared play space—are a unique but relatively understudied style of game that is well-positioned to tackle this multi-faceted problem by providing different players with different interfaces, challenges, abilities, and information while tightly coupling their interactions through shared goals and feedback.

My research focuses on better understanding the design of asymmetric cooperative games and how they can leverage interdependence to enhance players' perceptions of social connectedness. Based on a review of existing asymmetric cooperative games and related literature, I developed an initial conceptual framework that identified several mechanical forms of asymmetry common to these games. I adopted a "research through design" approach to then apply several forms of mechanical asymmetry to the iterative design of two prototype asymmetric cooperative games, *Goombagrams* and *Beam Me 'Round, Scotty!* (BMRS). I then conducted a series of focused player experience studies examining and refining different aspects of the conceptual framework using the most promising of those prototypes, *BMRS*. The first study established several characteristic dynamics of asymmetric cooperative play including considerations of directional dependence, synchronicity, necessity, leadership and primacy. These insights were used to evolve the *BMRS* prototype and mount a second study demonstrating that, even when controlling for visual and narrative aesthetic details, asymmetric cooperative play is perceived as more socially engaging than symmetric cooperative play. My third and final study closed the theoretical loop between the mechanical design elements identified in my framework and the socially enriching effects of interdependence by demonstrating how deliberately increasing the mechanical coupling between players could generate corresponding increases in perceptions of social connectedness.

Collectively, my research contributions can help both game developers and researchers to design more effective asymmetric cooperative experiences through a better understanding of this uniquely social style of game.

Acknowledgements

Though it my look as if only my name appears on the title page of this thesis, truly this work has dozens of co-authors.

First and foremost, I would like to thank my supervisor, Mark Hancock. It has been an amazing journey working with and learning from him over the course of my PhD. His genuine enjoyment and deep knowledge of games combined with his ability to target and refine interesting research avenues has made it a genuine joy to puzzle through these uncharted research waters together.

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Thank you to Neil Randall and Agata Antkiewicz for creating and shepherding the University of Waterloo's Games Institute from it's inception to the lively hub of games scholarship it is today. They have created a truely unique and supportive environment in which to conduct games research and collaborate with like-minded researchers.

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Tremendous thanks to my family (both immediate and extended) for their love and support throughout my (now numerous) academic adventures. No matter how far down this rabbit hole I venture (and no matter how esoteric my contributions to dinner conversations have becomes) they have always been there to warmly support my love of science, technology, and games.

And finally, Joanna, I cannot thank her enough. Many a night I had bolted anxiously awake thinking in terror about the enormity of the task that lay ahead of me but she has stood with me and supported me without question through the thick and thin of it. Together we have slowly but surely chipped away at that mountain and, now that this task lays completed behind us, I look forward to our next adventures together and the many bright years ahead.

For Joanna

Your love and support made this possible.

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Chapter 1

Introduction

This dissertation focuses on the use of asymmetry in the design of cooperative digital games as a means of generating interdependence between players, thereby enhancing those players' perceptions of social connectedness during their shared play experiences. This work represents an early contribution to a currently under-studied field of games research which, in the longer term, could lead to games which enhance players' social relationships and lead to improved social well-being outcomes.

In this chapter, I begin with a discussion of what motivates this work (section 1.1), before discussing where it is situated in the larger context of current academic research and games industry practice (section 1.2). I then detail the specific scope of my work (section 1.3), and the research questions (section 1.4) and methods I employed (section 1.5). Finally, I list the major contributions of my work (section 1.6), followed by an outline of the remaining chapters of this dissertation which describe my work in greater detail (section 1.7).

1.1 Motivation

Play is a fundamental component of human development and is an important means of forming healthy relationships throughout life (Granic et al., 2014; Gray, 2011; Vella et al., 2013). Digital games, having become one of the most popular forms of modern recreation (Association, 2018; Entertainment Software Association, 2018), are for many people their de facto form of play and represent a significant proportion of how their leisure time is spent. Much like other hobbies, players' relationships with games often extends beyond just *playing* them and includes discussing games with friends, reading the latest critical reviews, researching upcoming new releases, and may even include watching others play in casual (e.g., Twitch streaming (Interactive, 2018) and YouTube "Let's Play" videos (Letourneau, 2019)) and professional settings (e.g., eSports teams (aXiomatic Gaming LLC, 2019) and international tournaments (Corporation, 2019)). Since their relatively fringe beginnings in the basements and arcades of the 1970s and 1980s, digital gaming's rapid rise to popularity and prominence has prompted researchers to investigate the technical development of new kinds of games as well as the social and psychological impact this dynamic and multifaceted medium has on its participants.

While digital game play can be a positive experience, there are similarly numerous examples of the negative effects of uncontrolled digital game play. On one hand, for example, are romantic partners using their shared hobby as a vehicle for creative marriage proposals (Fogel, 2012), parents finding new avenues to bond with their children over shared play experiences (Skwarecki, 2016), and communities rallying to support charitable causes through their shared love of digital games (LLC, 2019). On the other hand, are examples of excessive play leading to damaging social isolation (Shen and Williams, 2011), predatory design practices causing financial ruin (Gerken, 2018; Needleman, 2015), and addiction so severe it has recently been identified as a disorder by the World Health Organization (World Health Organization, 2019).

According to Shen and Williams (2011), an important determinant of the long-term impact of digital game play is whether or not such play displaces social time with meaningful, preexisting social relationships. Their work found that if digital game play involves family and friends from a player's everyday life, it can augment and enhance those important relationships. Conversely, if players predominantly play with anonymous online strangers, particularly when that play time comes at the cost of maintaining pre-existing real world relationships, it can result in increased loneliness and worsened family communications. Ducheneaut et al. (2006) have argued that even games we might expect to be hugely social experiences, such as the "massively multiplayer online" (MMO) game *World of Warcraft* (Blizzard Entertainment, 2004) with its millions of players, can actually result in individualistic and egocentric player behaviour. In essence, time spent playing games is best spent playing with people who we have preexisting social relationships with; merely playing with strangers is not sufficient.

Compounding this problem however, is the natural variety of game preferences, aptitudes, and individual skill levels among the members of preexisting social circles. While one person may enjoy action-oriented games, their friend may prefer puzzle or strategy games. When this pair wishes to play games together, it is likely that one partner or the other will end up playing a game they do not enjoy or, even worse, the pair may choose not to play any games together at all for lack of a means to bridge their mutual preference divide. Similar roadblocks arise when considering sharply distinct demographics of players: what games can the elderly easily play with the young? The able-bodied with the disabled?

In this thesis, I investigate the concept of *asymmetric cooperative games* — which I define as games that present their players with sharply contrasting aesthetic experiences in the same shared play space — as a potential avenue for both bridging players' preexisting preference boundaries and providing unique, multi-faceted experiences which enhance social connectedness. Conversely, I frame *symmetric* multiplayer games (e.g., chess, basketball) as those games that adopt a "one size fits all" approach wherein every player has access to the same abilities and information, uses the same controls/interfaces, or faces the same in-game challenges. For particularly skilled or experienced players, this can lead to situations where they race ahead of their fellow players, an absence of meaningful challenge, and feelings of being disconnected from the larger group. For less skilled play partners, this imbalance can lead to feelings of frustration, inadequacy, and a similar lack of social connectedness.

In contrast, *asymmetric* games deliberately differentiate players' abilities, information, and interfaces to create designed interdependence between cooperating play partners. By limiting who can perform certain actions, learn certain information, or overcome certain obstacles, players must constantly be mindful of their play partners' situation and capabilities. Since no one player is fully capable of succeeding on their own, teamwork and socialization become an inherent part of the asymmetric play experience rather than a desirable side effect. Furthermore, because each player's aesthetic experience is inherently distinct, it is possible for the designers of asymmetric games to have each role appeal to players with contrasting abilities and preferences.

While theoretically appealing, asymmetric games are relatively under-studied in academia, relatively few successful asymmetric cooperative games have been produced in the commercial space, and even less is known about how to effectively design such games at a fine-grained, mechanical level. My thesis explores this exciting research space with the goal of understanding the characteristics of the asymmetric cooperative play experience as well as developing a conceptual framework to aid in the concrete design, discussion, and analysis of asymmetric cooperative games; games that excel at both bridging preexisting preference boundaries and provide enriching social experiences for their players.

1.2 Context

My work primarily employs Games User Research (GUR) techniques, itself a game-centric sub-discipline within the larger field of Human-Computer Interaction (HCI) and thus Computer Science. Where Computer Science focuses on the theory, engineering, and design of computer systems from a primarily technological perspective, Human-Computer Interaction research focuses on the human elements of computer systems use. Such work incorporates theories from psychology, sociology, cognitive science, ergonomics, phenomenology, and design to study not just what computers can do but how they can or should be designed in order to better accommodate human behaviours and physical/cognitive strengths and weaknesses.

GUR extends and adapts these same HCI principles into the unique context of games and play. Particularly with digital games, many of the same challenges are present as when studying more traditional computer interfaces: how to present information to the player; how to receive and interpret input; how to scaffold players' learning and mental models of how these interactive systems work; avoiding errors, misunderstandings, and frustrations; and ultimately how to design more effective systems/games.

Perhaps the most important distinction between GUR and HCI then is in the distinction between what constitutes *success* in HCI versus GUR: in GUR, "enjoyment", "immersion", and "fun" become central priorities, just as important (or even more so) than concerns of "success", "accuracy", or "productivity". Both disciplines share many of the same research techniques (e.g., observation, prototyping, experimentation, iteration) but GUR embraces the additional wrinkle that what is "most efficient" is not always what is most "fun".

From psychology and sociology, my work draws on theories regarding how enriching relationships build up "social capital" via repeated social exchanges and meaningful interdependence. My work adapts these theories into the context of game design and leverages the powerful effects of human "in group" behaviours to catalyze enriching social play experiences.

Finally, my research also draws on research from the field of Computer-Supported Collaborative work (CSCW). There, researchers investigate how computer systems can facilitate or (when poorly designed) thwart collaborative activities and their coordination. CSCW explores how computer systems play a pivotal role in how groups form shared mental models of complex systems, build situational awareness, and negotiate turn-taking, leadership, and strategy decisions. The design of games, as a fanciful form of work, is affected by many of the same considerations and benefits from adoption of many of the same lessons and insights.

1.3 Scope

My work focuses specifically on co-located, cooperative play in action-oriented digital games and the *mechanical* means by which game designers can deliberately enhance their players' perceptions of social connectedness. Many of the lessons learned over the course of my research may be more generally applicable to a wider variety of game styles, play environments, and group sizes but it is important to recognize the specific context from which my primary research and design insights have been drawn.

My work focuses on co-located play because of its socially enriching properties. Research has shown that time spent playing games with pre-existing social relationships (and particularly relationships with whom players have repeated social contact with *outside* of game space) is particularly socially enriching (section 2.3). Remote play (e.g., online), especially with anonymous strangers, has been shown to instead displace this important face-to-face play time with friends and family and lead to negative social outcomes.

Similarly, my work focuses on cooperative play for the naturally pro-social behaviours such play elicits. While competitive play *can* elicit pro-social behaviour (e.g., friendly rivalries), extra care must be taken to avoid frustration and misunderstandings. From a design perspective, it is also easier to engineer more controlled gameplay systems players must work cooperatively to overcome (i.e., player-versus-environment) than competitive gameplay scenarios that must account for unpredictable player-versus-player behaviours.

1.4 Research Questions

Within the aforementioned scope, my work focuses on three major avenues of inquiry.

Question 1: What are the prominent characteristics of asymmetric cooperative games?

Similar to more common genre terms such as "first person shooter", "real-time strategy game" or "Metroidvania", the phrase "asymmetric game" is used across different gaming communities and in commercial marketing materials but it is significantly less well understood in common discussion. In my experience, game-minded people will "know an asymmetric game when they see one" but are often hard-pressed to clearly describe what makes a game asymmetric or not, and further, whether one game can be said to be *more* asymmetric than another. Coming to a clearer understanding of the salient components of asymmetric cooperative games will improve the specificity and clarity of future discourse relating to the design and analysis of this unique style of game.

Question 2: How does asymmetric cooperative play differ from symmetric cooperative play in terms of players' social experiences?

One of the theoretical strengths of asymmetric cooperative games is the inherent interdependence generated by the asymmetries between player roles. However, many other features of the shared play experience remain the same regardless of whether players are playing a symmetric or asymmetric cooperative game: the shared audio/visual/narrative experience, physical proximity, the fun of spending time in a friend's company, etc. As previous research has shown (Shen and Williams, 2011), simply playing *any* game with friends can have beneficial social effects. Thus, relative to the traditional excitement of exploring a new game world or the enjoyment of learning new gameplay mechanics with a friend, does the unique interdependence of asymmetric cooperative play have significant impact on the otherwise traditional cooperative play experience?

Question 3: Can the asymmetries between cooperative players be "tuned" to be deliberately more or less intense and, by extension, affect players' aesthetic experience of interdependence in a predictable way?

Is the interdependence felt by players during asymmetric cooperative play a binary experience (i.e., "it's either there or it's not") or can players' experiences of interdependence be carefully crafted and made to feel alternately strong or mild based on the game designer's intent? If so, we become able to identify and recommend specific mechanical means of affecting players' social interactions during play and thus will gain another tool for more deliberately crafting enriching social experiences.

1.5 Approach

To answer these three questions, I adopted a mixed-methods approach with an emphasis on iterative prototype design and experimentally-controlled player experience studies. In order to examine the player experience phenomena at the heart of asymmetric cooperative play, it was necessary to be able to generate authentic play scenarios while maintaining fine-grained control over the mechanical detail of the games involved. Thus, significant time and effort was invested in the analysis of existing asymmetric games and the subsequent development of several of my own asymmetric cooperative games to be used as experimental tools.

Throughout the development of the various prototype games, I continuously solicited feedback from research colleagues, game development practitioners, and lay members of the general public over the course of numerous public exhibitions in order to iteratively refine

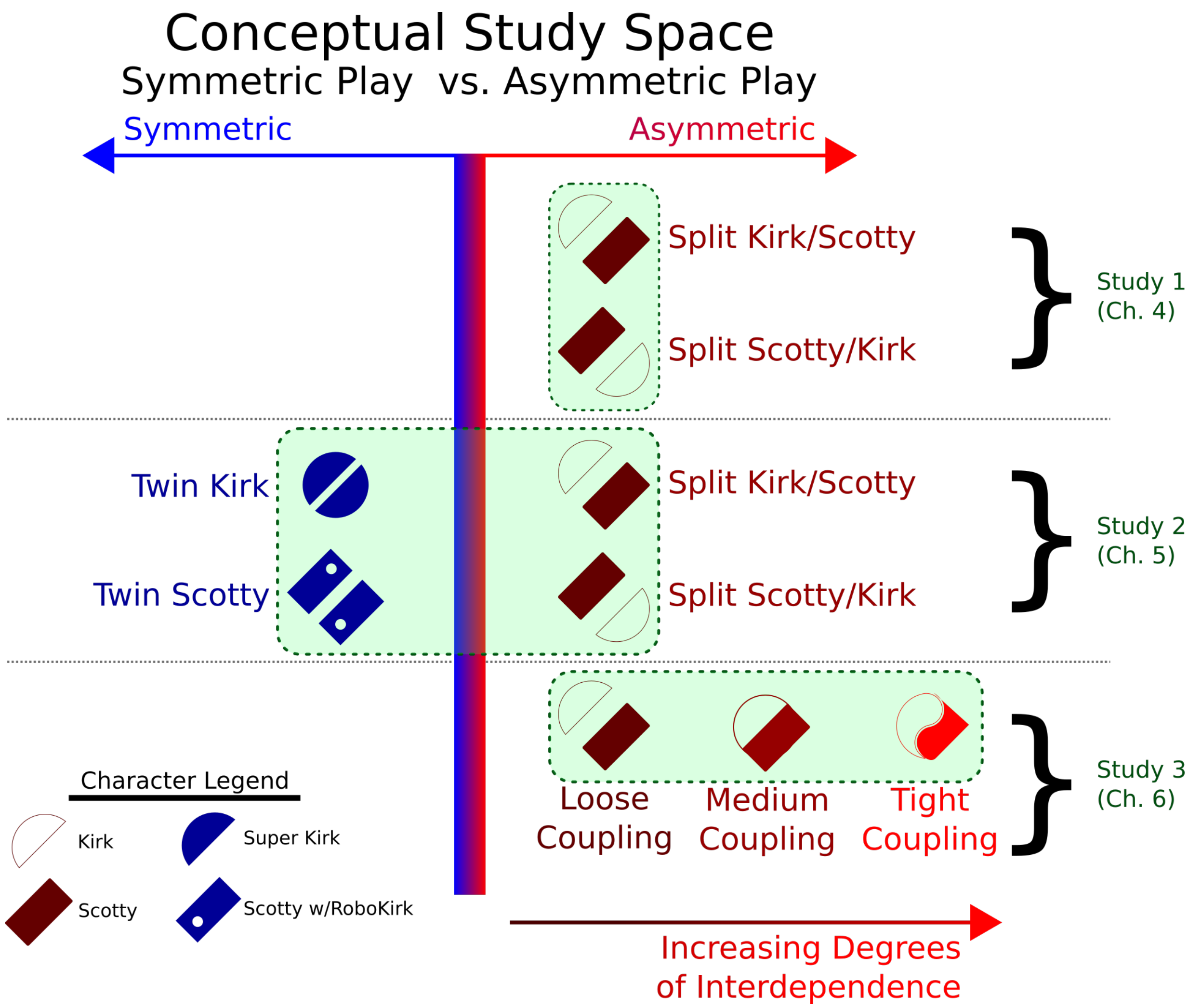


Figure 1.1: Diagram depicting the conceptual space explored by the three player experience studies described in this thesis. Each study examines a particular section of a hypothetical "symmetric vs. asymmetric" design spectrum.

the prototypes and better study the interplay between asymmetry, interdependence, and social connectedness at the heart of my thesis. I subsequently used my primary prototype game (*Beam Me 'Round, Scotty!*) to conduct three targeted player experience studies and collected both qualitative (interviews, audio/video/gameplay recordings) and quantitative player experience metrics (self-report surveys). Figure 1.1 visualizes the conceptual design space examined by each study along a hypothetical "symmetric vs. asymmetric" spectrum.

With this mixed-method approach, I was able to explore both the nuanced details of how specific design choices affected subtle player experience measures such as perceptions of immersion and behavioural engagement, as well as pursue broader threads of inquiry such as game preference dynamics based on play partner and the value of deliberately constraining player choice during design.

I chose not to employ internet survey techniques or gameplay studies using remote participants due to the potential loss of observational fidelity and the difficulty of interpreting participant responses *post facto*. I also chose not to employ commercial asymmetric games during player experience studies due to the degree of fine-grained mechanical control I would concede without access to the underlying game code. Wanting to compare a variety of asymmetric cooperative gameplay experiences (including experiences that were not asymmetric at all), it would be difficult to control for the likely confounds introduced had I attempted to compare vastly different audio/visual/narrative aesthetics between games from different studios.

My chosen approach of primarily employing in-lab, co-located player experience studies using my own custom prototype games afforded me the ability to observe players directly, follow up with pertinent interview questions immediately following their play session, review audio/video recordings of each session to dig into finer detail, and make immediate and fine-grained changes to a controlled prototype game in order to improve each subsequent player study.

1.6 Contributions

My work has produced the following main research contributions:

1. A conceptual framework, building upon the MDA framework of Hunicke et al. (2004), describing specific mechanical means of generating asymmetries between players in cooperative games, the characteristic dynamics of asymmetric cooperative play, and the resultant nuanced aesthetics of interdependence in these games. (chapter 3)

2. The design of two prototype asymmetric games (*Goombagrams* and *Beam Me 'Round, Scotty!*) that demonstrate the concrete realization of the concepts described in my conceptual framework as well as serve as experimental tools for exploring asymmetric cooperative play. (chapter 4)

3. A player experience study establishing characteristic dynamics of asymmetric cooperative play in the context of *Beam Me 'Round, Scotty!*. (chapter 5)

4. A player experience study demonstrating that asymmetric play leads to greater feelings of connectedness than symmetric play given the same social context and visual/narrative aesthetics. (chapter 6)

5. A player experience study demonstrating how deliberate mechanical manipulations that increase interdependent coupling of players' asymmetries of ability can increase players' perceptions of social connectedness. (chapter 7)

6. A synthesis of high-level insights drawn from observations running across all of my player experience studies and the iterative development of my prototype games. (chapter 8).

1.7 Outline

In chapter 1, I introduce the premise of my work and motivate my investigation of the design of asymmetric cooperative games. I describe the importance of play and the fundamental role play has in human social development as well as the non-obvious problem of multiplayer games which result in individualistic/ego-centric play and how asymmetric cooperative games are well suited to addressing these design challenges.

In chapter 2, I describe the current state of the art of asymmetric cooperative games in both industry and academia.

In chapter 3, I detail my conceptual framework for the design and study of asymmetric cooperative games based on the Mechanics-Dynamics-Aesthetics framework of Hunicke et al. (2004). In it, I outline a series of design primitives and associated design vocabulary which I used to develop the various experimental prototype games and player experience studies throughout my work.

In chapter 4, I describe my design-centric research approach and my focus on exploring the low-level mechanical elements which can be used to generate enhanced social connectedness during asymmetric cooperative play. I then describe in detail the salient design elements of the two primary prototype games I developed (*Beam Me 'Round, Scotty!* and *Goombagrams*), how their parallel development refined my conceptual framework, and their use as experimental tools in subsequent player experience studies.

In chapter 5, I describe the first of three player experience studies I conducted using the evolving *Beam Me 'Round, Scotty!* prototype. This first study explored the salient dynamics and aesthetics of the asymmetric *Beam Me 'Round, Scotty!* experience and established that my mechanical design choices were indeed generating the desired interdependent cooperative aesthetics.

In chapter 6, I describe the second player experience study I conducted contrasting the asymmetric *Beam Me 'Round, Scotty!* experience with two symmetric variations of the same game. This study established a baseline of comparison between symmetric and asymmetric play while controlling for social context, visual aesthetic, and narrative; establishing that asymmetric play generates a significantly enhanced perception of social connectedness over symmetric play.

In chapter 7, I describe the third and final player experience study I conducted comparing increasingly tight coupling of players' cooperative abilities in *Beam Me 'Round, Scotty!*. This study demonstrated that it is indeed possible to deliberately design for increasing degrees of social connectedness using the design vocabulary established in my conceptual framework.

In chapter 8, I discuss my collective research results and synthesize higher-level insights into the subtle complexities of interdependence in asymmetric cooperative play.

Finally, in chapter 9, I summarize the major contributions of my work, discuss their limitations, and discuss directions for future research in this area.

Chapter 2

Related Work

In this chapter, I discuss the related work that has informed my present research. My work draws on previous research from the fields of Games User Research (GUR), Human-Computer Interaction (HCI), Computer Supported Collaborative Work (CSCW), social and organizational psychology, as well as modern game design practice.

Digital games themselves are a rapidly evolving medium with entirely new game genres, hardware platforms, and play contexts constantly emerging. In just 50 years, digital games have progressed from relatively simplistic recreations of traditional sports (e.g., *Tennis for Two* (Higinbotham, 1958)) through text adventures (e.g., *Colossal Cave Adventure* (Crowther, 1976)), arcade games (e.g., *Donkey Kong* (Nintendo Co. Ltd., 1981)), home consoles (e.g., *Super Mario Bros.* (Nintendo Creative Department, 1985)), 3D graphics (e.g. *Halo* (Bungie Studios, 2001)), massively multiplayer online games (e.g. *World of Warcraft* (Blizzard Entertainment, 2004)), and, most recently, mobile games (e.g. *Angry Birds* (Rovio Entertainment, 2009)), consumer-level virtual reality games (e.g., *Beat Sabre* (Beat Games, 2018)), and international "eSports" (e.g., *DotA 2* (Valve Corporation, 2013)).

Digital games became the focus of many academic researchers in the 1990s as a result of social and political concern surrounding the potentially harmful effects of violence in video games (Ferguson, 2013) on children and related "moral panics". Recently, more nuanced academic research has emerged focusing on the multifaceted complexity of digital games and their use as tools for training (Rosser et al., 2007), education (Squire, 2008), scientific problem solving (Cooper et al., 2010), and other "gamification" applications (Deterding et al., 2011).

In the commercial space, the Entertainment Software Association (Entertainment Software Association, 2018) estimated U.S. video game industry revenue at $36 billion in 2017.

As a point of comparison, this makes commercial video games an economically larger industry than both music and movies combined (according to reports from their respective industry associations) (Motion Picture Association of America, 2017; Recording Industry Association of America, 2017). Modern "AAA" (that is, cutting edge, high-budget) video games require millions of dollars, hundreds of multi-disciplinary staff, and years of work to successfully design, develop, and launch.

In addition to traditional bug testing and quality assurance teams, many major game studios have also begun staffing internal playtesting teams (Electronic Arts Inc., 2019; Ubisoft Entertainment SA, 2019) that focus on the overall player experience and attempt to understand whether or not their upcoming games are "fun". Yet despite these gargantuan efforts, it remains difficult for companies to predict whether any individual title will prove commercially successful as the very concept of "fun" remains extremely difficult to even define. Consistent and predictable success remains elusive since what is "fun" in a commercial sense (i.e., what is attractive enough to be paid for) for one player today will likely prove different than what is fun for another player, that same player when playing with others, what that same player used to find fun at different stages of their life, and so on. Internal playtest data is rarely made public and many industry-academia partnerships occur under non-disclosure agreements. Nonetheless, there is significant academic work focused on understanding these challenges and the value of fun, games, and play.

Less immediately driven by commercial pressures, many academic studies of modern digital games occur from an "outside-in" perspective where academic researchers dissect and decompose the latest commercial games and use them as experimental tools in order to better understand the complex player experience phenomena so frantically sought after in industry but with the patience and rigour of more scientific methods.

My work draws on previous research from several domains which I broadly categorize as follows:

Understanding Play (Section 2.1) By its very nature, play is about partially suspending reality and voluntarily engaging in an arbitrary fiction: moving a ball past a line, making special combinations out of a random allotment of symbolic cards, or getting your fellow players to guess a word by only drawing clues. As will be discussed in later sections, there is ample structure and theory surrounding play and games but in pursuing a greater understanding of that structure, it is important to first acknowledge the fundamentally fantastical premise underpinning almost all play.

The Player Experience (Section 2.2) At the root of Games User Research (GUR) is the measurement of players' experiences. When playing a particular game or experiencing a particular experimental condition, are players frustrated? Entertained? Immersed? Excited? Unlike more productivity-oriented fields, where *performance* metrics such as speed, accuracy, or error rate can be used as points of comparison for research advances, the important player *experience* metrics used in GUR are both less clearly defined and more difficult to measure directly. Instead, it is often necessary to employ various self-report surveys where players are asked to describe their own experiences either in-situ or after the fact; both with accompanying limitations and potential confounds (Podsakoff et al., 2003).

Moreover, not everyone experiences games in the same way. Different people play games for different reasons, enjoy different elements of those games, and are attracted to different types of challenges or experiences. Effectively characterising players' interests and preferences is an ongoing research challenge that may some day prove instrumental in predicting the success of a priori design choices but, for now, can help serve as guiding archetypes for design discussions.

Social Play (Section 2.3) Previous research in team sports, social and organizational psychology, and computer-supported collaborative work helps describe the complex dynamics of interaction between co-players. Different styles of tasks and different forms and degrees of feedback can engender different social responses just as strongly as changing the relationship between or disposition of players.

Understanding players' social experiences during play requires drawing on numerous constructs from social psychology such as social capital, group cohesion, social closeness, and interdependence theory. I discuss each in turn and describe their suitability for my present study of asymmetric cooperative play.

Game Design & Research (Section 2.4) The actual process of developing games is exceedingly complex and, even in professional studios, design processes are still largely guided by informal heuristics and implicit experience hard-won over time. Much like the field of software engineering, decades of industry practice have resulted in a variety of "best practices" in game design that are constantly being revised and are still rapidly evolving. I discuss a subset of those design patterns that I have adopted for my work and highlight how they have informed my research.

In the following sections, I discuss each of these research themes in more detail.

2.1 Understanding Play

At the root of play is the (often implicit) agreement between participants to abide by certain rules. Players agree that they are playing "for fun" and establish new personal, social, and game-specific boundaries within which everyone agrees to participate. Dutch historian Johan Huizinga described this natural tendency for dynamic group play as a metaphorical "magic circle" (Huizinga, 1949). Huizinga framed play as stepping into an ephemeral zone of make-believe; inside which the fantasy of the game world/rules held sway and the usual structures of the real world could be subverted temporarily. The children's game "hot lava" is a simple example of magic circle play, where players agree to avoid touching the floor of a play room and instead only clamber across furniture. Football (soccer) is only slightly more structured (in essence, push a ball past a line without using your hands) and yet it is one of the most popular games in the world.

Recognizing this agreement between players, to make-believe and constrain themselves for the sake of playing together, is one of the fundamental components of formalized game systems and represents a powerful means of sharing "fun" experiences between different players. The concept of the "magic circle" informs my study of asymmetric games in three ways: First, by underscoring the importance of the ephemeral qualities of play that draw different participants into a shared playful experience. Second, by highlighting that constraining players can, perhaps counter-intuitively, enhance their enjoyment rather than diminish it. Third, by recognizing how the dynamic, unstructured, and unpredictable nature of play can complicate attempts to analyze, define, abstract, and dissect "fun" in the pursuit of new scientific understanding.

In his 1961 book *Man, Play and Games* (Caillois, 2001), French sociologist Roger Caillois extended Huizinga's discussions of play in culture by proposing more specific forms of play in combination with different degrees of structure. Caillois' four forms of play included *agon* (competition such as in Chess), *alea* (chance such as in slot machines or dice), *mimicry* (role playing such as in theatre), and *ilinix* (vertigo and altered perceptions such as in roller coasters or tumbling down a hill). Caillois' framework also discussed the different degrees of structure employed in play; ranging from the spontaneous and freeform play of *paidia* (e.g., "Cops and Robbers") to the rigid rules, manuals, limits, and restrictions of *ludus* (e.g., board games).

While Caillois' specific classifications were proposed well before the invention of digital games, his work serves as a starting point for modern attempts to formalize studies of digital game play and establishes a common vocabulary for dialog. More recent work by Deterding et al. (2011) in the realm of "gamification" (which they define as "the use of game design elements in non-game contexts") has continued to extend these conceptual frameworks by further teasing apart the differences between play and games and discovering ways of identifying, abstracting, and transposing more granular "gameful elements" (e.g., leaderboards, quests, achievements) into unique new contexts. In my work, these frameworks serve as useful guides for specific explorations of more focused types of play and the different types of players that are drawn to different games.

2.2 The Player Experience

In order to advance our understanding of asymmetric play, it will be necessary to be able to measure and compare the affect of different mechanical manipulations on the resultant player experiences. There is significant ongoing work in the field of games user research attempting to decompose the "fun" of play into component concepts which are more tractable and amenable to scientific study (Mekler et al., 2014). Several experimental tools have been developed specifically for games research or adapted from other research disciplines (notably psychology) in order to measure different subsets of these concepts such as a player's sense of mastery, immersion, and intuitive controls (Jennett et al., 2008; Ryan et al., 2006); motivation (McAuley et al., 1989); engagement (Brockmyer et al., 2009); flow (Sweetser and Wyeth, 2005); social presence (Kort et al., 2007); and social closeness (Gachter et al., 2015) during play. Typically, these measures take the form of self-report questionnaires administered during or shortly after play sessions.

Work by Ryan et al. (Przybylski et al., 2010; Ryan et al., 1983, 2006) attempts to understand player enjoyment and motivations from a bottom-up perspective by viewing digital game play through the lens of Self-Determination Theory (SDT). Their SDT approach frames player motivations as stemming from fundamental psychological desires for autonomy, competence, social relatedness, and immersion. Their Player Experience of Needs Satisfaction (PENS) survey (Ryan et al., 2006) was specifically developed to measure how well players perceive these needs as being fulfilled during digital game play. PENS responses have been shown to be more reliable at gauging player satisfaction and enjoyment over longer periods of time in comparison to questions asking players to rate their perceptions of the less well-defined concept of "fun".

What is more, work by Sheldon and Niemiec (2006) has shown that it is not just the raw degree to which any individual need is perceived to be satisfied but the overall balance of all such needs that has the largest positive effect on well-being. Thus, we see that creating "good" games is already a complex, difficult, and multi-faceted task. In order to elicit meaningful, long-term interest from their players, games should strive to fulfill as many of these psychological needs as fully as possible.

Recent work by Denisova et al. (2016) examined a trio of the most commonly used player experience questionnaires and found significant overlap between major subsets of Ryan et al.'s PENS questionnaire (Ryan et al., 2006), the "Immersive Experience Questionnaire" (IEQ) (Jennett et al., 2008), and the "Game Engagement Questionnaire" (GEQ)

(Brockmyer et al., 2009). Denisova's group concluded that "each of the questionnaires could be used equally reliably to measure player engagement generally" (Denisova et al., 2016, p. 36). They recommended that selecting which questionnaire to employ would be better decided on a case-by-case basis depending on a project's specific research focus. (E.g., if measuring "relatedness" is more important than "immersion", the PENS survey's dedicated relatedness sub-scale may be more elucidating than the IEQ.)

Less easily expressed than questions of relatedness or competence is measuring the experience of mental "flow". A seminal theory in psychology and a key component of game enjoyment, Mihaly Csikszentmihalyi described the concept of mental flow (Csikszentmihalyi and Csikszentmihalyi, 1992) as being "in the zone", fully engaged, and engrossed in a satisfying and rewarding activity such as knitting, jogging, painting, reading, or playing games. Csikszentmihalyi's study of flow investigated this near-universal human experience and has drawn further connections between a task's difficulty and the participant's relative level of skill. In short: if a task is too difficult relative to a person's current level of skill, they feel frustrated, but if a task is too easy for their current level of skill, they feel bored. Flow is most often achieved when a task is slightly beyond a person's current abilities and they have sufficient time and resources to dedicate to improving their skill through practice.

In pursuit of this pleasurable and engrossing feeling, many game designers strive to have their players experience a flow state by balancing a game's challenge to match and slightly exceed their player's skill (Section 2.4.3).

For my study of cooperative games however, it is important to note that flow is traditionally discussed as an individual experience that does not normally account for the back-and-forth rhythm of dialog, a diversity of player perspectives, or the distributed cognition necessary for coordinated team play.

Work by Kaye (2016) studied the differences in player experience between solo play and cooperative play using a modified version of the Flow State Scale questionnaire (Jackson and Marsh, 1996). They found that although individual flow ratings were lower for players in cooperative versus solo play, overall no differences in post-gameplay mood were observed.

Their results highlight the difficulty of applying individual measures of flow in group play contexts and suggest the need for an alternative but as yet undeveloped measurement tool for hypothetical "group flow". Such a tool would ideally probe a team's shared sense of competency and each player's confidence in the task-relevant knowledge of their collaborators as a substitute for traditional indicators of flow state such as timelessness and uninterrupted focus. (Section 2.3 discusses some potential tools that approximate this concept.)

As my work focuses on designing play experiences that are socially enriching (rather than engrossing per se), I instead focus on concepts from social psychology that more directly addresses the social qualities of group activity such as behavioural engagement and social connectedness along with the more established measurement tools that have been developed around them. A more detailed discussion of these concepts and their associated self-report measures can be found in section 2.3

2.2.1 Psychophysiological Measures

Efforts are also being made to bring a greater degree of objectivity to games user research tools through the use of psychophysiological sensors such as measuring a player's galvanic skin response, heart rate, or brain waves (Mandryk et al., 2006; Nacke et al., 2008). While not prone to the same biases and inaccuracies of player self-reports, unfortunately the data recorded by such devices is often noisy, the equipment is prone to setup error, and the sensors can be cumbersome or obtrusive when worn (Kivikangas et al., 2011). Further complicating the use of such devices, the data they record typically requires careful interpretation by experimenters in order to draw meaningful conclusions about the game experience itself (Kivikangas et al., 2011). For example, heart rate data can clearly show *when* a player's pulse rate increased but it does not draw clear conclusions as to *why* the player's pulse rate increased nor whether such an increase was enjoyable or frustrating.

Recent work by Mansfield et al. (2012) further demonstrated the difficulty of interpreting physiological data: By comparing measures of physiological coherence (i.e. particular heart rate patterns associated with flow/optimal performance and positive mental states) with self-report survey measures of mental "flow", they found contradictory correlations across three distinct activities (including video game play). Mansfield et al. concluded that "[physiological] coherence and [mental] flow are discrete constructs despite their theoretical similarities."

Despite the attractive objectivity psychophysiological sensors bring to games user research, there is not yet a unifying framework that connects psychophysiological measures to underlying player motivations nor to the specific game design elements commonly described in player typology frameworks (see section 2.2.2). Complicated further by the dynamics of social interaction (Section 2.3) and the prospect of needing to correlate multiple players' psychophysiological metrics simultaneously, my study of asymmetric cooperative games instead focuses on better established techniques such as player self-report surveys, verbal interviews, and thematic analysis of participants' recorded gameplay sessions.

2.2.2 Player Typologies

Just as there have been attempts to conceptualize and bring structure to different types of play, there has also been significant research investigating different types of players. By studying players' in-game actions and patterns of behaviour, numerous player typologies (Bartle, 1996; Kallio et al., 2011; Nacke et al., 2014; Tondello et al., 2016; Yee, 2006) have been developed to explicate the relationships between different players' experiences and their preferred in-game elements. These typologies often divide players into archetypal categories with names such as "Achievers", "Jokers", and "Fighters" according to the specific sets of in-game elements which commonly appear in games popular with each player type. Within these typologies, for example, "Achievers" are said to frequently play games involving leaderboards and collectible in-game items while "Fighters" frequently play games involving player-versus-player combat and aggressive action.

As of yet however, there is no widely accepted player typology that encompasses the full complexity of the modern player experience and caution has been recommended when attempting to draw conclusions from player typologies in practice (Bateman et al., 2011; Busch et al., 2016). A common criticism of strict player typologies is how the rigidity of their categorization does not allow a player to be classified as, for example, both a "Fighter" and an "Achiever", even if they enjoy both kinds of associated game elements.

More modern player typologies have adopted a trait-based approach (Park et al., 2011; VandenBerghe, 2012) and conceptualize players as expressing different proportions of preferences (e.g., one can be mainly an "Achiever" but occasionally exhibit "Joker" and "Socializer" characteristics). While these trait-based typologies allow for more subtlety, they still suffer from an inability to account for the fluid nature of individual players' preferences and behaviours that have been shown to change over time and in different social contexts (consider the "Person-Situation" debate (Fleeson and Noftle, 2008; Kenrick and Funder, 1988) from personality psychology). Play patterns developed from one genre of game may not necessarily carry over to other genres, and player motivations have been argued to change based on time (Yee, 2006), environmental context (Gajadhar et al., 2008), play partners (Inkpen et al., 1995), and even marketing awareness (VandenBerghe, 2012).

Further, many player typologies focus heavily on those game genres that were popular at the time the typology was developed rather than identifying underlying causes (i.e., the why) of player preferences. For the purposes of my design-centric work, this is particularly problematic as most typology frameworks have been developed from a top-down, after-the-fact perspective: surveying players on their existing play habits and self-described preferences, attempting to identify common groupings, and forming those groups into labeled types/traits. While this approach does help identify game elements common to games preferred by certain player types, it does not provide useful insight into how to design or develop games which successfully employ those target elements beyond "they should be included". As such, they can not be used to reliably predict the future success of any given game, design, or experimental manipulation.

Given the still formative nature of most player typologies, in my work I instead employ the broader concepts of "player types" to guide my design thinking more generally à la Cooper's "personas" (Cooper et al., 1998; Grudin and Pruitt, 2002). That is, as representative archetypes around which target player experiences can be prototyped while still recognizing the need to constantly test and validate those prototypes with real players in real play contexts in order to ground them with concrete feedback.

As part of that cautious usage, I adapted the BrainHex typology survey (Nacke et al., 2014) in two of my player studies (chapters 6 & 7) for use not as a strict categorization tool but as a co-variate in my statistical analyses. That is, to test if player traits can account for variance between different player experience metrics in addition to my experimental control factors of asymmetric vs. symmetric play (chapter 6) and degrees of interdependence (chapter 7).

2.3 Social Play

While individual play can be beneficial (e.g., promoting imagination, creativity, experimentation, and self-reflection) (Granic et al., 2014), the social nature of group play and its ability to draw people together is one of the greatest strengths of organized games and is the feature that originally drew me to study asymmetric cooperative play. Indeed, the physical and psychological benefits of social play are well studied (Greitemeyer and Osswald, 2010; Kaye and Bryce, 2012; Shen and Williams, 2011; Walker, 2010), and feelings of relatedness have been shown to be essential motivators for engagement and continued play (Przybylski et al., 2010; Vella et al., 2013).

With whom and in what social contexts one plays has been shown to have an important impact on players' overall engagement, physiological arousal, and positive appraisals of their play experiences (De Kort et al., 2007; Waddell and Peng, 2014). Generally, co-located play is preferred over remote play (e.g., online) because face-to-face interaction affords richer social interactions and easier interpretation of both verbal and non-verbal cues; for example, helping players differentiate between friendly banter and open hostility (Gajadhar et al., 2008). Similarly, research has shown that playing with existing friends and relatives is preferred over playing with strangers, due to a deeper social history, a better understanding of friends' social/emotional traits, and the opportunity for enduring social interaction once play is finished (Ravaja et al., 2006).

However, different games fulfill these social needs to different extents and games that include multiple players do not necessarily fulfill this social need in a meaningful way. For example, Ducheneaut et al. (2006) highlight the unexpectedly individualistic and egocentric play that can prevail in massively multiplayer online (MMO) games. Describing what they called the "alone together" paradox within the popular MMO *World of Warcraft* (Blizzard Entertainment, 2004), they found that the multitude of other players in the shared game world were often treated as an audience in front of which players could display their latest loot. Or, much like for the many laptop workers common in urban coffee shops, other players acted as a source of idle chatter and a sense of ambient sociality rather than serving as sources of enduring and meaningful new social connections. Following their examination of a wider variety of social play contexts (beyond just MMOs), Stenros et al. (2009) echoed Ducheneaut et al.'s concern. While they celebrated the ability for online multiplayer games to provide new venues for social interaction and engagement, they also warned that "many of these social online games' may not be nearly as intensely or deeply social as has been assumed".

2.3.1 Teamwork and Interdependence

Turning to lessons learned from research in sports psychology begins to unpack this apparent "alone together" paradox. Bruner et al. (2011) and Evans and Eys (2015) demonstrated that positive interdependence between athletes, beyond contributing towards competitive success, also led to enhanced group cohesion, personal satisfaction, and closer relationships. Importantly, this effect was evident only in those sports where the entire team's success required group collaboration (e.g., soccer, relay races) and was not evident in sports where multiple athletes simply represented the same institution or trained together but competed as individuals (e.g., varsity marathon running). Bruner et al. attributed this effect to the presence of two factors: task interdependence (where athletes actions required collaboration with others) and outcome interdependence (where groups succeeded or failed collectively). These results mirror research from organization psychology by Saavedra et al. (1993) that observed similar social benefits in workplace environments.

On the other hand, work by van der Vegt et al. (2001) observed how too much interdependence can lead to "process losses" and reduced task satisfaction due to frustration and cognitive overhead. Going further, work by Sherif (1961) demonstrated how interdependence could be deliberately employed to generate negative social behaviours such as bullying.

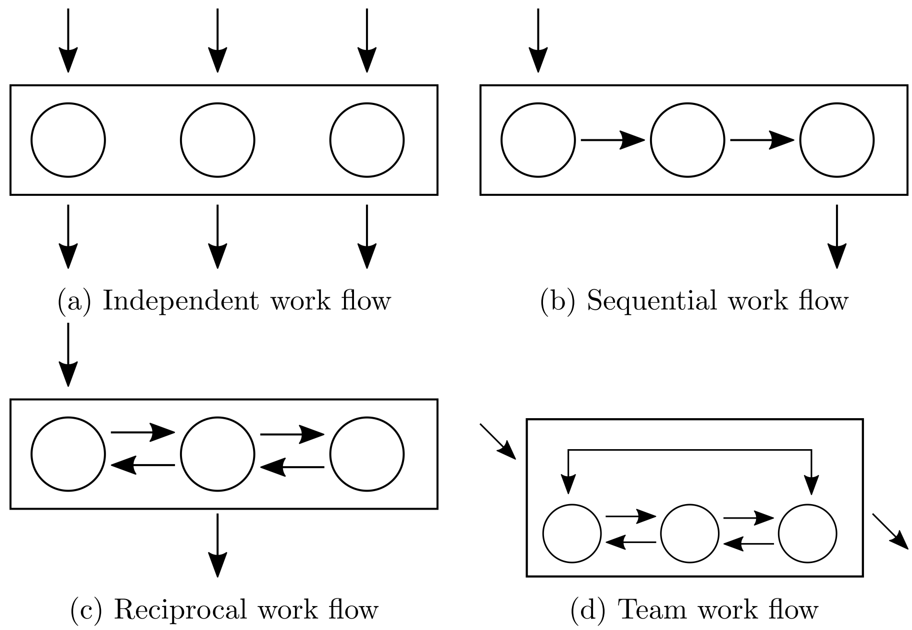


Figure 2.1: Saavedra et al.'s depictions of work flow through different organizational configurations and the patterns of interdependence between collaborators.

Thus we see that interdependence is a key component of team satisfaction and social engagement but it not a simple case of "more is better".

In order to better understand this complexity, Saavedra et al.'s (Saavedra et al., 1993) study of team work provides more specific conceptualizations of interdependence, including "task interdependence" (whether progress with one's task requires a collaborator's intervention), "goal interdependence" (whether one's individual outcomes/rewards are affected by a collaborator's performance), and "feedback interdependence" (whether feedback about one's performance is given individually or collectively). According to Saavedra et al., each form of interdependence could also be broken down further depending on the structure of the work task and the flow of information between group members (Figure 2.1).

2.3.2 Social Capital & Exchange

An alternative perspective on Ducheneaut's "alone together" (Ducheneaut et al., 2006) paradox comes from Social Exchange (Lawler, 2001; Thibaut, 1970) and Interdependence

Theory (Rusbult and Van Lange, 2003) from sociology literature. Within those frameworks, social interactions are viewed as economic exchanges of favours and kindness. In a mutually beneficial social relationship, each party supplies the wants of the other party at a lower cost to self than the value of the resource gained in return. Reciprocal, positive relationships are likely to endure while negative, costly relationships tend to be terminated. In Ducheneaut's study of *World of Warcraft* (Blizzard Entertainment, 2004) players, the relative lack of group play can thus be seen as stemming from group play being more costly (in terms of time, effort, and organization) than the comparative speed, efficiency, and greater individual rewards of solo play.

In my study of asymmetric cooperative games, this "social interaction as economic exchange" perspective highlights an important opportunity: by designing and developing my own experimental games, I gain complete control over the relative "cost to self" versus "benefit to partner" value propositions for each game mechanic and thus can deliberately set up "social exchanges" which are naturally more profitable when both players interact than if they were to try to go it alone.

The sociology concept of "social capital" (Putnam, 2001; Williams, 2006) elaborates on this "socialization as economic exchange" metaphor by describing how the emotional impact of repeated social exchanges can accumulate over time (much like economic capital) and further distinguishing between social interactions which generate "bridging" versus "bonding" social capital. According to Putnam (2001), *bridging* social capital is inclusive, cross-cultural, and generated when people from different backgrounds (e.g., race, ethnicity, politics) make connections with each other. Bridging social capital can help expand people's perspectives but is often relatively shallow and does not easily provide emotional support. In contrast, Putnam describes *bonding* social capital as exclusive, intimate, and typical of tightly bonded individuals such as family and close friends. Bonding social capital is characterized by the strong emotional support it provides and partners' willingness to help each other even at personal cost.

Williams et. al. (Williams, 2006; Williams et al., 2006) explored the generation of different forms of social capital in *World of Warcraft* (Blizzard Entertainment, 2004) guilds (i.e. players who have chosen to team up in permanent large groupings). On one hand, they found that guild mates with preexisting social relationships (e.g., friends from outside the game) were able to leverage their time playing together to extend and enhance their existing relationships (and thus build bonding social capital). On the other hand however, the researchers found that more than half of all players they interviewed either viewed their guild mates as casual acquaintances akin to coworkers or as not important outside the game at all (and thus were only able to build bridging social capital, if any). Research by Trepte et al. (2012) and Steinkuehler and Williams (2017) similarly noted the ability of games to enhance bonding social capital within preexisting relationships but also emphasized physical proximity (and the ability for subsequent, on-going social interaction outside of games) as an important component of players building up bonding social capital.

Research by Shen and Williams (2011) adds another layer to the discussion of gaming with preexisting relations versus strangers by highlighting how online play can also have actively detrimental effects if it displaces social time that would otherwise have been spent with more important social connections such as family and friends. Work by Kowert et al. (2014) highlighted correlations between increased social online game play and smaller social circles of a lower quality for adolescent players; providing support for the presence of displacement effects due to increased online video game play with strangers.

Work by Hellström et al. (2012) highlighted the importance of accounting for players' motivations for playing, noting that players with primarily social motives were at reduced risk for negative consequences (such as losing sleep or missing school) than those who played primarily for escapism or to achieve status among their peers.

Finally, work by Depping et al. (2018), while surveying players about their favourite social gameplay experiences, found that bonding social capital was most effectively generated while playing those games that exhibited interdependence as a central theme.

Collectively, these previous works underscore the complex nature of social enrichment and digital game play. Players are best able to form emotionally supportive, bridging social capital when they have preexisting social relationships with their play partners as well as opportunities to interact with those play partners repeatedly outside of the game. For these reasons, my work focuses on designing interdependence in games' as a means of encouraging the development of bonding social capital between players and each of the player experience studies described in this dissertation (chapters 5, 6, 7) were deliberately designed to recruit only participants with preexisting social relationships.

2.3.3 Play with Family & Friends

These constraints of the development of bonding social capital, that games are best played with physically proximal, preexisting social relations, naturally suggest that games are best played with family and friends. Work by Voida and Greenberg (2009) studying domestic gaming showed that, indeed, family game play is one of the richest social play contexts. However, they also uncovered several new design challenges within that space. In particular, they noted how the diverse *relationship* roles (e.g., mentor, sibling, guardian) combined with the inter-generational nature of families (e.g., adults, grandparents, teenagers, youths) and their deep knowledge of each other's gaming strengths and weaknesses resulted in different family members naturally stratifying themselves into different *play* roles: tech-savvy teenagers would troubleshoot equipment problems for the whole and act as "projectionists" while adults would shepherd the youngest children and make sure that everyone played fairly, and grandparents would act as ceremonial arbitrators and engaged spectators.

Further work by Voida et al. (2010) found that different in-game mechanics had different influences on the individual and group experiences. For example, the "star power" mechanic in the group music game Rock Band (Harmonix Music Systems Inc., 2007) could be used to alternately compete for higher score bonuses (for mutually high skill groups) or used by stronger players to "save" failing play partners. In contrast, the seemingly novice-friendly "drop-in, drop-out" cooperative play mechanics in *Lego Star Wars* (Traveller's Tales Limited, 2005) were viewed as cheating by those players who exploited it.

Voida et al. (2010) suggest that "those gamer groups that participated in more interdependent practices (à la Rock Band and Lego Stars Wars) may have experienced increased cohesiveness". They found that interdependence emphasized the gaming group as a whole over the individual and that collaborative games that lack interdependence do not always contribute to group-oriented practices.

Thus a core problem for games seeking to enhance social connections between players arises: according to "social capital" frameworks, players are best served spending their limited gaming time playing with friends and family members yet those same play partners bring with them a wealth of distinct play preferences, skill levels, and capabilities. Meanwhile, designing game mechanics which can accommodate that variety of player types while successfully emphasizing group interaction is not as straightforward as might originally be assumed.

My work focuses on *asymmetric* games because they appear uniquely positioned to accommodate and cater to sharply contrasting player styles in the same shared experience; a potentially excellent solution for family and friends with different preferences looking to play games together. What's more, asymmetric *cooperative* games typically feature tightly-coupled interdependence between their different player roles; a potentially excellent design context in which to generate enriching social play experiences.

2.4 Game Design & Research

Isbister (2010) discusses the challenges of designing enriching social play directly and presents several recommendations for maximizing the validity of player experience research involving multiple players. Foremost, she strongly emphasizes the importance of ecological validity when studying social play. She recommends performing play studies in-situ when possible (e.g., at home rather than in a laboratory) and recommends recruiting play testers with preexisting relationships. In this way, the relaxing atmosphere that is characteristic of group recreation can emerge (e.g., playful banter between participants) which leads to richer feedback than would otherwise be obtained from more specific survey probing of solo players or unacquainted groups.

Though optimistic about its future, Isbister also laments how underdeveloped the study of social digital game play has been relative to the study of individual play. With dedicated social play frameworks and survey tools only recently beginning to emerge and become refined, Isbister emphasizes the need to draw on external disciplines such as social psychology, anthropology, and communication.

In the next section, I examine related research from the field of computer-supported collaborative work (CSCW) and discuss how its lessons can be adapted for use in games user research.

2.4.1 Shared Awareness in Collaborative Tasks

Gutwin and Greenberg (2002) presented a descriptive framework of workspace awareness for real-time groupware that highlighted many of the challenges facing digitally-mediated collaborators. They described how, unlike collaborators in physical workspaces, where the boundaries of the workspace are fixed and shared awareness is much easier and more natural to maintain (e.g., through simple observation of where one's partner was working or looking), digital workspaces could be much more confusing due to their virtual flexibility.

Gutwin and Greenberg (1998) discuss the important trade-offs between individual power and shared awareness in their analysis of groupware systems design. In particular, they highlight how the synthetic, constructed environment of a groupware system affords the designers of such systems the freedom (and ultimate responsibility) to decide how the system will look, how the system will behave when people work together using it, and who will be given the benefit of power/authority and who must necessarily suffer/defer during shared interactions.

Work by Tang et al. (2006), specifically exploring collaborative tabletop workspaces, discusses the concept of "loose" versus "tight" coupling between workers' interactions. They conceptualize this coupling as a spectrum of engagement between two collaborators and investigated how collaborators would dynamically flow from one end of the coupling spectrum to the other depending on the specific nature of their task and tools.

Wuertz et al. (2018, 2017) extends this research of group awareness into distributed multiplayer games, specifically looking at the use of notification pings and awareness cues designed into multiplayer online battle arena (MOBA) games such as *DotA2* (Valve Corporation, 2013). Their fine-grained analysis of DotA2's awareness tools describes not only which tools were used for which purposes (whether this coincided with the game's designers intentions or not) and which tools were used more or less often, but also how the otherwise perfunctory nature of the awareness tools took on emotional significance over time. For example, the positional ping tool (normally just a temporary audio/visual mark at a specific location) was often used to express frustration and anger when players perceived their teammates were letting the team down. Unexpectedly, *DotA2*'s much more sophisticated annotation system (that allows players to draw simple messages and symbols on the game terrain itself) was rarely used at all for either in-game or social communication.

In my work (chapter 7), I adapt Tang et al.'s coupling framework for use in the study of asymmetric cooperative games. I experimentally manipulate the degree of coupling between co-players and observe its effects of their social play experience. In chapter 8, I discuss how, as Gutwin and Greenberg (1998) noted, designing the mechanics of asymmetric cooperative coupling is a deliberate design trade-off wherein, somewhat counter to traditional workspace applications, providing ample awareness tools in asymmetric cooperative play can undermine the intended interdependence aesthetic.

2.4.2 Cooperative, Collaborative, and Asymmetric Games

In addition to the recommendations by Isbister (2010) for effective social play research methods, significant effort has been put into analyzing common patterns of play and effective in-game mechanics for promoting beneficial social play. Work by Zagal et al. (2006) surveyed successful social board games and argued for the distinction between competitive, cooperative, and collaborative games wherein players are increasingly tightly-coupled in both their actions and goals.

Work by Beznosyk et al. (2012) investigated synchronous cooperation in remote casual games and elaborated on this concept of "coupling" between players. In their work, they loosely define "closely-coupled" games as those that require "a lot of waiting or if the actions of one player directly affect the other player" (Beznosyk et al., 2012, p. 7). Conversely, "loosely coupled" games "did not require tight collaboration between players and allow more independent performance" (Beznosyk et al., 2012, p. 7). Based on player experience surveys for six prototype games they developed around these classifications, they found that closely coupled games tended to be rated significantly higher in terms of excitement, engagement, and replayability despite also being rated highly in terms of challenge.

This highlights an exciting interplay between cooperation, challenge, and excitement, but the provided definitions of loose and tight coupling are somewhat difficult to incorporate into a design process. For example, “a lot of waiting” (a supposed virtue by the existing definition) is likely indicative of the underlying appeal of planning and coordination among teammates. More usefully, work by Rocha et al. (2008) identified several design patterns that encourage closely-coupled play, included limiting resources, complementary roles, interaction with the same object, shared puzzles, shared goals, and abilities that can be used on other players.

Game designer and educator James Portnow (Portnow, 2015) advances Beznosyk et al.’s concepts of tightly-coupled play by framing them as “signaling mechanics”. Using an example of what he calls “weak asymmetry” from popular online shooter “Team Fortress 2” (Valve Corporation, 2007), Portnow describes the medic character’s healing beam (which can only be used on other players) as a mechanic that intuitively signals to players that medics are meant to support teammates. (This specific mechanic is directly adapted into *Beam Me ’Round, Scotty!* See chapter 4.)

Portnow used “Fable: Legends” (Lionhead Studios, 2016) as a counterpoint that exhibited much rarer “strong asymmetry”, as it allowed a team of four adventurers to play against a fifth as “master of the labyrinth” who opposed the other players by spawning enemies and obstacles. (In my work, I would describe this as an “asymmetry of team size”. See chapter 4.)

In my work, I integrate the vocabulary of “strong asymmetry”, but opt for the term “mild asymmetry” rather than “weak asymmetry” to avoid any characterization of such games as “lesser” in any way.

2.4.3 Balancing and Rubber Banding

The idea of designing game systems to allow players of different skill levels to enjoy playing the same game has been studied extensively in the contexts of “balancing” and “rubber banding” (Cechanowicz et al., 2014; Gerling et al., 2014; Vicencio-Moreira et al., 2015). In single player games, this balancing typically takes on the form of “difficulty modes” (e.g., easy, medium, hard) where the frequency or severity of obstacles is scaled down or up to accommodate different players. Examples included more numerous enemies, fewer beneficial resources to employ, or tighter time limits.

In multiplayer games, this balancing often takes on the form of “rubber banding” where stronger players are artificially handicapped or weaker players are provided artificial boosts in order to maintain a minimal distance between players. In a racing game, for example, if one player is particularly skilled and spends the majority of their time far ahead of their competitors, the shared play experience can suffer because the leading player does not feel challenged and the trailing player(s) do not feel as if they have any reasonable chance to win. The *Super Mario Kart* (Nintendo EAD, 1992) series is a particularly well known example of rubber banding in racing games where, for example, the most powerful special abilities (and thus those which would most likely lead to advancing) are only ever given to players in last place.

Overt in-game balancing for skill (e.g., easy/medium/hard difficulty modes, handicaps, or rubber banding) has been shown to have detrimental effects on feelings of self-esteem in player dyads (Gerling et al., 2014), as the low-skilled player does not feel that they can compete on equal footing, and the high-skilled players do not feel a sense of accomplishment from winning a competition known to be unfair. Hidden balancing mechanisms (e.g., point multipliers, aiming assist) have been shown to be more effective at fostering a competitive atmosphere (Vicencio-Moreira et al., 2015).

However, balancing for skill does not address potential mismatches in different players' underlying motivations. That is, being more competitive in a racing game through hidden speed boosts does not enhance a player's experience as much if they dislike racing games to begin with. In my work, I build on this prior research by considering differences in both ability and preference as important elements of asymmetric play; differences to be embraced and emphasized rather than normalized.

I also distinguish these forms of in-game skill balancing from the design-time exercise of "tuning" a game's mechanics for interest/longevity. When tuning mechanics, developers tweak the effectiveness of their games' available abilities and strategies to avoid the formation of a single "dominant strategy" (Schreiber, 2009). For example, when one choice of vehicle in a racing game is clearly superior in all performance metrics, every other player is implicitly forced to choose that same vehicle in order to compete; this makes the overall game repetitive, less interesting, and wastes the development effort that went into the many unused alternatives.

2.4.4 Asymmetry as Design Tool & Social Catalyst

"Asymmetric games" are a relatively rare style of game in which different players engage with the same play experience in sharply contrasting ways. In baseball, for example, while the offensive team fields a series of single batters who try to hit the ball and run the bases, the defensive team fields nine players who attempt to catch the ball, and tag the offensive players out. Where one team can use baseball gloves and throw the ball with their hands, the other team can use a baseball bat and aren't necessarily allowed to otherwise touch the baseball at all[1]. Chess, in contrast, can be viewed as a symmetric game because both players have identical pieces with identical abilities and rules.

With digital games, examples of symmetric play vastly outnumber asymmetric play and, as a result, asymmetric games are significantly less well studied. This as a missed opportunity, however, as my work argues that asymmetric games are uniquely positioned to generate interdependence between players, build bonding social capital, and accommodate differences in player preferences and abilities without resorting to artificial balancing.

Research from psychology has shown that the social need to belong is a fundamental human motivation (Baumeister and Leary, 1995) and having others designated as either part of one's in-group or out-group can have immediate and powerful social effects (Sherif, 1961). Work by Emmerich and Masuch (2017) has even explored how heightened interdependence can, perhaps counter to intuition, lead to lessened frustration between collaborating partners in games with time pressure.

As will be discussed in more detail in chapter 4, the design of asymmetric games and the deliberate introduction of various asymmetries between players (e.g., asymmetries of ability, information, interface, goal, etc.) are natural ways to not only implicitly designate in-group membership but to also ensure that every team member has an exclusive and meaningful role to play for the benefit of the larger group.

2.4.5 Asymmetry and Interdependence in Academic Games

Recent research has either explored asymmetric games directly or incorporated asymmetric design elements to achieve specific goals (Benford et al., 2006; Haas, 2014; Maurer et al., 2015). In their game "Tabula Rasa" (Graham et al., 2013), Graham et al. presented one player with a gamepad-controlled platforming game and a second player with an interactive tabletop level editor that could alter the platforming game terrain in real time. When the players were allowed to play freely, the experimenters observed a wide variety of emergent play styles as the tabletop players alternately collaborated with, shepherded, constructed challenges for, or deliberately antagonized the platforming player.

Sajjadi et al.'s *Maze Commander* (Sajjadi et al., 2014) demonstrated how asymmetries of information and perspective can be used to promote communication and coordination between players, though they can also prove frustrating.

[1]The asymmetry of baseball is diminished somewhat since the same players switch offensive/defensive roles throughout each game.

Depping et al.'s (Depping et al., 2016) digital version of the board game *Labyrinth* demonstrated that asymmetries of abilities between players could be an even more effective tool for building trust between strangers than traditional "icebreaker" activities.

In Gerling's and Buttrick's "Last Tank Rolling" (Gerling and Buttrick, 2014), a player in a wheelchair controls a powerful virtual tank that a freestanding player can hide behind for protection. Although an exciting example of allowing players with different physical abilities to leverage their unique strengths without relying on artificial skill balancing, they did not evaluate their design in a formal player experience study.

Ellis et al. (2008) specifically set out to design games that enhanced players sense of interdependence noting "greater identification with a group leads to greater trust and cohesion, improved communication, improved cooperation, greater individual contribution to the common good of the group, and increased group productivity". However, Ellis et al. did not validate the success of their game's designs and it is not yet known whether their chosen game designs achieve their social experience goals.

In the previous examples, the asymmetries between players were critical to the overall player experience but were not the primary research focus. In each case, the *effects* of the asymmetries between players were explored and, in some cases, formally studied but the actual process by which each game was designed was incidental and rarely examined in detail. My work seeks to understand the conceptual space of asymmetric cooperative game design itself in addition to formal validation of the pro-social benefits such games may present. One of the primary contributions of my work has been the development of a conceptual framework which is meant to enhance the design of future asymmetric cooperative games and guide research involving them in general.

2.4.6 Asymmetry and Interdependence in Commercial Games

Although there are numerous examples of asymmetric commercial games, the majority of such games exhibit "milder" forms of asymmetry typically in the form of "character classes" that possess slight variations on the same core abilities. In such games, one character class may have stronger melee attacks than others, can jump higher than others, or can lift heavier objects than others. In each case however, every player can still attack, jump, or lift objects, just to greater or lesser degrees depending on their class choice. (E.g., *Team Fortress 2* (Valve Corporation, 2007), *Starcraft* (Blizzard Entertainment, 1998), *Diablo* (Blizzard North, 1996), *Overwatch* (Blizzard Entertainment, 2016)).

Much more rare are games that exhibit "stronger" forms of asymmetry such as asymmetries of information, interface, or goal. (E.g., *Artemis Spaceship Bridge Simulator* (Robertson, 2010), *Clandestine* (Logic Artists, 2015)). In these games, some players may have access to information that others do not, may use entirely different hardware interfaces to interact with the game world, or may be pursuing entirely different goals from their fellow players.

In either case however, asymmetric games are vastly outnumbered by "symmetric" and single-player games. Strongly asymmetric games tend to be developed by smaller studios and released to niche audiences. Rarely do major studios create strongly asymmetric games for mainstream audiences. When they do, it is typically considered a risky choice and has historically not proven as commercially successful as more convenient game designs.

Matt Colville (Wood, 2018), lead designer of the (at one time) highly anticipated competitive online shooter game *Evolve* (Turtle Rock Studios, 2015), cited asymmetry as the core design problem that ultimately resulted in the game's lackluster reception and commercial failure. In Evolve, a team of four sci-fi hunters (with class based ability variations) cooperate to take on a single competing player who controls a gargantuan alien monster. Less than two years after release, *Evolve*'s online servers were shut down, with Colville lamenting "So we never really got 4v1 (4 players versus 1 player) to work. It caused more problems than we had ever imagined... It was a game that really only worked when you were playing with your friends".

Originally released in 2002, the team-based, online, World War II themed, first-person shooter (FPS) game *Battlefield 1942* (Digital Illusions CE, 2002) was one of the earliest multiplayer games to present players not only with mild asymmetries (in the form of various soldier classes such as sniper, medic, and engineer) but strong asymmetries (in the form of various land, air, and sea vehicles that multiple teammates could control simultaneously). Like Colville's experience with *Evolve*, my own experiences playing *Battlefield 1942* demonstrated glimpses of asymmetric design brilliance undermined by the challenges of tightly coupled interdependence with online strangers.

This frustration was most evident in *Battlefield 1942*'s most powerful vehicle: the naval battleship. The battleship's enormous long-range cannons could clear dozens of enemies and entire encampments from across the map but first required a second player to engage an "artillery spotting" mechanic to create a temporary overhead camera that battleship players could see through and use to gradually zero in their long-range artillery shots. A single, one-time action on the part of the spotting player could unleash the powerful battleship cannons and easily swing the tide of an entire match. Yet, critically, I rarely observed this level of asymmetric cooperation in normal online play between strangers. Game servers were often filled with repeated requests from battleship players waiting for someone, anyone, to spot for them and enable the battleship players to contribute to their team's success. In the meanwhile, they could end up sitting, helpless, on the fringes of the game map for the entire match.

Since 2002, the *Battlefield* series has continued to enjoy sustained popularity across 14 distinct games but none have included the same degree of designed interdependence as the original *Battlefield 1942*. While the mild asymmetries between soldier classes and multi-person vehicle crews remained, the mechanics of subsequent *Battlefield* games seemed increasingly designed to ensure that individual players could always contribute to their team without strictly needing to rely on intervention from anyone else.

Using my conceptual framework (chapter 4), we can similarly begin to describe the aesthetic strengths and weaknesses of other commercial asymmetric cooperative games. In *Star Fox Zero*'s (Nintendo EPD & Platinum Games, 2016) and *Clandestine*'s (Logic Artists, 2015) cooperative modes, asymmetries of ability, information, and challenge split each game's normal collection of single-player abilities between two play partners. However, the core design compromise of still accommodating single player play means that a second player is never strictly necessary and so the aesthetic experience of interdependence can suffer. In my experiences with *Clandestine*, for example, I have found this accommodation resulted in a lock-step back-and-forth between the "agent" and "hacker" roles as one player/character was forced to wait for the other to complete a task before proceeding.

In contrast, the bomb-defusing game *Keep Talking and Nobody Explodes* (Steel Crate Games, 2015) *requires* two teams of players to cooperate simultaneously in order to succeed. By design, the game cannot be played any other way and the resultant aesthetic is a uniquely tense, collaborative rush.

Asymmetry and interdependence can also take on more subtle forms. In his video essay on the design of the popular and commercially successful cooperative, short-order chef game *Overcooked* (Ghost Town Games, 2016), game designer Mark Brown (Brown, 2018) highlights how even though all four players control identical chef avatars, the design of the kitchens (i.e. the levels) and the mechanics of the kitchen appliances themselves are what generates interdependence between players. The core gameplay loop of *Overcooked* consists of fulfilling meal orders. Each meal requires a specific combination of ingredients and some ingredients require special means of preparation before the dish can be assembled and served. Onion soup, for example, requires fetching onions from a crate, chopping them at a chopping board, cooking three chopped onions in a pot, plating the soup, and then serving the plate.

While each step can be completed individually by any individual player/chef, the design of the very first level of *Overcooked* sees a long counter placed to deliberately cut the kitchen in half and distributes the sequence of onion crate, chopping board, cooking pot,

Figure 2.2: Screenshot of the first level of *Overcooked* (Ghost Town Games, 2016). Despite every player having identical/symmetric abilities, the layout of the kitchen and appliances forces players to collaborate asymmetrically by passing ingredients back and forth across the central island rather than inefficiently running around it repeatedly.

and serving plates on alternating sides Figure 2.2. In this way, if a single player wanted to complete a meal on their own, they would have to repeatedly walk out and around the center island at least three times but, because success in *Overcooked* is based on time/speed, this would prevent players from fulfilling the necessary number of orders quickly enough. Instead, if players cooperate and pass the meal components back and forth to each other across the island, they can significantly streamline their collaborative efforts, complete multiple tasks in parallel, and greatly increase the speed at which they fulfill meal orders. Most of *Overcooked*'s other core mechanical designs emphasize this same parallelization of effort and force otherwise identical/symmetric chefs/players to collaborate asymmetrically in order to succeed.

2.5 Chapter Summary

As prior research has shown, the mere potential for interaction with other players is not sufficient for generating enriching social play. Instead, there are specific elements within each game that may encourage more meaningful social interactions between players to varying degrees. By the nature of their heterogeneity, asymmetric cooperative games present unique opportunities to mechanically induce interdependence between players and act as a social catalyst that facilitates, if not outright necessitates, tightly-coupled social interaction between players.

In the following chapter, I lay out my conceptual framework for understanding the characteristics of asymmetric games that provides an alternative (and more concrete) vocabulary for design relative to the more general terms such as "coupling" and "complimentary roles" used previously. I then detail how I used this framework to design two prototype games that were subsequently used in player experience studies to test my theories regarding asymmetry and interdependence in cooperative digital games.

Chapter 3

Conceptual Framework

In this chapter, I present the conceptual framework I have developed to support the design and study of asymmetric cooperative games. The foundation of my framework broadly adapts the three-layer "mechanics, dynamics, aesthetics" construction of Hunicke et al.'s (Hunicke et al., 2004) MDA Framework, which is concerned with the design of games in general, and introduces numerous novel concepts specific to asymmetric cooperative play. In order to develop my framework, I performed a review of existing asymmetric games from academia and industry, identified mechanical elements characteristic of asymmetric cooperative games, and then proceeded through several rounds of iterative design, prototyping, and experimentation to expand upon and refine every part of my framework. The final result of that iterative process is presented in this early chapter so as to establish the necessary vocabulary that I then use to describe my work throughout the remainder of this dissertation.

I begin this chapter with a discussion of modern game design practice and a brief overview of Hunicke et al.'s MDA framework before describing the details of my conceptual framework concerning the design and study of asymmetric cooperative games.

3.1 Game Design

Modern digital game design practice is a complex alchemy of creative and technical skills often involving dozens, if not hundreds, of highly specialized collaborators. Game designers must imagine, evolve, refine and explicitly describe all of the minute details that go into a complete game experience, communicate those details to their team, and then work to deliver that experience to their players. Today, large commercial development projects can last anywhere from three to six years from inception to launch and can cost many millions of dollars to produce. Throughout the development, production, and marketing process, game designers continuously incorporate practical feedback from their engineering and art staff, respond to changes in schedule and financing from producers, and evolve their designs based on player experience testing. In short, modern commercial game design is as much an art as it is a science and designers constantly wrestle with finding effective ways to communicate, discuss, and re-evaluate their methods and techniques.

In order to bring some structure to this complex process and provide a common vocabulary with which to discuss concepts and challenges, numerous design frameworks (e.g. VandenBerghe's "5 Engines of Play" (VandenBerghe, 2012), Jesse Schell's "Book of Lenses" (Schell, 2014)), have emerged to serve as practical guidelines and frameworks for collaboration. Each is typically tailored for an individual studio's culture/capabilities, and is continuously refined over time based on real-world performance and sales data from previous projects. According to VandenBerghe, these design frameworks are typically formed by rough amalgams of theories adapted from psychology, marketing, and games user research and their application still relies heavily on expert intuition. Faced with the strict time and budget constraints of commercial projects, VandenBerghe describes how the efficiency of these approximate but practicable guidelines often outweighed the difficulty and high cost of attempting to develop scientifically precise player motivational models or rigidly prescriptive game design manuals. Further, most common frameworks focus on and best describe the popular types of games upon which they were developed. Current frameworks do not effectively address less common styles of games, such as asymmetric cooperative games. As such, there is a need for new conceptual frameworks that are better tailored towards the unique strengths and challenges of this promising but understudied form of play.

3.1.1 Mechanics, Dynamics, and Aesthetics Framework

In my work, I build most directly upon Hunicke et al.'s (Hunicke et al., 2004) "Mechanics, Dynamics, and Aesthetics" (MDA) framework as it is particularly useful for the way it conceptualizes the different layers of interaction separating game designers and game players. In the MDA framework, different game elements exist along a three-part continuum (Figure 3.1) extending from the game designer on one end (left) to the player on the other (right).

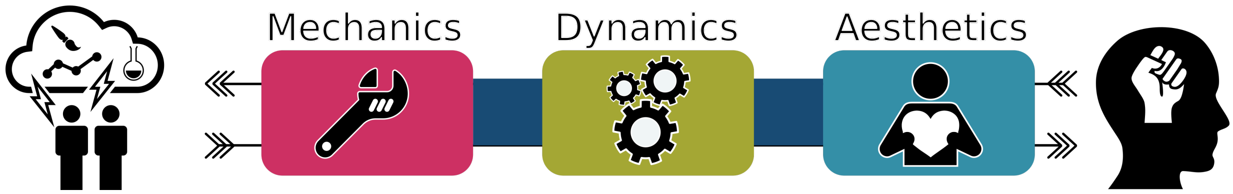


Figure 3.1: A diagram depicting the three main conceptual layers of Hunicke et al.'s "Mechanics, Dynamics, and Aesthetics Framework" (Hunicke et al., 2004). Arrows depict the flow of design intent (from designer on the left to player on the right) and input (from player on the right to designer on the left). In this figure, the iconic fist inside the player's "mind" represents their preference for action-oriented play.

At the **mechanics** layer, the game's designers plan and implement the game's underlying systems, algorithms, timings, features, etc. For example, how high does the player's character jump? How many times can the player restart if they fail a challenge? How many obstacles are there in a scene and how difficult are they to overcome? At this level, before the game has even begun, the game can be viewed as a series of specific design decisions under the direct control of the game's designers.

At the **dynamics** layer, the game is running and the myriad of individual mechanics combine with the player's inputs, aptitudes, and previous experiences to form a lively and interactive whole. A game's dynamics can be steered via the designs' specific mechanical choices but are equally influenced by the players' unpredictable inputs.

Finally, a game's **aesthetic** layer represents the emotional responses the game evokes in the player as a result of engaging with the game's dynamics. For a player unused to third-person action games and gamepad controls for example, a grueling melee combat game like *Dark Souls* (FromSoftware, 2011), with tight mechanical timing and punishing enemies, might be viewed as a frustrating and unfair slog. Alternatively, a player seeking a challenge and already familiar with complex gamepad controls might instead view such games as an invigorating odyssey through an exciting but dark fantasy landscape. Viewed within the MDA framework, it can be said that the mechanics of the game have not changed, but each player's unique personal experiences alter the dynamics at play and give rise to vastly different aesthetic experiences.

My work adopts the broad structure of the MDA framework and its notion that game designers have only indirect influence over their players' aesthetic experiences. Designers can make specific mechanical decisions in an attempt to steer a game towards a particular experience, but must also acknowledge that each player contributes their own personal history and abilities to the play experience. In the context of social play, the designer's indirect influence is even more pronounced given the additional interaction between players outside of the game itself.

My focus on asymmetric games specifically embraces the individual differences between players and studies how asymmetric mechanics (and the complex game dynamics they give rise to), can be used to generate varying aesthetics that appeal to multiple different styles of player within a single game. In essence, my work studies the unique aesthetic "gap" that asymmetric games can create between different kinds of players (Figure 3.2).

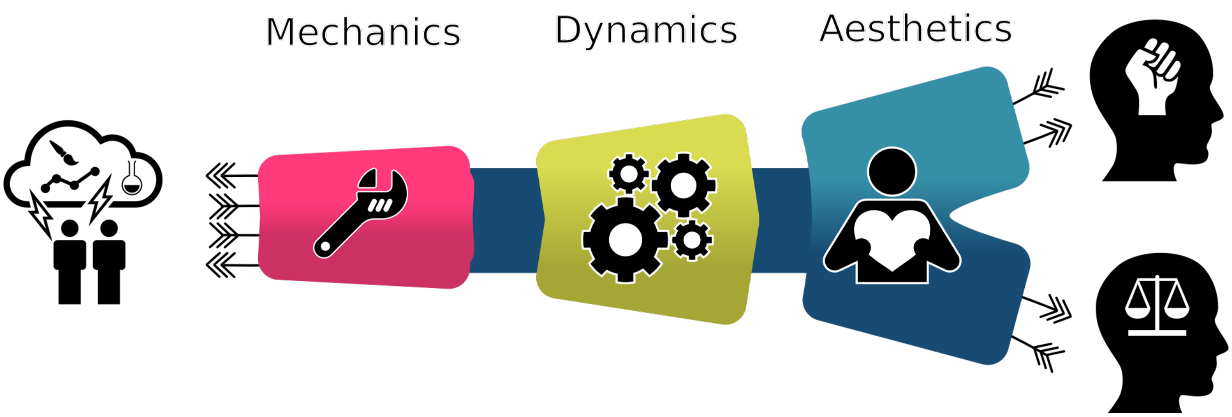


Figure 3.2: A diagram depicting the conceptual split that asymmetric cooperative games attempt to create wherein a common set of shared mechanics attempts to elicit distinct aesthetic experiences for players with different preferences (represented here by the fist and scales icons inside the players' "minds".)

3.2 Conceptual Framework for the Design of Asymmetric Cooperative Games

Combining the history of asymmetric game design discourse and research with my analyses of commercial asymmetric games, the development of my own prototype games, and several player experience studies (see chapters 5, 6, and 7), I have built up my own conceptual framework (Figure 3.3) for the design of asymmetric cooperative games and a vocabulary of design elements that can be leveraged to enhance players' social play experience.

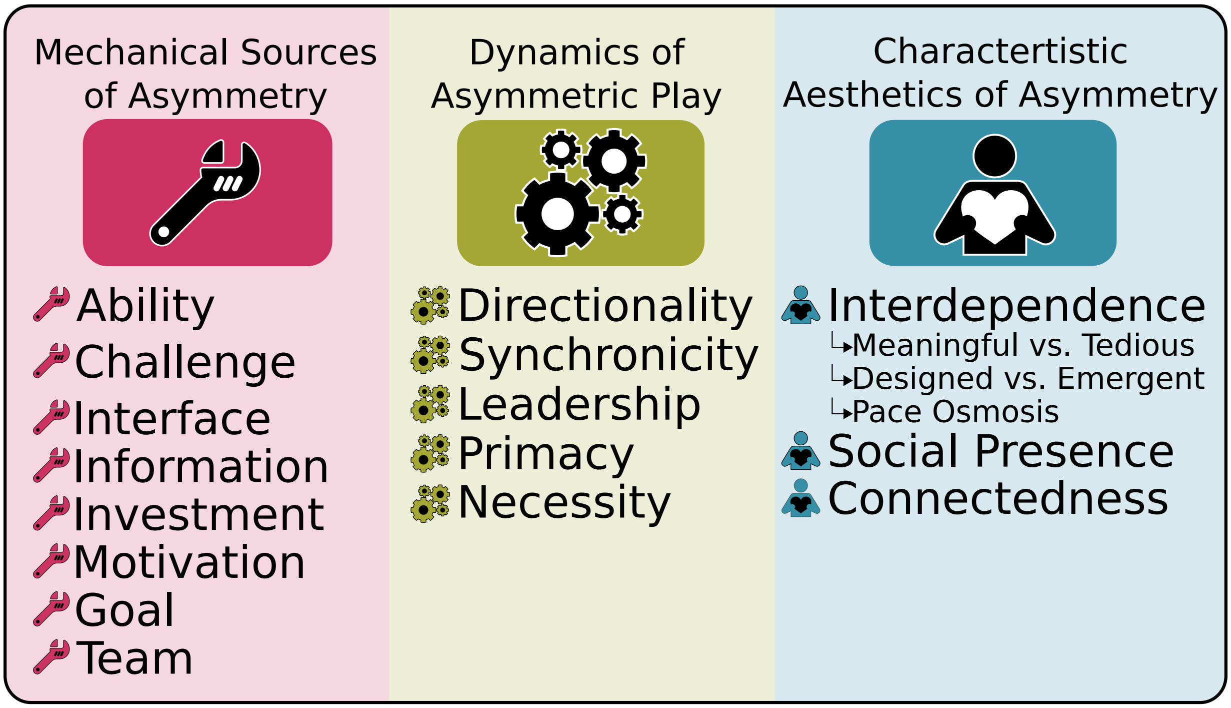


Figure 3.3: Diagram depicting the mechanics, dynamics, and aesthetic elements that I have identified as characteristic of asymmetric cooperative games over the course of my research. Descriptions of these elements can be found in the remainder of this chapter with additional discussion of the aesthetics of interdependence in chapter 8.

3.2.1 Mechanical Sources of Asymmetry

This portion of my conceptual framework describes specific means of introducing asymmetry into a game's low-level rules. These are the "levers" that designers can manipulate to create differences between players and, particularly in cooperative contexts, introduce different degrees of interdependence between them.

Asymmetry of Ability By far the most common mode of incorporating asymmetry into a game's design, asymmetry of ability is exhibited when some players are able to act in ways that other players are not. In its mildest form, this could be as simple as different cars having different acceleration/handling characteristics in a racing game. More commonly, many games allow players to select their in-game characters from a group of "classes" (e.g. medic, soldier, spy, sniper) that are each designed to fulfill a different role within a team dynamic (e.g. support, reconnaissance, defense, offense). Choosing their preferred class allows players to tailor their experience to their individual skills but, ultimately, all players are still playing essentially the same game (e.g. a band of humanoid adventurers trekking through dangerous wilderness). In more extreme cases, asymmetries of ability can drastically change the style of game the player is participating in; for example, where some players act as foot soldiers alongside other players piloting armoured tanks, or dogfighting in the sky in a shared military battle (e.g. *Battlefield 1942* (Digital Illusions CE, 2002)).

Asymmetry of Challenge Asymmetry of challenge occurs when the *types* of challenges a player encounters are different from those encountered by their peers. Consider, for example, a pizza delivery game where one player must keep the kitchen pantries freshly stocked with ingredients (managing cash flows and supply logistics) while a second player races to deliver the fresh pizzas to customers through chaotic traffic. The first player must employ foresight and planning while the second player relies primarily on reflexes and manual dexterity. This is distinct from the more common differences in the *scale* of challenge (e.g. where one player faces a greater number of enemies in an action game or a tighter spacing of notes in a music/rhythm game), which has historically been the effect of choosing a game's "difficulty setting" (e.g. from "easy" to "hard"). Asymmetries in challenge commonly result due to asymmetries of ability between player (as in the previous pizza company example) but this is not necessarily always so pronounced (as in the previous band of adventurers example).

Asymmetry of Interface Different interfaces can be more appropriate for different tasks and different users. Mouse input has been shown to afford superior performance in some pointing tasks (such as aiming in First Person Shooter games, or unit selection in Real-Time Strategy Games) while modern gamepads present a multitude of buttons, joysticks, and sensors for complex, simultaneous input which is ideal for 3D platforming, adventure, or fighting games. At the same time, different interfaces may be preferable for reasons external to the games themselves. For example, touch-screen interfaces may prove more accessible for a player with reduced manual dexterity due to age, injury, or other medical conditions.

Asymmetry of Information Asymmetry of information is exhibited when a subset of players knows something that other players do not. For example, consider a game where one player is provided a map through a labyrinth and must communicate it to their fellow players in order for everyone to escape. Particularly in cooperative games, dividing information between players typically has the effect of increasing communication between teammates as the player with the information works to transmit pertinent details in a timely manner.

Asymmetry of Investment Not all players have the same type or amount of resources to contribute to a shared play experience. People's available leisure time can vary wildly; with students often able to dedicate a few hours a day to their favourite hobbies while parents of young children may only have a few spare minutes a week to dedicate to games. A war game that exhibits asymmetry of investment could, for example, have some players execute daily hour-long tactical maneuvers with their virtual military platoon while another player takes five minutes once a week to update the overall strategic plan for the larger war.

Asymmetry of Motivation Each player's motivations for choosing to participate in play can vary widely and it can be important to be mindful of these distinctions during the design process. For example, consider young children playing the real-estate trading game Monopoly (Magie, 1906) with their parents. While the children might find the game inherently enjoyable and delight in trading properties, charging rents, and seeing their imaginary bank balances ebb and flow, the parents might choose to play as an exercise in teaching their children about simple math. For the parent, Monopoly might not be as inherently engaging as a source of entertainment, but they still "enjoy" playing for the opportunities it presents for them to take on the role of educator.

Asymmetry of Goal Similar to asymmetries of motivation, asymmetry of responsibility can arise when players seek to achieve different outcomes within the same play context. Consider the game of football/soccer where, with few exceptions (such as goal keepers), all players are provided the same equipment and play according to the same rules. However, due to the evolution of team strategies, different players choose to take on different roles and prioritize different objectives (yet they all have the same motivation to score points and win the game). The defense works to guard their goal and clear the ball, players on the wings focus on mobility and creating opportunities for passes, and strikers focus on agility and shooting. By designating specific roles to individual players, complex team strategies can form and each player's experience can be made to be largely unique from their teammates' despite all playing with the same rules, information, and abilities.

Asymmetry of Team In most competitive games, the number of players on each team is kept balanced. From a game design perspective, fairness is maintained through symmetry and there is a convenient mirroring of design where both teams have the same rules, abilities, information, and equipment. However, with careful consideration, not all games need be similarly constrained. Unique forms of play can emerge when one team is allowed to be larger than the other or more than 2 teams are set in opposition/collaboration/co-operation with each other. Balancing for fairness or longevity can be maintained by introducing other forms of asymmetry to counter-balance the difference in team size. For example, the smaller team could be provided with more potent abilities or more useful information.

While this list is not exhaustive, it can be used as a design tool to generate ideas for new gameplay mechanics depending on project requirements and constraints. It has been my experience that changing what type of mechanical asymmetry a game employs results in a major transformation of the overall player experience. As will be discussed next, altering more specific aspects of how individual mechanics are implemented can be used to create more subtle changes in a game's dynamics.

3.2.2 Dynamics of Asymmetric Cooperative Play

Through the study of asymmetry in existing games and through the application of the above mechanical sources of asymmetry in my own prototype game designs, I have identified several characteristic dynamics of asymmetric play. Particularly during cooperative gameplay, the designed asymmetries between players' mechanical abilities, interface, information, etc. can force players to rely on each other for different reasons and at different times. Each must coordinate with the other and contribute where they are best able in order for the group to meet their shared goals. Game developers and researchers can use these concepts to help inform their design choices and tailor their game's player experience to their target audience or research purpose.

In this section, I extend the concepts of "tight" and "loose" coupling outlined by Beznosyk et al. (2012) based on the player interactions I observed during my various player studies (see chapters 5, 6, 7). My framework introduces additional specificity regarding the direction and timing of interdependent player relationships.

Direction & Degree of Dependency

By manipulating a game's mechanics, distinct degrees and directions of interdependence can be engineered between multiple cooperating players. These flows of dependency between players can be visualized as a directed graph with each node in the diagram representing a sequential action taken by a player during the game (e.g. progressing from one room to the next in a maze, encountering an obstacle, activating an ability). Consider Figure 3.4, where the top and bottom row of directed circles represents the sequential actions of two independent players in a multiplayer game. In the common, fully independent case, both the blue player and the green player proceed from moment to moment without necessary regard for the other player's actions.

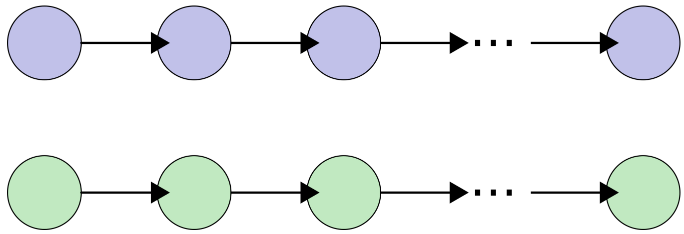
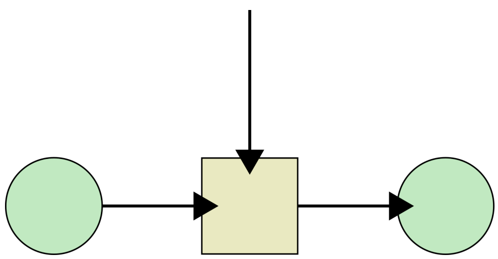
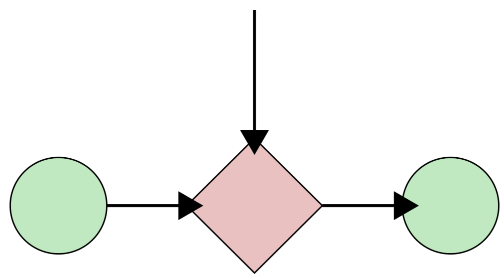


Figure 3.4: Flow diagram representing independent play of two players (blue and green).



(a) Optional interdependence.



(b) Required interdependence.

Figure 3.5: Flow diagram elements depicting moments of interdependence between players.

A point of interdependence can be represented using an incoming arrow from another player's sequence of actions. Square nodes (Figure 3.5a) can be used to represent optional moments of dependency where intervention would prove beneficial but is not strictly necessary. Diamond nodes (Figure 3.5b) can be used to represent moments of mandatory dependency where progress cannot occur without external intervention. Further visual details, such as the style of incoming line, can be used to convey additional information such as the different forms of action being taken that may be specific to a certain game's design. In this arrangement, when and how a given player is dependent on the intervention of an outside agent can be more easily communicated at design time.

With these visual aids established, we can more easily visualize the different patterns of interdependence that might occur in asymmetric cooperative games. Particularly when dependencies are not reciprocal, these dynamics can lead to interesting aesthetic imbalances between players.

Unidirectional Dependence This form of dependence emerges when one player's actions are reliant on a second player's intervention but not vice versa (Figure 3.6). For example, in the 2002 online multiplayer war game Battlefield 1942 (Digital Illusions CE, 2002), players in powerful offshore battleships (green) could use their powerful guns to bombard entire enemy bases, but first required a cooperating allied scout (blue) to sight the long-distance trajectories through their binoculars (dotted lines).

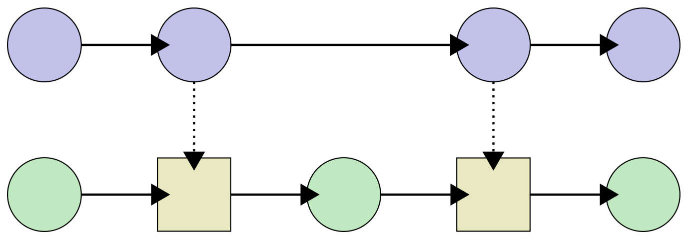


Figure 3.6: Unidirectional dependence where the green player relies on optional intervention from the blue player.

Mirrored Dependence The simplest form of interdependence, where the nature of each player's reliance on each other is identical (Figure 3.7). For example, multiple identical space marines working together in a battle. Each player is generally reliant on the others to cover their respective fronts in the conflict, lest the entire team be overrun. This form of interdependence can be viewed as more naturally *symmetric* and is common in traditional cooperative games where, for example, it is easier to explain one set of rules that all players use.

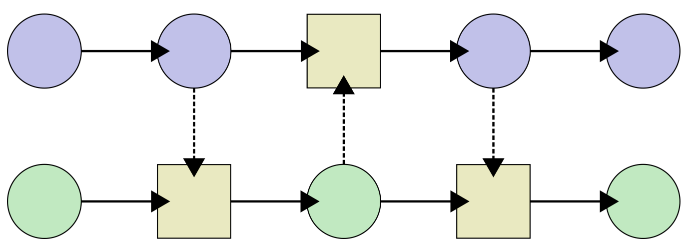


Figure 3.7: Mirrored dependency where the nature of each players' interdependence with each other is the same.

Symbiotic Dependence Where Player A's and Player B's goals are reliant on each other's intervention but through different mechanisms (Figure 3.8). For example, in zombie horror game *Resident Evil 5* (Capcom, 2009), where one player is carrying a cumbersome, two-handed flashlight down a pitch-black tunnel while a second player must protect both players by fending off encroaching zombies with a pitchfork.

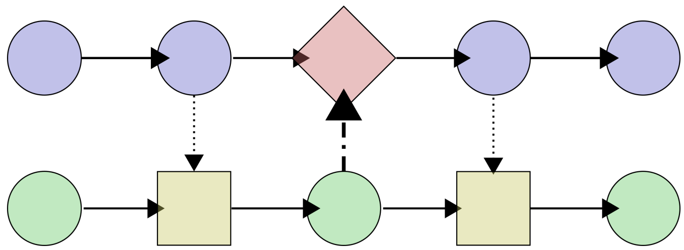


Figure 3.8: Symbiotic dependence where each player is reliant on the other in unique ways.

3.2.3 Timing and Synchronicity

Often just as important as *what* players do, *when* players act can drastically affect the aesthetics of play. When a game challenges multiple players to interact with each other, game designers must consider the duration and relative timing between each player's interdependent actions. Different types of actions can be viewed as discrete (e.g. flipping a switch, scoring a goal) or continuous (e.g. remain inside a designated region, cranking a winch to raise a platform). Similarly, individual player actions must also be considered relative to the actions of their partner (e.g. before, after, or simultaneously). Together, a number of unique design combinations emerge. Figure 3.9 illustrates these forms of synchronicity where Player A's actions are blue, Player B's actions are green, arrowheads represent discrete actions in time, and boxes represent continuous actions over time.

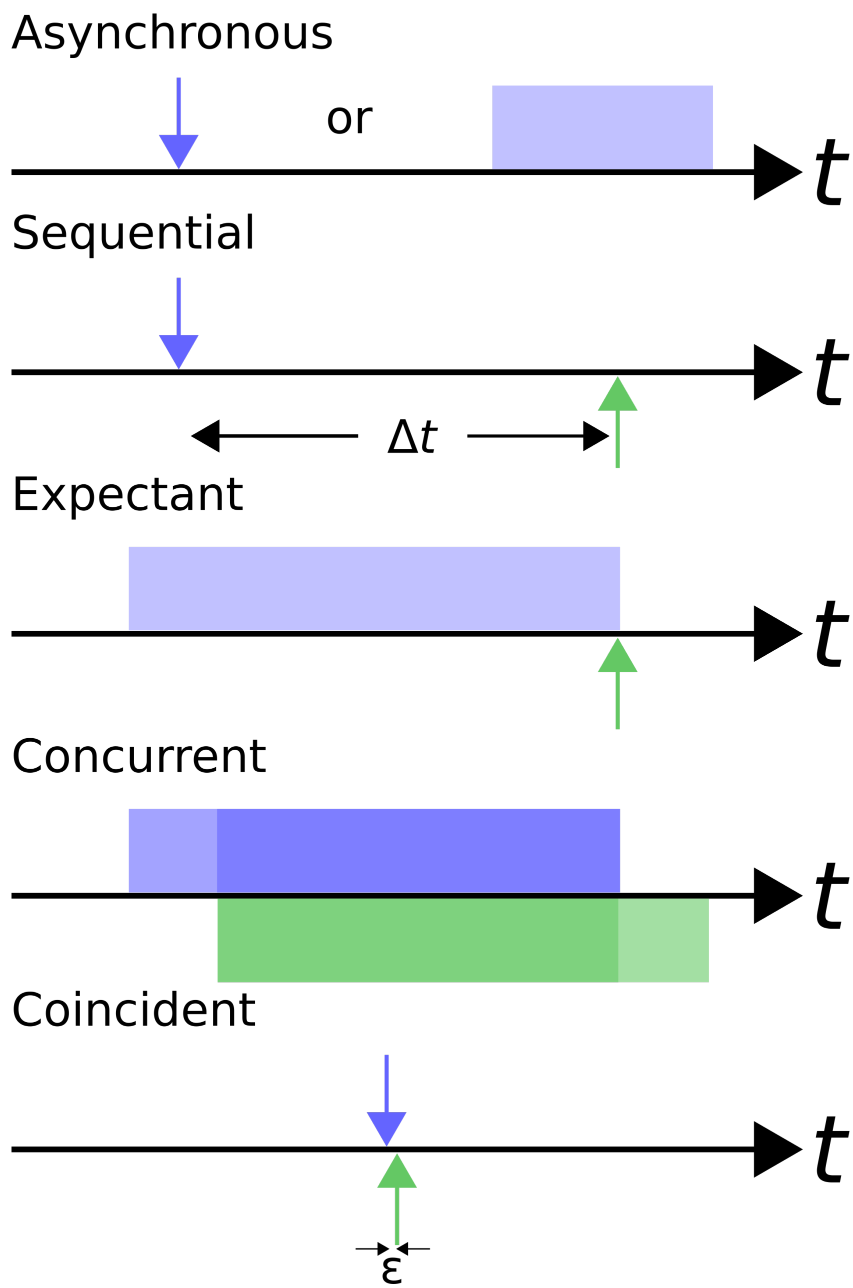


Figure 3.9: Graphical timelines depicting different degrees of synchronization between two interdependent players' actions. Player A's actions are blue. Player B's actions are green. Coloured arrowheads and regions represent discrete and continuous actions in time respectively.

Asynchronous Timing - Player A performs an action (either discrete or continuous) and Player B is unconcerned with the specifics of when. E.g., one player picks up a coin and places it in the other player's inventory.

Sequential (Disjoint) Timing - Player A completes their action some time (Δt) before Player B begins their action. E.g., one player removes the protective casing from an armoured enemy with a grenade, allowing the second player to finish the enemy off their default melee attacks.

Expectant Timing - Player A can trigger an action if Player B is prepared (and waiting). E.g., one player must stand atop a spring-loaded gate, weighing it down into place, while the second player locks the mechanism into place.

Concurrent Timing - Both Player A and Player B continuously perform their respective actions. E.g., one player controls the left tread of a tank while the second player controls the right tread.

Coincident Timing - Player A and Player B must perform discrete actions at the same moment (or within some small ϵ). E.g., both players must throw a matching pair of switches within 1 second of each other.

Considering both the direction and timing of interdependence can be a useful design exercise for generating new play mechanics or modifying existing ones. My third player experience study (chapter 7) investigates elements of this theory directly. The results of that study indicate that there is a qualitative increase in "interestingness" (or at least the difficulty of execution) as well as a quantitative increasing in feelings of social connection as one progresses down these lists. For example, actions with coincident timing are distinctly harder to execute than those with disjoint sequential timing. Considering these heuristics when designing for the generation of flow states (Csikszentmihalyi and Csikszentmihalyi, 1992) (i.e., tuning for appropriate challenge level), this would suggest for example, that pairs of more skilled players would likely prefer coincident timing and symbiotic interdependence over less demanding forms.

3.2.4 Leadership & Primacy

In order to achieve a shared goal in a cooperative setting, interdependent players must constantly strategize and negotiate with each other over what objectives should be prioritized, which player is best able and best equipped to pursue those goals, when to take action, and what the other players should be doing in the meantime. This cycle of observation, negotiation, decision, and action repeats on both rapid time scales (e.g. "I'll deal with this enemy while you stun that one!") and large time scales ("Let's take our time and explore. We might find hidden treasure!").

Even in games where the narrative designates one player as a leader or captain, the resultant dynamics of cooperative play can yield very different outcomes. Depending on the preexisting relationships between players or the asymmetries designed into a game's mechanics, some interdependent teams can exhibit fluid leadership dynamics where players trade proposed strategies back and forth. In other scenarios, particularly with teams of players with significant imbalances in skill, a minority of players can dominate the decision making process and dictate the entire group's actions. (E.g., "You go here. Now go there. Ok, keep going while I do this.")

I distinguish this "leadership" dynamic from the related but distinct concept of "primacy" that I have observed in interdependence pairs. Primacy, in these cases, refers to the the motivating dynamics that prompt and drive leadership choices. For example, if one player is suddenly ambushed by enemies, their sudden and direct bodily danger would assume primacy, rapidly override existing team goals, and prompt new leadership proposals to spring forth. (E.g., "Oh, wow! Watch out! Let's deal with those enemies first!")

The important distinction between these dynamics lies in how the player motivating strategic decisions (the player in danger) and the player making those decisions (the team leader) can be made to be the same or different players depending on the game's design goals. Constantly placing the more skilled player in dangerous situations and forcing the less skilled player to make leadership decisions (e.g., by providing the less skilled player with powerful asymmetric information) can be a way of prompting an interesting social role reversal.

3.2.5 Necessity

Finally, whether or not players' interdependence is strictly necessary at a mechanical level can have a powerful impact on players' social play experiences. Increasing the frequency and degree of interdependence between players such that one player cannot succeed without their partner sets up a tight coupling between them and *forces* them to cooperate in order to succeed in the game. This can have a strong impact on their perceptions of social connectedness (e.g., two enthusiast gamers seeking a teamwork challenge) but can also lead to feelings of frustration and disappointment if players don't live up to each others' expectations. Conversely, creating loose coupling between players that doesn't necessarily require collaborative intervention can result in feelings of disconnection and lack of importance for some player groups *or* a stress-free environment of welcome but non-critical assistance (e.g., a teenager allowing their younger sibling to play an optional support role).

3.3 Aesthetics of Asymmetry

In the MDA framework, a game's aesthetics emerge during play in combination with each player's unique perspectives and expectations and is the element that the game's designers have the least direct control over.

In my research, I have focused on identifying mechanical elements and gameplay dynamics that can enhance players' experiences of interdependence (Johnson, 2003), relatedness (Przybylski et al., 2010), social connectedness (Gachter et al., 2015), and social presence (Kort et al., 2007).

In order to test the effects of these elements, I have incorporated several of the above mechanics and dynamics of asymmetry into my own prototype game designs; providing a configurable platform with which to conduct formal player studies and explore the emergent aesthetics of asymmetric play. In the next section, I describe the development of two of my most fully-developed prototype games *Goombagrams* and *Beam Me 'Round, Scotty!*.

3.4 Chapter Summary

In this chapter, I presented my conceptual framework for the design and study of asymmetric cooperative games, originally based upon the MDA framework from Hunicke et al. (2004), and refined over several player experience studies and prototype design iterations.

The specific contribution from this chapter is:

- A conceptual framework, building upon the MDA framework of Hunicke et al. (2004), describing specific mechanical means of generating asymmetries between players in cooperative games, the characteristic dynamics of asymmetric cooperative play, and the resultant nuanced aesthetics of interdependence in these games.

In the next chapter, I describe my overarching research approach and two of the experimental prototype games I developed as part of my iterative process for validating and refining my conceptual framework.

Chapter 4

Research through Design and Development

In this chapter, I describe my overarching approach to studying asymmetric cooperative games and their ability to enhance players' social experiences. I describe why I chose to adopt a medium-fidelity prototyping strategy and I describe the various prototype games I have developed to serve as experimental tools over the course of my research.

Games User Research's (GUR) focus on the phenomenology of players' experiences leaves academic researchers in a difficult position particularly when it comes to the study of social play. The phenomena being studied during individual play emerge when a player engages with the complexity and sophistication of modern digital games. However, the phenomena being studied during social play are *supported* by the playful context games provide but are ultimately *created* by the players themselves. Cutting edge graphics, complex and nuanced controls, compelling narratives, and immersive sound design are all important components of how games engage players and hold them spellbound but are only the first necessary layer from which genuine social play experiences emerge. Playful banter, vulnerability, mentorship, relationship growth, and group bonding are a desirable byproduct of social play that can theoretically be encouraged with effective game design but cannot be overtly forced upon players.

While researchers in industry may be able to leverage the variety of technical expertise within their own companies to run player studies using higher-fidelity prototypes, academic researchers often find replicating that same degree of in-game sophistication extremely difficult without the hundreds of creative professionals, millions of dollars, and years of work that are necessary to create modern games. Faced with relatively severe limitations in time, person power, and budget when attempting to run their own player experience studies, academic games researchers must often choose between either employing commercial games or building their own prototype games. Each approach has distinct advantages and disadvantages.

Using commercial games in player experience studies allows researchers to observe player interactions with authentic, complex, high-fidelity products but denies researchers low-level control over how those games behave and look. Researchers can observe players' responses to a particular game but it can be difficult to generalize those results and compare them to players' experiences with other games that likely have vastly different controls schemes, mechanical systems, visual aesthetics, and so on.

When building their own prototype games, researchers maintain full control over the low-level mechanics of the player experience and so can affect much more subtle experimental manipulations but are often forced to boil the aesthetic complexities of modern digital games down into more practical abstractions with simplistic graphics, basic controls, little to no narrative motivation, and only rudimentary sound design.

Theoretically, this low-fidelity approach has the additional advantage of also being more scientifically tractable in the sense that using low-fidelity prototypes might provide "pure", basic, and confound-free examinations of the "true" player experiences underlying the messy complexity of modern digital game play. However, boiling games down to simplistic abstractions risks diminishing or distorting the complex social play phenomena that emerge on top of gameplay and that are actually the focus of social play studies. This caution is echoed by recommendations in Isbister's (Isbister, 2010) framework for enabling social play wherein she argues that, in order to best study social play phenomena, researchers should place particular emphasis on ecological validity: employing more fully fleshed-out games rather than low-fidelity prototypes, recruiting study participants with preexisting social relationships, and playing in familiar social contexts such as at home rather than in a laboratory.

Considering both the emergent nature of social play phenomena and the mercurial fluidity of players' preferences, I would argue that this tension between gameplay fidelity and scientific tractability in the study of social play phenomena represents a "wicked problem" as described by Rittel and Webber (1973):

> "[A wicked problem] is a problem with multi-faceted complexity, shifting stakeholder desires, and one where the information needed to understand them depends on one's idea for *solving* it. That is to say: in order to *describe* a wicked problem in sufficient detail, one has to develop an exhaustive inventory of all

> conceivable *solutions* ahead of time. ... Of course, the higher the level of a problem's formulation, the broader and more general it becomes and the more difficult it becomes to do something about it... The one-best answer is possible with tame problems but not with wicked ones."

Although Rittel & Webber were originally discussing the difficulties of finding general solutions to complex societal/governmental planning problems, Zimmerman et al. (2007) highlighted how the same wicked complexity can be observed in HCI research and interaction design. How can a researcher determine the one best solution to an interaction design problem given all possible contexts and users? Similarly, how do we determine the one best combination of game elements given all possible play contexts, preferences, and social combinations?

When faced with complex, under-constrained problems that are difficult for traditional scientific and engineering approaches to address, Zimmerman et al. argued for the adoption of a *research through design* approach that instead seeks to understand wicked problems from multiple perspectives, generate many possible solutions, and refine our understanding of those problems through cyclical iteration.

Rather than first focusing on the *universal*, research through design focuses on the *particular* by, as described by Stolterman (2008), "creating something with a specific purpose, for a specific situation, for a specific client and user, with specific functions and characteristics, and done within a limited time and with limited resources."

The result, as elaborated upon by Gaver (2012), is that "instead of being extensible and verifiable, theory produced by research through design tends to be provisional, contingent, and aspirational." These designed particulars can go on to inspire thriving research programmes that eventually build up a wider constellation of concrete exemplars. From that constellation, we can then draw broader conclusions about the design space itself and return to improving our understanding of the underlying scientific "truths".

For these reasons, I have adopted a *research through design* approach in my own work. By participating in the iterative design, development, and study of my own particular prototype games (Figure 4.1), I can control the mechanical elements of my players' gameplay experiences and observe whether and how my deliberate manipulations affect their social play experiences.

My work focuses on co-located players with pre-existing social relationships playing medium-fidelity prototype games that strike a balance between experimental control and ecological validity. My primary metrics stem from statistical analysis of players' self-report

Figure 4.1: Iterative progression of the Kirk avatar's appearance in my prototype game *Beam Me 'Round, Scotty!*. From left to right: a basic placeholder (2014), basic animation with a blocky appearance (2015), more complex animations and female appearance (2016), final model used for 3rd-person, over-the-shoulder perspective (2017 onward).

surveys and thematic analysis (Braun and Clarke, 2006) of play session video and audio recordings.

Finally, it is important that I acknowledge that although the generation of bonding social capital as a result of interdependence during play may be *prompted* by the skillful design of asymmetric cooperative games, social capital is ultimately cemented through repeated social exchanges between players *over time* and *outside* of play. To accurately gauge whether a particular set of game elements can be more or less effective at generating bonding social capital in a prescriptive manner would require executing difficult and costly longitudinal studies.

As such, in the aspirational spirit of research through design, my research and player experience studies focus on players' much more immediate perceptions of social closeness, relatedness, and behavioural engagement. It is my implicit hypothesis that enhanced perceptions of these emotions and behaviours will lead to long-term improvements in players' social capital, however it has proven necessary to first uncover effective mechanical means by which to enhance these precursor feelings through a game's design. Thus, the research I describe in this thesis is knowingly but a first step; an exploration of how to deliberately generate those precursor feelings in players with the eventual goal of long-term, beneficial social outcomes.

Having outlined my approach to research, in the next section I describe my approach to game design and my conceptual framework outlining the mechanical means I have identified of leveraging asymmetry and interdependence to enhance players' social experiences during play.

4.1 Prototype Games

While the above conceptual framework was originally based on observations of existing asymmetric cooperative games from industry and academia, it was repeatedly expanded and refined in combination with both the iterative development of my own prototype games and the subsequent player experience studies I conducted using them.

The two most fleshed out prototypes, *Goombagrams* and *Beam Me 'Round, Scotty!* (*BMRS*), were originally designed and developed in parallel, deliberately designed around sharply contrasting genres in order to better explore the design space of asymmetric cooperative games and test the flexibility and utility of my emerging framework as a design tool.

Conceptually, both games focus heavily on introducing asymmetries of ability between player (i.e., "I can do something you can't" and vice versa) because this form of asymmetry is, by far, the most popular asymmetry found in existing commercial games and thus there were many example mechanics to draw on. At the core of most games is a set of rules governing what players can and cannot do within the game world. Creating a separate, asymmetric set of abilities for a second player simultaneously with the first is a natural extension of the initial game design process.

I also focused on introducing asymmetries of interface where possible. From a usability perspective, certain styles of play (e.g. platforming versus strategy games) are better suited to certain input and output devices (e.g., gamepads versus mouse/keyboard respectively) and so these asymmetries of interface were a natural compliment to players' asymmetric abilities. Introducing asymmetries of interface was also a relatively cost efficient means of deepening my exploration of how different forms of asymmetry affect players' social experiences.

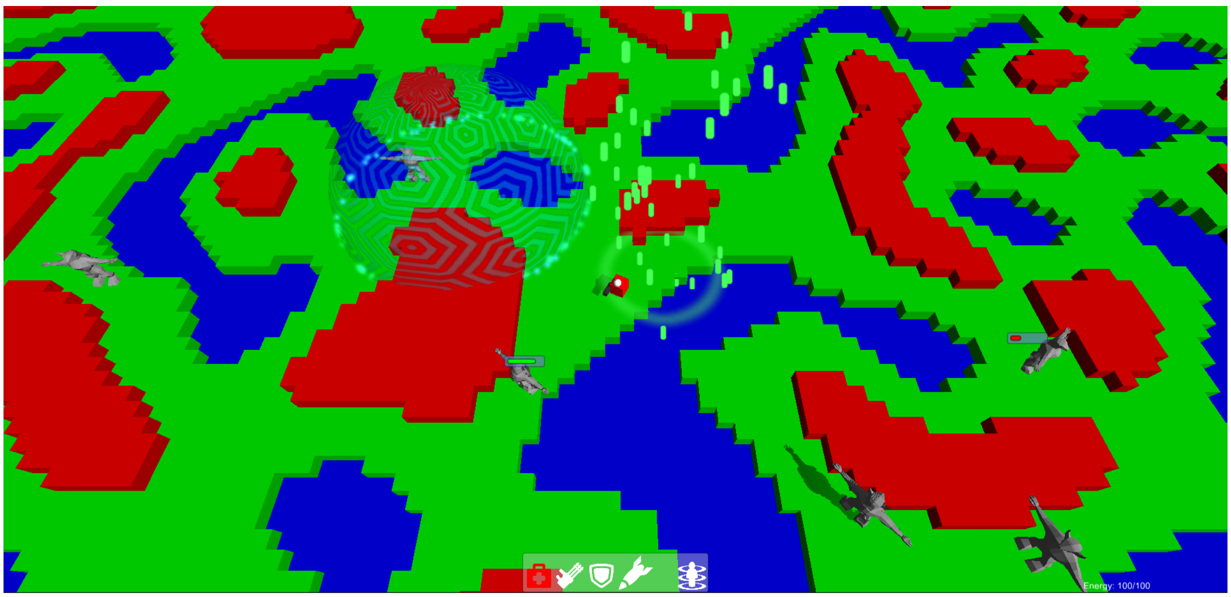


Figure 4.2: A screenshot of one of the earliest iterations of *Beam Me 'Round, Scotty!* circa 2014. Here, the Kirk avatar (represented as a simple red box with white sphere-ical "head" at center) traversed a procedurally generated terrain seeking an exit. The Scotty player has deployed a "shield bubble" (patterned transparent sphere, center left) and "heal beam" (green dashes, top center) via their ability selection menu (icons, bottom center). Although Scotty's ability set would change and the procedural terrain would later be replaced with deterministic, designed level sections, the essential elements of *BMRS* gameplay were present even at this earliest stage.

Finally, as I continued to iterate on my prototype games' designs and particularly with *BMRS*'s second and third versions (see chapters 6 & 7), I was eventually able to introduce simple asymmetries of information between players. In contrast to the often silent, zen-like flow states some players can slip into when playing with identical information, these asymmetries of information often prompt new, more overt examples of social interaction between study participants as they worked to communicate, share information, and strategize together.

Goombagrams was deliberately designed to served as a point of comparison and contrast to *Beam Me Round, Scotty!* by combining two new game genres along with a distinct visual aesthetic so as to improve the generalizability of my conceptual framework and design recommendations. Where *Beam Me Round, Scotty!* combined elements of third-person adventure games (e.g., *The Legend of Zelda* (Nintendo EAD, 1994)) with mouse-based strategy games (e.g. *DotA2* (Valve Corporation, 2013)) and semi-realistic 3D visuals (see Figure 4.6), *Goombagrams* combined word-centric puzzle games (e.g., *Scrabble* (Butts, 1938), *Bananagrams* (Nathanson, 2006)) with action platforming games (e.g., *Super Mario Bros.* (Nintendo Creative Department, 1985), *Megaman* (Capcom, 1987)) and a colourful, cartoonish 2D style (see Figure 4.5).

In both cases, one player was intended to fulfill a relatively action-oriented role while their play partner filled a relatively slow and more thoughtful role. In both prototypes, each player used a different hardware interface from their play partner (i.e. gamepad versus mouse).

The iterative design and development of both prototype games took place over many months (and years, in the case of *BMRS*) including numerous informal playtesting sessions and public exhibitions. *Beam Me 'Round, Scotty!* in particular benefited from testing and design feedback from the University of Waterloo's Undergraduate Game Development Club. As *BMRS* grew and evolved, I would bring the latest iteration of the game to the club's weekly meetings and receive insightful design-centered feedback from fellow game designers. Over the course of my research, *BMRS* was also exhibited at several of the Games Institute's public-facing events and thus I was able to gather more player-centered feedback from lay members of the public. This multitude of perspectives and repeated opportunities for iteration was instrumental in refining the *BMRS* play experience in between formal player experience studies.

A particularly encouraging aspect of these many informal playtesting opportunities was watching strangers play my prototype game for the first time. Once the controls had been explained to them, players would eagerly work to finish the levels without my input. What's more, when public players finally managed to work together and help Kirk reach the exit, they would often spontaneously "high five" each other in celebration. Not only had many of these players never seen *BMRS* before but, particularly in the case of the public exhibitions, they had often never met their play partners before either. That *Beam Me 'Round, Scotty!* was enjoyable enough as a game in it's own right and successful enough as an exercise in creating feelings of interdependence and connectedness to prompt strangers to publicly celebrate together was viewed as a powerful, if informal, indicator that my research showed promise.

In the following sections I describe the relevant mechanics and dynamics of *Goombagrams* and *Beam Me 'Round, Scotty!* in more detail. Later, in chapters 5, 6, and 7, I discuss the player experience studies I conducted using *Beam Me 'Round, Scotty!* and the insights I gained from them that informed my understanding of the characteristic aesthetics of asymmetric cooperative play.

4.1.1 Goombagrams

The prototype that would come to be called *Goombagrams*[1] was originally conceived under the alternate title *Lemmingrams* as part of a tentative research collaboration with Microsoft Research's *Illumishare* (Junuzovic et al., 2012) project. A unique, prototype hardware device resembling an articulated desktop lamp, the *Illumishare* contained both a camera and digital projector within its head. Pairs of *Illumishare* devices could be used to simultaneously capture, transmit, and re-project physical desktop surfaces to remote partners. This created a shared, digitally augmented workspace through which, for example, a paper with handwritten notes on a first *Illumishare* desktop would be digitally projected onto a second *Illumishare* desktop. A collaborator could then make their own physical notes that would, in turn, be re-projected back to the first desktop. From the perspective of developing new asymmetric games, I found the prospect of combining physical and digital elements into the same gameplay environment to be an attractive opportunity.

In order to take advantage of the unique physicality and tabletop form-factor of the *Illumishare* interface, I conceived of *Lemmingrams*: a combination of the puzzle/herding game *Lemmings* (DMA Design, 1991) and the letter-tile shuffling word game *Bananagrams*

[1] In order to expedite the parallel development of both *Goombagrams* and *Beam Me 'Round, Scotty!* as well as bring an alternative perspective to the use of my conceptual framework as a design tool, practicing independent game designer Jay Chilibecki was hired as an Undergraduate Research Assistant to lead the development of *Goombagrams* while I focused on the development of *Beam Me 'Round, Scotty!*. Over the course of his four month term, Jay worked with me to transpose the emerging themes of asymmetric play observed in the earliest versions of *Beam Me 'Round, Scotty!* into the unique mechanics and aesthetics of *Goombagrams* and vice versa.

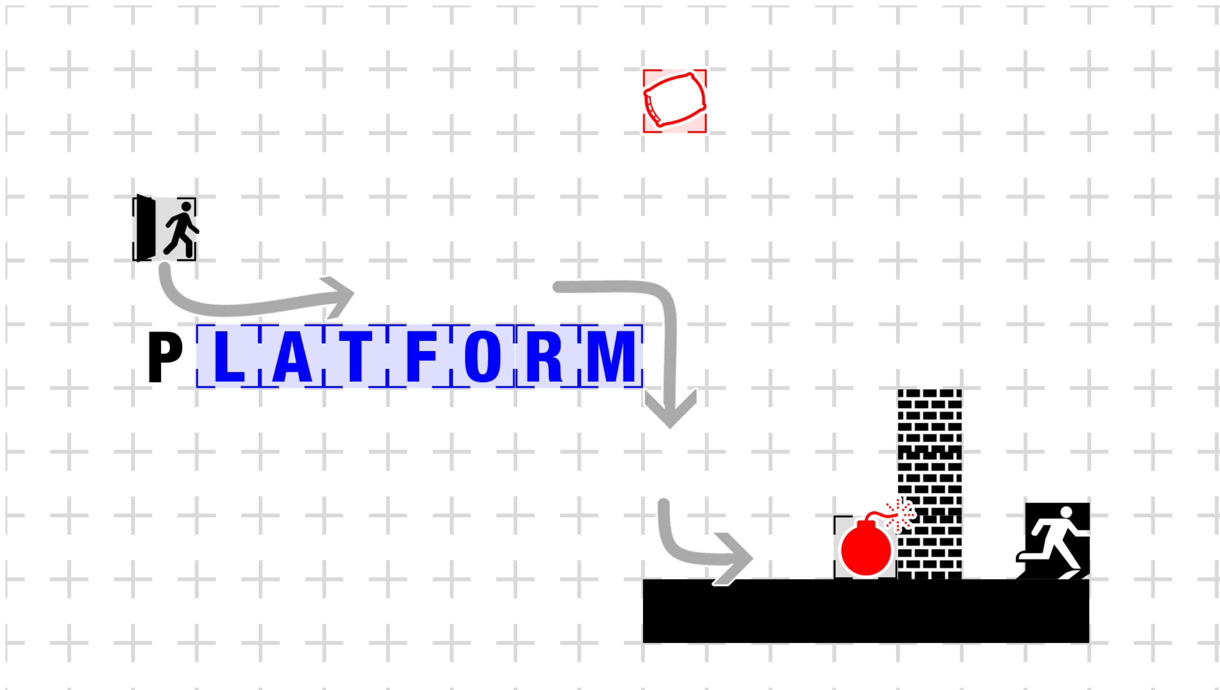


Figure 4.3: An early concept image depicting the essential features of a *Lemmingrams* level. Both players must shepherd a "lemming" from the entrance door to the exit door using a series of tools/gadgets such as pillows or bombs to affect the environment (red player) or by spelling out words to form physical platforms (blue player).

(Nathanson, 2006). Both games have a strong emphasis on the physical placement of tangible artifacts that can indirectly affect a simulated game world and so were a natural fit for adaptation to the *Illumishare*.

The *Bananagrams* inspiration in particular drew on my own experiences playing similar word games (e.g., *Scrabble* (Butts, 1938)) with friends and relatives. In my experience, the slower pace and more thoughtful nature of word-centric games tends to appeal to older players. Further, the ability to incorporate physical letter tiles into *Lemmingrams* via the *Illumishare* devices was viewed as an excellent way to incorporate a tangible, low-tech gameplay interface in an envisioned "elder gamer" design persona (Grudin and Pruitt, 2002).

Figure 4.3 shows an early *Lemmingrams* design diagram. The goal of each *Lemmingrams* level was for a pair of players to cooperatively shepherd a non-player character "lemming" (i.e., a character that mindlessly walks forward) from an entrance door to an

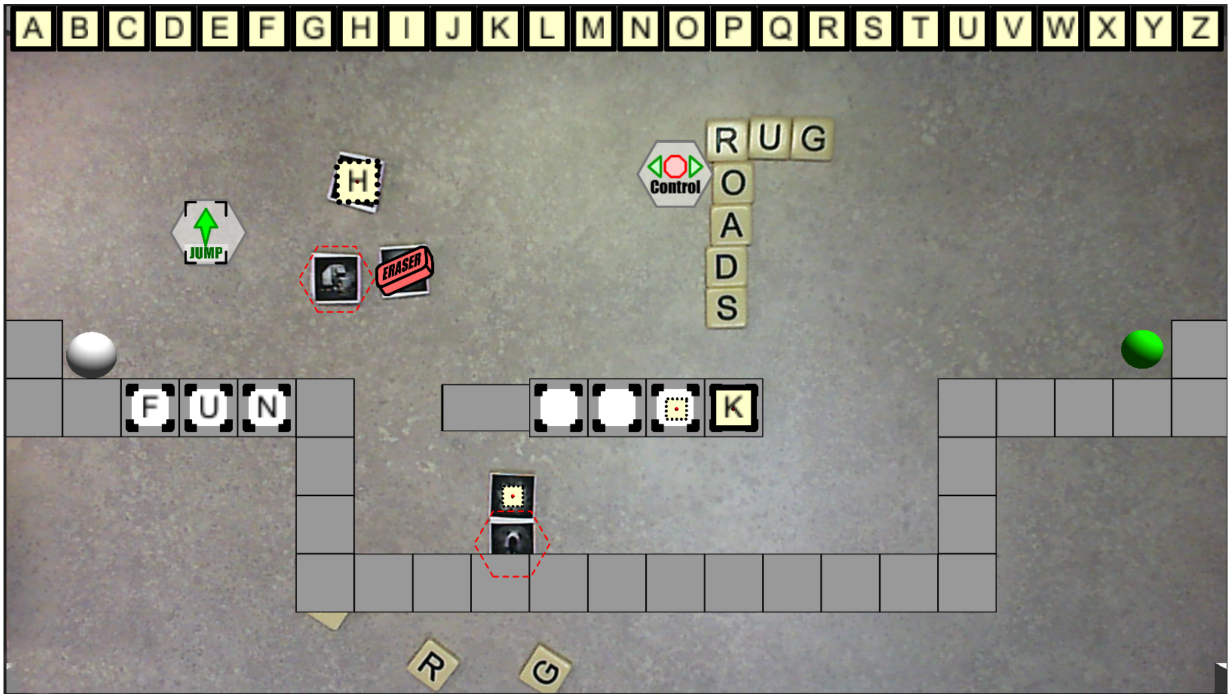


Figure 4.4: An early prototype image of *Lemmingrams* using a single *Illumishare* device. Using the *IllumiShare*'s camera, the *Bananagrams*-style player could place physical tiles on a real tabletop which the virtual, platforming, non-player character (represented as a white sphere on the left) could then travel across.

exit door. In Figure 4.3, black objects depict parts of the virtual puzzle/level, blue letters represent physical tiles that the *Bananagrams* player has placed to spell words and thus create physical platforms, and red icons represent "gadget" tiles that the second player has placed to affect the physics or layout of the level. In this particular case, the red player has placed a pillow that will fall to the base of a drop that the lemming is expected to fall over as well as a bomb that will create a hole in a wall that is otherwise obstructing the lemming's path to the exit door.

Figure 4.4 shows an early *Lemmingrams* proof-of-concept using a single *Illumishare* device. A desktop with physical letter tiles can be seen with the game world and puzzle elements virtually overlaid in the foreground. Due to ongoing technical setbacks with the *Illumishare* software however, we opted to abandon the unique hardware. We used this change as an opportunity to make the two player roles in *Lemmingrams* even more asymmetric from a conceptual perspective. Where previously both *Lemmingrams* players had interacted with the game by placing physical tiles within the *Illumishare* workspace, now we were free to refocus our prototype's design using more traditional but more distinct combinations of mouse, keyboard, and gamepad inputs (an approach *Beam Me 'Round, Scotty!* was already employing by that time).

Thus, the *Lemmings*-inspired role was dropped from the game and replaced with a classical 2D platforming role in the vein of *Super Mario Bros.* (Nintendo Creative Department, 1985) and *Megaman* (Capcom, 1987). In this way, rather than both players affecting the same simulated non-player character, one player would now *be* that affected, in-game character. The *Bananagrams* player would still "spell out" platforms and trigger in-game mechanisms, but the second player would now actively be the one to run across and interact with those mechanisms in the game world.

To reflect this shift in design, the prototype game was renamed from *Lemmingrams* to *Goombagrams*; With "Goomba" being the name of the very first, brown, mushroom-shaped, enemies encountered in the original *Super Mario Bros.*. Figure 4.5 shows a screenshot of the redesigned *Goombagrams* prototype with its much more vibrant *Super Mario*-inspired visual style.

For convenience, I will henceforth refer to the two *Goombagrams* players and their respective asymmetric interfaces/abilities/challenges using the same shorthand names used during the internal development of the prototypes: with the "Megaman" 2D platformer role played using a gamepad (named after the hero of a long-running platforming game series) and the letter tile placing puzzle "Wiley" role played using a mouse (named after a cunning older scientist character from that same game series).

Now free from the constraints imposed by the *Illumishare* cameras, we were able to focus on exploring the design space of the asymmetric player roles presented by *Goombagrams*. Applying early versions of my conceptual framework, we were able to expand upon the basic asymmetries between the two players' cooperative mechanics and generate new mechanics to fill gaps identified via the framework.

For example, the "spelled words form physical platforms" mechanics established in *Lemmingrams* carried forward into *Goombagrams* and represented a form of unidirectional dependence with sequential timing; the Megaman player would have to wait for the Wiley player to form certain platforms before being able to proceed. Seeking to create a complimentary mechanic which imposed a unilateral dependence of Wiley waiting for Megaman, "letter loot" enemies were created. These enemies would have key letter tiles visibly locked away inside them (much like a treasure chest) but would require the Megaman player to first defeat the enemy using their platforming abilities (e.g. jump on the enemy's head) before the Wiley player could use the letter tile to solve word puzzles elsewhere in the level.

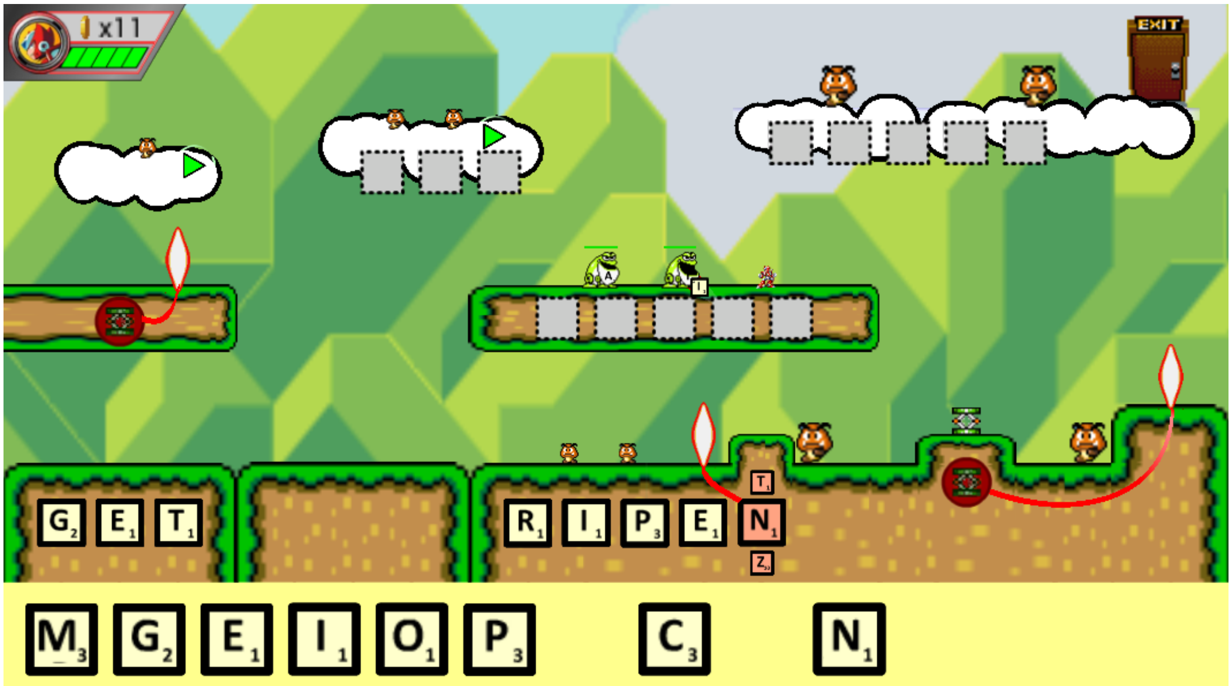


Figure 4.5: Screenshot of the final version of *Goombagrams*. The “Wiley” (Scrabble) player now played using a mouse and had to spell words to unlock props for the platforming player to employ. Conversely, the “Megaman” (platforming) player could “unlock” letter tiles and word slots for the “Scrabble” player to use; forming a bidirectional dependence.

By charting the various forms of directional dependence and synchronicity between the Megaman and Wiley roles, my conceptual framework allowed us to identify several more gaps in the variety of asymmetric mechanics and dynamics within *Goombagrams*. For example, my framework prompted us to design letter tile slots that Wiley could not manipulate unless Megaman was standing on a specific switch. By setting that switch in a dangerous location, we could thus create an exciting challenge scenario with expectant timing where the Wiley player would have to pay attention to and anticipate the Megaman player’s actions.

We were also able to expand this framework-guided mechanics brainstorming approach into the higher-level structure of the *Goombagrams* levels themselves. For example, the structure of one puzzle level was designed to focus on a central elevator shaft. Wiley could direct the elevator carriage to move to different floors based on the length of the word spelled out in the word slot connected to the elevator. Since both the Megaman and Wiley players could see the entire level (with all possible floors and rooms) from the outset, this provided both players an opportunity to plan and strategize together about which floors to attempt to visit first and which challenges to try to overcome in what order. Certain floors were locked off without Megaman first obtaining extra letter tiles from “letter loot” enemies and so the rhythm of this level flowed from planning, to moving the elevator, defeating the enemies on a certain floor, and then repeating the process with a new round of planning once the additional letter tiles had been obtained.

Although no formal player experience studies were conducted using *Goombagrams*, it was frequently playtested informally by fellow researchers and members of the university game development community. Guided by my conceptual framework, we continued to develop new mechanics to interconnect the Megaman and Wiley players in different ways but eventually identified a new, overarching problem permeating the *Goombagrams* play experience: while the Wiley role was designed to appeal to our envisioned persona of a *Scrabble*-loving, older gamer (i.e., a player who preferred slower-paced, thoughtful challenges over high-speed, reflex-based, action challenges), with each new interdependence mechanic that was implemented, playtesters noted that the perceived pace of both the Megaman role and the Wiley role were increasingly bleeding into each other.

With the exception of “Speed Scrabble” (where players challenge themselves to place words as quickly as possible), the feeling of being rushed or having to come up with new letter combinations by urgent request of outside players is antithetical to the slower, contemplative experience most avid *Scrabble* players typically enjoy. Yet essentially all of the new mechanics that required the Megaman player to wait for the Wiley player (e.g., any interdependence dynamics with Expectant, Concurrent, or Coincident timing) imposed an uncomfortable haste upon the Wiley role. Those *Goombagrams* playtesters who expressed that they normally preferred *Megaman*-style play over *Scrabble*-style play also described the uncomfortable sluggishness that the cooperative interdependence of *Goombagrams* forced upon them. Conversely, playtesters who played as Wiley but were otherwise ambivalent between the two roles did not mind the urgency of the word play but did express how the Wiley role felt more constrained and less interesting than the Megaman role.

By this point, I had decided that the distance between the target “Megaman enthusiast” and “Scrabble grandparent” persona around which the *Goombagrams* roles were designed was too wide a design gap to easily bridge within the basic premise of *Goombagrams* as it existed at the time. Considering the second significant overhaul that would be required in order to have *Goombagrams* work well as an experimental tool, it was decided that ongoing research and development efforts would instead focus on *Beam Me ’Round, Scotty!* as it was designed around target player personas (i.e., “action gamers” and “strategy gamers”) typical of gameplay with much more similar pace.

This critical design challenge of "pace osmosis" and how it appears particularly difficult to overcome in tightly-coupled asymmetric roles is revisited in section 8.2 where I discuss the complex interactions between pace and necessity in interdependent play. In the following section, I describe the *Beam Me 'Round, Scotty!* prototype game in more detail.

4.2 Beam Me 'Round, Scotty!

In this section, I describe the underlying narrative basis for *Beam Me 'Round, Scotty!*, the core mechanics of its two player roles, and the design of the primary test levels used in the three player experience studies that constitute chapters 5, 6, and 7.

With a wider variety of existing games from more popular genres to draw inspiration from, *Beam Me 'Round, Scotty!* (*BMRS*) proved to be a more flexible prototype and a more tractable experimental tool. The core narrative framing for *Beam Me 'Round, Scotty!* solidified early and from that anchoring sprang a natural abundance of relevant mechanics, visuals, and sound designs.

While the design details most relevant to my research (e.g., player's asymmetric abilities and how they interacted with each other) are discussed below, Appendix A presents additional details that may help to clarify more peripheral details of potential interest (e.g. the technology the prototype was developed with and in-game enemy behaviours). To further elucidate the design details discussed below, Appendix B includes a supplementary video demonstrating representative gameplay from the different versions of *BMRS* discussed throughout this work.

4.2.1 Narrative

In order to provide players with a quickly understandable narrative context, I modelled the in-game characters and scenarios of *BMRS* around the popular television series *Star Trek*. Previous knowledge of *Star Trek* was not required to play or understand the game however and the in-game character names "Kirk" and "Scotty" were simply used as short-hand labels to encompass the respective asymmetries of interface (gamepad vs. mouse), abilities (shooting vs. teleporting), and challenges (reflex vs. planning) players experienced in each role.

In *BMRS*, one player would control the courageous space captain Joanna T. Kirk using a dual-joystick gamepad in an action-oriented experience that challenged players'

Figure 4.6: Two screenshots from the second iteration of *Beam Me 'Round, Scotty!*. On the left is the Scotty player's overhead perspective of the game world played on a multi-touch table. On the right is the Kirk player's perspective played from an over-the-shoulder, third-person perspective using a gamepad.

manual dexterity, coordination, and reaction speed. Kirk's mechanics focused on walking, aiming, and shooting a simple blaster while avoiding taking damage from hostile aliens and environmental hazards (Figure 4.7).

Simultaneously, the second player assumed the role of plucky engineer Scotty who, still aboard an orbiting starship, deployed the ship's various special abilities to assist Kirk in her adventures. The Scotty experience was designed to be low-anxiety and low-speed while favouring forethought over reflexes.

4.2.2 Special Abilities

Over *BMRS*'s various iterations, Scotty's special abilities always followed the same five core themes. These themes were designed to cover a variety of actions players might expect to encounter over the course of playing including offensive, defensive, locomotive, and utility actions:

- a Shock Beam that could stun enemies in place and power-up machines
- a Heal Beam that could restore Kirk's vitality
- a defensive Shield that could protect Kirk from enemies and hazards

Figure 4.7: A promotional rendering of Kirk navigating the alien world as used in recruitment posters for the third *Beam Me 'Round, Scotty!* study (chapter 7). Based on recommendations from (VandenBerghe, 2012) highlighting the importance of how players come to experience new games (in addition to their experiences while playing them), extra care was placed into promotional material so as to set an authentic tone starting from participants' first exposure to *Beam Me 'Round, Scotty!*.

- a Bomb that could blast enemies and obstacles after a short delay
- a Teleporter that could instantly move Kirk short distances

Deploying these abilities would cost Scotty energy; energy that was drawn from a pool that slowly regenerated but had to be carefully managed lest Kirk end up left in a dangerous situation without support. In certain situations, Kirk could also pick up energy orbs in the game world that would provide Scotty with a quick boost of energy. In this way, scenarios could be designed that reverse the usual dynamic of Kirk relying on Scotty to use their abilities into one where Scotty relied on Kirk for energy bursts.

4.2.3 Level Design

The two main levels of *BMRS* (Level A and Level B) were composed of a series of distinct sections meant to invoke different styles of interdependence between the Kirk and Scotty players. The overall structure of both levels was designed to be identical (i.e., with the same combination of sections in approximately the same order) but were designed to be visually distinct so as to avoid learning effects during experiments with multiple conditions.

Below, I detail the goals of each section and describe how my elements of asymmetric games (subsection 3.2.2) were used to guide their design:

Light Combat (Unidirectional, Asynchronous) Consisting of only a few enemies at a time, these sections were designed to be easily handled by Kirk with minimal intervention from Scotty.

Teleport Gap (Unidirectional, Expectant) Large terrain obstacles such as chasms and cliffs that were otherwise impassable to Kirk alone were presented early on in each level so as to prompt Scotty players to use their Teleport ability for the first time.

Environmental Hazard Hazards such as erupting jets of steam and windy walkways over pools of lava were designed to prompt Scotty to experiment with their other abilities (e.g., shield walls) and further test participant's cooperative dynamics.

Separation Challenge (Bidirectional, Concurrent) More complex obstacles were used to "separate" the Kirk and Scotty players temporarily; forcing them to overcome individual challenges without direct intervention from their partner. For example, at one point in Level A, Kirk would encounter a drawbridge next to a chasm that was too wide for Scotty's teleport ability. Nearby, a damaged power generator could be used (by either Kirk or Scotty) to manually lower the drawbridge but it was specifically designed to require continuous operation in order to prevent the drawbridge from rising up again and blocking the way forward. At the same time, hostile wasps would spring out of a nearby dormant wasp nest whenever the drawbridge was operated. This "drawbridge ambush" scenario forced one player to focus on operating the drawbridge while the other dealt with the now hostile wasps. However, because of the concurrent, continuous timing of both challenges, neither partner could directly aid the other. This level section in particular would prompt numerous interesting player interactions as participants struggled to adapt to their new interdependence dynamic on the fly.

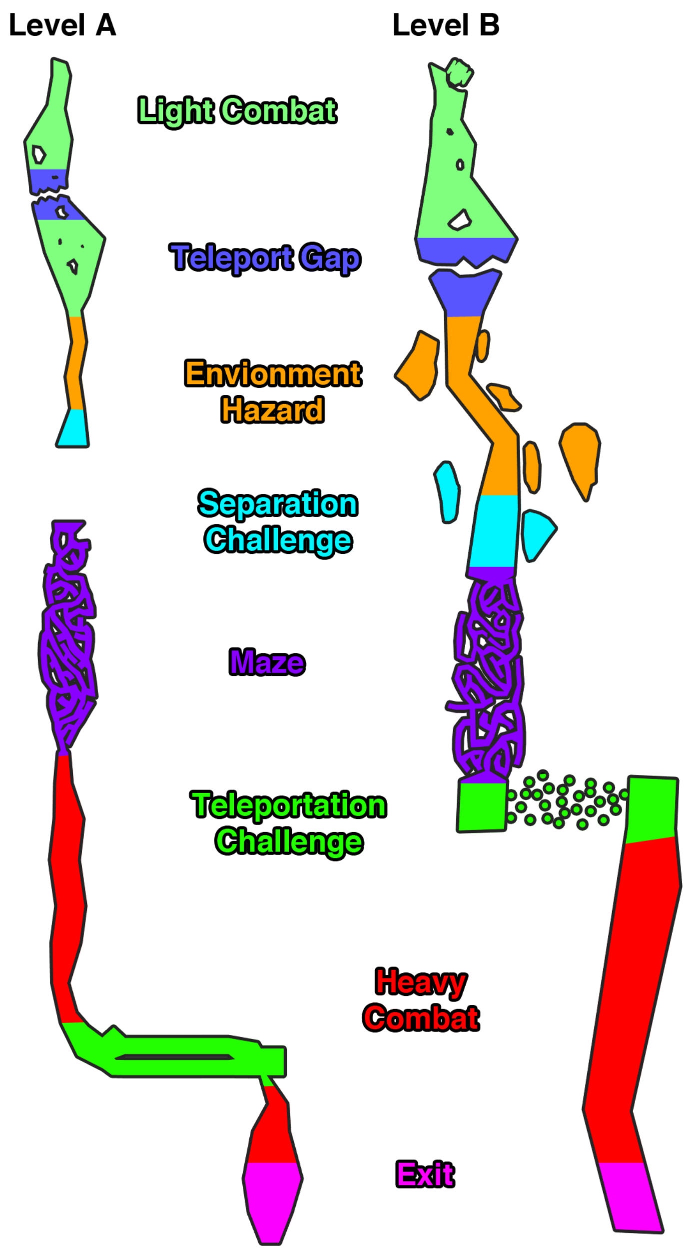


Figure 4.8: Diagram detailing mirrored designs of Level A and Level B for the first version of *Beam Me 'Round, Scotty!*. The different sections were designed to deliberately alter the dynamics of interdependence between Kirk and Scotty players.

Maze (Bidirectional, Asynchronous + Concurrent) For this level section, Scotty's teleportation ability would be temporarily disabled[2]. Besides consisting of many branching and confusing paths, this maze was filled with precariously narrow walkways perched over pits, threatening laser sentries, and destructible boulders blocking secret detours. The maze required constant attention from Scotty and challenged Kirk to traverse the laybrinth while picking up extra energy pods to fuel her partner's abilities. Scotty would have to clear away boulders with torpedoes and stun sentries while Kirk quickly and carefully walked through the maze. In later versions of the maze section (see chapters 6 & 7), the maze obstacles were changed from recessed pits to tall walls, limiting Kirk's view to only a few meters forward, and forcing Kirk to rely on Scotty's overhead view to navigate the maze.

Teleportation Challenge (Unidirectional, Asynchronous) In Level A, pairs of enormous flaming boulders rolled down narrow side-by-side walkways with alternating timing. In Level B, an archipelago of lava fountains bridging two sections of terrain erupted intermittently. In both cases, these sections pushed the typical directional dependence of Kirk on Scotty to the opposite limit as Scotty was forced to rapidly teleport Kirk around the shifting obstacles. Scotty had to be quick and deliberate with teleportation while Kirk stood relatively still, only moving to collect necessary energy boosts for Scotty. This section was designed to deliberately force Scotty players into a rapid, reflex-dependent dexterity challenge which was atypical of Scotty's role.

Heavy Combat (Bidirectional, Asynchronous + Concurrent + Coincident) The final sections of each level were filled with many different kinds of enemies (some with surprise ambush abilities, some with long-range attacks, some invulnerable to Kirk's weapons or requiring special tactics) in order to text Kirk's combat abilities. For particularly skilled pairs of players, this was an opportunity for both Kirk and Scotty players demonstrate all the skills they had practiced up to this point and to work together quickly and efficiently to deploy shields, dodge attacks, and eventually reach the level exit.

4.3 Chapter Summary

In this chapter I described my "research through design" approach to tackling the many complex facets of simultaneously studying and designing asymmetric cooperative games that enhance players' social experiences. I described my conceptual framework supporting the design and study of asymmetric cooperative games that I have developed over the

[2]Ostensibly by some nearby alien crystals interfering with Scotty's sensors.

course of my research including multiple mechanical forms of asymmetry, the characteristic gameplay dynamics they generate, and the resultant aesthetics of interdependence between asymmetric cooperating players. Finally, I described the process of how I employed my conceptual framework to design two prototype asymmetric cooperative games, *Goombagrams* and *Beam Me 'Round, Scotty!*.

Specifically, the main contribution of this chapter is:

1. The design of two prototype asymmetric games (*Goombagrams* and *Beam Me 'Round, Scotty!*) that demonstrate the concrete realization of the concepts described in my conceptual framework as well as serve as experimental tools for exploring asymmetric cooperative play.

In the next chapter, I describe the first of a series of player experience studies I conducted using the first iteration of *Beam Me 'Round, Scotty!* and the variety of dynamic player responses, interactions, and frustrations that study uncovered.

Chapter 5

Study 1: Understanding Player Behaviours in Asymmetric Cooperative Games

This chapter details the first player experience study conducted using *Beam Me 'Round, Scotty!*. At this point in my research, my conceptual framework describing asymmetric cooperative games was based solely on previous research literature, an analysis of commercial asymmetric cooperative games, and my own personal play experiences.

As discussed in chapter 4, the low-level mechanics of *BMRS* had been designed around specific forms of asymmetry with the goal of creating a multi-faceted play experience that appealed to separate action-oriented and strategy-oriented player personas simultaneously. However, outside of informal play testing with colleagues, the dynamics and aesthetics of *Beam Me 'Round, Scotty!* still needed to be formally explored via controlled player experience testing.

Indeed, many of the unique dynamics and aesthetics observed in this first player experience study (e.g., directionality, leadership, primacy) directly informed the second draft of my conceptual framework.

The version of *Beam Me 'Round, Scotty!* used in this first player experience study was also entered into the Student Game Design Competition at the 2015 ACM annual symposium on Computer-Human Interaction in Play (CHI PLAY '15) where it received both the Judge's Choice Award and Audience Choice awards from the assembled community of international games user researchers. While not directly informing my results, these awards served as reassuring validation of the relevance of and interest in my work shown by the larger research community in my field.

5.1 Study Methodology

In this section, I detail the experiment methodology we employed in order to investigate the player experience of our prototype asymmetric game.

This study focused on observing how the mechanical asymmetries introduced between the Kirk and Scotty roles affected the dynamics between play partners. Between the distinct Kirk and Scotty roles and the design of the levels (as described in subsection 4.2.3, participants were exposed to asymmetries of ability, challenge, and interface as well as different directional (e.g., unidirectional, symbiotic) and timing (e.g., asynchronous, expectant, concurrent, coincident) dependency challenges.

5.1.1 Participants

A total of 34 participants (8 identified as female, 26 identified as male) were recruited in pairs (2 female-female, 6 female-male, 9 male-male) from the local university area (21 aged 18-20, 9 aged 21-23, 4 aged 24-29) and were required to have a preexisting relationship (e.g. friends, housemates).

5.1.2 Study Procedure

Each study session lasted approximately one hour broken up into several phases (Figure 5.1). The study was conducted in an isolated room with two large-screen displays on opposite walls, each with its own computer, speakers, mouse, keyboard, and gamepad input devices. During the training/single-player conditions, participants played on their own separate computers. They could talk to each other and hear each other's in-game actions but could not see each other unless they turned around. This arrangement was chosen in an attempt to preserve the social atmosphere of co-located play regardless of whether pairs were playing on the same screen or separately. During the multiplayer/mission conditions, both participants played on the same computer sharing a single screen.

An initial survey collected demographic information, details about each participant's game playing habits (e.g. favourite games, frequency and duration of typical play sessions), as well as a series of self-rated skill scores in various game genres (e.g. "How skilled would you consider yourself when playing first-person shooter games?") The next four phases had participants play a particular level from the game with each play session followed by a post-gameplay experience survey. Based on the PENS questionnaire (Przybylski et al., 2010), the survey asked participants to rate their experience based on their feelings of autonomy, competence, relatedness, immersion, and intuitive controls during play using a 7-point Likert scale.

Each of the introductory survey, the post-gameplay surveys, and the first two levels were completed by both participants separately on their own computer. "Level A", "Level B", and the concluding semi-structured interview were completed by both participants together as a pair.

The training levels were always completed by both players first and individually so that both players could learn to control the two different in-game characters. These levels presented a series of simple challenges that would instruct the players how to employ each character's primary abilities. For Kirk (gamepad), this included walking, aiming, and shooting with no Scotty present. For Scotty (mouse), this included the use of the five special abilities (i.e., Teleport, Heal Beam, Shock Beam, Torpedo, and Shield Wall) as players escorted an AI controlled "RoboKirk" towards the level exit. RoboKirk would automatically navigate towards the exit while shooting at any enemies within range and pause at impassable obstacles or chasms. While RoboKirk's basic AI behaviour would cause them to advance towards the exit generally, they could not otherwise be commanded and so required near constant shepherding from their human Scotty partner as RoboKirk marched ceaselessly forward into danger.

Levels A and B were played by both participants together with one as Kirk and the other as Scotty. When the pair played the second level in the sequence, they would switch roles (i.e. the participant who played Kirk in the first level would play Scotty in the second level and vice versa). The order of Level A and B was counterbalanced between participant pairs.

5.2 Results

Quantitative statistical analysis was incorporated into the structure of this primarily qualitative exploratory study in order to highlight unexpected trends or future avenues of investigation. In this section, I present the statistical analysis of those player experience surveys, followed by a thematic analysis of participants' gameplay and interview recordings.

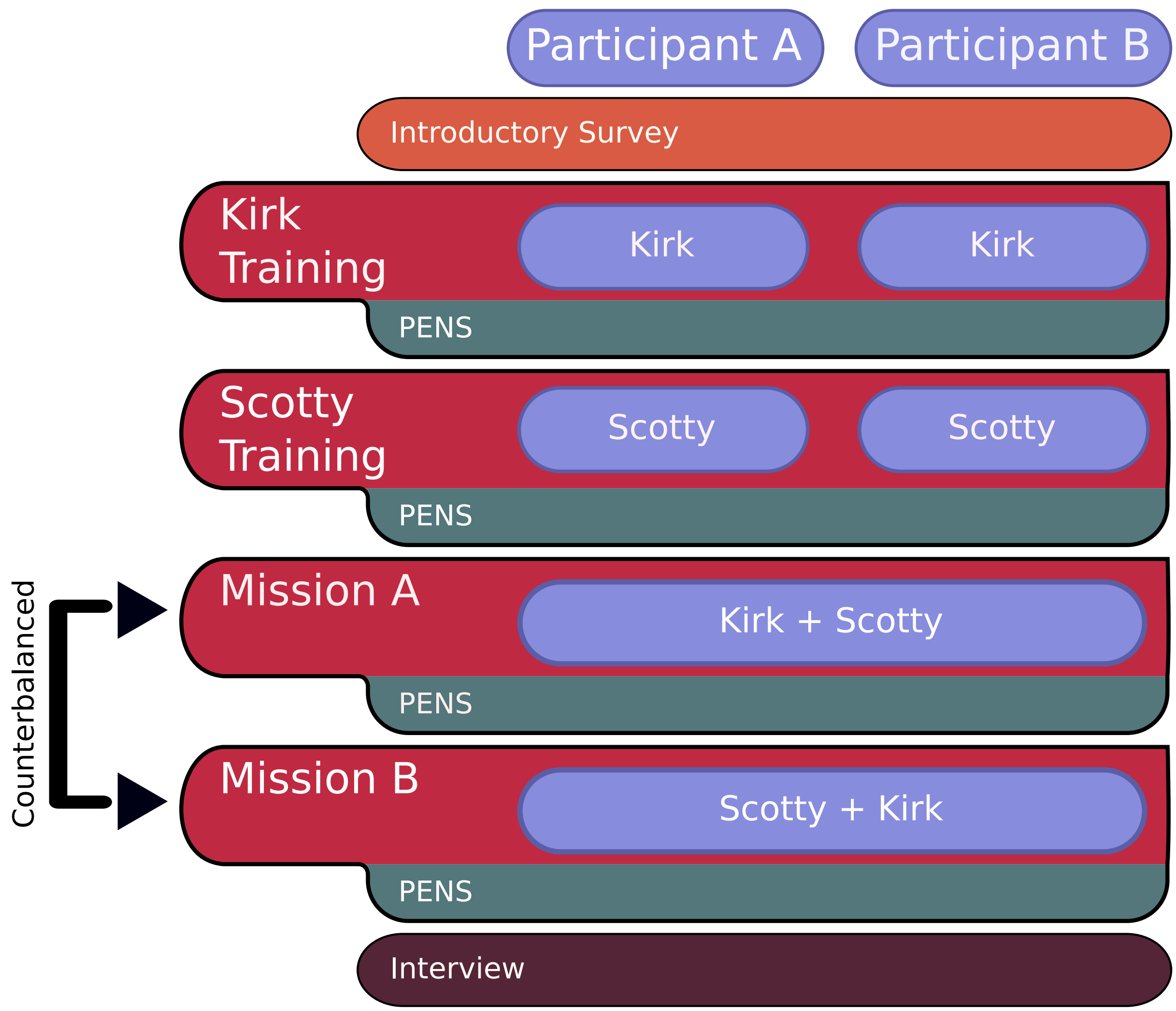


Figure 5.1: Diagram showing the procedure followed in the first *BMRS* player experience study. From top to bottom, participants first learned how to play both the Kirk and Scotty roles before playing asymmetrically with their partner and completing surveys/interviews regarding their experience.

5.2.1 Survey Results

This first study was originally designed with only one factor in mind: which character (and thereby, which distinct combination of asymmetric interface, abilities and challenge) was experienced. The first two (of four) play sessions (i.e., Kirk Training and Scotty Training) were originally envisioned as simple, single-player learning opportunities for players to familiarize themselves with new gameplay mechanics and so were not the primary focus of this study. However, participants ultimately still completed the same post-gameplay player experience surveys with these single-player levels as they did with the subsequent asymmetric multiplayer levels, so statistical survey data was available to contrast single-player and multiplayer experiences.

We conducted a 2 (character) $\times$ 2 (number of players) RM-ANOVA on the PENS survey sub-scales. There was a significant main effect of character on autonomy ($F_{1,33} = 52.8$, $p < .001$, $\eta_p^2 = .62$) where playing as Kirk was rated as affording less autonomy than playing as Scotty. Similarly, there were significant main effects of character on ratings of intuitive controls ($F_{1,33} = 4.83$, $p < .05$, $\eta_p^2 = .13$) with the gamepad (Kirk) rated as more intuitive than the mouse (Scotty).

There were also significant main effects for number of players on autonomy ($F_{1,33} = 28.76$, $p < .001$, $\eta_p^2 = .47$) relatedness ($F_{1,33} = 135.26$, $p < .001$, $\eta_p^2 = .80$), intuitive controls ($F_{1,33} = 5.60$, $p < .05$, $\eta_p^2 = .15$), and immersion ($F_{1,33} = 36.09$, $p < .001$, $\eta_p^2 = .52$). In all cases, playing together was rated higher than playing separately. However, it is important to note that the single-player experiences were not counterbalanced, and so this could be an order effect, and not conclusively an effect of number of players. Thus, survey results were inconclusive, though the thematic analysis described next provided much richer data and was the primary intent of our study design.

5.3 Thematic Analysis

A thematic analysis (Braun and Clarke, 2006) was performed on the gameplay footage (19.96 hours of audio + video) from all of the participant pairs. In this section, I describe the salient themes most relevant to the design of asymmetric games that emerged from that analysis. When relevant, participants are labelled according to their group number and distinguished as either partner A or B (e.g., P.13A and P.13B).

5.3.1 Leadership and Primacy

From a narrative perspective, the character of Kirk was introduced as a marooned spaceship captain trying to escape from a hostile planet with remote assistance from their ship's engineer. When designing *BMRS*, Kirk had been envisioned as the main focus of play, but my observations of players' experiences highlighted how the dynamics of play can yield different results.

In this player study, I observed both fluid leadership dynamics, where players would trade proposed strategies back and forth, as well as heavily biased pairings where one of the players would dominate decision making and dictate the majority of actions to their partner.

In imbalanced pairings, I observed the dominant player dictating what tactics and timings to employ (e.g., "go here, do this"), regardless of which in-game character the leader was playing. During interviews, many such pairs highlighted that the subordinate player often didn't *want* the responsibility of leadership. These players often claimed to feel less competent with the game and were happy to allow their partner to take on the additional cognitive load of coordinating their cooperation.

More common however, was a balanced and fluid leadership dynamic wherein whichever player had the most promising strategic proposal at any given moment would temporarily lead the pair. Noticing a new obstacle or recognizing a new opportunity, each player would call out suggestions as they arose and command/subordination would flow back and forth rhythmically. This cycle of observation, negotiation, decision, and action repeated on rapid time scales (e.g. "I'll deal with this enemy while you stun that one!"), large time scales ("Let's take our time and explore. We might find hidden treasure!"), and with different flavours of synchronicity (e.g. coincident teleportation maneuvers, expectant shield wall shootouts, and sequential activation of switches).

I view these leadership dynamics (or how play partners decide on their in game responses) as distinct from the dynamic of what I've come to call "primacy" that *motivates* many player-player negotiations. For example, if Kirk is suddenly ambushed by a group of enemies, this sudden danger would rapidly override existing team goals and a new leadership proposal would spring forth. ("Oh wow! Look out! Let's deal with those enemies first!") Alternatively, in the midst of a rapid teleportation obstacle course, Scotty's dwindling energy reserves (and the swift defeat Kirk would suffer should Scotty run out of energy at that time) prompted "collecting energy pods" to become the prime motivator for new action proposals. I observed that the play partner who proposed these reactive strategies (leader) did not necessarily correlate with the player whose needs assumed primacy at that moment.

Viewed together from a design perspective, while both primacy and leadership emerge as a dynamical concern, primacy appears more directly manipulable via a game's mechanics (i.e., designers can create scenarios that motivate/threatened one partner or the other) whereas leadership appears to be more heavily influences by players' pre-existing personalities and relationship.

5.3.2 Effect of Player's Skill on Experienced Aesthetic

After playing both roles, participants generally either viewed Scotty as a helpful assistant and Kirk as a lead actor/hero/captain *or* they viewed Scotty as a powerful, commanding overseer and Kirk as a fragile liability meant to be protected and shepherded to the level's exit. These sentiments are exemplified by player comments such as:

> "(As Kirk) you feel like you have more control than you give Kirk respect as Scotty. When you're playing as Scotty, you're like 'He's my pawn.' And when you're Kirk, you're like 'I need Scotty to do things. (Feebly) But I have **some** control. I have **some** self-respect! Ha!' ... But I think Scotty, in this case, would be the main character, since he has so much control. Kirk was really just walking through." [P.11B]

Which perspective was taken depended on the relative confidence and skill of the two players. Highly skilled Kirk players (accurate shots, took minimal damage) could easily progress forward through enemies and hazards with minimal assistance from Scotty; typically only pausing at obstacles that *required* Scotty's abilities. (E.g., clearing a boulder away with torpedoes). Alternatively, weaker Kirks tended to progress more slowly, always waiting for Scotty's tactical intervention (e.g., shield walls, stun beams).

When asked to describe the relative potency of Kirk versus Scotty, almost universally participants described Scotty as the more capable and more interesting character. With her simple "run and gun" mechanics, Kirk was described as a much simpler character to play as but with her own straight-forward appeal.

> "(Kirk) is technically the leader but she doesn't have as much control as Scotty, really. Although ... it is fun, the shooting parts." [P.11A]

In addition, participants nearly universally complained about Kirk's slow movement speed and suggested future improvements such as running faster, a dedicated sprint button (with limited stamina), jumping, or a dodge-roll. These results highlighted shortcomings in BMRS' tuning of abilities, options, and excitement at the time but were eventually addressed (with the exception of jumping) in the updated versions of *BMRS* used in future studies.

These participant responses showed that, even though the underlying mechanics had not changed, the personal experience, skill, and perspectives that individual players brought to their interaction with *BMRS* created striking differences in their ultimate aesthetic experience. This unpredictability in player experiences and the only indirect influence designers have on aesthetics when their mechanics are translated through players' dynamic inputs is in keeping with the MDA framework from Hunicke et al. (2004).

5.3.3 Mechanical Interactions

Reflecting on participants' interactions with *Beam Me 'Round, Scotty!* in this first study, I become keenly aware of how deliberate interdependence between players was both an advantage and disadvantage from the perspective of designing asymmetric cooperative games. Implementing the previously mentioned player suggestions would prove complicated due to the myriad of interconnected mechanical systems involved. For example, giving Kirk a jump or dodge-roll ability would potentially invalidate a number of existing platforming challenges (e.g. the maze, lava boulder sections) and takes away from Scotty's responsibilities as the teleporter and primary provider of long distance movement.

More subtly, synchronization between players' actions during heavy combat situations was consistently described as one of the most troublesome aspects of Scotty players' experiences. Scotty players said they often felt overwhelmed trying to rapidly switch between Scotty's various abilities and deploy them accurately and quickly. In essence, the reflex challenges designed for Kirk players were negatively affecting Scotty due to tight synchronicity demands. Notably, these player frustrations mirror similar "pace osmosis" criticisms levelled at *Goombagrams* (see section 8.2).

Unique to *BMRS* however, Scotty's pacing problems were unexpectedly exacerbated by design decisions involving the in-game camera mechanics. In this first version of *BMRS*, both players viewed the game world using the same camera and screen. However, the shared camera view shifted based on *Kirk's* movements and so Scotty had to attempt to counteract these movements on-the-fly in order to keep his target beneath his cursor. This is counter to the slower and more thoughtful Scotty experience original envisioned.

5.3.4 Familiarity with Interface

Analysis also highlighted the strong role participant's gaming history played in selecting new game experiences. Many players expressed a distinct preference for one game character over the other, but this was heavily influenced by their existing familiarity with the two different control schemes (i.e., gamepad vs. mouse/keyboard) and was largely unaffected by their positive or negative experiences playing *BMRS* as either Kirk or Scotty. Players who predominately played console games preferred playing with the gamepad (and therefore as Kirk) whereas players who predominately played games on PC preferred playing with the mouse (and therefore as Scotty).

This was not entirely unexpected as certain game interfaces tend to be more or less suitable (or at least heavily associated with) different game styles. For example, real-time strategy games are rarely released on game console that lack mouse and keyboard support. However, in order to determine the specific influence of interface on players' asymmetric play experience would require a separate experiment design.

5.3.5 Play Partner Familiarity & Desirability of Interdependence

Similar to findings by game analytics firm Quantic Foundry (Embaugh, 2018), many of our participants described how in-game frustrations could be ameliorated by having some degree of familiarity with one's play partner. In contrast, when playing with strangers online, loose coupling or outright competition was preferable to cooperative play.

> "LAN (local area network) games are fun if they're hard in the sense that you're relying on your friends. With online games, co-op is fun if you can do it yourself, because then you're not relying on them. But if you're trying to find a happy medium, I don't think there is one ... [where] you could play online with a stranger and you're reliant on them... [but] you're not mad when they screw up. Moral of the story is I don't play co-op online." [P.11B]

Similarly, our participants claimed to play different types of games with different types of players (i.e., Alanna would play *BMRS* with Bob but not with Cathy).

When asked about playing games with their family or parents, participants typically said that they rarely played their *favourite* games with family members. Instead, family play typically consisted of more "casual" style games such as *Just Dance* (Ubisoft Paris,

2009) or *Wii Sports* (Nintendo EAD, 2006) that had a broader (but perhaps shallower) appeal.

Participants reported that they essentially never played *video* games with their parents. Yet, many participants did play *board/party* games with their parents (such as *Yahtzee* (Lowe, 1956) or *Charades* (French aristocracy, 1800)).

When asked why, participants cited general disinterest from their family members or a lack of available time to invest in learning complex new game rules.

5.3.6 Interdependence and Necessity

Almost universally, players claimed to enjoy needing to rely on each other. When discussing the drop-in-drop-out secondary roles found in games such as *Super Mario Galaxy* (Nintendo EAD Tokyo, 2007) and *Rayman Legends* (Ubisoft Montpellier, 2013) and how these roles neither require as much skill to play as the primary characters nor are strictly necessary to progress in the game, players typically stated they preferred to be dependent on each other rather than always being self-sufficient:

> "[Playing an optional role] It's good in that sense but if you actually play video games, it's not great. You feel useless."[P.11B]
>
> "Yeah, because you're not really doing anything. And you're not needed in any actual way. You can't contribute very much." [P.11A]

Many participants described how cooperative play was fun despite (and often even because of) the inherent frustration of coordination.

Validating the designed intent of *BMRS*'s main levels, many participants described how the necessity of both the Kirk and Scotty roles ebbed and flowed depending on the different sections of the levels being encountered. During combat, participants described how the game progressed largely based on Kirk's skill while Scotty's contributions during these sections were appreciated but were not often viewed as strictly necessary. Alternatively, during "puzzle" sections such as the maze or teleportation challenges, Scotty's potency and necessity were pushed to the forefront by the game's mechanics and Kirk was often viewed as simply "along for the ride".

More generally, many players drew parallels with some modern commercial games such as *New Super Mario Bros. Wii* (Nintendo EAD, 2009) which allow multiple players on screen simultaneously. In these games, players who fall off platforms or are defeated by enemies are relegated to a "bubble" which follows the surviving players around. Once the surviving player reaches a safe location, "bubbled" players can pop out and resume their normal play. However, participants complained that this often led to problems where imbalances between players' skills caused the less-skilled players to spend a majority of their time in-bubble and frustrated; essentially not participating in the game.

5.3.7 The Drawbridge Ambush

Level A's "separation challenge" section, which came to be known as "The Drawbridge Ambush", saw Kirk encounter a chasm too wide for Scotty's teleport ability to cross. A nearby machine could be operated to slowly lower a drawbridge into place but needed to be continuously monitored as otherwise the drawbridge would rapidly rise out of position again. Meanwhile, whichever partner was not attending to the machine would need to fend off a swarm of agitated wasps; thus forcing both play partners to split their attention and work separately.

While the mechanism was designed such that either Kirk or Scotty could operate the machine, which participant ultimately did turned out to be more dependent on the relative skill of the two participants rather than what character they were playing as. Highly skilled Scotty players would deal with the wasps either by blocking them with a shield wall or shocking them in place whereas highly skilled Kirk players could manage to dodge the wasps' attacks and eliminate them with Kirk's blaster. In both scenarios, the less skilled player could focus on the relatively simple task of continuously lowering the drawbridge.

What's more, participants' reactions to this ambush scenario neatly encapsulate the differences between *leadership* and *primacy* as discussed in my conceptual framework (see subsection 3.2.4). Participant pairs would often puzzle over how to proceed when encountering the drawbridge mechanism for the first time. Once one of the players discovered how to work the machine, the wasp ambush would trigger shortly thereafter. For both scenarios (puzzling and ambush response), it was often evident which of the players was the natural leader of the pair, even though it was always Kirk that was endangered by the wasps and regardless of whether it was Kirk or Scotty who was already operating the drawbridge.

By forcing the Kirk and Scotty players to temporarily operate independently from each other, we see that the design of the "separation challenge" had proven particularly revealing in terms of the underlying complexities of designing for asymmetric cooperative experiences.

5.4 Hypothetical Mechanics

As part of the interview segment of the study, participants were asked to reflect on a hypothetical future iteration of *BMRS* where, instead of having distinct Kirk and Scotty characters, players both played as "Super Kirks". In this hypothetical configuration, both players would use gamepads to control identical on-screen characters similar to traditional Kirk play but would also have individual access to all of the abilities normally reserved for Scotty (e.g. Super Kirk could teleport themselves and deploy their own shield wall)

While most participants stated that this configuration would be more individually potent, the majority of participants claimed to prefer the existing interdependent Kirk/Scotty relationship. Only those players who described themselves as particularly focused on achievement and high-skill gameplay expressed interest in the hypothetical Super Kirk configuration.

A second hypothetical configuration was also proposed and discussed during the participant interview. In this "Kirk & Spock" configuration, although players again used gamepads to control two on-screen characters, Scotty's abilities would be split evenly between them such that, for example, only Kirk could deploy Shield Walls while only the new Spock character could deploy torpedoes. This Kirk & Spock configuration was more warmly received than hypothetical Super Kirks in some cases but those players who had strong preferences for mouse interfaces still preferred the original Kirk + Scotty configuration.

While these hypothetical gameplay scenarios were originally discussed with participants as part of the semi-structured interviews at the end of each Study 1 experiment session as a means of further exploring players' perceptions of asymmetric cooperative play, they were later expanded upon and formally tested in my second player experience study (see chapter 6).

5.5 Discussion

In the previous section, I discussed several of the recurring themes I observed based on gameplay recordings and player interviews from my in-lab study of the first iteration of BMRS. Much of that insight directly informed my MDA-centric conceptual framework discussed in section 3.2. Next, I discuss potential design implications and recommendations for asymmetric games based on my observations.

5.5.1 Leadership and Primacy

Future asymmetric game designs could leverage the observations from this study by deliberately altering the balance of leadership and primacy between different players. Consider mechanics which introduce an asymmetry of information between players: If the imbalance were severe enough, it would become prohibitive for the less informed player (even if they were the stronger personality and the de facto leader in a particular player pairing) to constantly ask to be kept informed enough to make leadership decisions.

In theory, leadership would default to the player with the most information. If the normal social dynamic of the pair were deliberately reversed (e.g. a child in the leadership role with their parents as subordinates), such an asymmetric game could be employed as a role-reversal exercise.

5.5.2 Familiarity

I interpreted the consistency between participants' controller preference prior to the study and their character preference after the study as a mixed result. It both underscored the importance of designing games for diverse preferences as well as highlighted the dominant influence of participants' previous competencies and the limited nature of single laboratory studies.

In terms of asymmetric design and family members' hesitation to play new games together, these results speak to a need for new players to be able to intuitively osmose the game's rules, mechanics, and controls to overcome some of the likely psychological barriers at play in these scenarios. While the average age of video game players continues to rise as the first generation of "gamers" age, there are still a large number of people for whom video games remain a foreign and intimidating concept. No matter how suitable and intuitive a role a well-designed asymmetric game affords them, some people may still not be sufficiently enticed to play new, unfamiliar games with their friends and family.

5.5.3 The Difficulty of Tuning Asymmetric Mechanics

The same diversity of inputs, obstacles, information, and aesthetics that can make asymmetric games appealing can cause the playtesting, debugging, and tuning of individual play mechanics to be a significantly more complex task in asymmetric games.

For example, when playing as Scotty in this study, several participants expressed a desire to use their left hand on the keyboard to select abilities and their right hand on the mouse to deploy them. (For this iteration of *BMRS*, Scotty's only input was via the mouse.) While Scotty players' ability to respond to overwhelming amounts of enemies would be greatly increased with a two-handed interface, the design of levels and the layout of enemies would need to be reworked to suit Scotty's enhanced speed and this would ultimately bring Scotty's aesthetic experience closer to Kirk's already action-oriented play style.

From one perspective, these were action-oriented players asking to bring Scotty's gameplay more in-line with their preferences. Depending on the overall design intent when developing a new asymmetric cooperative game, acquiescence to these requests could alienate the slower-paced, strategy-oriented players Scotty's role was originally designed around.

An alternative design strategy is also possible. Employing my conceptual framework for designing asymmetric experiences, consider instead a mechanic where Kirk throws handheld beacons throughout the environment that request specific forms of assistance which Scotty would need to manage and prepare in advance. Scotty players could then "authorize" the deployment of each ability request with a single button. In this configuration, we can generate a cleaner and stronger asymmetry of challenge: with the preparation of the special abilities falling to Scotty and the targeting of those abilities now falling to Kirk.

5.6 Chapter Summary

In this chapter, I presented the first of three player experience studies employing my prototype asymmetric cooperative game *Beam Me 'Round, Scotty!*. During this study, pairs of participants were recruited to play multiple specifically designed levels, taking turns fulfilling interdependent action-oriented and strategy-oriented roles, and were invited to reflect on their experiences. The results of this study's player experience surveys, my thematic analysis of participants' gameplay recordings, and the participants' semi-structured interview responses served as an early exploration of the design space of asymmetric cooperative games. Whereas the various *mechanical* forms of asymmetry found in my conceptual framework (chapter 3) were able to be derived from a survey of existing asymmetric cooperative games in industry and academia, observations of participant behaviours in this first player experience were instrumental in the identification of the characteristic *dynamics* of asymmetric cooperative play.

Thus, the primary contribution of this chapter is specifically:

1. A player experience study establishing characteristic dynamics of asymmetric cooperative play in the context of *Beam Me 'Round, Scotty!*.

For game designers and researchers, the insights gained from this study (which have been incorporated into my conceptual framework in chapter 3) are some of the first to specifically identify characteristic dynamics of asymmetric play such as directional dependence, synchronicity, necessity, leadership, and primacy.

The insights gained from this first study were used to refine my conceptual framework, helped steer the trajectory of my research, and prompted two follow-up player experience studies which I discuss next in chapter 6, a comparison of asymmetric versus symmetric cooperative play, and chapter 7, a study investigating the effects of increasing degrees of mechanical coupling on players' social play experiences.

Chapter 6

Study 2: Symmetry vs. Asymmetry

This chapter describes the second player experience study I conducted using *Beam Me 'Round, Scotty!*. Having gauged the characteristic social and gameplay dynamics of *BMRS* in the previous exploratory study, this second study was designed to build on those results in a controlled experiment contrasting *symmetric* versus *asymmetric* cooperative play. The primary goal of this second study was to determine if players' perceptions of interdependence and social camaraderie that had been observed in the first study were a result of the asymmetric mechanics designed into *BMRS*'s Kirk and Scotty roles or whether those social experiences were instead a result of *BMRS*'s "marooned captain being aided by their crew" narrative trappings. In other words, were the asymmetries and interdependence mechanics I had designed into *Beam Me 'Round, Scotty!* enhancing players' perceptions of social connectedness or was it merely the co-located play context and/or the cooperative nature of the game's plot?

With the experimental goal of contrasting *asymmetric* versus *symmetric* play in mind, I set about making significant alterations to the original *Beam Me 'Round, Scotty!* prototype game. For convenience and brevity moving forward, I will henceforth refer to the original iteration of *Beam Me 'Round, Scotty!* that was used in my first player experience study as *Beam Me 'Round, Scotty! 1* (*BMRS1*) and the next prototype iteration used in this second study as *Beam Me 'Round, Scotty! 2* (*BMRS2*). From a "research through design" perspective (see chapter 4), this is where the substantial time and effort I had already invested into developing the first *BMRS* prototype began to pay dividends. The mechanical alterations I implemented in the transition from *BMRS1* to *BMRS2* in service to this second player experience study were both less costly to implement than the development of a completely new one-off prototype would have been **and** the research results gained from maintaining visual and narrative coherence were both richer and more specific.

6.1 *BMRS2*: The Next Iteration

In order to realize this "Symmetry vs. Asymmetry" experiment, I chose to contrast the traditional, asymmetric "Split" play mode (where one participant played as Kirk and one played as Scotty) with two new gameplay modes titled "Twin Kirk" and "Twin Scotty". In these new symmetric modes, rather than having each participant play as different characters, with their associated asymmetries of ability, interface, and challenge, these "Twin" modes had participants play as the *same* character at the same time (i.e., two Kirks or two Scottys) and therefore with the same interface, abilities, challenges, etc.

In order to be able to support both participants playing as the same character in *BMRS2*, it was necessary to make substantial changes to *BMRS1*'s hardware interfaces. Implementing these alterations proved the most challenging for the "Twin Scotty" condition: As the Unity game engine (Unity Technologies, 2005) that *BMRS* had been developed in did not easily support multiple input pointers (recall Scotty players used a mouse in *BMRS1*), the interface for controlling Scotty was transposed to use multi-touch tablet devices for *BMRS2*. For experimental consistency, Scotty players used this new tablet interface for all conditions during the second player study regardless of whether they were playing with another Scotty or a single Kirk.

Shifting Scotty's interface from a mouse on the same screen that the Kirk player used to a separate multi-touch tablet came with the associated challenges of networking Scotty's and Kirk's shared simulation of the game world across three separate devices: the main PC running the game that displayed two Kirk perspectives on two monitors as well as two networked multi-touch tablets that supported two simultaneous Scotty players. Although this represented another substantial investment of development time and effort, it also afforded the introduction of rich new asymmetries of information between Scotty's and Kirk's now separated perspectives into the game world (see Figure 6.1).

In order to simplify Scotty's gameplay actions, avoid occlusion issues, and reinforce the narrative that Scotty was "providing assistance from an orbiting starship", Scotty's tablet now showed the game world from a top-down, satellite view. No longer forced to share the same perspective as Kirk, Scotty players were also now free to pan their view around the game world independently.

With the shift from mouse to tablet interface, changes were also made to how Scotty players targeted their abilities within the game world. In *BMRS1*, Scotty players were tasked with targeting their special abilities precisely using the mouse and on-screen cursor. In *BMRS2* however, the relative difficulty of requiring precise selection using fingers on a touchscreen (Benko et al., 2006; Holz and Baudisch, 2011) prompted the development of

Figure 6.1: Screenshots of the second iteration of *Beam Me 'Round, Scotty!*. The left image shows Scotty's new top-down perspective on their multi-touch tablet. The various tokens on the left edge could be dragged into the 3D view to deploy abilities. The multi-arrow button in the top left would recenter the view on Kirk and the meter in the top corner indicated how much energy Scotty had to deploy their special abilities. The right image shows Kirk's new over-the-shoulder perspective and updated 3D visuals with meters tracking Kirk's health, stamina, and energy (for using Super Kirk abilities).

a new drag-and-drop interface centered around the placement of virtual "tokens" (see the left half of Figure 6.1).

Following the same five themes (i.e., heal, shield, shock, bomb, teleport) as in *BMRS1*, Scotty players in *BMRS2* could deploy their abilities by dragging corresponding tokens from a sidebar on the left side of the screen and dropping them into the game world. Once dropped in valid locations (i.e., on the ground and not within walls or over pits), the token/ability would activate and remain active until the corresponding token was either returned to the sidebar or the Scotty player ran out of energy.

The effect of each ability was also slightly modified to accommodate the new token metaphor. Since the aesthetic goal was to no longer require Scotty players to precisely target individual objects, most of Scotty's special abilities were changed to operate over an area rather than a single target. Initial playtests suggested that this area-of-effect, token-based metaphor was simpler to understand and was more suitable for the new touchscreen interface and this trade-off between ease and precision was viewed as a net positive. For Scotty players, it was now possible to be "close enough" and these relaxed precision demands were viewed as better suiting the more thoughtful, less reflexive player archetype Scotty's role was originally designed around.

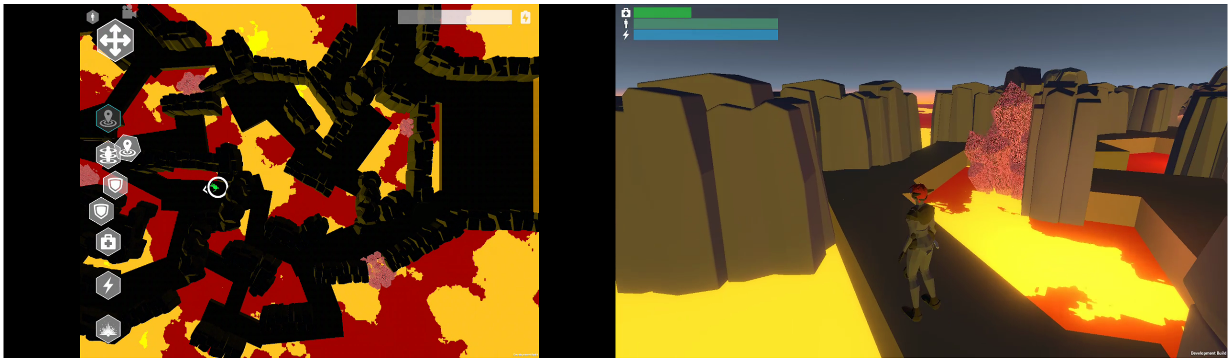


Figure 6.2: Screenshots from *BMRS2* showing the asymmetric perspectives between Scotty (left) and Kirk (right) players. The asymmetry of information presented by perspective was particularly pronounced in the "lava maze" section of the second gameplay study.

Significant changes were also made to Kirk's interface. Having been freed from the design constraint of needing to share a single display with Scotty, Kirk's perspective into the 3D world was brought down from an elevated isometric view to an over-the-shoulder, third-person perspective (see the right side of Figure 6.1) and Kirk players were given manual control of their own camera's orientation via their gamepad's right joystick (similar to many modern 3D action games). In *BMRS2*, Kirk's blaster pistol was replaced with a handheld axe, shifting Kirk's primary focus from ranged shooting and accuracy to melee combat and dodging/positioning. Kirk could throw her axe at enemies (and have it teleport back to her hand upon command) but this was relatively slow and did minimal damage in comparison to melee strikes. Instead, Kirk's axe throwing mechanic was designed to serve as a means for Kirk players to affect objects at a distance rather than as a primary means of combat. Also unique to *BMRS2*, Kirk could now make short distance dodge rolls (as heavily requested by players of *BMRS1*) as well as activate a forearm-mounted energy shield (much like a medieval knight) that could block incoming attacks.

When playing as Kirk in the "Twin Kirk" condition, both participants used the same control scheme on their own personal gamepad but now also had separate screens focusing on their own individual Kirk avatar's progress.

In terms of interfaces, splitting the Kirk and Scotty roles onto separate hardware in *BMRS2* provided space enough to accommodate any combination of Kirks and Scottys between two players. However, from a design perspective, transforming *Beam Me 'Round, Scotty!* from the asymmetric cooperative game as it was originally envisioned into two symmetric variants presented several critical challenges. What was prompted by a relatively small shift in the conceptual research space necessitated a much larger shift in terms of design and implementation.

6.1.1 Lonely Kirk vs. Super Kirk

While conceptually straightforward, implementation of *BMRS2*'s new symmetric play modes presented several major design challenges; foremost among them was what I've come to refer to as the "Lonely Kirk" paradox. As described in subsection 4.2.3, the game's various level sections contained numerous obstacles that were originally designed to require collaboration between Kirk's and Scotty's asymmetric abilities in order to be overcome.

For example, in the proposed symmetric "Twin Kirk" condition with no attendant Scotty, it was not clear how two regular Kirk players would traverse a chasm. This obstacle, usually overcome with the help of Scotty's teleportation ability, would prove impassable to a "lone" Kirk without either alterations to Kirk's mechanics or to the chasm itself.

Two alternative solutions were devised: the first, which I called the "Super Kirk" solution[1], gave Kirk players control over the same set of special abilities as the now absent Scotty (i.e., Super Kirks could heal themselves, teleport themselves, etc.). The alternative, what I called the "Lonely Kirk" solution, would require altering the game level itself (e.g., by removing chasms) and effectively removing Scotty's abilities from the game entirely.

The Super Kirk alternative was chosen as I felt it retained as many of the salient elements of the baseline "Split" condition as possible with minimal collateral mechanical changes. Employing gamepad buttons that had been unused up to this point, Super Kirk players could select their desired special ability and aim at points on the ground using a targeting reticle that would appear at the center of their screen. Once the player "pulled the trigger" (much like gamepad-controlled shooter games), the associated ability effect would be deployed to the chosen point in an identical fashion to Scotty. Also like Scotty, Super Kirks were given their own independent energy pool to power their ability usage that they would have to monitor and replenish.

Given the differences between Scotty's and Kirk's views of the game world, implementing Super Kirk's ability targeting revealed additional unanticipated complications. Where Scotty's overhead perspective meant it was equally easy to target special abilities regardless of distance from Kirk, Kirk's over-the-shoulder perspective meant that distant targets

[1]The mechanics of "Super Kirk" were first hypothesized during interviews with participants as part of the first *Beam Me 'Round, Scotty!* player experience study (section 5.4)

Figure 6.3: Screenshot of *BMRS2* showing a Super Kirk player targeting their bomb ability (green spheres, center). The oblique angle (to the ground) of Kirk's unique over-the-shoulder perspective presented unanticipated challenges when transposing Scotty's traditional abilities to Kirk.

were viewed at oblique angles, were smaller, and were thus more difficult to aim at than nearby targets.

In the maze area of the game level (see Figure 4.8), this difference in perspective was particularly noticeable. There, the large walls and branching paths that were originally designed to make Kirk dependent on Scotty for navigation in *BMRS1* completely blocked Kirk's line of sight and ability to target special abilities in *BMRS2* (see Figure 6.2). Although alternative targeting techniques and visualization aides were tested, ultimately I decided to limit Super Kirk's targeting to line-of-sight so as to avoid the confusion and frustration that early playtesters experienced when allowed to teleport through walls to destinations they couldn't otherwise see.

6.1.2 Monophobic Scotty

A second, more subtle challenge that arose when implementing *BMRS2*'s symmetric mechanics mirrored that of the "Lonely Kirk vs. Super Kirk" paradox but with an added twist: the prospect of a "Lonely Scotty" play mode with no Kirk characters to administer to was viewed as fundamentally impossible. Unlike with the Super Kirk solution in the "Twin Kirk" condition, it would not make sense to eliminate the Kirk character entirely for the "Twin Scotty" condition. Put simply: with no Kirk player, who or what would the symmetric Scotty players escort? Who would their special abilities affect and benefit?

Drawing inspiration from the tutorial levels from *BMRS1*, I chose to have each Scotty player escort their own "RoboKirk" character; an AI-controlled avatar that Scotty players could provide simple navigation commands to but that would not attack enemies nor defend themselves. Two alternative solutions that were considered but ultimately rejected included pairing partners with a more sophisticated AI RoboKirk and having both symmetric Scotty players escort a single RoboKirk.

RoboKirk was deliberately designed to be as simple-minded as possible so as to avoid any "uncanny valley" (Mori, 1970) behavioural problems. A more sophisticated AI would inevitably fall short of players' expectations for a live human partner and thus introduce even more confusion and potential experimental confounds.

Similarly, it was feared that having both Twin Scotty players shepherd a single RoboKirk might introduce new forms of interdependence between players (that would only apply to this condition) as they negotiated how and when to help their shared ward.

6.2 Study Methodology

Having successfully designed, developed, and pilot-tested three new gameplay modes (i.e., Split, Twin Kirk, and Twin Scotty), I set about conducting a 2 (character: Kirk vs. Scotty) $\times$ 2 (symmetry: asymmetric vs. symmetric) within-subjects player experience study.

6.2.1 Participants

Using posters placed around the University of Waterloo campus, I recruited 40 participants in 20 pairs (5 female/female, 4 female/male, 11 male/male) with a median age of 21 (range: 18-26) from the local university population. The majority (35 of 40) participants were students. Each pair was required to have a pre-existing social relationship (e.g., friends, classmates, family) but did not otherwise require any special qualifications (e.g., no prior game playing experience necessary). Participants were each compensated $15 for their time.

6.2.2 Equipment

In a private room within a university research lab (Figure 6.4), participants were seated in rolling office chairs in front of a table and an Asus GL502VM gaming laptop (Intel Core i7 6700HQ CPU, 16GB RAM, NVIDIA GeForce GTX1060 GPU). The laptop display (15.6 inch, 1920×1080 pixels) was extended to an HP EliteDisplay E27i monitor (27 inch, 1920×1080 pixels). The larger 27 inch monitor was positioned approximately 40 cm further back on the table such that both displays took up the same proportion of the players' field of view. Two Samsung Galaxy Tab S3 Android tablets, and two DualShock 4 gamepad controllers were connected to the laptop via 1.8 m long USB cables allowing players to pick up and manipulate the devices comfortably. A video camera positioned above and behind the main displays recorded participants' verbal interactions, facial expressions, and non-verbal gestures. Participants' in-game actions were recorded via screen capture on each of the four display screens (two PC monitors, two tablets).

6.2.3 Procedure

Figure 6.5 details the experiment procedure using in this second player experience study. To begin each session, the experimenter explained the overall study procedure to the participant pair and described the basic plot of the game. Each participant would then play

Figure 6.4: Photo showing the room layout used during study 2. Pairs of participants were seated side-by-side with two monitors, two tablets, and two gamepads within easy reach. An additional camera positioned behind the monitors captured participants facial expressions and non-verbal gestures.

through the entire prototype game four times, once for each condition. Thus each participant completed the game as Kirk twice, once with their partner as Kirk (Kirk, symmetric) and once with their partner as Scotty (Kirk, asymmetric), as well as Scotty twice, once with their partner as Scotty (Scotty, symmetric) and once with their partner as Kirk (Scotty, asymmetric). These four conditions were counterbalanced using a random Latin square of size four in order to accommodate for carryover effects.

Whenever participants played as Scotty, they used the tablet interface, and whenever participants played as Kirk, they used a gamepad. When playing symmetrically (both Kirk or both Scotty), each participant still had access to the absent character's perspective

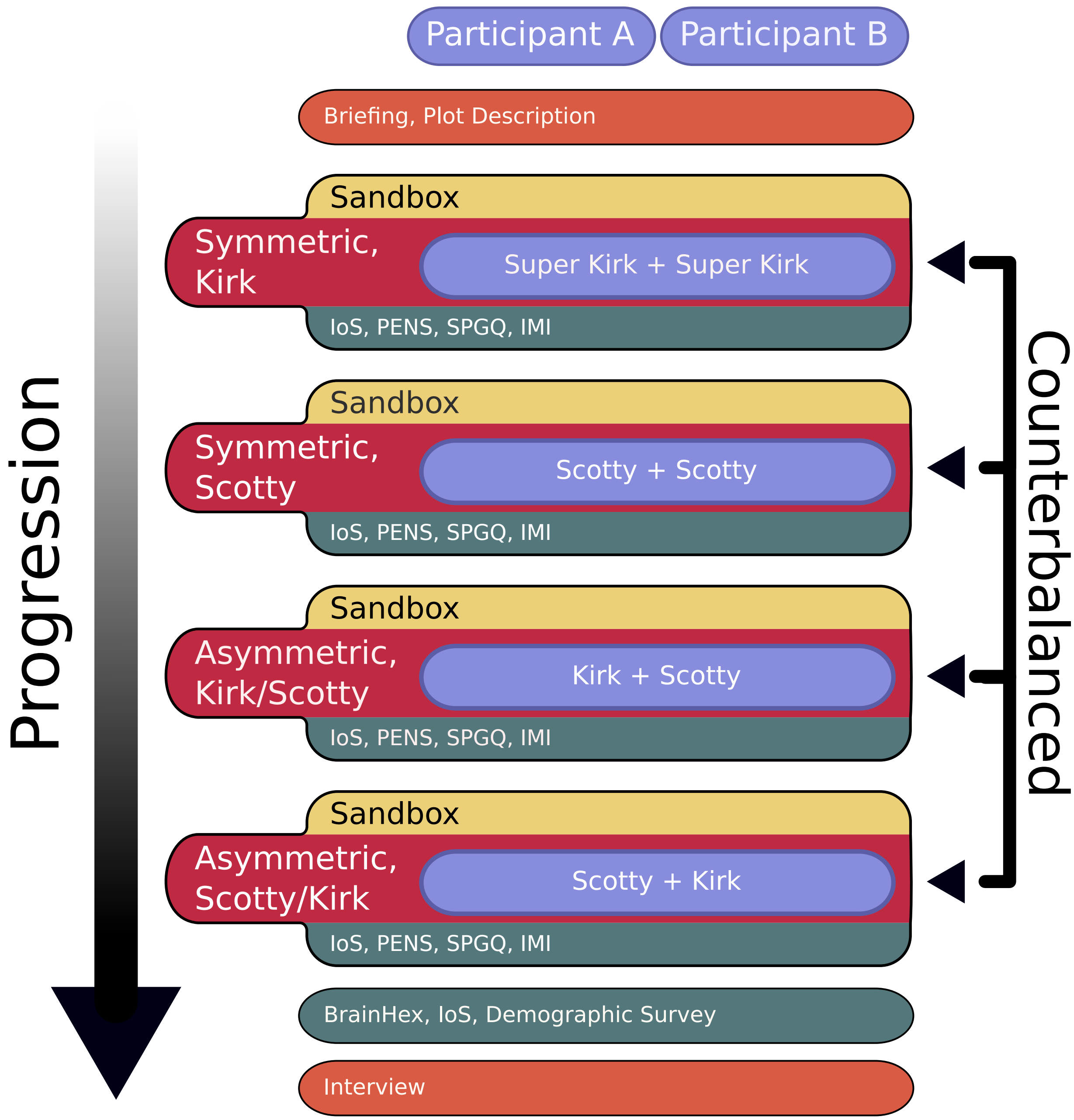


Figure 6.5: Diagram depicting the experiment procedure for the second *Beam Me 'Round, Scotty!* player experience study. Pairs of participants played each of four counterbalanced conditions covering every combination of symmetric/asymmetric mechanics and Kirk/Scotty roles.

(i.e., when playing as Super Kirk, participants could still see an overhead view from their unused tablet) and thus participants still had access to the same breadth of information in all conditions with only their mechanical abilities changing.

Each combination of role and symmetry required unique training (e.g., playing as Kirk with a human Scotty partner that can beam you around was different than playing as two Kirks that each beam themselves around) and so, before each condition, participants were given a brief tutorial on how to use the new mechanics as well as five minutes to play and experiment with the new configuration in a shared sandbox level.

6.2.4 Measures

In addition to the Player Experience of Needs Satisfaction (PENS) (Przybylski et al., 2010) questionnaire employed in the first *Beam Me 'Round, Scotty!* study, this second player experience study administered a wider range of survey tools focusing on measures of participants' social experiences. The Social Presence in Gaming Questionnaire (SPGQ) (Kort et al., 2007) was included for its focus on empathy and behavioural engagement between players and because it avoids making explicit assumptions about team structures or cooperation versus competition. The Inclusion of the Other in the Self Scale (Gachter et al., 2015) was included as it has been shown to be a particularly simple, effective, and easy-to-administer tool for gauging perceptions of "closeness" or "connectedness" in behavioural science literature. And finally, the interest, effort, and pressure sub-scales of the Intrinsic Motivation Inventory (Ryan et al., 1983) were included in an attempt to better understand the nature of the interactions between participants; for example, while the IoS scale could reveal if participants felt connected, the SPGQ and IMI could help determine if that connection was frustrating or supportive in nature.

Finally, each participant completed a short demographic questionnaire which also included the BrainHex (Nacke et al., 2014) player type survey. As was discussed in chapter 2, the still formative nature of most player typology surveys makes them ill-suited for prescriptive design outside of loose player personas. Instead of its usual application as a means of assigning participants into strict types/categories, BrainHex was included in this study as a way of gauging participants' game play preferences at the outset of their study session.

Rather than assume that their game play preferences (as measured by BrianHex) were somehow intrinsic or would hold steady beyond the experiment session at hand (as is often claimed in player typology papers), I knowingly assumed that their self-reported BrainHex preferences would likely change given a different social context or play partner. My intention was merely to test for correlations between participants' individual BrainHex responses and their other player experience questionnaires (PENS, SPGQ, IoS) and as a potential means of explaining any patterns observed across different participants' play behaviours. The experimental session concluded with a semi-structured interview. Each session lasted approximately 90 minutes.

6.2.5 Hypotheses

The hypotheses motivating this second player study were as follows:

H6.1. Players would feel more connected to and perceive a greater sense of social presence with their play partners during the asymmetric conditions in comparison to the symmetric conditions.

H6.2. Individual player experience metrics would be more positive during the asymmetric conditions in comparison to the symmetric conditions.

H6.3. Players would be more motivated to play during the asymmetric conditions in comparison to the symmetric conditions.

6.2.6 Results

Due to a clerical error in copying the intended orders of conditions, the study sessions were not fully counterbalanced as originally intended and so a Latin square design was not accurately followed within each participant pair. However, the first trial was equally distributed between participants and thus, by excluding data from the second to fourth playthroughs, each self-report measure was analyzed using a between-participants factorial 2 (symmetry) $\times$ 2 (character) ANOVA. Post-hoc analyses used Bonferroni corrections.

Connectedness

There was a significant main effect of symmetry on connectedness ($F_{1,36} = 4.5$, $p = .04$, $\eta_p^2 = .11$), where participants playing as different characters reported feeling more connected to their play partner ($M = 4.0$, $SE = 0.3$) than participants playing as the same character ($M = 3.0$, $SE = 0.3$). This finding confirms my primary hypothesis (H6.1).

There was also a significant main effect of character on connectedness ($F_{1,36} = 7.6$, $p < .01$, $\eta_p^2 = .17$), where participants playing as Kirk reported feeling more connected to their play partner ($M = 4.2$, $SE = 0.3$) than participants playing as Scotty ($M = 2.9$, $SE = 0.3$). This was a more surprising result, but can be partially attributed to player comments that, because Kirk used an over-the-shoulder perspective, they felt more connected to their play partner and their actions due to immersion; as if they were "right there".

These main effects can be further explained by a significant interaction between character and symmetry on the connectedness measure ($F_{1,36} = 7.6$, $p < .01$, $\eta_p^2 = .17$, Figure 6.6). Post-hoc analysis revealed that for Kirk, participants rated themselves as feeling significantly more connected in the asymmetric condition (i.e., when their partner played as Scotty) than the symmetric condition when playing with another Kirk ($p = .001$), but when playing as Scotty this difference was not significant ($p = .66$). Moreover, the ratings of connectedness for Scotty when playing with either a Kirk partner or another Scotty were as low as when playing as Kirk with another Kirk. This finding illustrates that, while asymmetric play *can* lead to feeling more connected to one's play partner, the role a player takes on can have a significant impact on these feelings. When playing asymmetrically in this study, it was the Kirk player that felt more connected to their partner, not the Scotty player.

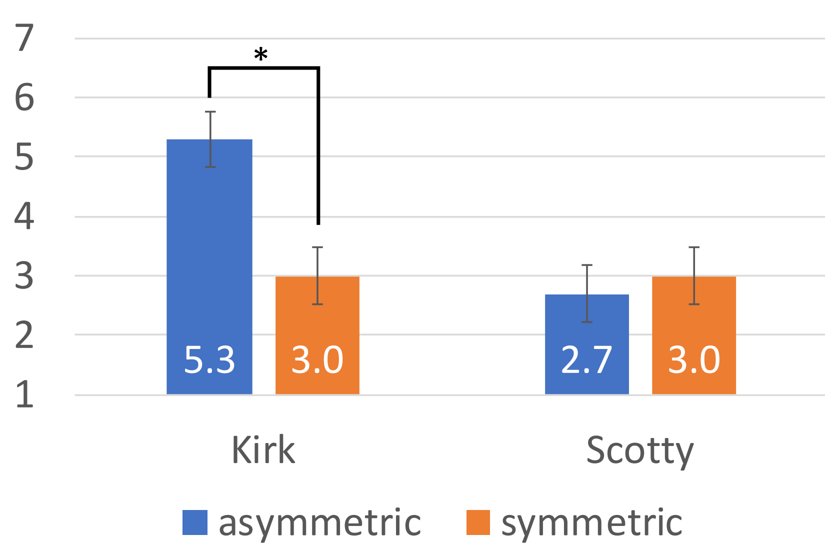


Figure 6.6: Interaction between character and symmetry on connectedness in the Inclusion of Other in the Self Scale. In asymmetric play, participants felt more connected to the other player, but only when playing as Kirk.

Social Presence

There was a significant main effect of symmetry on participants' perceptions of behavioural engagement with their partner ($F_{1,36} = 6.0$, $p = .02$, $\eta_p^2 = .14$), where participants rated asymmetric play as more engaging ($M = 5.8$, $SE = 0.2$) than symmetric play ($M = 5.2$, $SE = 0.2$). This finding again reinforces our primary hypothesis (H6.1) that when players take on asymmetric roles in play, they will feel more socially engaged. However, it should be noted that players in all conditions rated levels of social engagement quite highly ($M \geq 5.2$). There were no other main effects or interactions involving engagement, empathy or negative feelings ($F_{1,36} < 1.7$, $p > .20$).

Individual Player Experience

There were significant main effects of asymmetry on immersion ($F_{1,36} = 7.7$, $p < .01$, $\eta_p^2 = .18$) and intuitive controls ($F_{1,36} = 5.8$, $p = .02$, $\eta_p^2 = .14$). Participants rated asymmetric play as being both more immersive (asym.: $M = 4.7$, $SE = 0.2$; sym.: $M = 4.0$, $SE = 0.2$) and having more intuitive controls (asym.: $M = 6.0$, $SE = 0.2$; sym.: $M = 5.2$, $SE = 0.2$), confirming H6.2. There were no other main effects or interactions involving competence, autonomy, immersion, or intuitive controls ($F_{1,36} < 2.1$, $p > .16$).

Motivation

There were no significant main effects or interactions involving interest, effort, or pressure ($F_{1,36} < 2.2$, $p > .15$). We therefore cannot confirm our remaining hypothesis (H6.3) that players will be more motivated in asymmetric play.

Ranking of Game Modes

As part of the concluding interview for each study session, each participant was asked to rank the three game modes (two symmetric and one asymmetric played in two ways) in order of personal preference. The Split condition (with one Kirk and one Scotty) was ranked most favourite 22 times, second favourite 16 times, and least favourite 2 times. The Twin Kirk condition was ranked most favourite 17, second favourite 18 time, and least favourite 5 times. Finally, the Twin Scotty condition was ranked most favourite 1 time, second favourite 6 times, and least favourite 33 times. Figure 6.7 shows these ranking results as a chart.

Visually, there is an apparent disinterest in the TwinScotty condition, with most participants ranking it their least favourite mode. Both the Split and Twin Kirk conditions are more strongly preferred, with the Split condition appearing to be preferred slightly

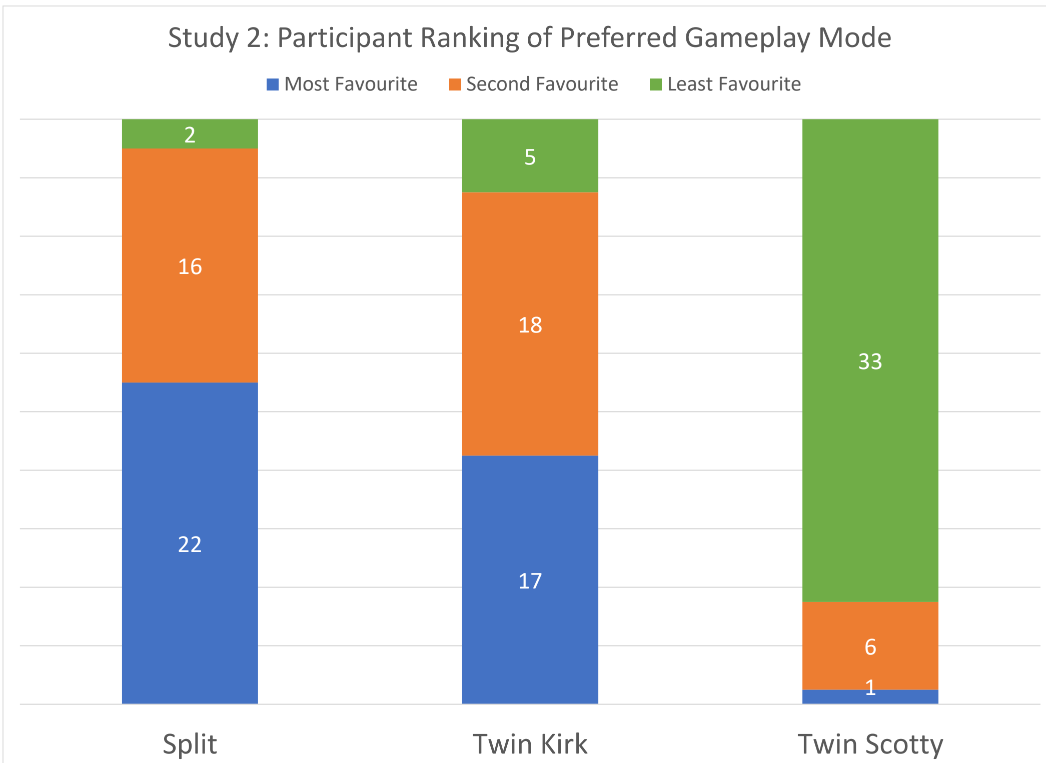


Figure 6.7: Participants were asked to rank the three game modes in order of personal preference. More than half chose Split as their favourite followed closely by Twin Kirk. Twin Scotty was generally participant's least favourite mode.

more often among participants. When asked to elaborate on their reasoning for their rankings, most participants either described how they enjoyed the unique coupling between split Kirk and Scotty or the more visually immersive experience of *seeing* one's partner and their actions embodied up close in the Twin Kirk condition. Consistently, participants described the Twin Scotty condition as feeling distant, indirect, and decoupled from their partner's actions.

6.2.7 Thematic Analysis

As with the *BMRS1* study, a thematic analysis (Braun and Clarke, 2006) was performed on participants' audio and video recordings as well as their semi-structured interview responses.

Display Cognitive Overload

In order to include two "Twin" conditions as similar to the original "Split" condition as possible, both Kirks' 3D views on the PC monitors and both Scottys' overhead views on the tablets remained active, even when not a direct part of a particular experimental condition. For example, during the "Twin Scotty" condition, when both players were otherwise occupied with their individual tablet interfaces, the two monitor perspectives automatically followed each player's respective RoboKirk character. Players did not have any control over this view but could still use it to indirectly observe the 3D world from their RoboKirk's perspective if desirable. Based on interview feedback, participants described that they rarely used this "RoboKirk View".

Conversely, some participants described how they *did* make use of the passive "RoboScotty" perspective while playing in the "Twin Kirk" condition (where they otherwise had their own individual 3D views of the game world to attend to on their own monitor). Many players claimed this passive overhead view was most helpful during the maze section of the game but otherwise described how it was difficult to switch their attention between their primary 3D view and the passive tablet display. Many participants made the suggestion that a passive "mini-map" with condensed visual details (e.g. symbolic enemy locations without any full-3D rendition of the terrain) should be added to Kirk's display instead.

Scotty's Range of Action

In *BMRS2*, Scotty players were able to freely pan their view and investigate portions of the game world distant from their play partner's focus. While this proved uniquely beneficial

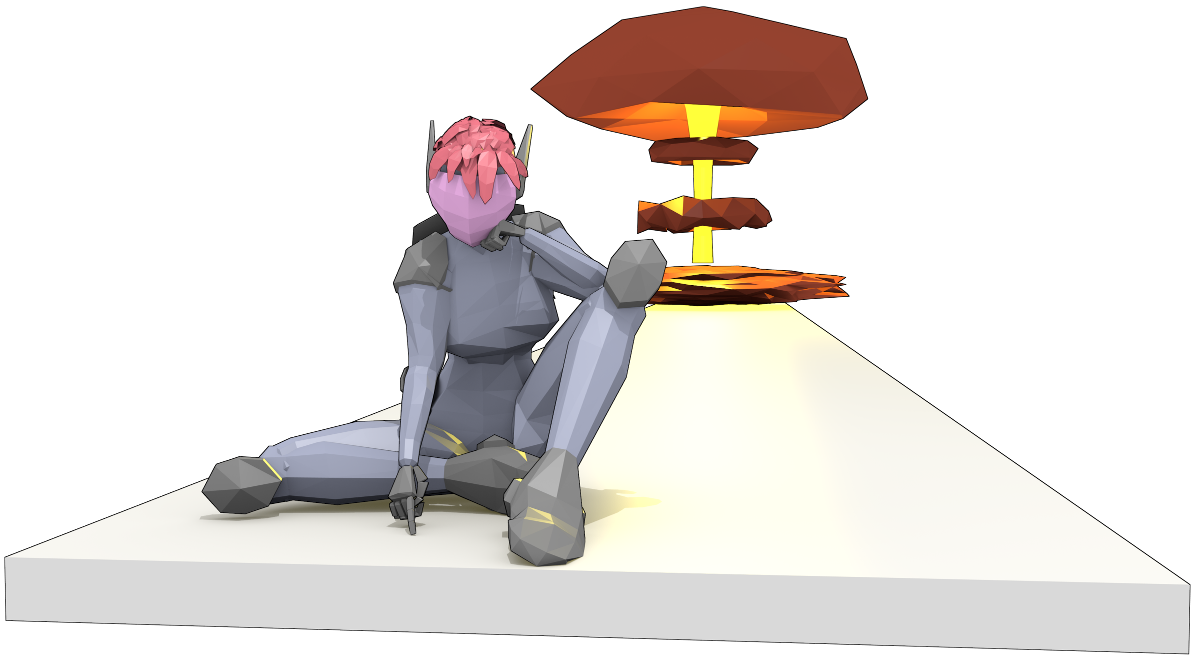


Figure 6.8: A vignette depicting the boredom some Kirk players experienced as a result of discovering *BMRS2*'s "carpet bombing dominant strategy". Scotty's range of action was deliberately limited in the game's next iteration in a direct attempt to re-tune this dynamic.

by allowing some Scotty players to "scout ahead" and warn their partner about upcoming obstacles (a unique asymmetry of information) there were unanticipated side effects. Many player pairs took advantage of this freedom with a form of preemptive "carpet bombing" behaviour wherein Scotty players would bomb any/all future enemies before Kirk even began to move. Even when playing as Super Kirk, players would exploit their ability to target far in the distance to clear out multiple enemies before approaching them at melee range (Figure 6.8)[2]

For particularly low-skilled participants, this tactic was viewed positively; allowing players to cautiously advance using their most potent abilities while avoiding engaging in

[2]I present several pre-rendered illustrations (which I refer to as "vignettes") to visually demonstrate some of the theoretical observations I discuss in this dissertation. These illustration make use of the same 3D models and visual style as when playing *Beam Me 'Round, Scotty!* itself but were composed in a separate 3D modelling program.

difficult and dangerous melee combat as Kirk. For highly-skilled participants however, this tactic was viewed as a relatively undesirable “dominant strategy” (Burgun, 2011) outcome whereby the meaningful challenge (and thereby enjoyment) of the game was reduced. Some high-skill pairs chose to deliberately avoid employing the tactic once they discovered it in order to find other sources of challenge and fun, but some high-skill pairs continued to employ the tactic and ultimately described those gameplay moments as boring.

Asymmetries within Symmetry

There were several instances in this study where I observed participants in the symmetric condition discovering ways to be dependent on one another, creating an emergent asymmetry. For example, participants would heal each other in the Twin Kirk condition or help each other to complete levels by having the more skilled player advance to the next level for both players. On the other hand, some participants (e.g., some particularly skilled dyads) would leverage these asymmetries within the symmetric condition to “compete”, for example by “rushing” to the end and preventing the other symmetric player from completing the level on their own.

Tuning & Voluntary Limitations

The majority of participants, when asked to discuss the relative utility of Scotty’s various abilities, described the teleportation ability as both the most useful and the most overpowered. Numerous participants lamented how many in-game challenges could be overcome simply by teleporting around them; so much so that some players expressed frustration at the tedium of having to manually walk at all when playing as Kirk.

When asked to suggest on how to improve the game overall, many participants’ suggestions centered on different means of limiting the effectiveness of the teleportation ability with comments such as, “While it’s definitely unique and cool, it really just breaks the game.”

Choosing Your Own Adventure

We occasionally observed pairs of participants engaging in uniquely creative forms of play such as dueling with each other (once they discovered friendly fire was possible); racing to complete each level section first, obstructing each other’s progress, and keeping score between themselves; and trying to get beyond the boundaries of the game world through creative use of Scotty’s teleportation ability and Kirk’s dodge action. These sorts of behaviours were seen almost exclusively in the most highly-skilled pairs of participants.

As a particularly noteworthy example, one pair of participants chose to deliberately constrain themselves by *not* using the teleportation ability to navigate a particularly difficult hazard which, from a design perspective, was specifically engineered to *require* use of the teleporter. Much to my surprise, these boundary-pushing dyads almost always achieved their self-directed goals.

Level Transitions & Collaboration

Another seemingly innocuous design decision that turned out to have significant repercussions on players' perceptions of interdependence and connectedness was the manner in which players could transition from one section of the level to the other. For technical simplicity (both regarding networking complexity and the limited computational power of Scotty's tablet interface), the single, monolithic game level laid out in *BMRS1* was divided into a series of discreet chunks that could be loaded independently for *BMRS2*. These level chunks directly correlated with the different sections designed to induce different forms of interdependence as discussed in subsection 4.2.3.

As players reached the exit to one section, they would trigger a transition and be moved to the entrance of the next section and repeat this process until ultimately reaching the exit. In the Split condition of *BMRS2* (as with *BMRS1*), where there was only one Kirk character at a time, this arrangement worked well. However, in the Twin Kirk and Twin Scotty conditions, with multiple Kirks active simultaneously, there was the new possibility of one Kirk reaching the section transition significantly ahead of their partner. In the interest of minimizing wait times (for both the speedy player and the overall experimental procedure), the design decision was made that as soon as *either* Kirk reached a transition, *both* Kirks would be moved to the next level section.

The unanticipated repercussions of this design decision were both positive and negative (Figure 6.9). On the one hand, for player dyads where one player was significantly slower or less skilled/confident than their partner, this "first past the post" mechanic allowed the more skilled player to effectively "carry" their partner through difficult challenges. In many cases, where a weaker player had failed a challenge repeatedly and grew frustrated, they would say to their partner "let's move on" and request that the stronger player trigger the next transition.

Conversely, for some particularly skilled dyads, the ability for one player to race through and trigger a transition before the other player could attempt a section was frustrating. These skilled players sometimes felt that their partners were thwarting their ability to meaningfully participate in the game. For example, one participant lamented that:

> "In the Split condition, when you're both focused on one character, it feels like

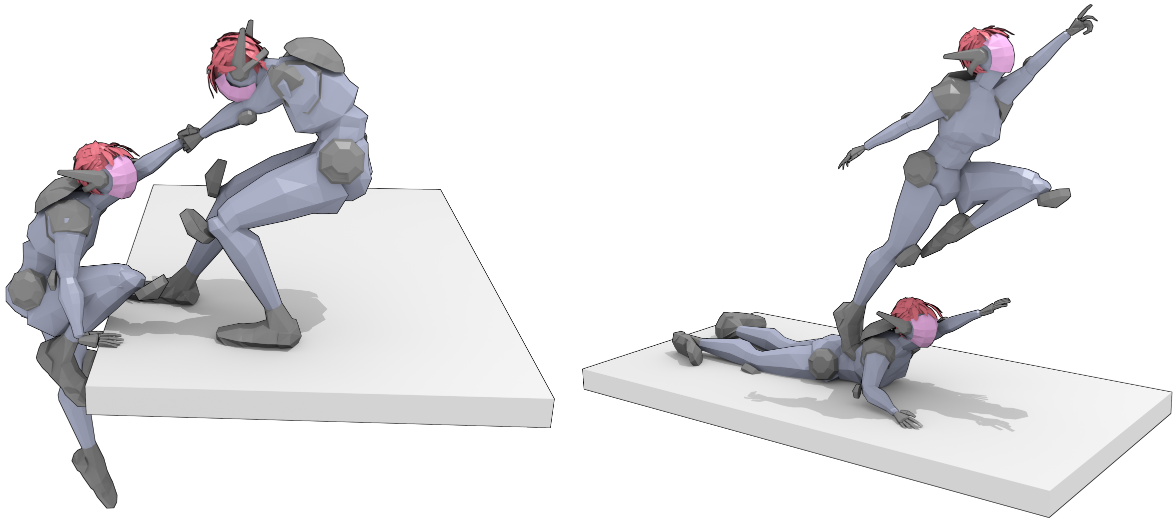


Figure 6.9: Vignette depicting how, depending on the relative skill between Twin Kirk participants, players could use level transitions to alternately support or thwart their partner's experiences of competence and autonomy. This unexpected dichotomy arose from seemingly small design choices governing level transition mechanics in *BMRS2*.

> your decisions are more meaningful. Whereas in Twin Kirk and Twin Scotty, it didn't matter what I did because he could just do the level for me." [P.208]

6.3 Chapter Summary

In this chapter, I described the second of three player experience studies I conducted contrasting the effects of symmetric versus asymmetric cooperative play on participants' perceptions of social connectedness while holding as many mechanical, narrative, and visual elements constant as possible. In general, the results of this study showed a clear benefit of asymmetric play over symmetric play in terms of players' perceptions of connectedness, social presence, immersion, and intuitive controls. While simple co-located play with preexisting social relations engendered a base level of social connectedness, the results of this study indicate that asymmetry and interdependence may be used to enhance players' social play experiences over and above that baseline.

Specifically, the primary contribution of this chapter is:

1. A player experience study demonstrating that asymmetric play leads to greater feel-

ings of connectedness than symmetric play given the same social context and visual/narrative aesthetics. (chapter 6)

With the benefits of asymmetric cooperative play established in a course-grained sense, I next sought to build a more nuanced understanding of how the design of asymmetric mechanical elements could be used to affect players' perceptions of social connectedness in a more fine-grained manner.

In the next chapter, I discuss my third and final player experience study wherein I put my conceptual framework to the test and compared the effects of deliberate mechanical manipulations affecting the degree of coupling between participants' interdependent actions and the resultant changes in their perceived social connectedness.

Chapter 7

Study 3: Degrees of Asymmetry

In this chapter, I describe the third player experience study I conducted examining the effects of increasing degrees of interdependence on players' social play experience in an asymmetric cooperative game.

As had been hinted at in the results of my first, exploratory player experience study (chapter 5), interdependence seemed to be at the heart of players' enhanced perceptions of social connectedness during asymmetric cooperative play. My second, experimental player study (chapter 6) deliberately contrasted symmetric and asymmetric cooperative play and yielded evidence that asymmetric mechanics (e.g., asymmetric abilities, information, interfaces) could enhance players' perceptions of social connectedness over and above symmetric cooperative play given the same visual aesthetics, co-located play context, and cooperative narrative elements. With the baseline effect of asymmetric mechanics established, I designed a third player experience study to examine whether the degree of interdependence (and thereby, players' perceptions of social connectedness) could be controlled in a fine-grained manner. If so, this would support the theoretical connection presented in my conceptual framework between some of the mechanical sources of asymmetry and their ability to enhance perceptions of social connectedness through deliberate design. Where the previous player experience study compared symmetric and asymmetric cooperation, this third study would explore the more subtle characteristics of interdependence *within* asymmetric cooperative play.

Based on the ideas of "loose" and "tight" coupling between players presented by Beznosyk et al. (2012) and my own conceptual framework for the design of asymmetric game mechanics, I chose to manipulate the degree of interdependence between participants via mechanical changes to the direction and degree of synchronicity between asymmetric

Kirk and Scotty pairs. The goal of these manipulations was to generate three distinct degrees of interdependence between participants (loose, medium, and tight coupling) and gauge how they affected participants' social play experience.

7.1 *BMRS3*: Design Space Dive

As with the two previous player experience studies, changes to *Beam Me 'Round, Scotty!*'s underlying mechanics were made in order to generate distinct experimental conditions and explore the further reaches of the conceptual interdependence spectrum (Figure 1.1). As before, for brevity and convenience, I adopt the shorthand identifier *BMRS3* when referring to this iteration of the *Beam Me 'Round, Scotty!* prototype (and associated player experience study 3) as distinct from *BMRS1* used in study 1 (chapter 5) and *BMRS2* used in study 2 (chapter 6).

BMRS3 returned to the "canonical" configuration of character roles (as seen in *BMRS1*) with one participant playing as a normal Kirk (without special powers) and one participant playing as Scotty (escorting a single, human Kirk player). Because there would only ever be one Kirk and one Scotty playing simultaneously, Scotty's interface was moved back to a mouse and keyboard setup on the same PC as Kirk's for logistical simplicity and reliability. In this configuration, each participant had their own monitor showing their character's unique perspective and there was no need for external networking.

Scotty's perspective assumed the same top-down orientation as from study 2 but, having returned to a mouse interface, the deployment of Scotty's abilities was tweaked to be more in-line with their usage in study 1: selecting a desired ability from an on-screen menu (or keyboard shortcuts) and deploying them by clicking directly on the game world terrain.

Players' complaints about Scotty's overlarge deployment range (subsubsection 6.2.7) were also addressed by limiting Scotty to only being able to deploy their special abilities within 20 meters of Kirk's position. In this way, Scotty could still "scout ahead" and inspect incoming enemies and obstacles visually, but they would only be able to act in coordination with Kirk.

Kirk's interface and controls remained largely unaltered from *BMRS2* with the exception of an additional "axe throwing" mechanic. Borrowing from Super Kirk's ability targeting mechanics, Kirk players in *BMRS3* were given the ability to aim and throw their handheld axe weapon. The axe would sail through the air under the effects of gravity and embed itself into the first enemy or piece of terrain it collided with. The damage the axe inflicted on targets was kept deliberately minimal such that axe throwing would remain largely situational and melee attacks would remain Kirk's primary means of combat. Attempting to swing or throw the axe again after it had been thrown would cause it to independently teleport back into Kirk's hand. (Many participants described this mechanics as being "just like Thor's hammer", in a reference to the popular *Marvel* (Branagh, K. (Director), & Feige, K. (Producer), 2011) superhero who is able to throw his mythical hammer and have it magically fly back to his hand.)

7.1.1 Study Factor: Degree of Interdependence

In order to generate three distinct degrees of interdependence (i.e., loose, medium, tight coupling) between Scotty and Kirk players, I focused on altering the mechanical behaviour of Scotty's five special abilities (i.e., heal, shield, shock, bomb, teleport). Having refined my conceptual design framework (section 3.2) based on insights gained from study 1 and study 2, designing a spectrum of ability variants for study 3 served as another opportunity to apply and test the utility of my framework in a directed design scenario. Following a general trend of increased synchronicity and increased inter-directional necessity, the "loosely coupled" abilities were designed to afford Scotty near independent action, the "tightly coupled" abilities required frequent, close coordination between Scotty and Kirk in order to be effective, and the "medium coupling" abilities were designed to sit between those two extremes.

Consider Scotty's Bomb ability as an example: In the Loose Coupling condition, with a single click Scotty players could deploy a bomb into the 3D world and, after a short countdown, the bomb would explode and clear a path for Kirk; a one-time, unilateral action on Scotty's part with no necessary action from Kirk. In the Medium Coupling condition, after Scotty deployed the bomb, Kirk would first need to approach and manually activate it before the countdown would begin; in this case, both Scotty and Kirk participated in a symbiotic use of the bomb with expected timing constraints via their respective one-time actions. Finally, in the Tight Coupling condition, Scotty's click would instead deploy a volatile "bomb rift" which could only be triggered by physically attacking it. As the rift would disappear after a short time, Kirk and Scotty players would need to coordinate closely on nearly coincident timing and positioning in order for Kirk players to be able to skillfully throw their axe at the rift and for this version of Scotty's bomb ability to be effective.

For brevity's sake, detailed descriptions of how each of the five abilities were designed to fit the three degrees of interdependence are omitted here in lieu of Table 7.1 for succinct

Table 7.1: Brief descriptions of how Scotty's and Kirk's interactions changed as the mechanics of Scotty's abilities were manipulated between the Loose, Medium, and Tight Coupling conditions in Study 2.

		Heal	Shield	Shock	Bomb	Teleport
Loose	S	Click on Kirk	Click on Kirk	Click near enemy	Click near enemy	Click at destination
	K	No action required				
Medium	S	Click near Kirk to engage, monitor energy, click to disengage	Click drag to draw wall	Click near enemy to engage, monitor energy, click to disengage	Click near enemy	Click drag to place two endpoints
	K	Stand nearby	Maneuver around	Attack shocked enemy	Approach, press button to arm bomb	Walk into endpoint
Tight	S	Hold button, track Kirk, monitor energy	Hold button, track Kirk, aim toward enemies	Await Kirk's signal, shock enemy	Click to place bomb	Click to ready destination, monitor energy
	K	Walk slowly	Coordinate attack and personal shield with Scotty	Throw and embed axe in enemy, notify Scotty	Hit bomb with thrown axe to detonate	Press button to trigger teleport

reference. In general, as the level of interdependence advanced from loose, to medium, to tight coupling, the dynamics of Scotty's and Kirk's interactions would proceed from unidirectional to symbiotic directionality and from asynchronous to concurrent/coincident timing. Both players would need to pay more continuous attention, coordinate in more detail, and execute more numerous, more skillful, and more bilateral actions in order to successfully utilize all of Scotty's five abilities. All other mechanical details, such as the speed at which Kirk was healed, the explosive range and power of the bombs, or the maximum distance travelled with each teleport remained the same across conditions.

7.2 Study Methodology

Having created a third iteration of the *Beam Me 'Round, Scotty!* prototype with three distinct degrees of interdependence between the Kirk and Scotty roles, I set about conducting a within-subjects player experience study with one factor (coupling: loose, medium, tight) to examine the effects of increasing degrees of interdependence on participants' social player experience.

7.3 Participants and Equipment

Expecting to encounter more subtle effect sizes than in study 2, the number of participants was increased for this third study. A total of 72 participants were recruited from the local university population in 36 pairs (7 female/female, 9 female/male, 20 male/male) with a median age of 23 (range: 18-33). Again, the majority (67 of 72) of participants were undergraduate students. The recruitment criteria (preexisting social relationship) and compensation were the same as the previous two studies.

The layout of tables, chairs, cameras, and displays remained essentially identical to study 2: both participants sat in front of their 27 inch, 1920×1080 pixel display with a camera positioned to record their speech, facial expressions, and non-verbal gestures. Both displays were positioned side-by-side with both players able to see their partner's screen. No longer needing to support two simultaneous Scotty players and for logistical simplicity, the interfaces used in study 3 reverted back to the same as used in study 1: The single Scotty player used a mouse and keyboard and the single Kirk player used a dual-axis joystick to interact with the game.

7.4 Procedure & Measures

This third study examined a single experimental factor (degree of interdependence) with three levels (loose, medium, and tight coupling). The general procedure followed the same "play, survey, play, survey" pattern (Figure 7.1) as both study 1 & 2 with all of the associated introduction, training, practice, and closing demographic/interview steps as before.

In addition to a question asking participants to rank the overall study conditions (loose, medium, tight coupling) in terms of overall preferences, additional questions were added during the concluding interview to probe participants about their preferences regarding the many variations of Scotty's abilities in this study. Participants were asked to rank the different variations of Scotty's five abilities (heal, shield, shock, bomb, teleport) according

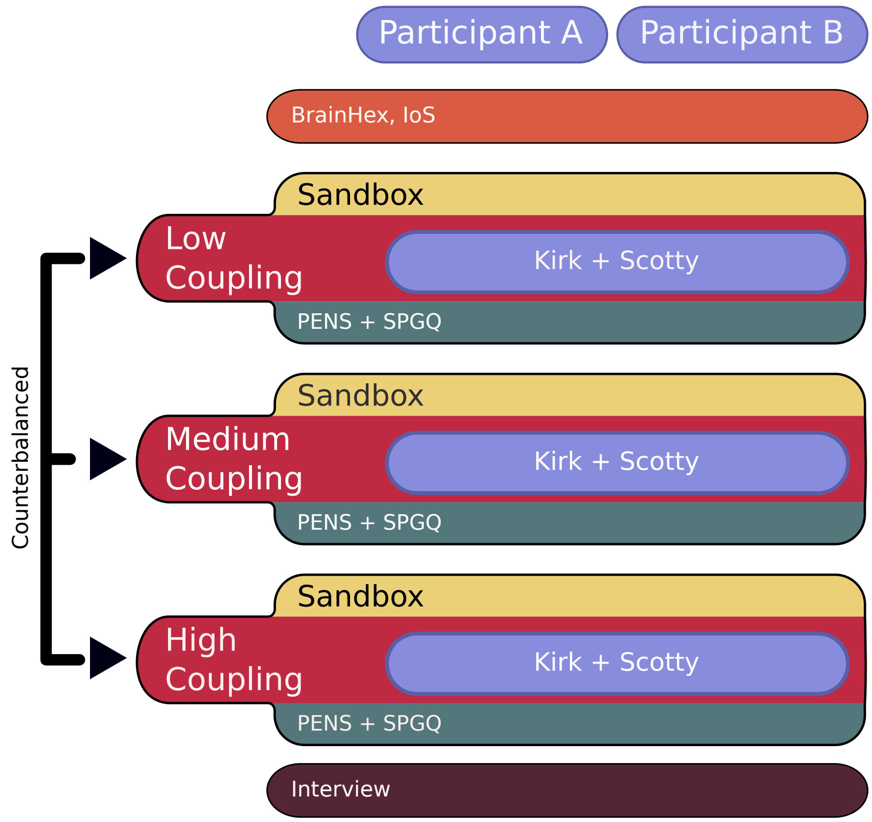


Figure 7.1: Diagram depicting the experimental procedure for the third *Beam Me 'Round, Scotty!* player experience study. Pairs of participants played each of three counter-balanced conditions covering loosely, medium, and tightly coupled interdependence between the Kirk and Scotty roles.

to four criteria: most powerful, easiest to use, made participant feel most connected to their partner, and personal favourite.

At the outset of each study session, the plot of the game and the controls for each character were explained to both participants before they were given the opportunity to decide which role each partner wanted to play. Once chosen, each participant played the same character for all three conditions. The sequence of conditions was fully counterbalanced to account for learning and fatigue effects (every permutation of 3 conditions, cycled 6 times).

Immediately following each study session, the experimenter assigned each participant a subjective "skill" rating (high, medium-high, medium, medium-low, low) based on how competent the experimenter perceived the participant to be at playing *Beam Me 'Round,* *Scotty!*. Competence in this case was based on how quickly participants learned the mechanics of the game, how effectively they achieved their own *self-directed* goals, and how seldom they made mistakes when attempting to meet their own goals. While this skill rating was not strictly reliable due to the subjective nature of the experimenter's interpretations (and the absence of additional raters and therefore any inter-rater reliability), it is included briefly in subsequent discussions as a qualitative guidepost when interpreting the dynamics of asymmetric cooperative play.

I place particular emphasis on *self-directed* player goals here because, in my experience, employing more quantitative measures of "skill" (e.g., time to completion, accuracy, error rate) is similarly difficult and prone to misinterpretation. Given the inherently playful nature of games, many times when observing *Beam Me 'Round, Scotty!* players the subjectively *most* skilled players were also the objectively *worst* players (from a scoring perspective) due to their propensity to goof around and invent arbitrary new goals for themselves. Having quickly mastered the basic mechanics and challenge of the game, these highly skilled players would, for example, challenge themselves to reach the exit without ever using Kirk's axe or without ever using Scotty's teleport ability.

7.5 Hypotheses

This study was designed to address the following hypotheses:

H7.1. As the degree of interdependence increased between players, participants would perceive a greater sense of connectedness and social presence with their play partners.

H7.2. Individual player experience metrics would be more positive for the tightly coupled condition than for loose coupling.

H7.3. Highly skilled players would most prefer tight coupling during play while low skilled players would prefer loose coupling during play.

7.6 Results

Study 3 proceeded without incident and all 72 participants' self-report measures were analyzed using a within-subjects RM-ANOVA. The significant quantitative results from this analysis are described below (Figure 7.2).

7.6.1 Social Connectedness & Engagement

There was a significant main effect of interdependence on connectedness ($F_{2,142} = 5.8$, $p = .004$, $\eta_p^2 = .076$), where participants felt significantly more connected to their play partner under the tight coupling condition ($M = 5.81$, $SE = 0.12$) than the loose coupling condition ($M = 5.26$, $SE = 0.16$), $p = .002$. Although there was a consistent trend across all three conditions (medium coupling $M = 5.51$, $SE = 0.14$) and the differences between medium-tight coupling was marginally significant ($p = .054$), the difference between loose-medium coupling was not statistically significant ($p > 0.12$).

There was also a significant main effect of interdependence on behavioural engagement ($F_{2,142} = 7.6$, $p = .001$, $\eta_p^2 = .097$) as measured by the SPGQ survey (Kort et al., 2007) where players reported feeling less engaged with their partner under the loose coupling condition ($M = 2.549$, $SE = 0.11$) than under both the tight ($M = 2.19$, $SE = 0.08$, $p = .002$) and medium ($M = 2.24$, $SE = 0.08$, $p = .006$) coupling conditions. (Lower scores indicate perceptions of stronger behavioural engagement.) These findings partially confirm the first hypothesis (H7.1) of this study.

7.6.2 Individual Player Experience

There were significant main effects of interdependence on interest ($F_{2,142} = 5.68$, $p = .004$, $\eta_p^2 = .074$), where participants felt more interested in the game under both the tight coupling ($M = 2.64$, $SE = .112$, $p < .007$) and medium coupling ($M = 2.77$, $SE = .112$, $p < .015$) than under the loose coupling condition ($M = 3.09$, $SE = .147$). There was no significant difference in interest between the tight and medium coupling conditions however ($p = 0.27$).

There were significant main effects of interdependence on effort/importance ($F_{2,142} = 11.5$, $p < .001$, $\eta_p^2 = .140$), where participants placed significantly more importance and effort in both the tight ($M = 3.64$, $SE = .143$, $p = .001$) and medium coupling ($M = 3.50$, $SE = .135$, $p < .001$) conditions than in the loose ($M = 4.09$, $SE = .146$) coupling condition. There was no significant difference in perceived importance between the tight and medium coupling conditions ($p = 0.25$). These findings partially confirm the second hypothesis (H7.2) of this study.

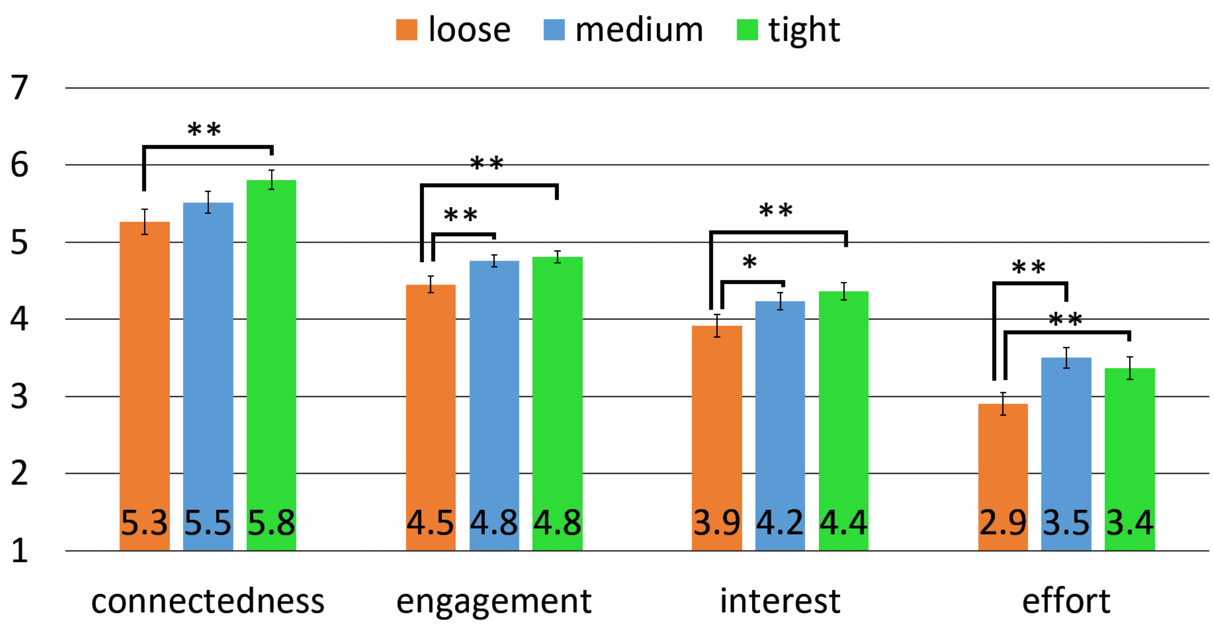


Figure 7.2: Graph showing the significant differences between participants' perceptions of connectedness, behavioural engagement, interest, and effort across the loose, medium, and tight coupling conditions of the third *Beam Me 'Round, Scotty!* study.

7.6.3 Mode Ranking

As with study 2, participants in study 3 were asked to rank the three gameplay modes (loose, medium, tight coupling) in order of personal preference as part of the concluding interview. Loose coupling was the most preferred mode for 25 participants, second most preferred mode for 22 participants, and least preferred mode for 33 participants. Medium coupling was the most preferred mode for 14 participants, second most preferred mode for 32 participants, and least preferred mode for 34 participants. Finally, tight coupling was the most preferred mode for 41 participants, the second most preferred mode for 26 participants, and the least preferred mode for 13 participants. Figure 7.3 shows these ranking results in chart form.

Visually, tight coupling appears to be more often preferred more strongly by participants. There is less clear separation between participants' preferences for loose and medium coupling. This pattern is consistent with verbal feedback provided during the interview portion of the study. When asked to elaborate on their chosen rankings, most participants described how they enjoyed having to work with their partners more closely and more fre-

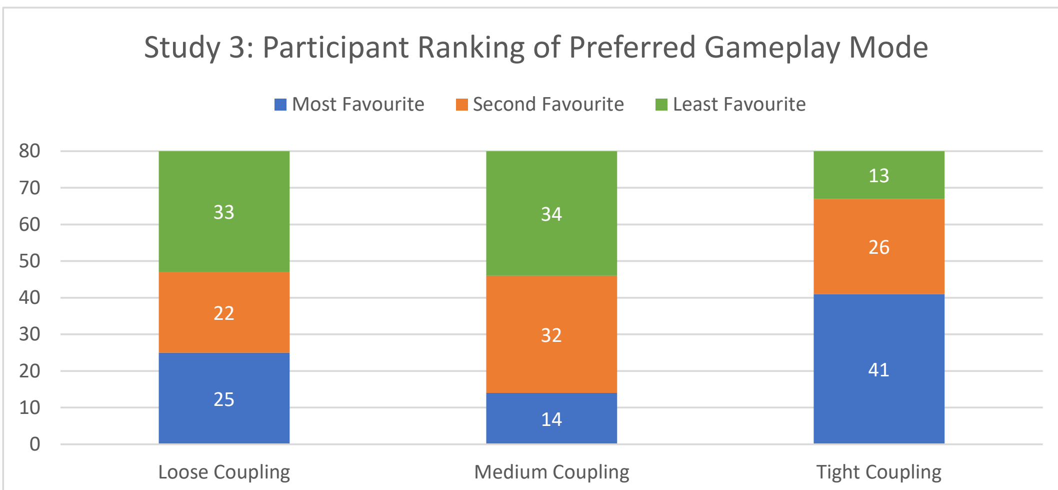


Figure 7.3: Participants were asked to rank the three game modes in order of personal preference. More than half chose Tight Coupling as their favourite while there was a less clear separation between Loose and Medium Coupling as second and least favourite.

quently during the tight coupling condition but there was a minority of participant pairs (those less highly skilled and those who described themselves as preferring less aggressive, less action-oriented play) who preferred the more casual medium and loose coupling conditions. Further, many participants expressed a desire to mix-and-match specific combinations of abilities drawn from each of the three coupling conditions (e.g., the tightly coupled bomb and shield abilities with the loosely coupled teleport and the medium-coupled heal and shock abilities).

7.6.4 Thematic Analysis

The thematic analysis (Braun and Clarke, 2006) of participants' gameplay recordings and interview responses revealed interesting nuances to the patterns found in their survey responses.

The Rhythm of Interdependence

When queried as to their overall preference of play modes, many participants described how they would most prefer to be able to shift and alter their interdependence with their partner over the course of the game. Multiple different styles of interdependent behaviour were observed across participant pairs, and while most players had distinct favourites, they were still cautious about being locked into a single dynamic over the course of a hypothetical full game (e.g., dozens of hours of play). As one participant described, "Shake it up from level to level, don't have the same style of dependence every time." [P129] These comments suggest that, despite the general trend towards enhanced social connectedness with increasing degrees of interdependence during short play sessions, it would be generally preferable for both the direction and intensity of dependence to vary over time throughout longer play sessions.

This mirrors the concept of "interest curves" from both game and film literature (Schell, 2014) wherein it is actually counter to overall audience enjoyment to present a sustained level of high excitement/interest over the full course of an experience. Rather than providing "more of a good thing", audiences eventually become bored and fatigued without being provided opportunities to relax and process the moments of intensity with complementary periods of calm.

Tedious Reliance vs. Thoughtful Contributions

Based on observations of players' collaborative decision making behaviours, simply having players "wait on other's actions" (as described by Beznosyk et al. (2012)) is not necessarily enough to engender feelings of interdependence and social connectedness. Rather, a partner's action is better received when that partner overcomes their own challenges in order to make a meaningful contribution to the team. For example, in the tight coupling condition, Scotty could only shock an enemy once Kirk had successfully embedded their axe into it; a bidirectional cooperative action with tight timing constraints and high skill requirements. However, Kirk simply barking at Scotty to "Shock!" (i.e. press Scotty's shock button) once Kirk's axe was in place was viewed as tedious by many participant pairs.

In contrast, Scotty using their unique perspective to plan out a route through a maze-like area and communicate directions (e.g. "left, right, straight") to Kirk was generally much better received even though the pattern of command/action was very similar. Interviewing participants about this distinction, the main difference appeared to be that Scotty was putting thought into their contribution rather than just the rote response of pressing a button when mindlessly commanded to. As one participant described, "This isn't a challenge. It's just tedious." [P135]

In this case, the distinction between tedious and thoughtful interactions likely stems from the asymmetry of information created between Kirk's and Scotty's perspectives in the maze area and an absence of meaningfully asymmetric information when using the tightly-coupled shock ability. In the maze, Kirk cannot see the overall layout of paths on their own and must rely on Scotty to use their unique information to plan a route. With the shock ability however, both Kirk and Scott know exactly what needs to happen (Scotty presses the shock button), the only challenge is *when* to press it: as soon as Kirk embeds the axe. Without any more sophistication to the shock/axe mechanics, this interdependence results in consistent and thoughtless tedium.

Ability Tuning

For each of the different mechanical conditions in this study, the specific timing and directions of coordination between participants was varied for each of Scotty's five abilities in order to manipulate the degree of coupling between the two players. At the same time, other factors not necessarily related to coordination (such as energy costs, damage, and duration) remained unchanged as experimental controls. However, reflecting on the gestalt play experience, these combined (in)actions had the potential effect of altering the efficacy of each ability as a whole.

More specifically, in the loose coupling condition, Scotty players could typically deploy their abilities unilaterally. In the tight coupling condition, Kirk players would typically have to intervene in some way before Scotty players' abilities could be fully utilized. In terms of balance/tuning, it could be argued that this made Scotty's abilities more cumbersome to use in the tight coupling condition and potentially less powerful for those participants who were unable to coordinate smoothly. In a more realistic design scenario then, the need to balance or tune the different abilities becomes important *in addition* to considerations of asymmetry and interdependence: if tightly coupled abilities are more difficult for player pairs to deploy, these more difficult to use abilities should be comparatively more powerful/effective in order to compensate and to ensure every choice of coupling degree is viable, interesting, and worthwhile.

Both during their play sessions and during the interview portion of the study, numerous participants noted this apparent oversight on the part of the game designers, for example exclaiming "Wait…so the [bomb] explosion isn't any bigger?! Well, that's just a hassle. Why even bother then?" [P129]

7.7 Discussion

Generally, the quantitative player experience metrics from this study indicated a trend towards improved perceptions of social connectedness as the degree of interdependence increased across *BMRS3*'s three experimental conditions. In conjunction, qualitative observations highlight numerous subtle complexities and challenges in the design of asymmetric cooperative games.

Enhancing social connectedness in asymmetric cooperative play is not simply a case of "more is better", with participants highlighting the potential frustration and exhaustion of sustained, tightly coupled interdependence over extended periods without any interesting variations in intensity. At the same time, the quality and necessary forethought required as part of a play partner's contribution is critical for ensuring that independence is viewed as meaningful and enriching rather than tedious.

Finally, the numerous mechanical elements not directly being studied such as the energy cost, area of effect, or potency of Scotty's various abilities, despite being held constant as experimental controls, were likely to have had some impact on players' gameplay experiences and thus both the quantitative and qualitative results. In this case, we again are faced with the interlocking complexity of mechanical design, gameplay dynamics, and research intent.

7.8 Chapter Summary

In this chapter, I described the third player experience study I conducted with my *Beam Me 'Round, Scotty!* prototype game, specifically investigating the effect of varying degrees of interdependence in players' asymmetric mechanics on their social play experience. I applied my conceptual framework (section 3.2) to design three variants (loose, medium, tight coupling) of each of Scotty's five special abilities (heal, shield, shock, bomb, teleport) to test the general hypothesis that increases in inter-directional dependence and synchronicity of player interactions would result in a commensurate increase in participants' perceptions of social connectedness.

Specifically, the primary contribution of this chapter is:

1. A player experience study demonstrating how deliberate mechanical manipulations that increase interdependent coupling of players' asymmetries of ability can increase players' perceptions of social connectedness.

This chapter demonstrates the utility of my conceptual framework for designing asymmetric cooperative mechanics as well as the deliberate degree to which interdependence between cooperating partners can be tailored. For both game designers and researchers, these results demonstrate that "degree of interdependence" can be viewed as a design parameter that can be deliberately tuned to generate perceptions of specific degrees of social connectedness in players and that my conceptual framework can be used to effectively guide that tuning process.

In the next chapter, I reflect on broader insights gained as a result of reflecting upon my research results as a whole and my overarching "research through design" approach.

Chapter 8

Synthesis

My conceptual framework supporting the design and study of asymmetric cooperative games (chapter 3) was originally rooted in informal but practicable design frameworks (Hunicke et al., 2004; VandenBerghe, 2012) that had been synthesized through the hard-won experience of veteran games designers over time. Faced with the wicked problems of this design space, I adopted a "research through design" (chapter 4) approach and selected specific design alternatives from among numerous possibilities as targets for more in-depth examination. Subsequently, my research has built upon those informal frameworks and brought increased scientific rigour to the study of asymmetric cooperative games through numerous, focused player experience studies and has begun to build up an understanding of the larger design space by generalizing trends from the concrete examples I had realized via my prototype games.

In this chapter, I describe several insights gained as a result of "returning to the surface" following the deep dives of my "research through design" approach: insights that have evolved over the course of each individual player experience study and the iterative process of refining my prototype games and conceptual framework but have ultimately only crystallized when reflecting upon my research as a whole.

8.1 Designed vs. Emergent Interdependence

One of the important dynamics of asymmetric cooperative play identified in my conceptual framework is the "necessity" of collaboration: whether or not particular intervention from a play partner (or even a partner role in its entirety) is strictly *required* in order for

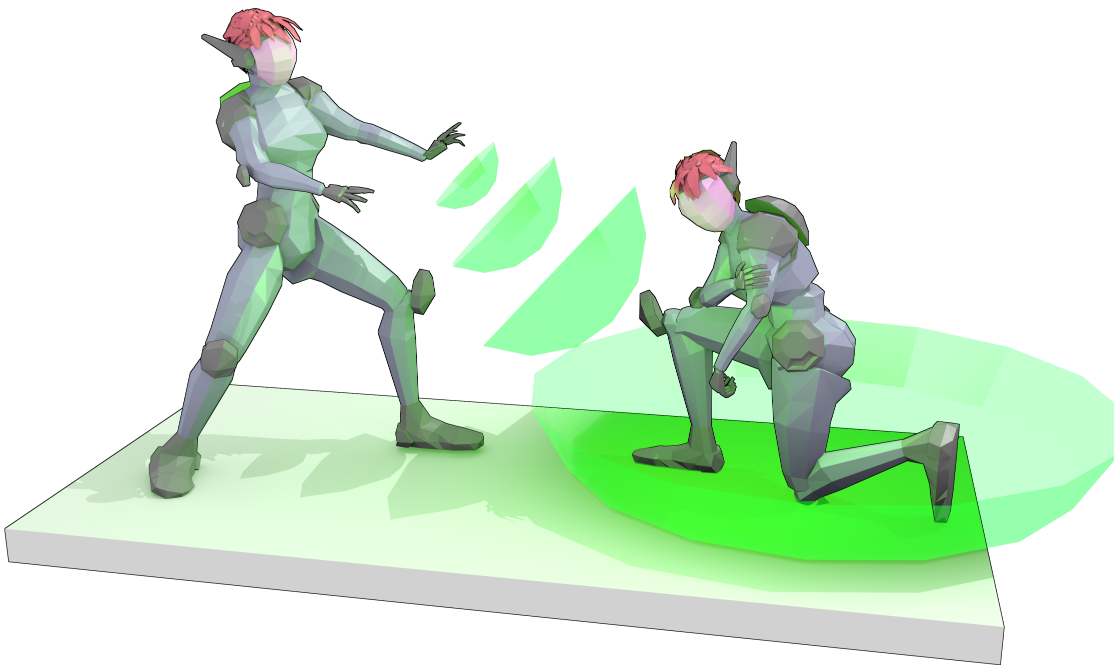


Figure 8.1: Vignette depicting a Super Kirk player using their healing ability on their partner. Different iterations of Super Kirk's heal mechanics alternately allowed, disallowed, or required interdependence between players; a subtle mechanical distinction that would have significant impact on players' social play experience.

a player to overcome certain in-game obstacles. Having reflected on the many creative and unexpected player behaviours across all three player experience studies, an important further distinction emerges regarding not just whether asymmetric mechanics are designed to *require* collaboration but also whether they *allow* or *disallow* collaboration.

A particularly clear example of this distinction comes from the improvised teamwork seen between "Super Kirk" players in study 2 (chapter 6) and how they employed their specially designed "heal" abilities. Because the Super Kirk heal ability was ultimately designed to operate in an area of effect (i.e., anyone standing near the deployment point would be healed), in addition to each player being able to heal themselves, it was also possible for them to heal their partner. In this way, the two Super Kirks were *allowed* to cooperate but it was not strictly *required* that they do so (Figure 8.1).

Compare this to an earlier iteration of Super Kirk's healing mechanic (not used in any study) that would have seen Super Kirk's heal ability affect only the player using it. In this form, it was mechanically impossible for one Super Kirk to heal another; players were strictly *disallowed* from healing each other. Finally, consider a third, hypothetical variant of Super Kirk's heal ability that players could only use on their partner. In this form, the heal ability would mechanically *require* collaboration.

By leaving the mechanical possibility for one Super Kirk to heal another but not require it, the game's design left space for players to decide whether and how they wanted to cooperate. In many cases, one player would opt to focus on healing both players while their partner handled combat actions. In this way, the two players self-selected their own asymmetric roles (despite possessing symmetric abilities) in an instance of "emergent interdependence". Contrast this with the normal "Split" condition (Study 1 & 3) where only Scotty could heal Kirk and this can be viewed as a form of "designed interdependence" between the two players as regards Kirk's health and survival.

For both designers and researchers, this is a subtle but important distinction that is likely to have a significant impact on social play experiences. Feelings of autonomy are core to individual player enjoyment but so too are feelings of overcoming well-suited challenges and feelings of relatedness with fellow players. Whether a particular choice of asymmetric mechanics enforces designed interdependence, allows for it to emerge, or deliberately disallows collaboration at certain moments can set these two player motivations in competition with each other.

8.2 Pace Osmosis

From the earliest play testing sessions with *Goombagrams* through each iteration of *Beam Me 'Round, Scotty!*'s player experience studies, "pace osmosis" has been a persistent design challenge. Here, I employ the chemical concept of "osmosis" (wherein molecules travel between two regions of differing concentration through a selectively permeable membrane) as a conceptual metaphor to help elucidate how the paces of asymmetric roles tend to seep into each other, often to the chagrin of players and designers alike.

In chemistry, the relative concentrations of the chemicals involved and the nature of the membrane separating them determine whether, how, and with what speed the particles transition between the regions and attempt to come to equilibrium. In my experience designing and studying asymmetric cooperative games, the degree to which the pace of asymmetric roles "osmose" into each other appears similarly dependent on how distinct each role's pace is designed to be and how necessary the interdependence between those roles is.

Throughout the development of both the *Goombagrams* and *Beam Me 'Round, Scotty!* prototypes, it was not uncommon for some players in both roles (i.e., Megaman & Wiley, Kirk & Scotty, respectively) to express feelings of frustration. Less skilled Scotty players, for example, would feel "rushed" or overwhelmed about being unable to deploy the necessary array of special abilities quickly enough to keep on top of their Kirk partner's rapidly evolving dangers. Conversely, more skilled Megaman players often felt "bogged down" and impatient by their slower partner's failure to "spell on demand" and catch up with their more action-oriented gameplay. Were these frustrations due to flaws in the game's interface designs? Were the recharge rates or energy costs of certain Scotty abilities miscalibrated?

In retrospect, it is now easier to recognize these frustration for what they were and understand why they were notably more severe in *Goombagrams* than in *Beam Me 'Round, Scotty!*. In both games, the pairs of player roles were designed to be heavily dependent on each other in service of my specific research questions exploring the influence of interdependence on players' perceptions of social connectedness. However, with each required interaction, each directional dependency, and each moment of synchronicity, the aesthetic membrane separating players would be penetrated and the pace of each asymmetric role would "osmose" into the other.

With *Goombagrams*, the personas guiding the design of the Wiley and Megaman roles were based on "Scrabble grandmothers" and "2D platformer youths" respectively; two vastly different target demographics. In *Beam Me 'Round, Scotty!*, the Kirk and Scotty roles were instead designed around "3D action adventure gamers" and "real-time strategy gamers" respectively; two much more similar game genres and target demographics.

To complete the metaphor then, it can be said that the pace gradients of each prototype game were trying to come to an equilibrium and the relatively distant gap between *Goombagrams*' target personas naturally resulted in more frequent and more severe frustration than the relatively similar target personas guiding the design of *Beam Me 'Round, Scotty!*. While this was ultimately not a significant problem for *Beam Me 'Round, Scotty!* players (and thus my player experience studies), "pace osmosis" may prove a critical challenge in future efforts to design and study asymmetric games that appeal to strongly contrasting play types. Indeed, the more evident "pace osmosis" frustration exhibited by Wiley and Megaman play testers is one of the primary reasons that *Beam Me 'Round, Scotty!* was chosen to advance as the primary experimental prototype over *Goombagrams* in the early stages of my thesis work.

It is not clear whether "pace osmosis" is simply an inherent and unavoidable characteristic of asymmetric cooperative games featuring tight interdependence between player roles. With more extensive study of a wider variety of games and a deliberate focus on the complexities of "pace osmosis", it may eventually be possible to better understand this subtle but pervasive phenomenon and design asymmetric games which effectively engage sharply contrasting player types. I propose one such avenue of future research in subsubsection 9.3.1.

8.2.1 Wicked & Unforeseen Consequences

Throughout the many iterations of *Beam Me 'Round, Scotty!*, one of the most significant mechanical changes made to the prototype's gameplay mechanics was the shift from a single, shared screen to separate screens and distinct in-game perspectives for Kirk and Scotty players. This change was originally prompted by frustrations from Scotty players trying to deploy their special abilities into the game world while having to counteract the unpredictable shifts in the shared perspective that only the Kirk player could control. Separating the players' views solved this seemingly minor usability problem and brought with it a pleasant additional benefit: the game could now present Kirk players with their own unique information independent of Scotty and vice versa.

Kirk could see objects much closer up and from a side-on perspective whereas Scotty could now only look at the world orthogonally to Kirk; straight down and from a detached, almost satellite perspective. An asymmetry of information could now flow both ways with Scotty having a broader overview and Kirk a narrower but more detailed perspective of the immediate area. Through play testing however, it became apparent that Kirk's perspective had another, somewhat unanticipated consequence: By having Kirk looking *forward* there was now the possibility for in-game elements to appear *behind* Kirk.

Indeed, the "Drawbridge Ambush" (first described in subsection 5.3.7) originally had one player lowering a drawbridge while the other fended off an ambushing swarm of angry wasps. In *BMRS1*, with its shared, isometric perspective, which player ended up handling which task came largely down to the individual personalities of the two participants and an exciting moment of quick decision making between them. In attempting to adapt this scenario to BMRS2 however, it became apparent that the original scenario had become largely incompatible with Kirk's new perspective. Whereas previously the ambushing wasps appeared nearby but within sight of both Kirk and Scotty players, in *BMRS2* the wasps appeared directly *behind* Kirk but offscreen. Whereas *BMRS1* players had found this ambush exciting, *BMRS*2 playtesters found this moment exceedingly frustrating and unfair (Figure 8.2).

Thus, in an attempt to improve the *usability* of Scotty's targeting mechanics, a chain of seemingly distinct mechanical changes led to a frustrating failure in *level design* for Kirk

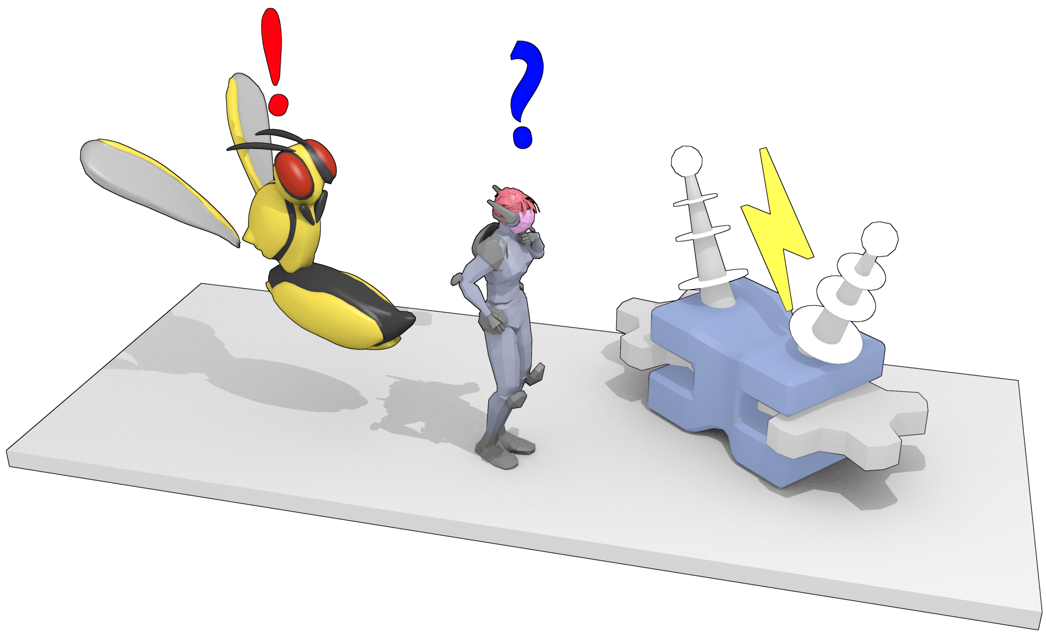


Figure 8.2: A vignette depicting the “Drawbridge Ambush” scenario. Well received by participants in *BMRS1*, the shift in Kirk’s perspective from isometric to over-the-shoulder resulted in unforeseen frustration as it was now possible for wasps to appear “behind” Kirk, off camera.

players. Many other such chains of unforeseen design consequences were encountered over the course of *Beam Me ’Round, Scotty!*’s iterations including challenges when implementing Super Kirk’s targeting abilities and Scotty’s networked tablet simulation in *BMRS2*, as well as when implementing the many tight, medium, and loose coupling variations of Scotty’s abilities in *BMRS3*.

Reflecting on game design as the “wicked problem” ((Rittel and Webber, 1973), chapter 4) that it is, these multifaceted design complexities within *Beam Me ’Round, Scotty!* and the unforeseen consequences that come with each mechanical manipulation are not actually unexpected or particularly notable.

What *is* important to note however, is how this same wicked complexity applies to manipulating research goals: how seemingly minor shifts in conceptual dimensions of a study can result in tremendous shifts in mechanical/design dimensions. As an example, the seemingly innocuous research question of “What would the effect be if we made *BMRS1* *less* asymmetric?" necessitated substantial hardware, software, and game design changes in order to uncover answers via study 2.

The proposed avenues of future work described in section 9.3 are presented in a similarly conceptual light but implementing the necessary designs and mounting the requisite player studies will likely require surprising amounts of time and effort. Unlike chemistry for example, where the question "What happens if we add more chlorine to this solution?" might result in a few more drops of liquid, the practical distances between seemingly proximal conceptual ideas in GUR are vast and challenging.

8.3 Designer Intent & The Joys of Constraints

The flexibility of choices made available to players is also a difficult balance to strike in asymmetric game design. On the one hand, games which allow players to tailor the difficulty, challenge, and combination of mechanics in play may be more likely to appeal to a wider range of players as such games allow the players themselves to tailor gameplay to suit their own tastes. On the other hand, as participant feedback from my studies has highlighted repeatedly, the constraints imposed on players via asymmetry and the deliberate interdependence asymmetry creates between players is one of the core strengths of asymmetric cooperative play. The "Super Kirk" condition in study 2 (chapter 6) sums up this challenge neatly: able to deploy all of Scotty's abilities on their own, Super Kirk is clearly more *powerful*, but is that individual power something pairs of players actually want? And should the game's designers even give players the choice between normal Kirk and Super Kirk?

Each of the three player studies described in this thesis posed hypothetical design questions to participants as part of their semi-structured interviews and each of those hypothetical questions centered around given players' choices. In study 1 (chapter 5), players were asked whether they'd prefer to play the traditional Split Kirk/Scotty configuration (as they had in that study) or a new Twin Super Kirks configuration (that had not yet been developed at that time). In study 2 (chapter 6), participants were asked whether they would prefer to play with their display screens side-by-side (as they had been during the study) or facing away from each other such that neither partner could see the other's view of the game world. Finally, in study 3 (chapter 7), participants were asked what version of the variously-coupled special abilities (tight, medium, loose coupling) they would prefer to play with in a longer version of the game.

In every case, participant responses were split. Many participants had clear preferences one way or the other. Many could see strengths (and weaknesses) in both options and described how their ultimate choices would be contingent on who they would be playing with, for how long, in what context, etc. Participants described how they expected that giving Scotty's powers to every player (as Super Kirk) would feel powerful but it could sever the link of necessary interdependence between players and diminishing the social play experience. Turning monitors away from each other could heighten the necessity of communication with each other (such as navigating the maze) and make the interdependent relationship richer but also prove frustrating for routine actions that should be better served with a shared mini-map or an on-screen compass. At no point was there a clearly best choice that would appeal to every individual player let alone every unique pair of players.

From a scientific perspective, the hypothetical choices that were presented to *BMRS* participants represent a yet further, unexplored, vastly multi-dimensional space. Fully mapping out that space in an attempt to identify "sweet spots" of interdependence, à la the more tractable challenge vs. aptitude "flow channel" concept laid out by Csikszentmihalyi (2014), would require simultaneous consideration of challenge, player aptitude, autonomy, asymmetry, necessity, social context, situational awareness, and many other variables. Yet, even if such an undertaking was practical, from a design perspective these concerns are all subsumed by the question of designer intent. Whether the heightened communication challenge and interdependence of not showing players their partner's screens is worth the increased cognitive overhead players would face can only be answered once the overall design intent of the experience is established. For example, if the design goal is to maximize perceived interdependence at all costs, hidden screens might be the better choice. However, if the design goal is to maximize perceived interdependence *for a wide audience*, hidden screens may be too severe.

8.4 Chapter Summary

In this chapter, I discussed several higher-level insights based on synthesizing broader trends from my research as a whole. I highlighted considerations and added nuance of what interdependence designers *allow* or *disallow* as distinct from previous discussions of what interdependence is *required* or not (subsection 3.2.5). I described the pervasive challenge of "pace osmosis" and how frustrations in asymmetric cooperative games due to mismatched player speeds can be exacerbated by the relative distance between aesthetic goals and how necessary interdependence is to players' interaction. I discussed the design tension of allowing players choice versus challenging them via constraints. Finally, I discussed how the "wicked problem" of game design generally also applies to navigating the conceptual spaces of games user research.

Chapter 9

Conclusion and Future Work

This thesis focuses on the use of asymmetry in the design of cooperative digital games as a means of generating interdependence between players, thereby enhancing those players' perceptions of social connectedness. My research has been motivated by the social benefits of play with preexisting friends and family as well as the challenges of finding games that present multi-faceted experiences, accommodate different types of players, and afford meaningful opportunities for each player to contribute to the same shared play experience. The results of my research included a conceptual framework for the design and study of asymmetric cooperative games, demonstrations of the utility of that framework through the development and testing of several prototype games (most notably *Beam Me 'Round, Scotty!*), and experimental evidence demonstrating not just that mechanical asymmetries can be leveraged to enhance players' perceptions of social connectedness but that, through careful design, that connectedness can be made to feel deliberately more or less intense.

In this chapter, the research contributions are summarized (section 9.1), the limitations of my findings are highlighted (section 9.2), and avenues for future research are discussed (section 9.3) followed by some closing remarks (section 9.4).

9.1 Contributions

Building on work from the fields of games user research (GUR), human-computer interaction (HCI), computer-supported collaborative work (CSCW), and game design practice, the work presented in this dissertation contributes to our understanding of asymmetric cooperative games. The major contributions of this work are briefly summarized below.

1. A conceptual framework, building upon the MDA framework of Hunicke et al. (2004), describing specific mechanical means of generating asymmetries between players in cooperative games, the characteristic dynamics of asymmetric cooperative play, and the resultant nuanced aesthetics of interdependence in these games. (chapter 3)
2. The design of two prototype asymmetric games (*Goombagrams* and *Beam Me 'Round, Scotty!*) that demonstrate the concrete realization of the concepts described in my conceptual framework as well as serve as experimental tools for exploring asymmetric cooperative play. (chapter 4)
3. A player experience study establishing characteristic dynamics of asymmetric cooperative play in the context of *Beam Me 'Round, Scotty!*. (chapter 5)
4. A player experience study demonstrating that asymmetric play leads to greater feelings of connectedness than symmetric play given the same social context and visual/narrative aesthetics. (chapter 6)
5. A player experience study demonstrating how deliberate mechanical manipulations that increase interdependent coupling of players' asymmetries of ability can increase players' perceptions of social connectedness. (chapter 7)
6. A synthesis of high-level insights drawn from observations running across all of my player experience studies and the iterative development of my prototype games. (chapter 8).

9.2 Limitations

The exploration and study of asymmetric cooperative games is still in its infancy. The above contributions represent important early steps in this area but there is still much more work to be done.

In my work, I adopted a research through design (Zimmerman et al., 2007) approach in order to address the wicked problems of asymmetric cooperative game design and thus used targeted iterations of characteristic mechanics, dynamics, and aesthetics (through my prototype games) to begin to understand specific pockets of this unique but under-studied design space. Many of the design details presented in this dissertation are therefore couched in the specific context of *Beam Me 'Round, Scotty!* and *Goombagrams*. In keeping with the research through design philosophy, I have described those prototype games in detail throughout this dissertation in order to convey the necessary context from which I have drawn more generalizable trends and conclusions.

It is important to note however that generalizing insights learned from one game to others is extremely difficult, and, with their inherently multifaceted nature, asymmetric games can often prove even more difficult to study and analyze than traditional symmetric multiplayer and single player games. Consider, for example, the challenge of adapting insights learned from studies of *Beam Me 'Round, Scotty!* to studies of massively multiplayer online games (e.g., Ducheneaut et al. (2006)) or to studies of abstract, meditative platformer games (e.g., Emmerich and Masuch (2017)). Many of the lessons learned in one play context may be broadly applicable to others but there will likely always be unique wrinkles or unanticipated twists that will require deliberate and focused study of each unique combination of design elements.

9.3 Future Work

In terms of immediate next steps, over the course of my research I never formally investigated the hypothetical "Kirk + Spock" condition originally posed to participants in study 1 (section 5.4). In this condition, both players would play as Kirk avatars but Scotty's abilities would *split* between them (e.g., only the Kirk player could heal and deploy shield walls while only the Spock player could place bombs and teleport players around obstacles). An experimental condition with such a split would be conceptually akin to the "Twin Kirk" and "Twin Scotty" conditions of study 2 (that manipulated symmetry while maintaining visual/narrative aesthetics) but would instead manipulate visual/narrative aesthetics while maintaining asymmetry.

There are also many other forms of asymmetry identified in my conceptual framework that remain to be studied. Asymmetries of investment, whereby some players are more heavily involved in play and others are only mildly involved, is perhaps the most intriguing and conceptually proximal to the themes of necessity and pace osmosis discussed in section 3.2 and section 8.2 but not directly addressed in any of the presented player experience studies. Consider, for example, a war game where "soldiers" compete in battles regularly throughout the week (à la typical first-person shooter games) while a "colonel" player perceives the game from a much higher, overview perspective and makes periodic strategic decisions once a week. When these two sets of players convene to discuss the outcomes of the week's battles, the colonel player conveys their decisions, and then the soldiers return to their fighting without the colonel even present.

Asymmetry of team size is another intriguing form of asymmetry because it immediately prompts cognitive ergonomic questions where, regardless of the abilities available to each player, one team has more mental focus and cognitive resources to dedicate to play than their opponents. It is foreseeable that the under-staffed team could become mentally overwhelmed by the simple virtue of "not having enough hands". It would be an interesting design challenge to determine how the game's systems could help compensate for this collective cognitive deficiency. In the same vein however, consider a parent playing with multiple young children. Being outnumbered in that case is less of a problem if one is dealing (mentally at least) with kids.

Below are two avenues of future research which consider more distinct research questions.

9.3.1 Rhythmic Interdependence & Role Reversals

As has been repeatedly suggested by participants across multiple studies when queried about expanding *Beam Me 'Round, Scotty!* into a longer experience, it will likely prove necessary to modulate how much collaboration is alternately required, allowed, or disallowed *over time* so as to afford players the opportunity to enjoy the strengths of each form without becoming bored or frustrated. Purposeful tilting of the direction and synchronicity of interdependence between players was designed into *Beam Me 'Round, Scotty!*'s levels from the earliest iterations (subsection 4.2.3) and participants most clearly identified the appeal of this rhythm of interdependence as part of the interview portion of study 3, but the specific effects of deliberately modulating interdependence over time have not been formally studied.

Overcoming Pace Osmosis & Contributing Spectators

As was discussed in section 8.2, pace osmosis appears to be an inherent frustration of asymmetric cooperative games. The more distinct the target aesthetics for asymmetric player roles and the more necessary interdependence between those roles becomes, the more likely that each player will be forced to accommodate and adapt to the pace of their partner's dynamics.

Finding a potential means of overcoming pace osmosis is a particularly attractive avenue of future research. As my present research indicates that necessity between asymmetric player roles is the design element that most directly influences pace osmosis, exploring the extreme opposite end of the necessity spectrum may yield unique insights not only into potential solutions, but also into further nuances of interdependence in asymmetric cooperative play generally.

I present the following example of how this might be achieved: In the critically acclaimed Nintendo classic *The Legend of Zelda: Ocarina of Time* the courageous hero Link is accompanied on his journey by the fairy Navi. In the original game, Navi was a non-player character who would automatically highlight interesting objects and locations in the world as the player, controlling Link, encountered them. Critically, as Navi was so small, she could have no real physical impact on the world. She could observe the world and communicate with Link but otherwise not affect gameplay.

From a narrative perspective, the relationship between Link and Navi is not entirely dissimilar to the relationship between the characters of Kirk and Scotty. The differences are mainly mechanical in that, in *Beam Me 'Round, Scotty!*, both players' mechanics are specifically designed to promote tight interdependence and cooperative interaction. Scotty is mechanically empowered to intervene on Kirk's behalf.

Consider instead, if the necessity of the Scotty role was sharply reduced to that of what I call a "contributing spectator" like Navi. Scotty players could still be presented with their own information display and their own unique perspective into the game world but, free from the *need* to intervene on Kirk's behalf, this Navi/Scotty player could relax and enjoy the more traditional performance of their play partner; with Navi/Scotty occasionally jumping in with useful, but not required, additional information.

Certainly, this version of Scotty would be very different from the versions of Scotty seen in *BMRS1*, *BMRS2*, and *BMRS3*, and so would be expected to appeal to a vastly different kind of player, but it would be illuminating to see how the greatly reduced necessity of their asymmetric role would affect the pair's social play experience.

9.4 Closing Remarks

This dissertation has demonstrated how asymmetry can be leveraged to generate interdependence between cooperating players in digital games and enhance their perceptions of social connectedness. This work brings structure to an understudied research space with the development of a conceptual framework that supports the design and study of asymmetric cooperative games. It demonstrates the application and utility of said framework through the realization of three iterations of *Beam Me 'Round, Scotty!* and other prototype games and describes many of the subtle complexities, dynamics, and aesthetics of asymmetry and interdependence in play.

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APPENDICES

Appendix A

Beam Me 'Round, Scotty! Design Details

This appendix includes more in-depth details about *Beam Me 'Round, Scotty!* that were not necessarily pivotal to the research discussion of asymmetric cooperative play as presented in this dissertation. These more technical and gameplay-centric details do form the larger play context in which those investigations were situated however, and so are described here for interested readers and to highlight the amount of time and effort that was invested into the development of the various prototypes over the course of this thesis.

A.1 Technology

Beam Me 'Round, Scotty! was developed using the Unity game engine (Unity Technologies, 2005) in the C# programming language and the Microsoft Visual Studio IDE (Microsoft Corporation, 2017). The Unity engine and its associated development editor provided several powerful APIs (i.e., graphics rendering, audio, input, physics, navigation, networking, and asset management) but all gameplay elements (e.g., mechanics, 3D models, etc.) were otherwise created by me.

All of *BMRS*'s 3D models and animations (e.g., player avatars, enemies, terrain, pickups) were created by me using the free and open-source 3D modelling application Blender (Blender Foundation, 1998).

The sound effects in *BMRS* (e.g., menu selection, weapon impacts, character grunts) were selected from several commercially available sound effect libraries. Tweaks to sound effects (e.g. pitch changes, time stretching, layering) were made using the free and open-source audio editing application Audacity (The Audacity Team, 2000).

Additional graphical elements (e.g., menu and UI icons, textures) were created and edited using the free and open-source image editing applications Inkscape (Numerous contributors (open source project), 2003) and GIMP (The GIMP Development Team, 1996).

A.2 Source Code

All of the *BMRS* code and production material were updated and maintained using the Git (Torvalds, 2005) version control system. These materials are available on a case-by-case basis via the University of Waterloo GitLab repositories service upon request. Please direct inquiries to John Harris (j6harris@uwaterloo.ca) and Mark Hancock (mark.hancock@uwaterloo.ca).

A.3 Enemies

In *Beam Me 'Round, Scotty!*, Kirk has crash landed on a planet full of both environmental hazards and hostile life forms. These serve as both static and dynamic obstacles for Kirk and Scotty players to overcome and represent the primary souces of challenge in *Beam Me 'Round, Scotty!*.

A.3.1 Wasp

The Wasp enemy was the first ever designed for *Beam Me 'Round, Scotty!*. Inspired by the first enemy players encounter in the original *Sonic the Hedgehod* Sonic Team (1991), the Wasp was designed as a near mindless robotic drone that would wander aimlessly until provoked, head directly towards Kirk if she came nearby, and then repeatedly fire slow-moving projectiles directly at Kirk once the gap closed sufficiently. This basic implementation worked well for *BMRS1* as early play testing revealed a useful feature of the Wasp's literally straightforward behaviour: with no way to shield herself from incoming enemy projectiles, Kirk's only means of avoiding damage from Wasps was to strafe out of the way. For higher-skill Kirk players, this was not much of a problem. More familiar with dual-joystick controls from modern video games, these players could "circle strafe" around small groups of Wasps with easy, quickly dispatching them without taking any damage at all. However, less skilled players had significantly more difficulty. Early playtesting had revealed that, despite being instructed on how to do so out the outset of play, many less skilled players would purposefully ignore the right joystick's aiming controls in order to simplify their focus on just the left joystick's movement and the shoulder button's blaster fire. To accommodate this behaviour, Kirk was programmed to face (and thereby aim) in the direction she was walking in the absence of player aiming input via the second joystick. This meant that low-skill Kirk players would always walk and shoot in the same direction and so, if they wanted to attack Wasps, would have to walk straight towards them and into the Wasp's own incoming projectiles. For these lower skill Kirks, Scotty players would very quickly notice their floundering partner and seek out a means of assisting them; typically discovering it in either the shield wall or shock beam. These early, frantic encounters would typically set up the pair's combat dynamics for the remainder of their run as they would quickly switch back to whichever interdependence dynamic had first worked for them during their first encounter.

For *BMRS2*, the Wasp's behaviour was modified significantly. With Kirk's new focus on melee combat and dodge mechanic (as well as an inability to both shield and attack simultaneously on their own), it was decided that the Wasps too would be switched to using melee attacks. The Wasp's primary offensive action became a "lunge attack" animation: once the Wasp's usual approach behaviour brought it close enough to Kirk, the Wasp would begin a quick but exaggerated wind-up animation with its stinger and then lunge forward, stinger first, a medium distance in a straight line. The design intent of the new Wasp's melee behaviour was to "telegraph" their incoming attack, giving skilled Kirk's enough time to notice and dodge out of the way, and then have the Wasp leave themselves vulnerable to reprisal if Kirk's dodge was successful.

A deliberately long "cooldown" period was also implemented to limit the frequency of each Wasp's lunge attack, giving Kirk players ample time to recover should the be hit and knocked down. The result was the Wasp maintaining it's position as the "basic enemy" of *BMRS2* and serving as excellent fodder for basic combat encounters.

A.3.2 Spider

The Spider enemy was envisioned as a complementary enemy to be placed occasionally alongside the Wasp. Most directly inspired by "Spider Mines" from *Starcraft* Blizzard Entertainment (1998), *BMRS*'s Spider would burrow underground waiting for Kirk to approach, pop up in ambush once nearby, and then run straight at Kirk before attempting to swipe at her with it's claws. This design drew on the concept of "orthogonally differentiable units" Brown (2016); Smith (2003); Worch (2014) wherein the Spider's high-pressure charging strategy was compliments the Wasp's relatively slow, long-range attack from a stand-off distance. When faced together, players would have a richer challenge space trying to deal with both Wasps and Spiders than they would by simply introducing more Wasps or even a "Super Wasp" with more health, damage, or speed.

The Spider's burrowing ability was also enhanced in *BMRS2* with the addition of Scotty's "radar signature" mechanic that allowed them to see enemies burrowed underground even when Kirk players could not. In this way, skilled Scotty players could warn Kirk players about upcoming Spider ambushes and potentially deploy countermeasures in advance (including torpedoing/bombing Spiders while they were still underground).

A.3.3 Beamos

Again drawing inspiration from classic game designs, the Beamos enemy copied its essentially appearance and behaviours from the enemies of the same name in the *Legend of Zelda* Nintendo EPD (2017) series. Acting as stationary sentries, Beamos enemies would slowly scan their surroundings in a predictable circular manner and, if an enemy entered their limited field of view, would charge up and fire a continuous laser beam that would burn a point on the ground that would chase their target until their target left the Beamos' sight radius. In *BMRS*, Beamos enemies were invulnerable to attack and placed inside the maze areas. On open ground, it was relatively easy to dodge around a Beamos' cone of vision but, by placing these enemies in the constrained corridors of mazes, Kirk players would now need to carefully plan when to pass by and/or would have to frantically navigate the more geographically hazardous areas under threat of the Beamos' lasers.

Appendix B

Beam Me 'Round, Scotty! Gameplay Video

This appendix is a video file demonstrating typical gameplay from different versions of *Beam Me 'Round, Scotty!*. As the complex dynamics of digital game play are difficult to capture in words, this video is intended to provide readers with a better understanding of how players interacted with the various gameplay roles, enemies, obstacles, and special abilities.

The file name of this video is "BMRSGameplayVideo.mp4"

If you accessed this thesis from a source other than the University of Waterloo, you may not have access to this file. You may access it by searching for this thesis on https://uwspace.uwaterloo.ca/UWSpace

Appendix C

Research Ethics Materials

Prior to involving human participants, the player experience studies described in this dissertation were reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee. The relevant materials are included below.

C.1 Study 1

The following documents were used as part of study 1 as discussed in chapter 5.

UNIVERSITY OF WATERLOO

Title of Project: *"Beam Me 'Round, Scotty!" Prototype Gameplay Exploration*

Student Investigator: **John Harris, John.Harris@UWaterloo.ca**

Faculty Supervisors: ***Dr. Stacey Scotty, ext. 32236, Stacey.Scotty@UWaterloo.ca***

Dr. Mark Hancock, ext. 36587, Mark.Hancock@UWaterloo.ca

Summary of the Project:

This project is part of a research program aimed at the design of new forms of multiplayer video games and novel game play mechanics. In order to develop effective design guidelines, we have developed a prototype game called "Beam Me 'Round, Scotty!" which explores multiple possible configurations of game play mechanics. Through observation of participants playing our prototype game and interviews regarding their experience, the researchers hope to further understand common patterns of play related to our prototype game mechanics. The information gathered in this study will be used to develop future games which better support multiplayer play.

Procedure:

Your participation in this study is voluntary. Participation involves completing several surveys and playing multiple different versions of our prototype game. The complete study session should last approximately one hour divided among several phases. You will complete some of these phases individually and others with a partner. A description of each phase follows.

Phase 1 (approximately 5 minutes): You will receive a "Player Background Survey" which will ask about your history playing video games. Example questions include:

- "List your three favourite video games."
- "How often do you play video games?"
- "Do you typically play single-player or multi-player games?"

Phases 2 & 3 (approximately 40 minutes): In Phases 2 and 3 you will play several levels from our prototype game and complete short surveys after each level.

Phase 4 (approximately 15 minutes): In Phase 4, you will be interviewed about your experience playing the prototype game and invited to provide feedback.

During each session, a researcher will observe and take notes regarding your interactions with the game, as well as your interactions with your partner in the sessions. Your game-based interactions will also be captured and stored in a computer log file. (e.g. buttons pressed, time played, number of attempts.) You will also be videotaped and any task materials produced during the session will remain with the researcher. You may decline to respond to questions if you wish. You may withdraw your participation at any time without penalty.

Confidentiality and Data Security:

Your name will not appear in any publication resulting from this study. With your permission, anonymous quotations may be used. In these cases participants will be referred to as Participant 1, Participant 2, … (or P1, P2, …) or collectively as a group (Group A, B,…). Data collected during this study will be retained for a minimum of 5 years in locked cabinets or on password protected desktop computers in a secure location. Electronic data will not include personal identifying information such as names.

You will be explicitly asked for consent for the use of photo/video/audio data, captured from the videotaping, for the purpose of reporting the study's findings. If consent is granted, these data will be used only for the purposes associated with teaching, scientific presentations, publications, and/or sharing with other researchers and you will not be identified by name. Anonymity cannot be promised for those participants who consent to allow their video and audio recordings to be used for presentation of research results however as your face and voice will not be blurred nor disguised in future image, video, or audio presentations.

Remuneration for Your Participation:

You will receive remuneration for your participation in this study, for a total of $10.

Risks and Benefits:

There are no known or anticipated risks from participation in this study. There are no direct benefits to you from participation. However, the results of this research may contribute to the knowledge base of game design research and lead to the development of improved multiplayer games.

Research Ethics Clearance:

I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. Should you have comments or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at 1-519-888-4567, Ext. 36005 or maureen.nummelin@uwaterloo.ca.

Thank you for your assistance in this project.

UNIVERSITY OF WATERLOO

CONSENT FORM

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

Project: ***"Beam Me 'Round, Scotty!" Prototype Gameplay Exploration***

I have read the information presented in the information letter about a study being conducted ***John Harris*** of the Department of ***Computer Science***, under the supervision of Professors ***Stacey Scott and Mark Hancock.*** I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

Sometimes a certain image and/or segment of videotape clearly shows a particular feature or detail that would be helpful in teaching or when presenting the study results at a scientific presentation or in a publication. I am aware that I may allow video and/or digital images in which I appear to be used in teaching, scientific presentations, publications, and/or sharing with other researchers with the understanding that I will not be identified by name but that anonymity cannot be promised as my face or voice will not be disguised. I am aware that I may allow excerpts from the conversational data collected for this study to be included in teaching, scientific presentations and/or publications, with the understanding that any quotations will be anonymous.

I am aware that I may withdraw my consent for any of the above statements or withdraw my study participation at any time without penalty by advising the researcher.

This project has been reviewed by, and received ethics clearance through a University of Waterloo Research Ethics Committee. I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact the Director, Office of Research Ethics at (519) 888-4567 ext. 36005.

	Please Circle One	**Please Initial Your Choice**
With full knowledge of all foregoing, I agree, of my own free will NO to participate in this study.	YES NO	__________
I agree to be videotaped.	YES NO	__________
I agree to let my conversation during the study be directly NO quoted, anonymously, in presentations of research results.	YES NO	__________
I agree to let clips, audio, and/or digital images from the NO video be used for presentations of the research results and I understand that while my name will not be used, my voice and/or image will be displayed and therefore my confidentiality cannot be protected.	YES NO	__________

Participant Name: ____
(Please print)

Participant Signature: _____________________________________ Date: _________________

Witness Name: ____
(Please print)

Witness Signature: ____ Date:__________________

C.2 Study 2

The following documents were used as part of study 2 as discussed in chapter 6.

UNIVERSITY OF WATERLOO

Title of Project: *"Beam Me 'Round, Scotty!" Prototype Gameplay Exploration*

Student Investigator: **John Harris, John.Harris@UWaterloo.ca**

Faculty Supervisors: ***Dr. Mark Hancock, ext. 36587, Mark.Hancock@UWaterloo.ca***

Dr. Ed Lank, ext. 35786, Lank@UWaterloo.ca

Summary of the Project:

This project is part of a research program aimed at the design of new forms of multiplayer video games and novel game play mechanics. In order to develop effective design guidelines, we have developed a prototype game called *Beam Me 'Round, Scotty!* which explores multiple possible configurations of game play mechanics. Through observation of participants playing our prototype game and interviews regarding their experience, the researchers hope to further understand common patterns of play related to our prototype game mechanics. The information gathered in this study will be used to develop future games which better support multiplayer play.

Procedure:

Your participation in this study is voluntary. Participation involves completing several surveys and playing multiple different versions of our prototype game. The complete study session should last approximately 90 minutes divided among several phases. You will complete some of these phases individually and others with a partner. A description of each phase follows.

Phases 1, 2, 3, and 4 (approximately 70 minutes): In these phases, you will play our prototype game; each time under different configurations and complete short surveys after session.

Phase 5 (approximately 5 minutes): You will receive a "Player Background Survey" which will ask about your history playing video games. For example, when playing games "how much do you enjoy just looking at the scenery?" or "how much do you enjoy collecting every possible item?"

Phase 6 (approximately 15 minutes): You will be interviewed about your experience playing the prototype game and invited to provide feedback.

During each session, a researcher will observe and take notes regarding your interactions with the game, as well as your interactions with your partner in the sessions. Your game-based interactions will also be captured and stored in a computer log file. (e.g. buttons pressed, time played, number of attempts.) You will also be videotaped and any task materials produced during the session will remain with the researcher. You may decline to respond to questions if you wish. You may withdraw your participation at any time without penalty.

Confidentiality and Data Security:

Your name will not appear in any publication resulting from this study. With your permission, anonymous quotations may be used. In these cases participants will be referred to as Participant 1, Participant 2, … (or P1, P2, …) or collectively as a group (Group A, B,…). Data collected during this study will be retained for a minimum of 5 years in locked cabinets or on password protected desktop computers in a secure location. Electronic data will not include personal identifying information such as names.

You will be explicitly asked for consent for the use of photo/video/audio data, captured from the videotaping, for the purpose of reporting the study's findings. If consent is granted, these data will be used only for the purposes associated with teaching, scientific presentations, publications, and/or sharing with other researchers and you will not be identified by name. Anonymity cannot be promised for those participants who consent to allow their video and audio recordings to be used for presentation of research results however as your face and voice will not be blurred nor disguised in future image, video, or audio presentations.

Remuneration for Your Participation:

You will receive remuneration for your participation in this study, for a total of $15.

Risks and Benefits:

There are no known or anticipated risks from participation in this study. There are no direct benefits to you from participation. However, the results of this research may contribute to the knowledge base of game design research and lead to the development of improved multiplayer games.

Research Ethics Clearance:

I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. Should you have comments or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at 1-519-888-4567, Ext. 36005 or maureen.nummelin@uwaterloo.ca.

Thank you for your assistance in this project.

CONSENT FORM

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

Project: ***"Beam Me 'Round, Scotty!" Prototype Gameplay Exploration***

I have read the information presented in the information letter about a study being conducted ***John Harris*** of the Department of ***Computer Science***, under the supervision of Professors ***Mark Hancock and Ed Lank.*** I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

Sometimes a certain image and/or segment of videotape clearly shows a particular feature or detail that would be helpful in teaching or when presenting the study results at a scientific presentation or in a publication. I am aware that I may allow video and/or digital images in which I appear to be used in teaching, scientific presentations, publications, and/or sharing with other researchers with the understanding that I will not be identified by name but that anonymity cannot be promised as my face or voice will not be disguised. I am aware that I may allow excerpts from the conversational data collected for this study to be included in teaching, scientific presentations and/or publications, with the understanding that any quotations will be anonymous.

I am aware that I may withdraw my consent for any of the above statements or withdraw my study participation at any time without penalty by advising the researcher.

This project has been reviewed by, and received ethics clearance through a University of Waterloo Research Ethics Committee. I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact the Director, Office of Research Ethics at (519) 888-4567 ext. 36005.

	Please Circle One	**Please Initial Your Choice**
With full knowledge of all foregoing, I agree, of my own free will to participate in this study.	YES NO	__________
I agree to be videotaped.	YES NO	__________
I agree to let my conversation during the study be directly quoted, anonymously, in presentations of research results.	YES NO	__________
I agree to let clips, audio, and/or digital images from the video be used for presentations of the research results and I understand that while my name will not be used, my voice and/or image will be displayed and therefore my confidentiality cannot be protected.	YES NO	__________

Participant Name: ____
(Please print)

Participant Signature: _____________________________________ Date: _________________

Witness Name: ____
(Please print)

Witness Signature: ____ Date:__________________

C.3 Study 3

The following documents were used as part of study 3 as discussed in chapter 7.

UNIVERSITY OF WATERLOO

Title of Project: *"Beam Me 'Round, Scotty!" Prototype Gameplay Exploration*

Student Investigator: **John Harris, John.Harris@UWaterloo.ca**

Faculty Supervisors: ***Dr. Mark Hancock, ext. 36587, Mark.Hancock@UWaterloo.ca***

Dr. Ed Lank, ext. 35786, Lank@UWaterloo.ca

Summary of the Project:

This project is part of a research program aimed at the design of new forms of multiplayer video games and novel game play mechanics. In order to develop effective design guidelines, we have developed a prototype game called *Beam Me 'Round, Scotty!* which explores multiple possible configurations of game play mechanics. Through observation of participants playing our prototype game and interviews regarding their experience, the researchers hope to further understand common patterns of play related to our prototype game mechanics. The information gathered in this study will be used to develop future games which better support multiplayer play.

Procedure:

Your participation in this study is voluntary. Participation involves completing several surveys and playing multiple different versions of our prototype game. The complete study session should last approximately 90 minutes divided among several phases. You will complete some of these phases individually and others with a partner. A description of each phase follows.

Play Phases (approximately 70 minutes): In these phases, you will play our prototype game; each time under different configurations and complete short surveys after each session.

Final Survey (approximately 5 minutes): You will receive a "Player Background Survey" which will ask about your history playing video games. For example, when playing games "how much do you enjoy just looking at the scenery?" or "how much do you enjoy collecting every possible item?"

Interview Phase (approximately 15 minutes): You will be interviewed about your experience playing the prototype game and invited to provide feedback.

During each session, a researcher will observe and take notes regarding your interactions with the game, as well as your interactions with your partner in the sessions. Your game-based interactions will also be captured and stored in a computer log file. (e.g. buttons pressed, time played, number of attempts.) You will also be videotaped and any task materials produced during the session will remain with the researcher. You may decline to respond to questions if you wish. You may withdraw your participation at any time without penalty.

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Remuneration for Your Participation:

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Risks and Benefits:

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Research Ethics Clearance:

I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours. Should you have comments or concerns resulting from your participation in this study, please contact Dr. Maureen Nummelin, the Director, Office of Research Ethics, at 1-519-888-4567, Ext. 36005 or maureen.nummelin@uwaterloo.ca.

Thank you for your assistance in this project.

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Project: ***"Beam Me 'Round, Scotty!" Prototype Gameplay Exploration***

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I am aware that I may withdraw my consent for any of the above statements or withdraw my study participation at any time without penalty by advising the researcher.

This project has been reviewed by, and received ethics clearance through a University of Waterloo Research Ethics Committee. I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact the Director, Office of Research Ethics at (519) 888-4567 ext. 36005.

	Please Circle One	**Please Initial Your Choice**
With full knowledge of all foregoing, I agree, of my own free will to participate in this study.	YES NO	__________
I agree to be videotaped.	YES NO	__________
I agree to let my conversation during the study be directly quoted, anonymously, in presentations of research results.	YES NO	__________
I agree to let clips, audio, and/or digital images from the video be used for presentations of the research results and I understand that while my name will not be used, my voice and/or image will be displayed and therefore my confidentiality cannot be protected.	YES NO	__________

Participant Name: ____
(Please print)

Participant Signature: ______________________________________ Date: _________________

Witness Name: ____
(Please print)

Witness Signature: ____ Date:__________________

Participants Needed

for research in

Video Game Play

We are looking for

pairs of volunteers

to take part in a study of our prototype video game *Beam Me ‘Round, Scotty!*

As participants, you and your friend would be asked to

play and provide feedback about our prototype game

complete an anonymous questionnaire about your video game playing preferences, and provide feedback during a short interview.

Participation involves a single session lasting approximately

90 minutes

In appreciation of your time, you and your friend will each receive

$15 compensation.

To volunteer for this study visit

http://GameScience.YouCanBook.Me

or contact John Harris (Department of Computer Science) at email John.Harris@UWaterloo.ca for more information.

This study has been reviewed by and received ethics clearance through a Univeristy of Waterloo Research Ethics Committee

UNIVERSITY OF WATERLOO

THE GAMES INSTITUTE

Appendix D

Study Materials

Below around the various experimenter scripts, player experience surveys, and interview questions employed during the player experience studies described in this dissertation.

"Beam Me 'Round, Scotty!" Prototype Gameplay Study

Recruitment Email

Subject: Pairs of video game players wanted for study of new prototype game at UW Games Institute

My name is John Harris. I am a PhD student from the department of Computer Science working with the University of Waterloo Games Institute to develop novel and experimental new games. My colleagues and I (with faculty supervisors Prof. Stacey Scott and Prof. Mark Hancock) are conducting a study of our latest prototype game "Beam Me 'Round, Scotty!" for which we require hands-on feedback from players in the local community.

Participation in this study involves coming into the Games Institute and playing an action-oriented video game using both a handheld gamepad and a keyboard/mouse. You will be asked a series of survey questions regarding your game playing preferences and your experience while playing the prototype game. The experiment will conclude with a semi-structured interview where you will be asked to provide suggestions for future improvements to the prototype game.

Participation in this study would take approximately 1 hour of your time. In appreciation of your time commitment, you will receive remuneration of $10. I would like to assure you that this study has been reviewed by and received ethics clearance through a University of Waterloo Research Ethics Committee. If you are interested in participating, please contact John Harris at John.Harris@UWaterloo.ca.

Sincerely,

John Harris
Games Institute
University of Waterloo

D.1 Introductory Script

Following the informed consent preamble wherein participants were briefed about the nature of the study and reviewed the Participant Information and Consent Forms (Appendix C), in each of the three studies, participants were introduced to the basic premise of *Beam Me 'Round, Scotty!* using the following introduction:

> To begin, are either of you familiar with or aware of the science fiction series *Star Trek*? [Participants respond.] I ask because the plot of *Beam Me 'Round, Scotty!* is loosely based on *Star Trek* and so if you are familiar with the show then many people just 'get' *Beam Me 'Round, Scotty!*. But it's OK if you're not because it's not necessary to be familiar with *Star Trek* in order to play. I'll explain everything you need to know either way.
>
> In short, courageous space captain Joanna T. Kirk has crash landed on a hostile alien planet and must find a means of escape. Meanwhile, plucky engineer Scotty is still up in the orbiting starship and can use the ship's various systems to help Kirk reach the exit.

This would be immediately followed by instructions on how to play whichever experimental condition the participants had been assigned to play first. For example, in Study 2:

> So this is Kirk's perspective as seen on this screen. [Pointing at monitor.] For this mode [Twin Scotty], you'll be using these tablets to deploy Scotty's abilities and help each of your own Kirks to reach the exit. [Experimenter would place a tablet in front of each participant.]

D.2 PENS Survey

The "Player Experience of Needs Satisfaction" survey was originally developed by Przybylski et al. Przybylski et al. (2010) as a tool for gauging players' perceptions of how well game experiences satisfied players' desires for autonomy, competence, relatedness, immersion, and intuitive controls.

All 5 sub-scales were administered in study #1 while the relatedness sub-scale was replaced with an expanded battery of more detailed social experience questions (i.e., subscales from the SPGQ, IoS, IMI surveys) for studies #2 and #3. In each case, the questions were presented on a 7-point Likert scale. Questions to be reverse coded are indicated with a (-).

Competence

1. I feel competent at the game.
2. I feel very capable and effective when playing.
3. My ability to play the game is well matched with the game's challenges.

Autonomy

1. The game provides me with interesting options and choices
2. The game lets you do interesting things
3. I experienced a lot of freedom in the game

Relatedness

1. I find the relationships I form in this game fulfilling.
2. I find the relationships I form in this game important.
3. I dont feel close to other players. (-)

Immersion

1. When playing the game, I feel transported to another time and place.

2. Exploring the game world feels like taking an actual trip to a new place.
3. When moving through the game world I feel as if I am actually there.
4. I am not impacted emotionally by events in the game (-).
5. The game was emotionally engaging.
6. I experience feelings as deeply in the game as I have in real life.
7. When playing the game I feel as if I was part of the story.
8. When I accomplished something in the game I experienced genuine pride.
9. I had reactions to events and characters in the game as if they were real.

Intuitive Controls

1. Learning the game controls was easy.
2. The game controls are intuitive.
3. When I wanted to do something in the game, it was easy to remember the corresponding control.

D.3 SPGQ Survey

The "Social Presence in Gaming Questionnaire" employed in studies #2 and #3 was originally developed by de Kort et al. Kort et al. (2007) as a means of comparing players' experiences of co-located and remote play. Social presence, in this case, measures how empathetic, psychologically involved, and behaviourally engaged players felt with each other.

In each case, the questions were presented on a 7-point Likert scale. Questions to be reverse coded are indicated with a (-).

Items

Psychological Involvement - Empathy

1. When the others were happy, I was happy.
2. When I was happy, the others were happy.
3. I empathized with the other(s).
4. I felt connected to the other(s).
5. I admired the other(s).
6. I found it enjoyable to be with the other(s).
7. I sympathized with the other(s).

Psychological Involvement - Negative Feelings

1. I tended to ignore the other(s).
2. The other(s) tended to ignore me.
3. I felt revengeful.
4. I felt schadenfreude (malicious delight).
5. I felt jealous of the other(s).
6. I envied the other(s).

Behavioural Engagement

1. My actions depended on the other's actions.
2. The other's actions were dependent on my actions.
3. What the others did affected what I did.
4. What I did affected what the others did.
5. The others paid close attention to me.
6. I paid close attention to the others.
7. My intentions were clear to the others.
8. The others' intentions were clear to me.

D.4 IMI Survey

Originally developed by !!! as a means of gauging !!!, select sub-scales of the "Intrinsic Motivation Inventory" were administered as post of each post-gameplay survey session during studies #2 and #3. Each question was presented on a 7-point Likert scale. Questions that were reverse coded are indicated with a (-).

Interest

1. I enjoyed playing this version of the game very much.
2. This version of the game was fun to play.
3. I thought this version of the game was boring. (-)
4. This version of the game did not hold my interest at all. (-)
5. I would describe this version of the game as very interesting.
6. I thought this version of the game was quite enjoyable.
7. While I was playing this version of the game, I was thinking about how much I enjoyed it.

Effort

1. I put a lot of effort into this version of the game.
2. I didn't try very hard to do well at this version of the game. (-)
3. I tried very hard on this version of the game.
4. It was important to me to do well at this version of the game.
5. I didn't put much energy into this version of the game. (-)

Pressure

1. I did not feel nervous at all while playing this version of the game. (-)
2. I felt very tense while playing this version of the game.

3. I was very relaxed playing this version of the game. (-)
4. I was anxious while playing this version of the game.
5. I felt pressured while playing this version of the game.

D.4.1 IoS Scale

The "Inclusion of the Other in the Self" scale (as presented by Gachter et al. Gachter et al. (2015) measures respondents' perceptions of "closeness" to a particular person. Respondents select what they feel is the appropriate degree of increasingly concentric circles from a Likert-like scale. This IoS scale has been shown to be a particular simple and effective measure that is easily understood and administered.

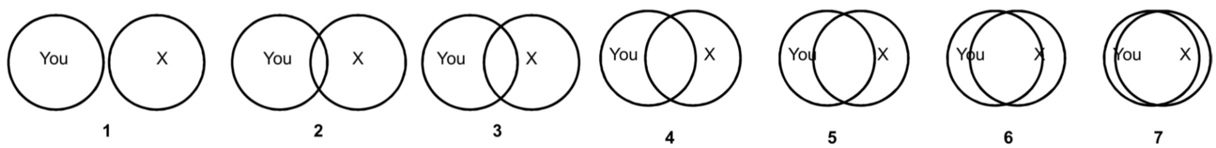


Figure D.1: The version of the "Inclusion of the Other in the Self" scale employed in both study 2 and 3.

BrainHex version 0.99 international hobo

1. Quiz

Instructions: *For each experience, choose "I love it!", "I hate it!" or "It's okay". Put a mark in the score sheet for each choice you make, and turn it into a number value when you have finished.*

"Exploring to see what you can find." [A]

"Frantically escaping from a terrifying foe." [B]

"Working out how to crack a challenging puzzle." [D]

"The struggle to difficult boss." [E]

"Playing in a group, online or in the same room." [F]

"Responding quickly to an exciting situation" [C]

"Picking up every single collectible in an area" [G]

"Looking around just to enjoy the scenery." [A]

"Being in control at high speed." [C]

"Devising a promising strategy when deciding what to try next." [D]

"Feeling relief when you escape to a safe area." [B]

"Taking on a strong opponent when playing against a human player in a versus match" [E]

"Talking with other players, online or in the same room." [F]

"Finding what you need to complete a collection." [G]

"Hanging from a high ledge." [C]

"Wondering what's behind a locked door." [A]

"Feeling scared, terrified or disturbed." [B]

"Working out what to do on your own." [D]

"Completing a punishing challenge after failing many times." [E]

"Co-operating with strangers." [F]

"Getting 100% (completing *everything* in a game)" [G]

2. Rate

Instructions: *Arrange the following experiences into a sequence from 6 (best) to 0 (worst), such that you have used each number only once. Add the score in the Rating column of the table below.*

[ ] "A moment of jaw-dropping wonder or beauty." [A]

[ ] "An experience of primeval terror that blows your mind." [B]

[ ] "A moment of breathtaking speed or vertigo." [C]

[ ] "The moment when the solution to a difficult puzzle clicks in your mind." [D]

[ ] "A moment of hard-fought victory." [E]

[ ] "A moment when you feel an intense sense of unity with another player." [F]

[ ] "A moment of completeness that you have strived for" [G]

3. Score

Place checks in the first three columns for Part 1, and values in the next column for Part 2.

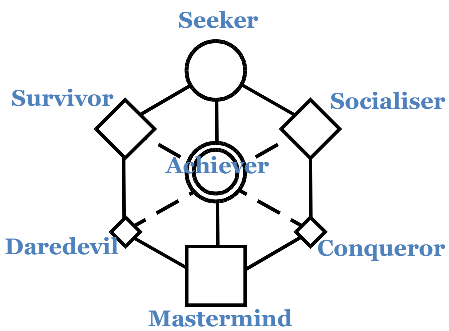
Letter	I Love It (+1)	I Hate It (-2)	It's Okay (+0)	Rating (+0 to 6)	Total
A					
B					
C					
D					
E					
F					
G					

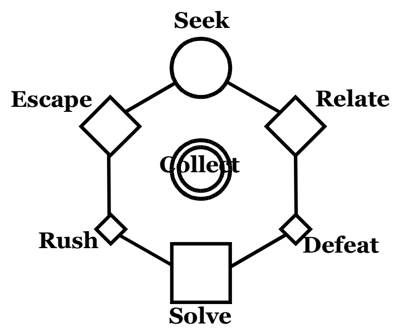
4. Results

Find your highest scoring letter in this table to find your BrainHex class!
Each score of zero or below also gives you your exceptions – the things you don't like!

Letter	BrainHex Class *(high score)*	BrainHex Exception *(zero/negative score)*	You like/Dislike...	Behaviour	Brain Region	Protein
A	**Seeker**	No Wonder	Finding curious and wonderful things	Curiosity	Hippocampus, Sensory Cortex	Endomorphin
B	**Survivor**	No Fear	Escaping from hideous and scary threats	Fear	Amygdala, (Adrenal glands)	Epinephrine
C	**Daredevil**	No Pressure	Rushing around at heights or high speed	Excitement	(Adrenal glands)	Epinephrine
D	**Mastermind**	No Problems	Solving puzzles and devising strategies	Decision making	Orbito-frontal cortex	(Dopamine)
E	**Conqueror**	No Punishment	Defeating impossibly difficult foes	Anger, Victory (fiero)	Hypothalamus, (Adrenal glands)	Norepinephrine
F	**Socialiser**	No Mercy	Hanging around with people you trust	Trust	Hypothalamus	Oxytocin
G	**Achiever**	No Commitment	Collecting and doing everything possible	Satisfaction, Victory (fiero)	Nucleus Accumbens	Dopamine

e.g. a high G with a negative C would be "Achiever (No Pressure)" and a high E with negative F would be "Conqueror (No Mercy)"





"Beam Me 'Round, Scotty!" Study 1
Sample Interview Questions

At this point in the study, both participants will have played the prototype game under several different in-game configurations . The experimenter will then conduct a semi-structured interview with both participants together. Some questions will be more pertinent to one player ("Kirk") or the other ("Scotty"). Below are some sample questions to be used to guide the interview.

- Do you (the two participants) normally play games together?
  - If so, how often? What are some of your favourite games? Why?
  - If not, would you like to? What is preventing you from playing together currently?
  - Can you think of other friends/family that you would want to play more games with?
- Can you comment on some of the differences you noticed between the various game levels you just played?
  - Do you feel you were able to cooperate with each other during gameplay?
  - Do you feel the game *wanted* or *required* you to cooperate at any point or was cooperation optional?
- Was there a clear leader/captain/instigator during the interaction between you?
  - If so, why was it so?
  - Is this a typical leadership dynamic between you (the two participants)?
- Can you comment on the different interfaces used for each character?
  - Did the control schemes seem appropriate? (Gamepad vs keyboard+mouse) Would you change them?
  - Can you comment on the camera system? (e.g. that it was centered on and controlled by the Kirk character even though the Scotty character needed to share the same view)
- To Scotty:
  - How would you describe your role in the game?
  - Did you feel overwhelmed at any point?
  - Did you feel powerful?
  - Did you feel necessary/useful?
- To Kirk:
  - How would you describe your role in the game?
  - Did you feel supported by Scotty?
    - If so, when was this most apparent? When was this least apparent?
    - If not, why?

Appendix E

Statistical Analyses

Below is the statistical analysis output from each of the player experience studies described in this dissertation. They are presented here for reference. The statistical software used was IBM SPSS Statistics 21.

E.1 Study 1 - Statistics Output

The following statistical output is for study 1 as described in chapter 5.

```
GET
  FILE='C:\Users\cosys\Documents\Harris\BMRS Study Data.sav'.
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  /MEASURE=Immersion
  /METHOD=SSTYPE(3)
  /EMMEANS=TABLES(OVERALL)
  /EMMEANS=TABLES(Character) COMPARE ADJ(LSD)
  /EMMEANS=TABLES(NumPlayers) COMPARE ADJ(LSD)
  /EMMEANS=TABLES(Character*NumPlayers)
  /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /WSDESIGN=Character NumPlayers Character*NumPlayers.

GLM ktut_immersion kplay_immersion stut_immersion splay_immersion ktut_autonom
y kplay_autonomy stut_autonomy splay_autonomy ktut_relatedness kplay_relatedne
ss stut_relatedness splay_relatedness ktut_competence kplay_competence stut_co
mpetence splay_competence ktut_intuitivecontrols kplay_intuitivecontrols stut_
intuitivecontrols splay_intuitivecontrols
  /WSFACTOR=Character 2 Polynomial NumPlayers 2 Polynomial
  /MEASURE=Immersion Autonomy Relatedness Competence IntuitiveControls
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  /EMMEANS=TABLES(Character) COMPARE ADJ(LSD)
  /EMMEANS=TABLES(NumPlayers) COMPARE ADJ(LSD)
  /EMMEANS=TABLES(Character*NumPlayers)
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  /CRITERIA=ALPHA(.05)
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CORRELATIONS
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  /MISSING=PAIRWISE.

CORRELATIONS
  /VARIABLES=kplay_competence INTROSkillThirdPersonAction INTROSkillFPS
  /PRINT=TWOTAIL NOSIG
  /MISSING=PAIRWISE.

CORRELATIONS
```

```
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tut_competence
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competence stut_autonomy
    stut_relatedness stut_immersion stut_intuitivecontrols kplay_autonomy kpla
y_relatedness
    kplay_immersion kplay_intuitivecontrols splay_competence splay_autonomy sp
lay_relatedness
    splay_immersion splay_intuitivecontrols INTROAge INTROPlayHowOften INTROPl
ayHowLong
    INTROWithFriendOften INTROSkillPlatformer INTROSkillPuzzle INTROSkillMOBA
INTROSkillMMO
    INTROSkillFighting INTROSkillRTS INTROSkillRacing INTROSkillSports INTROSk
illSimulation
    INTROSkillCrafting INTROSkillRhythm INTROSkillShmup INTROSkillPCAdventure
  /PRINT=TWOTAIL NOSIG
  /MISSING=PAIRWISE.

CORRELATIONS
  /VARIABLES=ktut_competence ktut_autonomy ktut_relatedness ktut_immersion ktu
t_intuitivecontrols stut_competence stut_autonomy stut_relatedness stut_immers
ion stut_intuitivecontrols kplay_competence kplay_autonomy kplay_relatedness k
play_immersion kplay_intuitivecontrols splay_competence splay_autonomy splay_r
elatedness splay_immersion splay_intuitivecontrols INTROAge INTROPlayHowOften
INTROPlayHowLong INTROWithFriendOften INTROSkillPlatformer INTROSkillFPS INTRO
SkillThirdPersonAction INTROSkillPuzzle
INTROSkillMOBA INTROSkillMMO INTROSkillFighting INTROSkillRTS INTROSkillRacing
 INTROSkillSports INTROSkillSimulation INTROSkillCrafting INTROSkillRhythm INT
ROSkillShmup INTROSkillPCAdventure
  /PRINT=TWOTAIL NOSIG
  /MISSING=PAIRWISE.
```

Correlations

Correlations

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ktut_competence	Pearson Correlation	1	.356*	.263	.069	.453**	.095	.137	.255	.270	.298	.532**
	Sig. (2-tailed)		.039	.133	.696	.007	.593	.439	.146	.122	.087	.001
	N	34	34	34	34	34	34	34	34	34	34	34
ktut_autonomy	Pearson Correlation	.356*	1	.436**	.315	.310	.362*	.602**	.291	.246	.119	.127
	Sig. (2-tailed)	.039		.010	.069	.074	.036	.000	.095	.161	.502	.476
	N	34	34	34	34	34	34	34	34	34	34	34
ktut_relatedness	Pearson Correlation	.263	.436**	1	.424*	.024	.287	.345*	.582**	.502**	.240	.149
	Sig. (2-tailed)	.133	.010		.012	.893	.100	.046	.000	.002	.172	.400
	N	34	34	34	34	34	34	34	34	34	34	34
ktut_immersion	Pearson Correlation	.069	.315	.424*	1	.175	-.155	.192	.211	.617**	-.046	.283
	Sig. (2-tailed)	.696	.069	.012		.323	.382	.277	.230	.000	.798	.105
	N	34	34	34	34	34	34	34	34	34	34	34
ktut_intuitivecontrols	Pearson Correlation	.453**	.310	.024	.175	1	.115	.230	.051	.103	.163	.388*
	Sig. (2-tailed)	.007	.074	.893	.323		.517	.191	.775	.563	.357	.023
	N	34	34	34	34	34	34	34	34	34	34	34
stut_competence	Pearson Correlation	.095	.362*	.287	-.155	.115	1	.405*	.430*	.217	.503**	.115
	Sig. (2-tailed)	.593	.036	.100	.382	.517		.017	.011	.218	.002	.516
	N	34	34	34	34	34	34	34	34	34	34	34
stut_autonomy	Pearson Correlation	.137	.602**	.345*	.192	.230	.405*	1	.415*	.164	.121	.228
	Sig. (2-tailed)	.439	.000	.046	.277	.191	.017		.015	.354	.494	.194
	N	34	34	34	34	34	34	34	34	34	34	34
stut_relatedness	Pearson Correlation	.255	.291	.582**	.211	.051	.430*	.415*	1	.587**	.401*	.310
	Sig. (2-tailed)	.146	.095	.000	.230	.775	.011	.015		.000	.019	.074
	N	34	34	34	34	34	34	34	34	34	34	34
stut_immersion	Pearson Correlation	.270	.246	.502**	.617**	.103	.217	.164	.587**	1	.365*	.368*
	Sig. (2-tailed)	.122	.161	.002	.000	.563	.218	.354	.000		.034	.032
	N	34	34	34	34	34	34	34	34	34	34	34
stut_intuitivecontrols	Pearson Correlation	.298	.119	.240	-.046	.163	.503**	.121	.401*	.365*	1	.118
	Sig. (2-tailed)	.087	.502	.172	.798	.357	.002	.494	.019	.034		.506
	N	34	34	34	34	34	34	34	34	34	34	34
kplay_competence	Pearson Correlation	.532**	.127	.149	.283	.388*	.115	.228	.310	.368*	.118	1
	Sig. (2-tailed)	.001	.476	.400	.105	.023	.516	.194	.074	.032	.506	
	N	34	34	34	34	34	34	34	34	34	34	34
kplay_autonomy	Pearson Correlation	.275	.506**	.461**	.494**	.470**	.250	.403*	.546**	.425*	.041	.364*
	Sig. (2-tailed)	.115	.002	.006	.003	.005	.154	.018	.001	.012	.816	.034
	N	34	34	34	34	34	34	34	34	34	34	34
kplay_relatedness	Pearson Correlation	.271	-.131	.179	.423*	.036	-.130	-.076	.325	.501**	.369*	.345*
	Sig. (2-tailed)	.121	.459	.312	.013	.841	.465	.669	.060	.003	.032	.045
	N	34	34	34	34	34	34	34	34	34	34	34
kplay_immersion	Pearson Correlation	.277	.036	.195	.621**	.208	-.166	-.097	.290	.781**	.255	.486**
	Sig. (2-tailed)	.113	.840	.269	.000	.239	.348	.585	.097	.000	.145	.004
	N	34	34	34	34	34	34	34	34	34	34	34
kplay_intuitivecontrols	Pearson Correlation	.602**	.062	-.034	.229	.568**	.051	.126	.171	.229	.340*	.707**
	Sig. (2-tailed)	.000	.726	.847	.192	.000	.775	.479	.334	.192	.049	.000
	N	34	34	34	34	34	34	34	34	34	34	34
splay_competence	Pearson Correlation	.374*	.236	.009	-.071	.337	.518**	.269	.240	.294	.421*	.451**
	Sig. (2-tailed)	.029	.179	.959	.692	.052	.002	.125	.171	.092	.013	.007
	N	34	34	34	34	34	34	34	34	34	34	34
splay_autonomy	Pearson Correlation	.319	.604**	.175	.152	.576**	.385*	.633**	.333	.275	.111	.216
	Sig. (2-tailed)	.066	.000	.321	.391	.000	.024	.000	.054	.115	.531	.220
	N	34	34	34	34	34	34	34	34	34	34	34
splay_relatedness	Pearson Correlation	.240	-.035	.200	.352*	.054	.118	.185	.366*	.537**	.351*	.377*
	Sig. (2-tailed)	.171	.843	.257	.041	.762	.507	.294	.033	.001	.042	.028
	N	34	34	34	34	34	34	34	34	34	34	34
splay_immersion	Pearson Correlation	.355*	.113	.339*	.641**	.258	-.040	.049	.386*	.811**	.235	.503**
	Sig. (2-tailed)	.039	.523	.050	.000	.141	.824	.782	.024	.000	.181	.002
	N	34	34	34	34	34	34	34	34	34	34	34
splay_intuitivecontrols	Pearson Correlation	.443**	.296	.264	.080	.412*	.395*	.225	.365*	.512**	.744**	.279
	Sig. (2-tailed)	.009	.090	.131	.652	.015	.021	.200	.034	.002	.000	.111
	N	34	34	34	34	34	34	34	34	34	34	34
INTROAge	Pearson Correlation	-.249	.097	.230	.220	-.106	.008	.025	.217	.082	.061	.080
	Sig. (2-tailed)	.156	.584	.191	.211	.549	.966	.889	.218	.644	.733	.652
	N	34	34	34	34	34	34	34	34	34	34	34
INTROPlayHowOften	Pearson Correlation	-.121	-.135	-.177	.072	-.168	-.152	-.132	-.096	-.234	-.144	.049
	Sig. (2-tailed)	.496	.448	.316	.685	.342	.392	.456	.589	.182	.416	.785
	N	34	34	34	34	34	34	34	34	34	34	34
INTROPlayHowLong	Pearson Correlation	.184	-.152	-.034	-.288	-.119	.207	-.023	.231	-.107	.361*	-.105
	Sig. (2-tailed)	.299	.392	.848	.099	.501	.241	.897	.188	.548	.036	.555
	N	34	34	34	34	34	34	34	34	34	34	34
INTROWithFriendOften	Pearson Correlation	.078	-.358*	.024	-.417*	-.368*	.199	-.195	.085	-.102	.124	.060
	Sig. (2-tailed)	.662	.038	.893	.014	.032	.258	.270	.631	.566	.484	.738
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillPlatformer	Pearson Correlation	.173	.003	.089	-.260	-.093	.044	.216	.104	-.055	.109	.120
	Sig. (2-tailed)	.328	.987	.618	.137	.601	.804	.219	.558	.757	.539	.499
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillFPS	Pearson Correlation	.206	-.240	-.017	-.404*	-.083	.123	-.098	-.067	-.232	.294	.025
	Sig. (2-tailed)	.242	.171	.925	.018	.642	.488	.582	.708	.186	.092	.888
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillThirdPersonAction	Pearson Correlation	.143	-.103	-.034	-.244	.053	.132	.012	.046	-.182	.072	-.128
	Sig. (2-tailed)	.418	.564	.851	.164	.767	.457	.948	.796	.303	.684	.469
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillPuzzle	Pearson Correlation	-.103	.029	.082	.421*	.283	-.015	.140	.118	.374*	.157	.159
	Sig. (2-tailed)	.562	.872	.645	.013	.104	.932	.428	.507	.029	.375	.369
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillMOBA	Pearson Correlation	-.008	-.082	.013	-.121	-.193	.193	.102	-.199	-.149	.018	-.158
	Sig. (2-tailed)	.965	.643	.941	.497	.273	.275	.565	.259	.399	.918	.372
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillMMO	Pearson Correlation	.071	.088	-.027	.038	-.075	.135	.119	.092	-.030	.032	.035
	Sig. (2-tailed)	.689	.620	.880	.832	.675	.445	.502	.603	.864	.859	.845
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillFighting	Pearson Correlation	.020	.001	.062	.138	.060	-.004	-.091	.100	.194	.052	.218
	Sig. (2-tailed)	.909	.993	.727	.436	.734	.984	.608	.574	.271	.770	.215
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillRTS	Pearson Correlation	.174	-.020	-.139	.062	-.076	.079	.029	-.003	.033	.320	.092
	Sig. (2-tailed)	.324	.911	.432	.727	.670	.655	.871	.988	.851	.065	.605
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillRacing	Pearson Correlation	.492**	.008	.212	.091	.194	.039	-.217	.152	.228	.047	.502**
	Sig. (2-tailed)	.003	.964	.229	.610	.271	.827	.218	.392	.196	.794	.002
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillSports	Pearson Correlation	.335	-.152	.023	-.342*	.159	-.095	-.169	.071	-.129	.276	.333
	Sig. (2-tailed)	.053	.389	.899	.048	.368	.593	.339	.690	.468	.114	.054
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillSimulation	Pearson Correlation	.005	.155	.041	.269	-.048	-.084	-.089	-.299	-.023	-.160	.159
	Sig. (2-tailed)	.978	.382	.820	.124	.790	.637	.618	.086	.897	.366	.368
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillCrafting	Pearson Correlation	.114	.106	-.070	.001	-.266	.081	.004	-.096	.147	.090	-.108
	Sig. (2-tailed)	.521	.552	.693	.996	.129	.647	.981	.588	.406	.613	.543
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillRhythm	Pearson Correlation	-.146	-.109	-.053	-.163	-.138	.070	.004	-.068	-.187	.005	-.060
	Sig. (2-tailed)	.409	.539	.767	.356	.438	.692	.983	.703	.289	.979	.735
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillShmup	Pearson Correlation	-.002	-.048	.156	.163	-.081	.219	-.025	.261	.259	.303	.141
	Sig. (2-tailed)	.990	.789	.377	.357	.649	.214	.888	.136	.139	.082	.425
	N	34	34	34	34	34	34	34	34	34	34	34
INTROSkillPCAdventure	Pearson Correlation	.014	.203	.212	.413*	.074	-.078	.093	.016	-.006	-.089	.154
	Sig. (2-tailed)	.936	.251	.228	.015	.679	.663	.599	.930	.975	.616	.385
	N	34	34	34	34	34	34	34	34	34	34	34

		kplay_autonomy	kplay_relatedness	kplay_immersion	kplay_intuitivecontrols	splay_competence	splay_autonomy	splay_relatedness	splay_immersion	splay_intuitivecontrols	INTROAge	INTROPlayHowOften	INTROPlayHowLong
ktut_competence	Pearson Correlation	.275	.271	.277	.602**	.374*	.319	.240	.355*	.443**	-.249	-.121	.184
	Sig. (2-tailed)	.115	.121	.113	.000	.029	.066	.171	.039	.009	.156	.496	.299
	N	34	34	34	34	34	34	34	34	34	34	34	34
ktut_autonomy	Pearson Correlation	.506**	-.131	.036	.062	.236	.604**	-.035	.113	.296	.097	-.135	-.152
	Sig. (2-tailed)	.002	.459	.840	.726	.179	.000	.843	.523	.090	.584	.448	.392
	N	34	34	34	34	34	34	34	34	34	34	34	34
ktut_relatedness	Pearson Correlation	.461**	.179	.195	-.034	.009	.175	.200	.339*	.264	.230	-.177	-.034
	Sig. (2-tailed)	.006	.312	.269	.847	.959	.321	.257	.050	.131	.191	.316	.848
	N	34	34	34	34	34	34	34	34	34	34	34	34
ktut_immersion	Pearson Correlation	.494**	.423*	.621**	.229	-.071	.152	.352*	.641**	.080	.220	.072	-.288
	Sig. (2-tailed)	.003	.013	.000	.192	.692	.391	.041	.000	.652	.211	.685	.099
	N	34	34	34	34	34	34	34	34	34	34	34	34
ktut_intuitivecontrols	Pearson Correlation	.470**	.036	.208	.568**	.337	.576**	.054	.258	.412*	-.106	-.168	-.119
	Sig. (2-tailed)	.005	.841	.239	.000	.052	.000	.762	.141	.015	.549	.342	.501
	N	34	34	34	34	34	34	34	34	34	34	34	34
stut_competence	Pearson Correlation	.250	-.130	-.166	.051	.518**	.385*	.118	-.040	.395*	.008	-.152	.207
	Sig. (2-tailed)	.154	.465	.348	.775	.002	.024	.507	.824	.021	.966	.392	.241
	N	34	34	34	34	34	34	34	34	34	34	34	34
stut_autonomy	Pearson Correlation	.403*	-.076	-.097	.126	.269	.633**	.185	.049	.225	.025	-.132	-.023
	Sig. (2-tailed)	.018	.669	.585	.479	.125	.000	.294	.782	.200	.889	.456	.897
	N	34	34	34	34	34	34	34	34	34	34	34	34
stut_relatedness	Pearson Correlation	.546**	.325	.290	.171	.240	.333	.366*	.386*	.365*	.217	-.096	.231
	Sig. (2-tailed)	.001	.060	.097	.334	.171	.054	.033	.024	.034	.218	.589	.188
	N	34	34	34	34	34	34	34	34	34	34	34	34
stut_immersion	Pearson Correlation	.425*	.501**	.781**	.229	.294	.275	.537**	.811**	.512**	.082	-.234	-.107
	Sig. (2-tailed)	.012	.003	.000	.192	.092	.115	.001	.000	.002	.644	.182	.548
	N	34	34	34	34	34	34	34	34	34	34	34	34
stut_intuitivecontrols	Pearson Correlation	.041	.369*	.255	.340*	.421*	.111	.351*	.235	.744**	.061	-.144	.361*
	Sig. (2-tailed)	.816	.032	.145	.049	.013	.531	.042	.181	.000	.733	.416	.036
	N	34	34	34	34	34	34	34	34	34	34	34	34
kplay_competence	Pearson Correlation	.364*	.345*	.486**	.707**	.451**	.216	.377*	.503**	.279	.080	.049	-.105
	Sig. (2-tailed)	.034	.045	.004	.000	.007	.220	.028	.002	.111	.652	.785	.555
	N	34	34	34	34	34	34	34	34	34	34	34	34
kplay_autonomy	Pearson Correlation	1	.225	.290	.220	.240	.641**	.155	.390*	.165	.224	-.274	-.168
	Sig. (2-tailed)		.200	.096	.212	.172	.000	.380	.022	.350	.202	.117	.342
	N	34	34	34	34	34	34	34	34	34	34	34	34
kplay_relatedness	Pearson Correlation	.225	1	.679**	.406*	.039	.069	.709**	.595**	.282	.089	.005	.077
	Sig. (2-tailed)	.200		.000	.017	.827	.698	.000	.000	.106	.617	.978	.664
	N	34	34	34	34	34	34	34	34	34	34	34	34
kplay_immersion	Pearson Correlation	.290	.679**	1	.396*	.225	.102	.622**	.902**	.360*	.193	-.092	-.182
	Sig. (2-tailed)	.096	.000		.020	.200	.567	.000	.000	.036	.273	.606	.304
	N	34	34	34	34	34	34	34	34	34	34	34	34
kplay_intuitivecontrols	Pearson Correlation	.220	.406*	.396*	1	.416*	.230	.359*	.314	.485**	-.101	.081	-.001
	Sig. (2-tailed)	.212	.017	.020		.014	.191	.037	.070	.004	.569	.649	.996
	N	34	34	34	34	34	34	34	34	34	34	34	34
splay_competence	Pearson Correlation	.240	.039	.225	.416*	1	.397*	.380*	.186	.626**	-.052	-.066	.198
	Sig. (2-tailed)	.172	.827	.200	.014		.020	.027	.293	.000	.772	.709	.262
	N	34	34	34	34	34	34	34	34	34	34	34	34
splay_autonomy	Pearson Correlation	.641**	.069	.102	.230	.397*	1	.261	.207	.369*	-.106	-.321	-.127
	Sig. (2-tailed)	.000	.698	.567	.191	.020		.136	.239	.032	.552	.064	.473
	N	34	34	34	34	34	34	34	34	34	34	34	34
splay_relatedness	Pearson Correlation	.155	.709**	.622**	.359*	.380*	.261	1	.569**	.388*	.143	-.012	.065
	Sig. (2-tailed)	.380	.000	.000	.037	.027	.136		.000	.023	.421	.948	.714
	N	34	34	34	34	34	34	34	34	34	34	34	34
splay_immersion	Pearson Correlation	.390*	.595**	.902**	.314	.186	.207	.569**	1	.342*	.058	-.141	-.037
	Sig. (2-tailed)	.022	.000	.000	.070	.293	.239	.000		.048	.745	.428	.835
	N	34	34	34	34	34	34	34	34	34	34	34	34
splay_intuitivecontrols	Pearson Correlation	.165	.282	.360*	.485**	.626**	.369*	.388*	.342*	1	-.170	-.150	.148
	Sig. (2-tailed)	.350	.106	.036	.004	.000	.032	.023	.048		.336	.397	.404
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROAge	Pearson Correlation	.224	.089	.193	-.101	-.052	-.106	.143	.058	-.170	1	.158	-.154
	Sig. (2-tailed)	.202	.617	.273	.569	.772	.552	.421	.745	.336		.374	.384
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROPlayHowOften	Pearson Correlation	-.274	.005	-.092	.081	-.066	-.321	-.012	-.141	-.150	.158	1	.380*
	Sig. (2-tailed)	.117	.978	.606	.649	.709	.064	.948	.428	.397	.374		.026
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROPlayHowLong	Pearson Correlation	-.168	.077	-.182	-.001	.198	-.127	.065	-.037	.148	-.154	.380*	1
	Sig. (2-tailed)	.342	.664	.304	.996	.262	.473	.714	.835	.404	.384	.026	
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROWithFriendOften	Pearson Correlation	-.396*	-.053	-.155	-.113	.149	-.455**	.124	-.177	-.071	.071	.053	.136
	Sig. (2-tailed)	.021	.768	.380	.524	.400	.007	.486	.317	.690	.690	.765	.443
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillPlatformer	Pearson Correlation	.008	.190	-.129	.043	.098	.005	.031	-.180	.041	.099	-.044	.186
	Sig. (2-tailed)	.963	.281	.466	.811	.580	.977	.861	.308	.819	.578	.803	.293
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillFPS	Pearson Correlation	-.264	-.060	-.305	.146	.104	-.234	-.041	-.200	.129	-.091	.155	.377*
	Sig. (2-tailed)	.131	.737	.079	.410	.557	.184	.816	.256	.468	.610	.383	.028
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillThirdPersonAction	Pearson Correlation	-.136	.067	-.148	.031	.098	.078	.105	-.050	-.015	-.160	.306	.571**
	Sig. (2-tailed)	.443	.707	.403	.860	.580	.660	.553	.780	.935	.366	.078	.000
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillPuzzle	Pearson Correlation	.411*	.458**	.440**	.227	.111	.321	.378*	.330	.151	.126	-.048	-.162
	Sig. (2-tailed)	.016	.006	.009	.198	.533	.064	.027	.057	.395	.479	.789	.361
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillMOBA	Pearson Correlation	-.215	-.120	-.196	-.151	.290	-.124	-.028	-.170	.070	-.212	.218	.360*
	Sig. (2-tailed)	.222	.500	.267	.395	.097	.486	.874	.337	.693	.230	.216	.037
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillMMO	Pearson Correlation	.118	.003	-.045	-.004	.385*	.015	-.006	-.029	.005	.109	.227	.430*
	Sig. (2-tailed)	.505	.988	.801	.984	.025	.931	.972	.869	.978	.539	.196	.011
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillFighting	Pearson Correlation	.044	.205	.250	.145	.091	-.225	.008	.223	.064	.065	.078	.112
	Sig. (2-tailed)	.805	.244	.154	.412	.611	.200	.965	.205	.719	.715	.661	.529
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillRTS	Pearson Correlation	-.116	.299	.122	.189	.333	-.055	.211	.133	.229	.000	.406*	.590**
	Sig. (2-tailed)	.513	.086	.491	.285	.054	.758	.232	.452	.192	1.000	.017	.000
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillRacing	Pearson Correlation	.215	.173	.266	.318	.196	-.174	-.075	.346*	.053	-.025	-.007	.148
	Sig. (2-tailed)	.221	.327	.129	.067	.267	.326	.673	.045	.764	.887	.969	.402
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillSports	Pearson Correlation	-.191	-.008	-.010	.312	.137	-.189	-.027	-.036	.163	.042	-.028	.230
	Sig. (2-tailed)	.279	.965	.954	.072	.441	.284	.878	.839	.357	.815	.877	.190
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillSimulation	Pearson Correlation	-.036	.117	.119	.027	-.039	-.123	-.074	.035	-.173	.107	.320	-.169
	Sig. (2-tailed)	.838	.510	.502	.880	.828	.487	.676	.845	.327	.548	.065	.340
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillCrafting	Pearson Correlation	-.086	.201	.091	.003	.321	-.040	.088	.025	.173	-.204	.014	.202
	Sig. (2-tailed)	.630	.255	.611	.988	.064	.822	.622	.890	.328	.246	.937	.251
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillRhythm	Pearson Correlation	-.058	.042	-.232	.003	.104	-.014	-.023	-.302	-.073	-.110	.095	.127
	Sig. (2-tailed)	.743	.816	.186	.988	.560	.937	.899	.082	.683	.535	.593	.474
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillShmup	Pearson Correlation	.129	.449**	.255	.300	.347*	.149	.436**	.142	.317	-.100	.170	.220
	Sig. (2-tailed)	.466	.008	.146	.085	.044	.400	.010	.424	.068	.574	.336	.210
	N	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillPCAdventure	Pearson Correlation	.293	.200	.016	.099	-.115	-.062	-.144	.090	-.203	.205	.375*	.180
	Sig. (2-tailed)	.093	.256	.931	.578	.517	.727	.417	.614	.249	.244	.029	.309
	N	34	34	34	34	34	34	34	34	34	34	34	34

		INTROWithFriendOften	INTROSkillPlatformer	INTROSkillFPS	INTROSkillThirdPersonAction	INTROSkillPuzzle	INTROSkillMOBA	INTROSkillMMO	INTROSkillFighting	INTROSkillRTS	INTROSkillRacing	INTROSkillSports	INTROSkillSimulation	INTROSkillCrafting	INTROSkillRhythm	INTROSkillShmup	INTROSkillPCAdventure
ktut_competence	Pearson Correlation	.078	.173	.206	.143	-.103	-.008	.071	.020	.174	.492**	.335	.005	.114	-.146	-.002	.014
	Sig. (2-tailed)	.662	.328	.242	.418	.562	.965	.689	.909	.324	.003	.053	.978	.521	.409	.990	.936
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
ktut_autonomy	Pearson Correlation	-.358*	.003	-.240	-.103	.029	-.082	.088	.001	-.020	.008	-.152	.155	.106	-.109	-.048	.203
	Sig. (2-tailed)	.038	.987	.171	.564	.872	.643	.620	.993	.911	.964	.389	.382	.552	.539	.789	.251
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
ktut_relatedness	Pearson Correlation	.024	.089	-.017	-.034	.082	.013	-.027	.062	-.139	.212	.023	.041	-.070	-.053	.156	.212
	Sig. (2-tailed)	.893	.618	.925	.851	.645	.941	.880	.727	.432	.229	.899	.820	.693	.767	.377	.228
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
ktut_immersion	Pearson Correlation	-.417*	-.260	-.404*	-.244	.421*	-.121	.038	.138	.062	.091	-.342*	.269	.001	-.163	.163	.413*
	Sig. (2-tailed)	.014	.137	.018	.164	.013	.497	.832	.436	.727	.610	.048	.124	.996	.356	.357	.015
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
ktut_intuitivecontrols	Pearson Correlation	-.368*	-.093	-.083	.053	.283	-.193	-.075	.060	-.076	.194	.159	-.048	-.266	-.138	-.081	.074
	Sig. (2-tailed)	.032	.601	.642	.767	.104	.273	.675	.734	.670	.271	.368	.790	.129	.438	.649	.679
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
stut_competence	Pearson Correlation	.199	.044	.123	.132	-.015	.193	.135	-.004	.079	.039	-.095	-.084	.081	.070	.219	-.078
	Sig. (2-tailed)	.258	.804	.488	.457	.932	.275	.445	.984	.655	.827	.593	.637	.647	.692	.214	.663
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
stut_autonomy	Pearson Correlation	-.195	.216	-.098	.012	.140	.102	.119	-.091	.029	-.217	-.169	-.089	.004	.004	-.025	.093
	Sig. (2-tailed)	.270	.219	.582	.948	.428	.565	.502	.608	.871	.218	.339	.618	.981	.983	.888	.599
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
stut_relatedness	Pearson Correlation	.085	.104	-.067	.046	.118	-.199	.092	.100	-.003	.152	.071	-.299	-.096	-.068	.261	.016
	Sig. (2-tailed)	.631	.558	.708	.796	.507	.259	.603	.574	.988	.392	.690	.086	.588	.703	.136	.930
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
stut_immersion	Pearson Correlation	-.102	-.055	-.232	-.182	.374*	-.149	-.030	.194	.033	.228	-.129	-.023	.147	-.187	.259	-.006
	Sig. (2-tailed)	.566	.757	.186	.303	.029	.399	.864	.271	.851	.196	.468	.897	.406	.289	.139	.975
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
stut_intuitivecontrols	Pearson Correlation	.124	.109	.294	.072	.157	.018	.032	.052	.320	.047	.276	-.160	.090	.005	.303	-.089
	Sig. (2-tailed)	.484	.539	.092	.684	.375	.918	.859	.770	.065	.794	.114	.366	.613	.979	.082	.616
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
kplay_competence	Pearson Correlation	.060	.120	.025	-.128	.159	-.158	.035	.218	.092	.502**	.333	.159	-.108	-.060	.141	.154
	Sig. (2-tailed)	.738	.499	.888	.469	.369	.372	.845	.215	.605	.002	.054	.368	.543	.735	.425	.385
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
kplay_autonomy	Pearson Correlation	-.396*	.008	-.264	-.136	.411*	-.215	.118	.044	-.116	.215	-.191	-.036	-.086	-.058	.129	.293
	Sig. (2-tailed)	.021	.963	.131	.443	.016	.222	.505	.805	.513	.221	.279	.838	.630	.743	.466	.093
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
kplay_relatedness	Pearson Correlation	-.053	.190	-.060	.067	.458**	-.120	.003	.205	.299	.173	-.008	.117	.201	.042	.449**	.200
	Sig. (2-tailed)	.768	.281	.737	.707	.006	.500	.988	.244	.086	.327	.965	.510	.255	.816	.008	.256
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
kplay_immersion	Pearson Correlation	-.155	-.129	-.305	-.148	.440**	-.196	-.045	.250	.122	.266	-.010	.119	.091	-.232	.255	.016
	Sig. (2-tailed)	.380	.466	.079	.403	.009	.267	.801	.154	.491	.129	.954	.502	.611	.186	.146	.931
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
kplay_intuitivecontrols	Pearson Correlation	-.113	.043	.146	.031	.227	-.151	-.004	.145	.189	.318	.312	.027	.003	.003	.300	.099
	Sig. (2-tailed)	.524	.811	.410	.860	.198	.395	.984	.412	.285	.067	.072	.880	.988	.988	.085	.578
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
splay_competence	Pearson Correlation	.149	.098	.104	.098	.111	.290	.385*	.091	.333	.196	.137	-.039	.321	.104	.347*	-.115
	Sig. (2-tailed)	.400	.580	.557	.580	.533	.097	.025	.611	.054	.267	.441	.828	.064	.560	.044	.517
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
splay_autonomy	Pearson Correlation	-.455**	.005	-.234	.078	.321	-.124	.015	-.225	-.055	-.174	-.189	-.123	-.040	-.014	.149	-.062
	Sig. (2-tailed)	.007	.977	.184	.660	.064	.486	.931	.200	.758	.326	.284	.487	.822	.937	.400	.727
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
splay_relatedness	Pearson Correlation	.124	.031	-.041	.105	.378*	-.028	-.006	.008	.211	-.075	-.027	-.074	.088	-.023	.436**	-.144
	Sig. (2-tailed)	.486	.861	.816	.553	.027	.874	.972	.965	.232	.673	.878	.676	.622	.899	.010	.417
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
splay_immersion	Pearson Correlation	-.177	-.180	-.200	-.050	.330	-.170	-.029	.223	.133	.346*	-.036	.035	.025	-.302	.142	.090
	Sig. (2-tailed)	.317	.308	.256	.780	.057	.337	.869	.205	.452	.045	.839	.845	.890	.082	.424	.614
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
splay_intuitivecontrols	Pearson Correlation	-.071	.041	.129	-.015	.151	.070	.005	.064	.229	.053	.163	-.173	.173	-.073	.317	-.203
	Sig. (2-tailed)	.690	.819	.468	.935	.395	.693	.978	.719	.192	.764	.357	.327	.328	.683	.068	.249
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROAge	Pearson Correlation	.071	.099	-.091	-.160	.126	-.212	.109	.065	.000	-.025	.042	.107	-.204	-.110	-.100	.205
	Sig. (2-tailed)	.690	.578	.610	.366	.479	.230	.539	.715	1.000	.887	.815	.548	.246	.535	.574	.244
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROPlayHowOften	Pearson Correlation	.053	-.044	.155	.306	-.048	.218	.227	.078	.406*	-.007	-.028	.320	.014	.095	.170	.375*
	Sig. (2-tailed)	.765	.803	.383	.078	.789	.216	.196	.661	.017	.969	.877	.065	.937	.593	.336	.029
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROPlayHowLong	Pearson Correlation	.136	.186	.377*	.571**	-.162	.360*	.430*	.112	.590**	.148	.230	-.169	.202	.127	.220	.180
	Sig. (2-tailed)	.443	.293	.028	.000	.361	.037	.011	.529	.000	.402	.190	.340	.251	.474	.210	.309
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROWithFriendOften	Pearson Correlation	1	.215	.382*	.092	-.407*	.183	.087	.129	.047	.254	.325	.058	.083	.150	-.061	-.187
	Sig. (2-tailed)		.221	.026	.605	.017	.301	.624	.467	.792	.148	.061	.743	.640	.398	.730	.289
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillPlatformer	Pearson Correlation	.215	1	.256	.238	.252	.077	.159	.429*	.189	.184	.261	-.042	.227	.238	.023	.158
	Sig. (2-tailed)	.221		.145	.175	.150	.666	.370	.011	.283	.298	.137	.813	.197	.176	.898	.372
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillFPS	Pearson Correlation	.382*	.256	1	.246	-.295	.166	.185	-.005	.320	.094	.439**	-.226	.038	-.033	.013	.081
	Sig. (2-tailed)	.026	.145		.160	.090	.349	.294	.978	.065	.597	.009	.199	.833	.852	.940	.650
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillThirdPersonAction	Pearson Correlation	.092	.238	.246	1	.148	.341*	.266	.066	.352*	.196	.043	-.047	-.024	.213	.335	.247
	Sig. (2-tailed)	.605	.175	.160		.405	.048	.128	.710	.041	.268	.810	.791	.892	.226	.053	.158
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillPuzzle	Pearson Correlation	-.407*	.252	-.295	.148	1	-.227	-.164	.265	-.056	.009	-.215	.060	-.028	.263	.420*	.250
	Sig. (2-tailed)	.017	.150	.090	.405		.196	.353	.130	.752	.961	.223	.736	.876	.132	.013	.154
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillMOBA	Pearson Correlation	.183	.077	.166	.341*	-.227	1	.587**	-.193	.518**	-.042	-.227	.214	.397*	.039	.211	.138
	Sig. (2-tailed)	.301	.666	.349	.048	.196		.000	.274	.002	.815	.196	.224	.020	.825	.230	.437
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillMMO	Pearson Correlation	.087	.159	.185	.266	-.164	.587**	1	-.005	.753**	.151	.052	.195	.399*	.026	.257	.390*
	Sig. (2-tailed)	.624	.370	.294	.128	.353	.000		.976	.000	.394	.769	.268	.019	.886	.143	.023
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillFighting	Pearson Correlation	.129	.429*	-.005	.066	.265	-.193	-.005	1	.076	.493**	.216	.174	.301	.284	.139	.327
	Sig. (2-tailed)	.467	.011	.978	.710	.130	.274	.976		.668	.003	.219	.326	.083	.103	.433	.059
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillRTS	Pearson Correlation	.047	.189	.320	.352*	-.056	.518**	.753**	.076	1	.115	.081	.283	.475**	-.096	.340*	.333
	Sig. (2-tailed)	.792	.283	.065	.041	.752	.002	.000	.668		.518	.648	.105	.005	.590	.049	.055
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillRacing	Pearson Correlation	.254	.184	.094	.196	.009	-.042	.151	.493**	.115	1	.347*	.371*	.132	.100	-.006	.365*
	Sig. (2-tailed)	.148	.298	.597	.268	.961	.815	.394	.003	.518		.044	.031	.458	.572	.974	.034
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillSports	Pearson Correlation	.325	.261	.439**	.043	-.215	-.227	.052	.216	.081	.347*	1	-.036	-.276	.150	-.023	-.103
	Sig. (2-tailed)	.061	.137	.009	.810	.223	.196	.769	.219	.648	.044		.841	.114	.398	.899	.563
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillSimulation	Pearson Correlation	.058	-.042	-.226	-.047	.060	.214	.195	.174	.283	.371*	-.036	1	.318	.215	.145	.456**
	Sig. (2-tailed)	.743	.813	.199	.791	.736	.224	.268	.326	.105	.031	.841		.067	.223	.412	.007
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillCrafting	Pearson Correlation	.083	.227	.038	-.024	-.028	.397*	.399*	.301	.475**	.132	-.276	.318	1	.210	.293	.191
	Sig. (2-tailed)	.640	.197	.833	.892	.876	.020	.019	.083	.005	.458	.114	.067		.233	.093	.279
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillRhythm	Pearson Correlation	.150	.238	-.033	.213	.263	.039	.026	.284	-.096	.100	.150	.215	.210	1	.426*	.298
	Sig. (2-tailed)	.398	.176	.852	.226	.132	.825	.886	.103	.590	.572	.398	.223	.233		.012	.087
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillShmup	Pearson Correlation	-.061	.023	.013	.335	.420*	.211	.257	.139	.340*	-.006	-.023	.145	.293	.426*	1	.232
	Sig. (2-tailed)	.730	.898	.940	.053	.013	.230	.143	.433	.049	.974	.899	.412	.093	.012		.188
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
INTROSkillPCAdventure	Pearson Correlation	-.187	.158	.081	.247	.250	.138	.390*	.327	.333	.365*	-.103	.456**	.191	.298	.232	1
	Sig. (2-tailed)	.289	.372	.650	.158	.154	.437	.023	.059	.055	.034	.563	.007	.279	.087	.188	
	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

```
GLM ktut_immersion kplay_immersion stut_immersion splay_immersion ktut_autonom
y kplay_autonomy
    stut_autonomy splay_autonomy ktut_relatedness kplay_relatedness stut_relat
edness splay_relatedness
    ktut_competence kplay_competence stut_competence splay_competence ktut_int
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    kplay_intuitivecontrols stut_intuitivecontrols splay_intuitivecontrols
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  /MEASURE=Immersion Autonomy Relatedness Competence IntuitiveControls
  /METHOD=SSTYPE(3)
  /PLOT=PROFILE(NumPlayers*Character)
  /EMMEANS=TABLES(OVERALL)
  /EMMEANS=TABLES(Character) COMPARE ADJ(LSD)
  /EMMEANS=TABLES(NumPlayers) COMPARE ADJ(LSD)
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  /PRINT=DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA=ALPHA(.05)
  /WSDESIGN=Character NumPlayers Character*NumPlayers.
```

General Linear Model

Warnings

The HOMOGENEITY specification in the PRINT subcommand will be ignored because there are no between-subjects factors.

Within-Subjects Factors

Measure	Character	NumPlayers	Dependent Variable
Immersion	1	1	ktut_immersion
		2	kplay_immersion
	2	1	stut_immersion
		2	splay_immersion
Autonomy	1	1	ktut_autonomy
		2	kplay_autonomy
	2	1	stut_autonomy
		2	splay_autonomy
Relatedness	1	1	ktut_relatedness
		2	kplay_relatedness
	2	1	stut_relatedness
		2	splay_relatedness
Competence	1	1	ktut_competence
		2	kplay_competence
	2	1	stut_competence
		2	splay_competence
IntuitiveControls	1	1	ktut_intuitivecontrols
		2	kplay_intuitivecontrols
	2	1	stut_intuitivecontrols
		2	splay_intuitivecontrols

Descriptive Statistics

	Mean	Std. Deviation	N
ktut_immersion	.0163	.94167	34
kplay_immersion	.7516	1.00915	34
stut_immersion	.2451	1.01348	34
splay_immersion	.6961	1.02761	34
ktut_autonomy	.4020	1.10029	34
kplay_autonomy	1.6961	1.11424	34
stut_autonomy	1.8529	.86531	34
splay_autonomy	1.9314	.87916	34
ktut_relatedness	-.04902	1.025376	34
kplay_relatedness	1.78431	.803537	34
stut_relatedness	-.06863	1.087980	34
splay_relatedness	1.90196	.600389	34
ktut_competence	1.5196	.94705	34
kplay_competence	1.6275	.89052	34
stut_competence	1.5588	.94181	34
splay_competence	1.7941	.69153	34
ktut_intuitivecontrols	2.0588	.80600	34
kplay_intuitivecontrols	1.9412	.84674	34
stut_intuitivecontrols	1.3627	1.29326	34
splay_intuitivecontrols	1.9020	.83899	34

Multivariate Tests[a]

Effect			Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Between Subjects	Intercept	Pillai's Trace	.901	52.789[b]	5.000	29.000	.000	.901	263.947	1.000
		Wilks' Lambda	.099	52.789[b]	5.000	29.000	.000	.901	263.947	1.000
		Hotelling's Trace	9.102	52.789[b]	5.000	29.000	.000	.901	263.947	1.000
		Roy's Largest Root	9.102	52.789[b]	5.000	29.000	.000	.901	263.947	1.000
Within Subjects	Character	Pillai's Trace	.680	12.329[b]	5.000	29.000	.000	.680	61.643	1.000
		Wilks' Lambda	.320	12.329[b]	5.000	29.000	.000	.680	61.643	1.000
		Hotelling's Trace	2.126	12.329[b]	5.000	29.000	.000	.680	61.643	1.000
		Roy's Largest Root	2.126	12.329[b]	5.000	29.000	.000	.680	61.643	1.000
	NumPlayers	Pillai's Trace	.836	29.510[b]	5.000	29.000	.000	.836	147.549	1.000
		Wilks' Lambda	.164	29.510[b]	5.000	29.000	.000	.836	147.549	1.000
		Hotelling's Trace	5.088	29.510[b]	5.000	29.000	.000	.836	147.549	1.000
		Roy's Largest Root	5.088	29.510[b]	5.000	29.000	.000	.836	147.549	1.000
	Character * NumPlayers	Pillai's Trace	.730	15.654[b]	5.000	29.000	.000	.730	78.269	1.000
		Wilks' Lambda	.270	15.654[b]	5.000	29.000	.000	.730	78.269	1.000
		Hotelling's Trace	2.699	15.654[b]	5.000	29.000	.000	.730	78.269	1.000
		Roy's Largest Root	2.699	15.654[b]	5.000	29.000	.000	.730	78.269	1.000

a. Design: Intercept
Within Subjects Design: Character + NumPlayers + Character * NumPlayers

b. Exact statistic

c. Computed using alpha = .05

Mauchly's Test of Sphericity[a]

						Epsilon[b]		
Within Subjects Effect	Measure	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Character	Immersion	1.000	.000	0	.	1.000	1.000	1.000
	Autonomy	1.000	.000	0	.	1.000	1.000	1.000
	Relatedness	1.000	.000	0	.	1.000	1.000	1.000
	Competence	1.000	.000	0	.	1.000	1.000	1.000
	IntuitiveControls	1.000	.000	0	.	1.000	1.000	1.000
NumPlayers	Immersion	1.000	.000	0	.	1.000	1.000	1.000
	Autonomy	1.000	.000	0	.	1.000	1.000	1.000
	Relatedness	1.000	.000	0	.	1.000	1.000	1.000
	Competence	1.000	.000	0	.	1.000	1.000	1.000
	IntuitiveControls	1.000	.000	0	.	1.000	1.000	1.000
Character * NumPlayers	Immersion	1.000	.000	0	.	1.000	1.000	1.000
	Autonomy	1.000	.000	0	.	1.000	1.000	1.000
	Relatedness	1.000	.000	0	.	1.000	1.000	1.000
	Competence	1.000	.000	0	.	1.000	1.000	1.000
	IntuitiveControls	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Character + NumPlayers + Character * NumPlayers

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Multivariate[a,b]

Within Subjects Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
Character	Pillai's Trace	.680	12.329[c]	5.000	29.000	.000	.680	61.643	1.000
	Wilks' Lambda	.320	12.329[c]	5.000	29.000	.000	.680	61.643	1.000
	Hotelling's Trace	2.126	12.329[c]	5.000	29.000	.000	.680	61.643	1.000
	Roy's Largest Root	2.126	12.329[c]	5.000	29.000	.000	.680	61.643	1.000
NumPlayers	Pillai's Trace	.836	29.510[c]	5.000	29.000	.000	.836	147.549	1.000
	Wilks' Lambda	.164	29.510[c]	5.000	29.000	.000	.836	147.549	1.000
	Hotelling's Trace	5.088	29.510[c]	5.000	29.000	.000	.836	147.549	1.000
	Roy's Largest Root	5.088	29.510[c]	5.000	29.000	.000	.836	147.549	1.000
Character * NumPlayers	Pillai's Trace	.730	15.654[c]	5.000	29.000	.000	.730	78.269	1.000
	Wilks' Lambda	.270	15.654[c]	5.000	29.000	.000	.730	78.269	1.000
	Hotelling's Trace	2.699	15.654[c]	5.000	29.000	.000	.730	78.269	1.000
	Roy's Largest Root	2.699	15.654[c]	5.000	29.000	.000	.730	78.269	1.000

a. Design: Intercept
Within Subjects Design: Character + NumPlayers + Character * NumPlayers

b. Tests are based on averaged variables.

c. Exact statistic

d. Computed using alpha = .05

Univariate Tests

Source	Measure		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Character	Immersion	Sphericity Assumed	.255	1	.255	1.048	.313	.031	1.048	.169
		Greenhouse-Geisser	.255	1.000	.255	1.048	.313	.031	1.048	.169
		Huynh-Feldt	.255	1.000	.255	1.048	.313	.031	1.048	.169
		Lower-bound	.255	1.000	.255	1.048	.313	.031	1.048	.169
	Autonomy	Sphericity Assumed	24.170	1	24.170	52.794	.000	.615	52.794	1.000
		Greenhouse-Geisser	24.170	1.000	24.170	52.794	.000	.615	52.794	1.000
		Huynh-Feldt	24.170	1.000	24.170	52.794	.000	.615	52.794	1.000
		Lower-bound	24.170	1.000	24.170	52.794	.000	.615	52.794	1.000
	Relatedness	Sphericity Assumed	.082	1	.082	.269	.608	.008	.269	.080
		Greenhouse-Geisser	.082	1.000	.082	.269	.608	.008	.269	.080
		Huynh-Feldt	.082	1.000	.082	.269	.608	.008	.269	.080
		Lower-bound	.082	1.000	.082	.269	.608	.008	.269	.080
	Competence	Sphericity Assumed	.360	1	.360	.448	.508	.013	.448	.100
		Greenhouse-Geisser	.360	1.000	.360	.448	.508	.013	.448	.100
		Huynh-Feldt	.360	1.000	.360	.448	.508	.013	.448	.100
		Lower-bound	.360	1.000	.360	.448	.508	.013	.448	.100
	IntuitiveControls	Sphericity Assumed	4.596	1	4.596	4.833	.035	.128	4.833	.569
		Greenhouse-Geisser	4.596	1.000	4.596	4.833	.035	.128	4.833	.569
		Huynh-Feldt	4.596	1.000	4.596	4.833	.035	.128	4.833	.569
		Lower-bound	4.596	1.000	4.596	4.833	.035	.128	4.833	.569
Error(Character)	Immersion	Sphericity Assumed	8.026	33	.243					
		Greenhouse-Geisser	8.026	33.000	.243					
		Huynh-Feldt	8.026	33.000	.243					
		Lower-bound	8.026	33.000	.243					
	Autonomy	Sphericity Assumed	15.108	33	.458					
		Greenhouse-Geisser	15.108	33.000	.458					
		Huynh-Feldt	15.108	33.000	.458					
		Lower-bound	15.108	33.000	.458					
	Relatedness	Sphericity Assumed	10.029	33	.304					
		Greenhouse-Geisser	10.029	33.000	.304					
		Huynh-Feldt	10.029	33.000	.304					
		Lower-bound	10.029	33.000	.304					
	Competence	Sphericity Assumed	26.556	33	.805					
		Greenhouse-Geisser	26.556	33.000	.805					
		Huynh-Feldt	26.556	33.000	.805					
		Lower-bound	26.556	33.000	.805					
	IntuitiveControls	Sphericity Assumed	31.377	33	.951					
		Greenhouse-Geisser	31.377	33.000	.951					
		Huynh-Feldt	31.377	33.000	.951					
		Lower-bound	31.377	33.000	.951					
NumPlayers	Immersion	Sphericity Assumed	11.962	1	11.962	36.093	.000	.522	36.093	1.000
		Greenhouse-Geisser	11.962	1.000	11.962	36.093	.000	.522	36.093	1.000

Univariate Tests

Source	Measure		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
		Huynh-Feldt	11.962	1.000	11.962	36.093	.000	.522	36.093	1.000
		Lower-bound	11.962	1.000	11.962	36.093	.000	.522	36.093	1.000
	Autonomy	Sphericity Assumed	16.013	1	16.013	28.757	.000	.466	28.757	.999
		Greenhouse-Geisser	16.013	1.000	16.013	28.757	.000	.466	28.757	.999
		Huynh-Feldt	16.013	1.000	16.013	28.757	.000	.466	28.757	.999
		Lower-bound	16.013	1.000	16.013	28.757	.000	.466	28.757	.999
	Relatedness	Sphericity Assumed	122.993	1	122.993	135.263	.000	.804	135.263	1.000
		Greenhouse-Geisser	122.993	1.000	122.993	135.263	.000	.804	135.263	1.000
		Huynh-Feldt	122.993	1.000	122.993	135.263	.000	.804	135.263	1.000
		Lower-bound	122.993	1.000	122.993	135.263	.000	.804	135.263	1.000
	Competence	Sphericity Assumed	1.001	1	1.001	2.625	.115	.074	2.625	.350
		Greenhouse-Geisser	1.001	1.000	1.001	2.625	.115	.074	2.625	.350
		Huynh-Feldt	1.001	1.000	1.001	2.625	.115	.074	2.625	.350
		Lower-bound	1.001	1.000	1.001	2.625	.115	.074	2.625	.350
	IntuitiveControls	Sphericity Assumed	1.511	1	1.511	5.597	.024	.145	5.597	.632
		Greenhouse-Geisser	1.511	1.000	1.511	5.597	.024	.145	5.597	.632
		Huynh-Feldt	1.511	1.000	1.511	5.597	.024	.145	5.597	.632
		Lower-bound	1.511	1.000	1.511	5.597	.024	.145	5.597	.632
Error(NumPlayers)	Immersion	Sphericity Assumed	10.937	33	.331					
		Greenhouse-Geisser	10.937	33.000	.331					
		Huynh-Feldt	10.937	33.000	.331					
		Lower-bound	10.937	33.000	.331					
	Autonomy	Sphericity Assumed	18.376	33	.557					
		Greenhouse-Geisser	18.376	33.000	.557					
		Huynh-Feldt	18.376	33.000	.557					
		Lower-bound	18.376	33.000	.557					
	Relatedness	Sphericity Assumed	30.007	33	.909					
		Greenhouse-Geisser	30.007	33.000	.909					
		Huynh-Feldt	30.007	33.000	.909					
		Lower-bound	30.007	33.000	.909					
	Competence	Sphericity Assumed	12.583	33	.381					
		Greenhouse-Geisser	12.583	33.000	.381					
		Huynh-Feldt	12.583	33.000	.381					
		Lower-bound	12.583	33.000	.381					
	IntuitiveControls	Sphericity Assumed	8.906	33	.270					
		Greenhouse-Geisser	8.906	33.000	.270					
		Huynh-Feldt	8.906	33.000	.270					
		Lower-bound	8.906	33.000	.270					
Character * NumPlayers	Immersion	Sphericity Assumed	.687	1	.687	3.020	.092	.084	3.020	.393
		Greenhouse-Geisser	.687	1.000	.687	3.020	.092	.084	3.020	.393
		Huynh-Feldt	.687	1.000	.687	3.020	.092	.084	3.020	.393
		Lower-bound	.687	1.000	.687	3.020	.092	.084	3.020	.393
	Autonomy	Sphericity Assumed	12.562	1	12.562	38.289	.000	.537	38.289	1.000
		Greenhouse-Geisser	12.562	1.000	12.562	38.289	.000	.537	38.289	1.000
		Huynh-Feldt	12.562	1.000	12.562	38.289	.000	.537	38.289	1.000
		Lower-bound	12.562	1.000	12.562	38.289	.000	.537	38.289	1.000
	Relatedness	Sphericity Assumed	.160	1	.160	.493	.488	.015	.493	.105
		Greenhouse-Geisser	.160	1.000	.160	.493	.488	.015	.493	.105
		Huynh-Feldt	.160	1.000	.160	.493	.488	.015	.493	.105
		Lower-bound	.160	1.000	.160	.493	.488	.015	.493	.105
	Competence	Sphericity Assumed	.138	1	.138	.383	.540	.011	.383	.092
		Greenhouse-Geisser	.138	1.000	.138	.383	.540	.011	.383	.092
		Huynh-Feldt	.138	1.000	.138	.383	.540	.011	.383	.092
		Lower-bound	.138	1.000	.138	.383	.540	.011	.383	.092
	IntuitiveControls	Sphericity Assumed	3.667	1	3.667	9.021	.005	.215	9.021	.830
		Greenhouse-Geisser	3.667	1.000	3.667	9.021	.005	.215	9.021	.830
		Huynh-Feldt	3.667	1.000	3.667	9.021	.005	.215	9.021	.830
		Lower-bound	3.667	1.000	3.667	9.021	.005	.215	9.021	.830
Error (Character*NumPlayers)	Immersion	Sphericity Assumed	7.507	33	.227					
		Greenhouse-Geisser	7.507	33.000	.227					
		Huynh-Feldt	7.507	33.000	.227					
		Lower-bound	7.507	33.000	.227					
	Autonomy	Sphericity Assumed	10.827	33	.328					
		Greenhouse-Geisser	10.827	33.000	.328					
		Huynh-Feldt	10.827	33.000	.328					
		Lower-bound	10.827	33.000	.328					
	Relatedness	Sphericity Assumed	10.729	33	.325					
		Greenhouse-Geisser	10.729	33.000	.325					
		Huynh-Feldt	10.729	33.000	.325					
		Lower-bound	10.729	33.000	.325					

Univariate Tests

Source	Measure		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
	Competence	Sphericity Assumed	11.890	33	.360					
		Greenhouse-Geisser	11.890	33.000	.360					
		Huynh-Feldt	11.890	33.000	.360					
		Lower-bound	11.890	33.000	.360					
	IntuitiveControls	Sphericity Assumed	13.416	33	.407					
		Greenhouse-Geisser	13.416	33.000	.407					
		Huynh-Feldt	13.416	33.000	.407					
		Lower-bound	13.416	33.000	.407					

a. Computed using alpha = .05

Tests of Within-Subjects Contrasts

Source	Measure	Character	NumPlayers	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Character	Immersion	Linear		.255	1	.255	1.048	.313	.031	1.048	.169
	Autonomy	Linear		24.170	1	24.170	52.794	.000	.615	52.794	1.000
	Relatedness	Linear		.082	1	.082	.269	.608	.008	.269	.080
	Competence	Linear		.360	1	.360	.448	.508	.013	.448	.100
	IntuitiveControls	Linear		4.596	1	4.596	4.833	.035	.128	4.833	.569
Error(Character)	Immersion	Linear		8.026	33	.243					
	Autonomy	Linear		15.108	33	.458					
	Relatedness	Linear		10.029	33	.304					
	Competence	Linear		26.556	33	.805					
	IntuitiveControls	Linear		31.377	33	.951					
NumPlayers	Immersion		Linear	11.962	1	11.962	36.093	.000	.522	36.093	1.000
	Autonomy		Linear	16.013	1	16.013	28.757	.000	.466	28.757	.999
	Relatedness		Linear	122.993	1	122.993	135.263	.000	.804	135.263	1.000
	Competence		Linear	1.001	1	1.001	2.625	.115	.074	2.625	.350
	IntuitiveControls		Linear	1.511	1	1.511	5.597	.024	.145	5.597	.632
Error(NumPlayers)	Immersion		Linear	10.937	33	.331					
	Autonomy		Linear	18.376	33	.557					
	Relatedness		Linear	30.007	33	.909					
	Competence		Linear	12.583	33	.381					
	IntuitiveControls		Linear	8.906	33	.270					
Character * NumPlayers	Immersion	Linear	Linear	.687	1	.687	3.020	.092	.084	3.020	.393
	Autonomy	Linear	Linear	12.562	1	12.562	38.289	.000	.537	38.289	1.000
	Relatedness	Linear	Linear	.160	1	.160	.493	.488	.015	.493	.105
	Competence	Linear	Linear	.138	1	.138	.383	.540	.011	.383	.092
	IntuitiveControls	Linear	Linear	3.667	1	3.667	9.021	.005	.215	9.021	.830
Error (Character*NumPlayers)	Immersion	Linear	Linear	7.507	33	.227					
	Autonomy	Linear	Linear	10.827	33	.328					
	Relatedness	Linear	Linear	10.729	33	.325					
	Competence	Linear	Linear	11.890	33	.360					
	IntuitiveControls	Linear	Linear	13.416	33	.407					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Transformed Variable: Average

Source	Measure	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	Immersion	24.830	1	24.830	7.793	.009	.191	7.793	.773
	Autonomy	294.118	1	294.118	111.784	.000	.772	111.784	1.000
	Relatedness	108.248	1	108.248	63.567	.000	.658	63.567	1.000
	Competence	359.125	1	359.125	238.014	.000	.878	238.014	1.000
	IntuitiveControls	448.596	1	448.596	212.023	.000	.865	212.023	1.000
Error	Immersion	105.142	33	3.186					
	Autonomy	86.827	33	2.631					
	Relatedness	56.196	33	1.703					
	Competence	49.792	33	1.509					
	IntuitiveControls	69.821	33	2.116					

a. Computed using alpha = .05

Estimated Marginal Means

1. Grand Mean

Measure	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Immersion	.427	.153	.116	.739
Autonomy	1.471	.139	1.188	1.754
Relatedness	.892	.112	.664	1.120
Competence	1.625	.105	1.411	1.839
IntuitiveControls	1.816	.125	1.562	2.070

2. Character

Estimates

Measure	Character	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Immersion	1	.384	.151	.078	.690
	2	.471	.167	.132	.809
Autonomy	1	1.049	.165	.714	1.384
	2	1.892	.135	1.617	2.167
Relatedness	1	.868	.121	.621	1.114
	2	.917	.122	.669	1.165
Competence	1	1.574	.138	1.293	1.854
	2	1.676	.122	1.427	1.926
IntuitiveControls	1	2.000	.125	1.745	2.255
	2	1.632	.171	1.284	1.981

Pairwise Comparisons

Measure	(I) Character	(J) Character	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
Immersion	1	2	-.087	.085	.313	-.259	.085
	2	1	.087	.085	.313	-.085	.259
Autonomy	1	2	-.843*	.116	.000	-1.079	-.607
	2	1	.843*	.116	.000	.607	1.079
Relatedness	1	2	-.049	.095	.608	-.241	.143
	2	1	.049	.095	.608	-.143	.241
Competence	1	2	-.103	.154	.508	-.416	.210
	2	1	.103	.154	.508	-.210	.416
IntuitiveControls	1	2	.368*	.167	.035	.027	.708
	2	1	-.368*	.167	.035	-.708	-.027

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Pillai's trace	.680	12.329[a]	5.000	29.000	.000	.680	61.643	1.000
Wilks' lambda	.320	12.329[a]	5.000	29.000	.000	.680	61.643	1.000
Hotelling's trace	2.126	12.329[a]	5.000	29.000	.000	.680	61.643	1.000
Roy's largest root	2.126	12.329[a]	5.000	29.000	.000	.680	61.643	1.000

Each F tests the multivariate effect of Character. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

b. Computed using alpha = .05

3. NumPlayers

Estimates

Measure	NumPlayers	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Immersion	1	.131	.151	-.176	.437
	2	.724	.170	.377	1.070
Autonomy	1	1.127	.151	.820	1.435
	2	1.814	.155	1.498	2.129
Relatedness	1	-.059	.161	-.387	.269
	2	1.843	.111	1.616	2.070
Competence	1	1.539	.120	1.295	1.783
	2	1.711	.116	1.475	1.947
IntuitiveControls	1	1.711	.140	1.426	1.995
	2	1.922	.125	1.668	2.175

Pairwise Comparisons

Measure	(I) NumPlayers	(J) NumPlayers	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	95% Confidence Interval for Difference[b] Upper Bound
Immersion	1	2	-.593*	.099	.000	-.794	-.392
	2	1	.593*	.099	.000	.392	.794
Autonomy	1	2	-.686*	.128	.000	-.947	-.426
	2	1	.686*	.128	.000	.426	.947
Relatedness	1	2	-1.902*	.164	.000	-2.235	-1.569
	2	1	1.902*	.164	.000	1.569	2.235
Competence	1	2	-.172	.106	.115	-.387	.044
	2	1	.172	.106	.115	-.044	.387
IntuitiveControls	1	2	-.211*	.089	.024	-.392	-.030
	2	1	.211*	.089	.024	.030	.392

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Pillai's trace	.836	29.510[a]	5.000	29.000	.000	.836	147.549	1.000
Wilks' lambda	.164	29.510[a]	5.000	29.000	.000	.836	147.549	1.000
Hotelling's trace	5.088	29.510[a]	5.000	29.000	.000	.836	147.549	1.000
Roy's largest root	5.088	29.510[a]	5.000	29.000	.000	.836	147.549	1.000

Each F tests the multivariate effect of NumPlayers. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

b. Computed using alpha = .05

4. Character * NumPlayers

Estimates

Measure	Character	NumPlayers	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Immersion	1	1	.016	.161	-.312	.345
		2	.752	.173	.400	1.104
	2	1	.245	.174	-.109	.599
		2	.696	.176	.338	1.055
Autonomy	1	1	.402	.189	.018	.786
		2	1.696	.191	1.307	2.085
	2	1	1.853	.148	1.551	2.155
		2	1.931	.151	1.625	2.238
Relatedness	1	1	-.049	.176	-.407	.309
		2	1.784	.138	1.504	2.065
	2	1	-.069	.187	-.448	.311
		2	1.902	.103	1.692	2.111
Competence	1	1	1.520	.162	1.189	1.850
		2	1.627	.153	1.317	1.938
	2	1	1.559	.162	1.230	1.887
		2	1.794	.119	1.553	2.035
IntuitiveControls	1	1	2.059	.138	1.778	2.340
		2	1.941	.145	1.646	2.237
	2	1	1.363	.222	.912	1.814
		2	1.902	.144	1.609	2.195

Pairwise Comparisons

Measure	NumPlayers	(I) Character	(J) Character	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Immersion	1	1	2	-.229	.147	.130	-.528	.071
		2	1	.229	.147	.130	-.071	.528
	2	1	2	.056	.078	.479	-.102	.213
		2	1	-.056	.078	.479	-.213	.102
Autonomy	1	1	2	-1.451*	.155	.000	-1.766	-1.136
		2	1	1.451*	.155	.000	1.136	1.766
	2	1	2	-.235	.149	.125	-.539	.068
		2	1	.235	.149	.125	-.068	.539
Relatedness	1	1	2	.020	.166	.907	-.318	.357
		2	1	-.020	.166	.907	-.357	.318
	2	1	2	-.118	.097	.236	-.316	.080
		2	1	.118	.097	.236	-.080	.316
Competence	1	1	2	-.039	.218	.858	-.483	.404
		2	1	.039	.218	.858	-.404	.483
	2	1	2	-.167	.145	.259	-.462	.128
		2	1	.167	.145	.259	-.128	.462
IntuitiveControls	1	1	2	.696*	.241	.007	.205	1.187
		2	1	-.696*	.241	.007	-1.187	-.205
	2	1	2	.039	.147	.791	-.259	.338
		2	1	-.039	.147	.791	-.338	.259

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Multivariate Tests

NumPlayers		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
1	Pillai's trace	.788	21.530[a]	5.000	29.000	.000	.788	107.648	1.000
	Wilks' lambda	.212	21.530[a]	5.000	29.000	.000	.788	107.648	1.000
	Hotelling's trace	3.712	21.530[a]	5.000	29.000	.000	.788	107.648	1.000
	Roy's largest root	3.712	21.530[a]	5.000	29.000	.000	.788	107.648	1.000
2	Pillai's trace	.125	.831[a]	5.000	29.000	.538	.125	4.157	.254
	Wilks' lambda	.875	.831[a]	5.000	29.000	.538	.125	4.157	.254
	Hotelling's trace	.143	.831[a]	5.000	29.000	.538	.125	4.157	.254
	Roy's largest root	.143	.831[a]	5.000	29.000	.538	.125	4.157	.254

Each F tests the multivariate simple effects of Character within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

b. Computed using alpha = .05

5. Character * NumPlayers

Estimates

Measure	Character	NumPlayers	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Immersion	1	1	.016	.161	-.312	.345
		2	.752	.173	.400	1.104
	2	1	.245	.174	-.109	.599
		2	.696	.176	.338	1.055
Autonomy	1	1	.402	.189	.018	.786
		2	1.696	.191	1.307	2.085
	2	1	1.853	.148	1.551	2.155
		2	1.931	.151	1.625	2.238
Relatedness	1	1	-.049	.176	-.407	.309
		2	1.784	.138	1.504	2.065
	2	1	-.069	.187	-.448	.311
		2	1.902	.103	1.692	2.111
Competence	1	1	1.520	.162	1.189	1.850
		2	1.627	.153	1.317	1.938
	2	1	1.559	.162	1.230	1.887
		2	1.794	.119	1.553	2.035
IntuitiveControls	1	1	2.059	.138	1.778	2.340
		2	1.941	.145	1.646	2.237
	2	1	1.363	.222	.912	1.814
		2	1.902	.144	1.609	2.195

Pairwise Comparisons

Measure	Character	(I) NumPlayers	(J) NumPlayers	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
							Lower Bound	Upper Bound
Immersion	1	1	2	-.735*	.146	.000	-1.032	-.438
		2	1	.735*	.146	.000	.438	1.032
	2	1	2	-.451*	.108	.000	-.670	-.232
		2	1	.451*	.108	.000	.232	.670
Autonomy	1	1	2	-1.294*	.189	.000	-1.678	-.910
		2	1	1.294*	.189	.000	.910	1.678
	2	1	2	-.078	.128	.545	-.339	.183
		2	1	.078	.128	.545	-.183	.339
Relatedness	1	1	2	-1.833*	.203	.000	-2.247	-1.420
		2	1	1.833*	.203	.000	1.420	2.247
	2	1	2	-1.971*	.177	.000	-2.331	-1.610
		2	1	1.971*	.177	.000	1.610	2.331
Competence	1	1	2	-.108	.153	.485	-.419	.203
		2	1	.108	.153	.485	-.203	.419
	2	1	2	-.235	.143	.108	-.525	.055
		2	1	.235	.143	.108	-.055	.525
IntuitiveControls	1	1	2	.118	.132	.379	-.151	.386
		2	1	-.118	.132	.379	-.386	.151
	2	1	2	-.539*	.150	.001	-.844	-.235
		2	1	.539*	.150	.001	.235	.844

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Multivariate Tests

Character		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
1	Pillai's trace	.791	22.006[a]	5.000	29.000	.000	.791	110.029	1.000
	Wilks' lambda	.209	22.006[a]	5.000	29.000	.000	.791	110.029	1.000
	Hotelling's trace	3.794	22.006[a]	5.000	29.000	.000	.791	110.029	1.000
	Roy's largest root	3.794	22.006[a]	5.000	29.000	.000	.791	110.029	1.000
2	Pillai's trace	.816	25.653[a]	5.000	29.000	.000	.816	128.265	1.000
	Wilks' lambda	.184	25.653[a]	5.000	29.000	.000	.816	128.265	1.000
	Hotelling's trace	4.423	25.653[a]	5.000	29.000	.000	.816	128.265	1.000
	Roy's largest root	4.423	25.653[a]	5.000	29.000	.000	.816	128.265	1.000

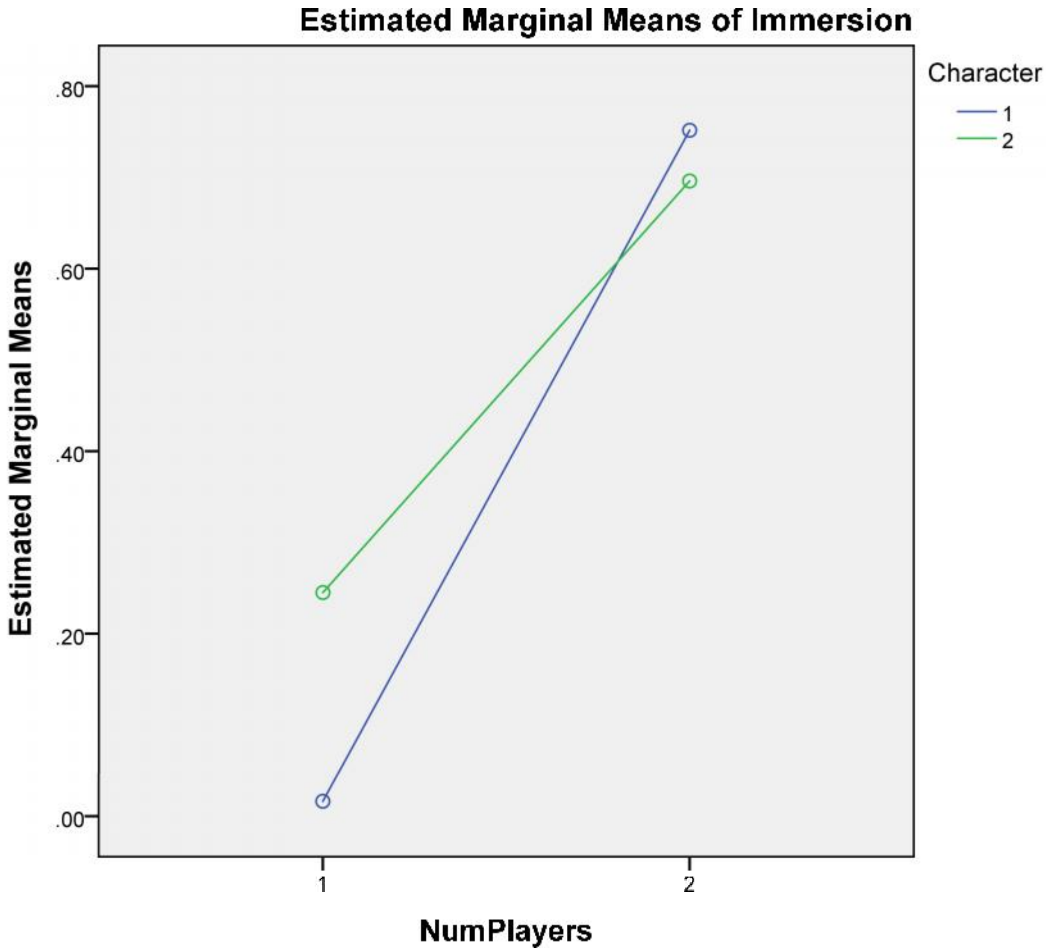
Each F tests the multivariate simple effects of NumPlayers within each level combination of the other effects shown. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

b. Computed using alpha = .05

Profile Plots

Immersion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2
NumPlayers

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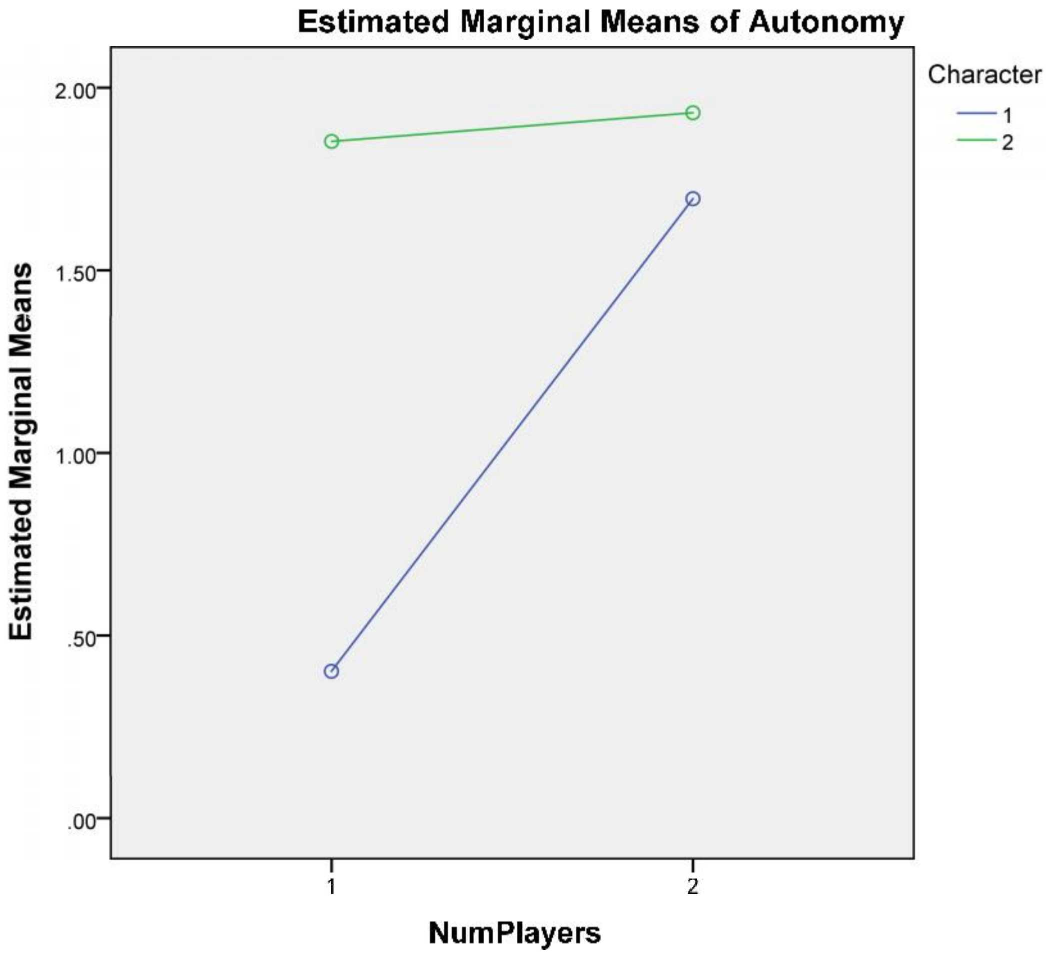
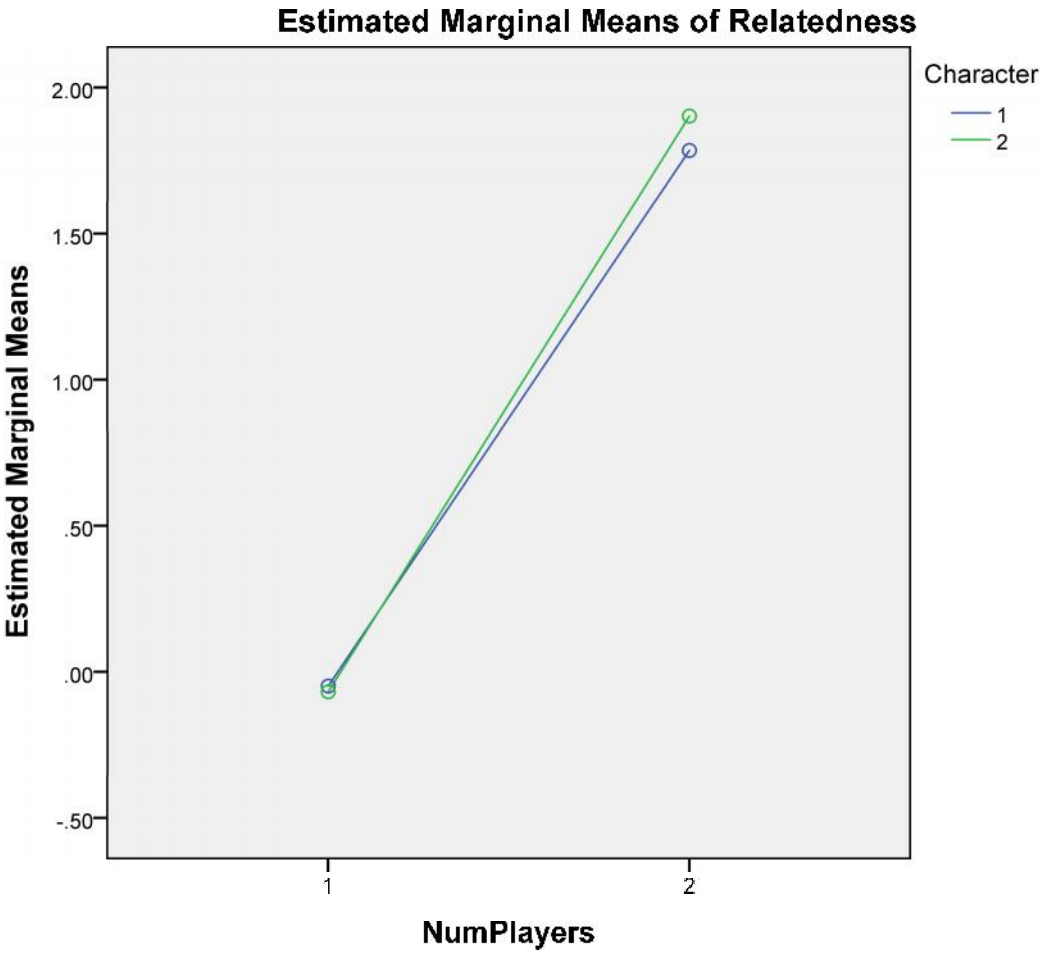


Relatedness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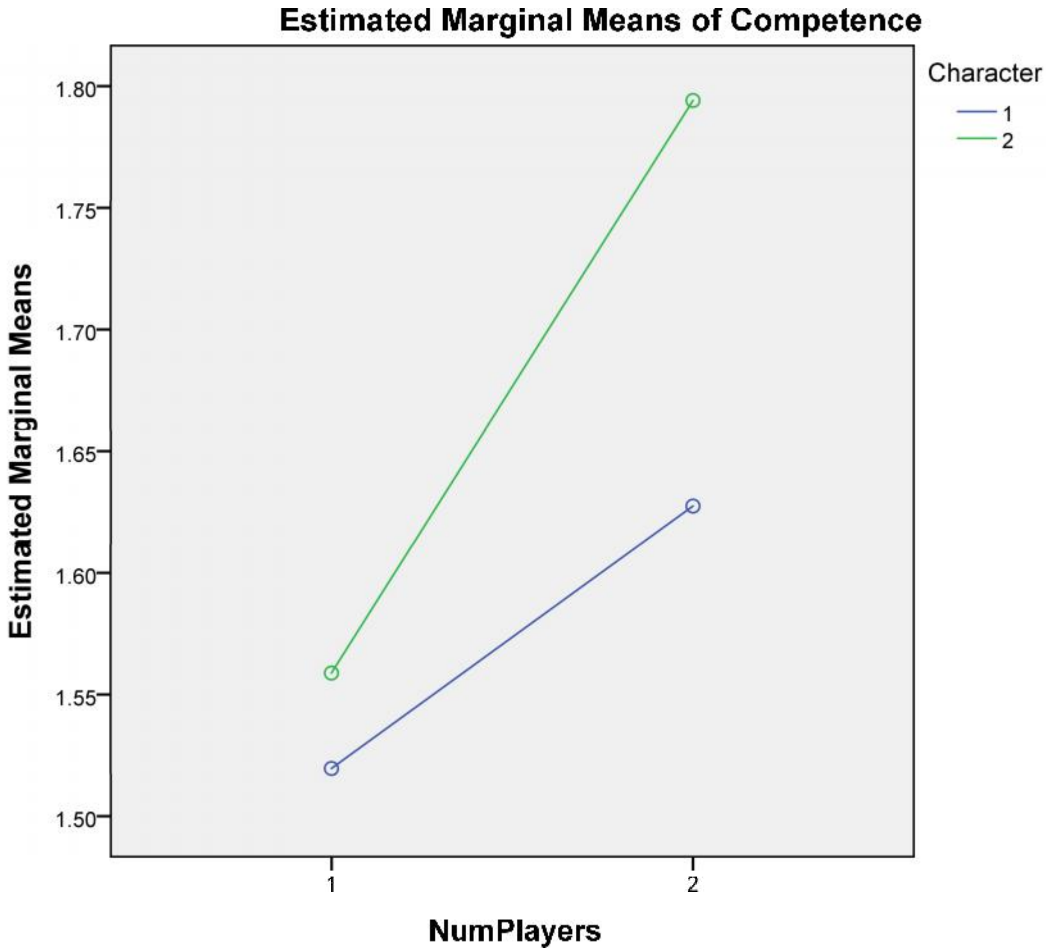
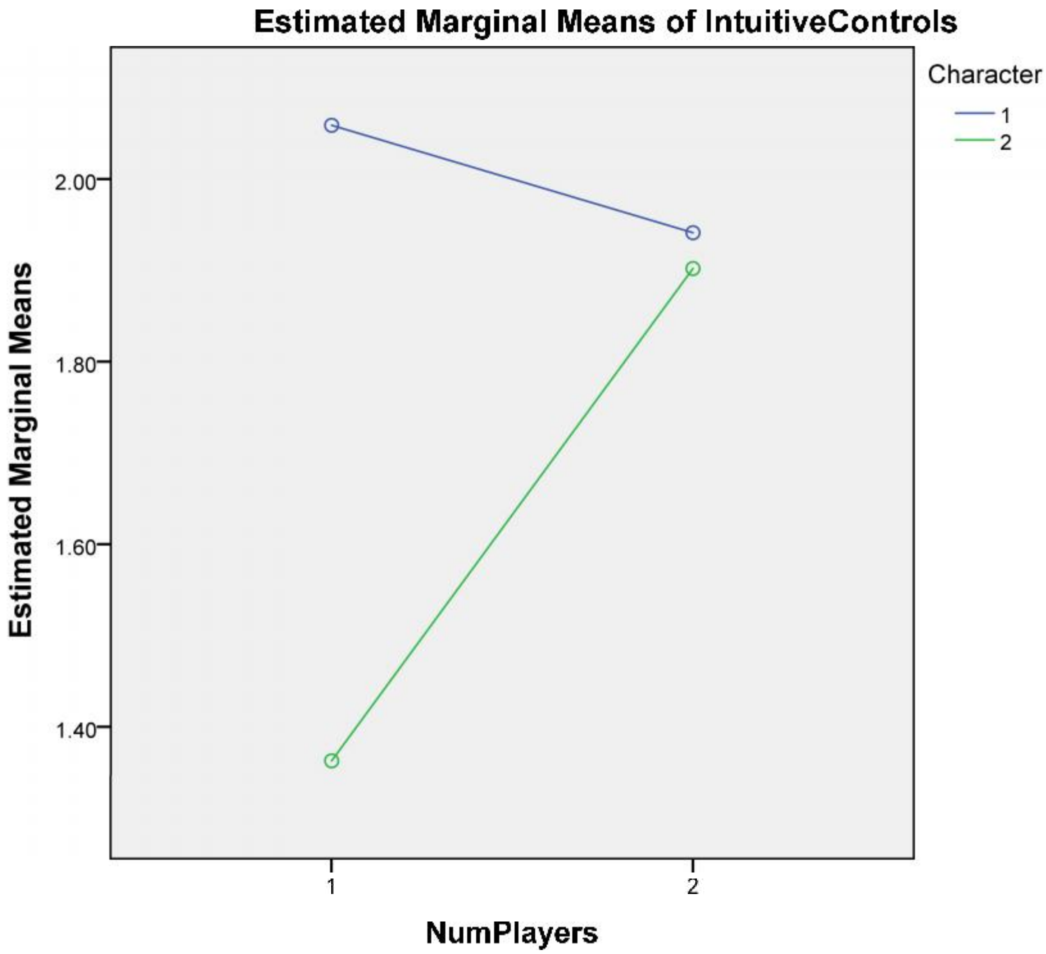
2
NumPlayers
Character
1
2

Competence



IntuitiveControls


Estimated Marginal Means of IntuitiveControls
Character
1
2
Estimated Marginal Means
2.00
1.80
1.60
1.40
1
2
NumPlayers

E.2 Study 2 - Statistics Output

The following statistical output is for study 2 as described in chapter 6. Due to a clerical error when administering the experiment conditions, it was necessary to manually extract only the subset of results for conditions that were properly counter-balanced. Hence, the below output data is in a less verbose format than would be expected were it pulled from SPSS in its raw form.

Estimates

Dependent Variable			Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
FirstConnected	A	K	5.300	.472	4.343	6.257
		S	2.700	.472	1.743	3.657
	S	K	3.000	.472	2.043	3.957
		S	3.000	.472	2.043	3.957
FirstCompetence	A	K	5.533	.225	5.077	5.989
		S	5.500	.225	5.044	5.956
	S	K	5.367	.225	4.911	5.823
		S	5.567	.225	5.111	6.023
FirstAutonomy	A	K	5.167	.305	4.549	5.784
		S	5.733	.305	5.116	6.351
	S	K	5.433	.305	4.816	6.051
		S	5.133	.305	4.516	5.751
FirstImmersion	A	K	4.811	.277	4.249	5.373
		S	4.678	.277	4.116	5.240
	S	K	3.900	.277	3.338	4.462
		S	4.056	.277	3.494	4.617
FirstIntuitiveControls	A	K	6.000	.341	5.309	6.691
		S	6.067	.341	5.376	6.757
	S	K	5.600	.341	4.909	6.291
		S	4.833	.341	4.143	5.524
FirstEmpathy	A	K	5.729	.282	5.156	6.301
		S	5.586	.282	5.013	6.159
	S	K	5.329	.282	4.756	5.901
		S	5.257	.282	4.684	5.830
FirstNegativeFeelings	A	K	2.917	.309	2.289	3.544
		S	2.783	.309	2.156	3.411
	S	K	2.517	.309	1.889	3.144
		S	2.983	.309	2.356	3.611
FirstEngagement	A	K	5.725	.247	5.224	6.226
		S	5.913	.247	5.412	6.413
	S	K	5.263	.247	4.762	5.763
		S	5.163	.247	4.662	5.663
FirstInterest	A	K	5.219	.244	4.724	5.714
		S	5.000	.244	4.505	5.495
	S	K	4.757	.244	4.262	5.253
		S	4.829	.244	4.333	5.324
FirstEffort	A	K	4.120	.110	3.896	4.344
		S	3.960	.110	3.736	4.184
	S	K	3.940	.110	3.716	4.164
		S	4.040	.110	3.816	4.264
FirstPressure	A	K	4.020	.212	3.590	4.450
		S	3.980	.212	3.550	4.410
	S	K	3.400	.212	2.970	3.830
		S	3.980	.212	3.550	4.410

Pairwise Comparisons

Dependent Variable				Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
							Lower Bound	Upper Bound
FirstConnected	K	A	S	2.300*	.667	.001	.946	3.654
		S	A	-2.300*	.667	.001	-3.654	-.946
	S	A	S	-.300	.667	.656	-1.654	1.054
		S	A	.300	.667	.656	-1.054	1.654
FirstCompetence	K	A	S	.167	.318	.604	-.478	.812
		S	A	-.167	.318	.604	-.812	.478
	S	A	S	-.067	.318	.835	-.712	.578
		S	A	.067	.318	.835	-.578	.712
FirstAutonomy	K	A	S	-.267	.431	.540	-1.140	.607
		S	A	.267	.431	.540	-.607	1.140
	S	A	S	.600	.431	.172	-.274	1.474
		S	A	-.600	.431	.172	-1.474	.274
FirstImmersion	K	A	S	.911*	.392	.026	.116	1.706
		S	A	-.911*	.392	.026	-1.706	-.116
	S	A	S	.622	.392	.121	-.172	1.417
		S	A	-.622	.392	.121	-1.417	.172
FirstIntuitiveControls	K	A	S	.400	.482	.412	-.577	1.377
		S	A	-.400	.482	.412	-1.377	.577
	S	A	S	1.233*	.482	.015	.257	2.210
		S	A	-1.233*	.482	.015	-2.210	-.257
FirstEmpathy	K	A	S	.400	.399	.323	-.410	1.210
		S	A	-.400	.399	.323	-1.210	.410
	S	A	S	.329	.399	.416	-.482	1.139
		S	A	-.329	.399	.416	-1.139	.482
FirstNegativeFeelings	K	A	S	.400	.438	.367	-.487	1.287
		S	A	-.400	.438	.367	-1.287	.487
	S	A	S	-.200	.438	.650	-1.087	.687
		S	A	.200	.438	.650	-.687	1.087
FirstEngagement	K							
	S							
FirstInterest	K							
	S							
FirstEffort	K							
	S							
FirstPressure	K							
	S							

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

StartSymmetric

Estimates

Dependent Variable		Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
FirstConnected	A	4.000	.334	3.323	4.677
	S	3.000	.334	2.323	3.677
FirstCompetence	A	5.517	.159	5.194	5.839
	S	5.467	.159	5.144	5.789
FirstAutonomy	A	5.450	.215	5.013	5.887
	S	5.283	.215	4.847	5.720
FirstImmersion	A	4.744	.196	4.347	5.142
	S	3.978	.196	3.580	4.375
FirstIntuitiveControls	A	6.033	.241	5.545	6.522
	S	5.217	.241	4.728	5.705
FirstEmpathy	A	5.657	.200	5.252	6.062
	S	5.293	.200	4.888	5.698
FirstNegativeFeelings	A	2.850	.219	2.406	3.294
	S	2.750	.219	2.306	3.194
FirstEngagement	A	5.819	.175	5.465	6.173
	S	5.213	.175	4.858	5.567
FirstInterest	A	5.110	.173	4.759	5.460
	S	4.793	.173	4.443	5.143
FirstEffort	A	4.040	.078	3.882	4.198
	S	3.990	.078	3.832	4.148
FirstPressure	A	4.000	.150	3.696	4.304
	S	3.690	.150	3.386	3.994

StartCharacter

Estimates

Dependent Variable		Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
FirstConnected	K	4.150	.334	3.473	4.827
	S	2.850	.334	2.173	3.527
FirstCompetence	K	5.450	.159	5.127	5.773
	S	5.533	.159	5.211	5.856
FirstAutonomy	K	5.300	.215	4.863	5.737
	S	5.433	.215	4.997	5.870
FirstImmersion	K	4.356	.196	3.958	4.753
	S	4.367	.196	3.969	4.764
FirstIntuitiveControls	K	5.800	.241	5.312	6.288
	S	5.450	.241	4.962	5.938
FirstEmpathy	K	5.529	.200	5.123	5.934
	S	5.421	.200	5.016	5.827
FirstNegativeFeelings	K	2.717	.219	2.273	3.160
	S	2.883	.219	2.440	3.327
FirstEngagement	K	5.494	.175	5.140	5.848
	S	5.538	.175	5.183	5.892
FirstInterest	K	4.988	.173	4.638	5.338
	S	4.914	.173	4.564	5.265
FirstEffort	K	4.030	.078	3.872	4.188
	S	4.000	.078	3.842	4.158
FirstPressure	K	3.710	.150	3.406	4.014
	S	3.980	.150	3.676	4.284

Tests of Between-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[l]
Corrected Model	FirstConnected	43.800[a]	3	14.600	6.554	.001	.353	19.661	.955
	FirstCompetence	.231[b]	3	.077	.152	.928	.013	.456	.075
	FirstAutonomy	2.333[c]	3	.778	.838	.482	.065	2.515	.213
	FirstImmersion	6.088[d]	3	2.029	2.643	.064	.181	7.930	.598
	FirstIntuitiveControls	9.631[e]	3	3.210	2.768	.056	.187	8.305	.620
	FirstEmpathy	1.455[f]	3	.485	.608	.614	.048	1.823	.164
	FirstNegativeFeelings	1.278[g]	3	.426	.445	.722	.036	1.335	.130
	FirstEngagement	3.901[h]	3	1.300	2.133	.113	.151	6.399	.499
	FirstInterest	1.268[i]	3	.423	.708	.553	.056	2.125	.185
	FirstEffort	.203[j]	3	.068	.555	.648	.044	1.665	.153
	FirstPressure	2.651[k]	3	.884	1.965	.137	.141	5.895	.464
Intercept	FirstConnected	490.000	1	490.000	219.950	.000	.859	219.950	1.000
	FirstCompetence	1206.336	1	1206.336	2384.703	.000	.985	2384.703	1.000
	FirstAutonomy	1152.044	1	1152.044	1241.725	.000	.972	1241.725	1.000
	FirstImmersion	760.772	1	760.772	991.070	.000	.965	991.070	1.000
	FirstIntuitiveControls	1265.625	1	1265.625	1091.463	.000	.968	1091.463	1.000
	FirstEmpathy	1199.025	1	1199.025	1502.721	.000	.977	1502.721	1.000
	FirstNegativeFeelings	313.600	1	313.600	327.657	.000	.901	327.657	1.000
	FirstEngagement	1216.885	1	1216.885	1995.944	.000	.982	1995.944	1.000
	FirstInterest	980.571	1	980.571	1643.239	.000	.979	1643.239	1.000
	FirstEffort	644.809	1	644.809	5290.138	.000	.993	5290.138	1.000
	FirstPressure	591.361	1	591.361	1315.110	.000	.973	1315.110	1.000
StartSymmetric	FirstConnected	10.000	1	10.000	4.489	.041	.111	4.489	.541
	FirstCompetence	.025	1	.025	.049	.825	.001	.049	.055
	FirstAutonomy	.278	1	.278	.299	.588	.008	.299	.083
	FirstImmersion	5.878	1	5.878	7.657	.009	.175	7.657	.768
	FirstIntuitiveControls	6.669	1	6.669	5.752	.022	.138	5.752	.646
	FirstEmpathy	1.327	1	1.327	1.663	.205	.044	1.663	.241
	FirstNegativeFeelings	.100	1	.100	.104	.748	.003	.104	.061
	FirstEngagement	3.675	1	3.675	6.028	.019	.143	6.028	.666
	FirstInterest	1.003	1	1.003	1.680	.203	.045	1.680	.243
	FirstEffort	.025	1	.025	.205	.653	.006	.205	.073
	FirstPressure	.961	1	.961	2.137	.152	.056	2.137	.296
StartedAsCharacter	FirstConnected	16.900	1	16.900	7.586	.009	.174	7.586	.764
	FirstCompetence	.069	1	.069	.137	.713	.004	.137	.065
	FirstAutonomy	.178	1	.178	.192	.664	.005	.192	.071
	FirstImmersion	.001	1	.001	.002	.968	.000	.002	.050
	FirstIntuitiveControls	1.225	1	1.225	1.056	.311	.029	1.056	.170
	FirstEmpathy	.115	1	.115	.144	.707	.004	.144	.066
	FirstNegativeFeelings	.278	1	.278	.290	.593	.008	.290	.082
	FirstEngagement	.019	1	.019	.031	.860	.001	.031	.053
	FirstInterest	.054	1	.054	.091	.764	.003	.091	.060
	FirstEffort	.009	1	.009	.074	.787	.002	.074	.058
	FirstPressure	.729	1	.729	1.621	.211	.043	1.621	.236
StartSymmetric * StartedAsCharacter	FirstConnected	16.900	1	16.900	7.586	.009	.174	7.586	.764
	FirstCompetence	.136	1	.136	.269	.607	.007	.269	.080
	FirstAutonomy	1.878	1	1.878	2.024	.163	.053	2.024	.283
	FirstImmersion	.209	1	.209	.272	.605	.007	.272	.080
	FirstIntuitiveControls	1.736	1	1.736	1.497	.229	.040	1.497	.222
	FirstEmpathy	.013	1	.013	.016	.900	.000	.016	.052
	FirstNegativeFeelings	.900	1	.900	.940	.339	.025	.940	.157
	FirstEngagement	.207	1	.207	.339	.564	.009	.339	.088
	FirstInterest	.211	1	.211	.353	.556	.010	.353	.089
	FirstEffort	.169	1	.169	1.387	.247	.037	1.387	.209
	FirstPressure	.961	1	.961	2.137	.152	.056	2.137	.296
Error	FirstConnected	80.200	36	2.228					
	FirstCompetence	18.211	36	.506					
	FirstAutonomy	33.400	36	.928					
	FirstImmersion	27.635	36	.768					
	FirstIntuitiveControls	41.744	36	1.160					
	FirstEmpathy	28.724	36	.798					
	FirstNegativeFeelings	34.456	36	.957					
	FirstEngagement	21.948	36	.610					
	FirstInterest	21.482	36	.597					
	FirstEffort	4.388	36	.122					
	FirstPressure	16.188	36	.450					
Total	FirstConnected	614.000	40						
	FirstCompetence	1224.778	40						

	FirstAutonomy	1187.778	40						
	FirstImmersion	794.494	40						
	FirstIntuitiveControls	1317.000	40						
	FirstEmpathy	1229.204	40						
	FirstNegativeFeelings	349.333	40						
	FirstEngagement	1242.734	40						
	FirstInterest	1003.322	40						
	FirstEffort	649.400	40						
	FirstPressure	610.200	40						
Corrected Total	FirstConnected	124.000	39						
	FirstCompetence	18.442	39						
	FirstAutonomy	35.733	39						
	FirstImmersion	33.722	39						
	FirstIntuitiveControls	51.375	39						
	FirstEmpathy	30.179	39						
	FirstNegativeFeelings	35.733	39						
	FirstEngagement	25.850	39						
	FirstInterest	22.751	39						
	FirstEffort	4.591	39						
	FirstPressure	18.839	39						

a. R Squared = .353 (Adjusted R Squared = .299)

b. R Squared = .013 (Adjusted R Squared = -.070)

c. R Squared = .065 (Adjusted R Squared = -.013)

d. R Squared = .181 (Adjusted R Squared = .112)

e. R Squared = .187 (Adjusted R Squared = .120)

f. R Squared = .048 (Adjusted R Squared = -.031)

g. R Squared = .036 (Adjusted R Squared = -.045)

h. R Squared = .151 (Adjusted R Squared = .080)

i. R Squared = .056 (Adjusted R Squared = -.023)

j. R Squared = .044 (Adjusted R Squared = -.035)

k. R Squared = .141 (Adjusted R Squared = .069)

l. Computed using alpha = .05

E.3 Study 3 - Statistics Output

The following statistical output is for study 3 as described in chapter 7.

```
GET
  FILE='D:\Google Drive\Research Projects\Beam Me Round Scotty\Study 3\Statistical Analysis\BMR
DATASET NAME DataSet5 WINDOW=FRONT.

SAVE OUTFILE='D:\Google Drive\Research Projects\Beam Me Round Scotty\Study 3\Statistical '+
    'Analysis\BMRSv3 - Combined Survey Data - Full.sav'
  /COMPRESSED.

SAVE OUTFILE='D:\Google Drive\Research Projects\Beam Me Round Scotty\Study 3\Statistical '+
    'Analysis\BMRSv3 - Combined Survey Data - Outliers Removed.sav'
  /COMPRESSED.
SORT CASES BY PID (A).
DATASET ACTIVATE DataSet4.
SORT CASES BY PID (A).
DATASET ACTIVATE DataSet5.
DATASET ACTIVATE DataSet5.

SAVE OUTFILE='D:\Google Drive\Research Projects\Beam Me Round Scotty\Study 3\Statistical '+
    'Analysis\BMRSv3 - Combined Survey Data - Outliers Removed.sav'
  /COMPRESSED.
GLM IOSConnectedByGame.A IOSConnectedByGame.B IOSConnectedByGame.C CompetenceAvgA CompetenceAvg
PressureAvgC ModeARank ModeBRank ModeCRank RankHealPowerful_1 RankHealPowerful_2 RankHealPowerf
RankShockEasiest_3 RankBombEasiest_1 RankBombEasiest_2 RankBombEasiest_3 RankTeleportEasiest_1
RankHealFavourite_3 RankShieldFavourite_1 RankShieldFavourite_2 RankShieldFavourite_3 RankShock
  /WSFACTOR=GameMode 3 Polynomial
  /MEASURE=IoSConnected Competence Autonomy Immersion IntuitiveControls Empathy NegativeFeeling
RankTeleportFavourite
  /METHOD=SSTYPE(3)
  /EMMEANS=TABLES(GameMode) COMPARE ADJ(LSD)
  /PRINT=DESCRIPTIVE ETASQ PARAMETER
  /CRITERIA=ALPHA(.05)
  /WSDESIGN=GameMode.
```

General Linear Model

[DataSet5] D:\Google Drive\Research Projects\Beam Me Round Scotty\Study 3\Statistical Analysis\BMRSv3 - Combined Survey Data - Outliers Removed.sav

Within-Subjects Factors

Measure	GameMode	Dependent Variable
IoSConnected	1	IOSConnectedByGame.A
	2	IOSConnectedByGame.B
	3	IOSConnectedByGame.C
Competence	1	CompetenceAvgA
	2	CompetenceAvgB
	3	CompetenceAvgC
Autonomy	1	AutonomyAvgA
	2	AutonomyAvgB
	3	AutonomyAvgC
Immersion	1	ImmersionAvgA
	2	ImmersionAvgB
	3	ImmersionAvgC
IntuitiveControls	1	IntuitiveControlsAvgA
	2	IntuitiveControlsAvgB
	3	IntuitiveControlsAvgC
Empathy	1	EmpathyAvgA
	2	EmpathyAvgB
	3	EmpathyAvgC
NegativeFeelings	1	NegativeFeelingsAvgA
	2	NegativeFeelingsAvgB
	3	NegativeFeelingsAvgC
Engagement	1	EngagementAvgA
	2	EngagementAvgB
	3	EngagementAvgC

Within-Subjects Factors

Measure	GameMode	Dependent Variable
Interest	1	InterestAvgA
	2	InterestAvgB
	3	InterestAvgC
Effort	1	EffortAvgA
	2	EffortAvgB
	3	EffortAvgC
Pressure	1	PressureAvgA
	2	PressureAvgB
	3	PressureAvgC
ModeRank	1	ModeARank
	2	ModeBRank
	3	ModeCRank
RankHealPowerful	1	RankHealPowerful_1
	2	RankHealPowerful_2
	3	RankHealPowerful_3
RankShieldPowerful	1	RankShieldPowerful_1
	2	RankShieldPowerful_2
	3	RankShieldPowerful_3
RankShockPowerful	1	RankShockPowerful_1
	2	RankShockPowerful_2
	3	RankShockPowerful_3
RankBombPowerful	1	RankBombPowerful_1
	2	RankBombPowerful_2
	3	RankBombPowerful_3
RankTeleportPowerful	1	RankTeleportPowerful_1
	2	RankTeleportPowerful_2
	3	RankTeleportPowerful_3

Within-Subjects Factors

Measure	GameMode	Dependent Variable
RankHealEaseOfUse	1	RankHealEasiest_1
	2	RankHealEasiest_2
	3	RankHealEasiest_3
RankShieldEaseOfUse	1	RankShieldEasiest_1
	2	RankShieldEasiest_2
	3	RankShieldEasiest_3
RankShockEaseOfUse	1	RankShockEasiest_1
	2	RankShockEasiest_2
	3	RankShockEasiest_3
RankBombEaseOfUse	1	RankBombEasiest_1
	2	RankBombEasiest_2
	3	RankBombEasiest_3
RankTeleportEaseOfUse	1	RankTeleportEasiest_1
	2	RankTeleportEasiest_2
	3	RankTeleportEasiest_3
RankHealConnected	1	RankHealConnected_1
	2	RankHealConnected_2
	3	RankHealConnected_3
RankShieldConnected	1	RankShieldConnected_1
	2	RankShieldConnected_2
	3	RankShieldConnected_3
RankShockConnected	1	RankShockConnected_1
	2	RankShockConnected_2
	3	RankShockConnected_3

Within-Subjects Factors

Measure	GameMode	Dependent Variable
RankBombConnected	1	RankBombConnected_1
	2	RankBombConnected_2
	3	RankBombConnected_3
RankTeleportConnected	1	RankTeleportConnecte_1
	2	RankTeleportConnecte_2
	3	RankTeleportConnecte_3
RankHealFavourite	1	RankHealFavourite_1
	2	RankHealFavourite_2
	3	RankHealFavourite_3
RankShieldFavourite	1	RankShieldFavourite_1
	2	RankShieldFavourite_2
	3	RankShieldFavourite_3
RankShockFavourite	1	RankShockFavourite_1
	2	RankShockFavourite_2
	3	RankShockFavourite_3
RankBombFavourite	1	RankBombFavourite_1
	2	RankBombFavourite_2
	3	RankBombFavourite_3
RankTeleportFavourite	1	RankTeleportFavourit_1
	2	RankTeleportFavourit_2
	3	RankTeleportFavourit_3

Descriptive Statistics

	Mean	Std. Deviation	N
IOSConnectedByGame.A: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	5.26	1.363	72
IOSConnectedByGame.B: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	5.51	1.222	72
IOSConnectedByGame.C: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	5.81	1.057	72
CompetenceAvgA	2.5648	.98445	72
CompetenceAvgB	2.4954	.91243	72
CompetenceAvgC	2.5231	1.04339	72
AutonomyAvgA	2.4861	.97534	72
AutonomyAvgB	2.3843	.90842	72
AutonomyAvgC	2.5046	1.02549	72
ImmersionAvgA	3.6049	1.20653	72
ImmersionAvgB	3.4969	1.14972	72
ImmersionAvgC	3.5478	1.10236	72
IntuitiveControlsAvgA	2.1481	.91397	72
IntuitiveControlsAvgB	2.3611	.92901	72
IntuitiveControlsAvgC	2.2454	.93780	72
EmpathyAvgA	2.4524	.77693	72
EmpathyAvgB	2.3135	.64006	72
EmpathyAvgC	2.3313	.70142	72
NegativeFeelingsAvgA	5.2477	.84475	72
NegativeFeelingsAvgB	5.2685	1.00956	72
NegativeFeelingsAvgC	5.3449	.87494	72
EngagementAvgA	2.5486	.91268	72
EngagementAvgB	2.2431	.67881	72
EngagementAvgC	2.1910	.65036	72
InterestAvgA	3.0866	1.24551	72
InterestAvgB	2.7679	.95198	72
InterestAvgC	2.6386	.94788	72
EffortAvgA	4.0944	1.24243	72
EffortAvgB	3.5000	1.14523	72

Descriptive Statistics

	Mean	Std. Deviation	N
EffortAvgC	3.6354	1.20937	72
PressureAvgA	5.2597	1.10996	72
PressureAvgB	4.8806	1.32481	72
PressureAvgC	5.0688	1.11306	72
ModeARank	2.0694	.84464	72
ModeBRank	2.3194	.72823	72
ModeCRank	1.6111	.72297	72
Rank each version of the Heal ability according to which seemed the most powerful? - A - Injection	1.82	.939	72
Rank each version of the Heal ability according to which seemed the most powerful? - B - Projector	2.31	.642	72
Rank each version of the Heal ability according to which seemed the most powerful? - C - Beam	1.88	.768	72
Rank each version of the Shield ability according to which seemed the most powerful? - A - Orb	1.68	.802	72
Rank each version of the Shield ability according to which seemed the most powerful? - B - Wall	2.35	.715	72
Rank each version of the Shield ability according to which seemed the most powerful? - C - Directed	1.97	.804	72
Rank each version of the Shock ability according to which seemed the most powerful? - A - Projector	1.78	.697	72
Rank each version of the Shock ability according to which seemed the most powerful? - B - Beam	1.76	.722	72
Rank each version of the Shock ability according to which seemed the most powerful? - C - Embedded Axe	2.46	.838	72
Rank each version of the Bomb ability according to which seemed the most powerful? - A - Pre-armed	1.57	.802	72
Rank each version of the Bomb ability according to which seemed the most powerful? - B - Kirk must arm	2.33	.712	72
Rank each version of the Bomb ability according to which seemed the most powerful? - C - Hit with axe	2.10	.754	72
Rank each version of the Teleport ability according to which seemed the most powerful? - A - Scotty clicks once	1.56	.748	72

Descriptive Statistics

	Mean	Std. Deviation	N
Rank each version of the Teleport ability according to which seemed the most powerful? - B - Portals	2.38	.740	72
Rank each version of the Teleport ability according to which seemed the most powerful? - C - Scotty clicks, Kirk confirms	2.07	.757	72
Rank each version of the Heal ability according to which was the easiest to use? - A - Injection	1.96	.911	72
Rank each version of the Heal ability according to which was the easiest to use? - B - Projector	2.13	.711	72
Rank each version of the Heal ability according to which was the easiest to use? - C - Beam	1.92	.818	72
Rank each version of the Shield ability according to which was the easiest to use? - A - Orb	1.51	.750	72
Rank each version of the Shield ability according to which was the easiest to use? - B - Wall	2.46	.670	72
Rank each version of the Shield ability according to which was the easiest to use? - C - Directed	2.03	.750	72
Rank each version of the Shock ability according to which was the easiest to use? - A - Projector	1.58	.687	72
Rank each version of the Shock ability according to which was the easiest to use? - B - Beam	1.83	.650	72
Rank each version of the Shock ability according to which was the easiest to use? - C - Embedded Axe	2.58	.765	72
Rank each version of the Bomb ability according to which was the easiest to use? - A - Pre-Armed	1.44	.785	72
Rank each version of the Bomb ability according to which was the easiest to use? - B - Kirk must Arm	2.13	.604	72
Rank each version of the Bomb ability according to which was the easiest to use? - C - Must hit with Axe	2.43	.728	72
Rank each version of the Teleport ability according to which was the easiest to use? - A - Scotty clicks once	1.46	.691	72
Rank each version of the Teleport ability according to which was the easiest to use? - B - Portals	2.40	.725	72
Rank each version of the Teleport ability according to which was the easiest to use? - C - Scotty clicks, Kirk confirms	2.14	.737	72

Descriptive Statistics

	Mean	Std. Deviation	N
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - A - Injection	1.96	.846	72
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - B - Projector	2.08	.801	72
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - C - Beam	1.96	.813	72
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - A - Orb	2.24	.778	72
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - B - Wall	2.22	.736	72
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - C - Directed	1.54	.749	72
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - A - Projector	2.22	.826	72
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - B - Beam	2.07	.635	72
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - C - Embedded Axe	1.71	.895	72
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - A - Pre-Armed	2.46	.838	72
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - B - Kirk must arm	1.92	.599	72
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - C - Must hit with Axe	1.63	.777	72
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - A - Scotty clicks once	2.29	.813	72
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - B - Portals	2.01	.722	72

Descriptive Statistics

	Mean	Std. Deviation	N
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - C - Scotty clicks, Kirk confirms	1.69	.816	72
Rank each version of the Heal ability according to which was your favourite? - A - Injection	2.00	.888	72
Rank each version of the Heal ability according to which was your favourite? - B - Projector	2.13	.749	72
Rank each version of the Heal ability according to which was your favourite? - C - Beam	1.88	.804	72
Rank each version of the Shield ability according to which was your favourite? - A - Orb	1.92	.818	72
Rank each version of the Shield ability according to which was your favourite? - B - Wall	2.25	.801	72
Rank each version of the Shield ability according to which was your favourite? - C - Directed	1.83	.787	72
Rank each version of the Shock ability according to which was your favourite? - A - Projector	1.86	.737	72
Rank each version of the Shock ability according to which was your favourite? - B - Beam	1.81	.725	72
Rank each version of the Shock ability according to which was your favourite? - C - Embedded axe	2.33	.888	72
Rank each version of the Bomb ability according to which was your favourite? - A - Pre-Armed	1.81	.850	72
Rank each version of the Bomb ability according to which was your favourite? - B - Kirk must arm	2.25	.666	72
Rank each version of the Bomb ability according to which was your favourite? - C - Must hit with axe	1.94	.870	72
Rank each version of the Teleport ability according to which was your favourite? - A - Scotty clicks once	1.71	.777	72
Rank each version of the Teleport ability according to which was your favourite? - B - Portals	2.22	.773	72
Rank each version of the Teleport ability according to which was your favourite? - C - Scotty clicks, Kirk confirms	2.07	.828	72

Multivariate Tests[a]

Effect			Value	F	Hypothesis df
Between Subjects	Intercept	Pillai's Trace	.996	1259.418[b]	11.000
		Wilks' Lambda	.004	1259.418[b]	11.000
		Hotelling's Trace	227.108	1259.418[b]	11.000
		Roy's Largest Root	227.108	1259.418[b]	11.000
Within Subjects	GameMode	Pillai's Trace	.939	1.917[b]	64.000
		Wilks' Lambda	.061	1.917[b]	64.000
		Hotelling's Trace	15.334	1.917[b]	64.000
		Roy's Largest Root	15.334	1.917[b]	64.000

Multivariate Tests[a]

Effect			Error df	Sig.	Partial Eta Squared
Between Subjects	Intercept	Pillai's Trace	61.000	.000	.996
		Wilks' Lambda	61.000	.000	.996
		Hotelling's Trace	61.000	.000	.996
		Roy's Largest Root	61.000	.000	.996
Within Subjects	GameMode	Pillai's Trace	8.000	.164	.939
		Wilks' Lambda	8.000	.164	.939
		Hotelling's Trace	8.000	.164	.939
		Roy's Largest Root	8.000	.164	.939

a. Design: Intercept
Within Subjects Design: GameMode

b. Exact statistic

Mauchly's Test of Sphericity[a]

Within Subjects Effect	Measure	Mauchly's W	Approx. Chi-Square	df	Sig.
GameMode	IoSConnected	.977	1.595	2	.450
	Competence	.898	7.503	2	.023
	Autonomy	.993	.514	2	.773
	Immersion	.951	3.549	2	.170
	IntuitiveControls	.942	4.149	2	.126
	Empathy	.916	6.178	2	.046
	NegativeFeelings	.998	.149	2	.928
	Engagement	.736	21.456	2	.000
	Interest	.836	12.568	2	.002
	Effort	.957	3.101	2	.212
	Pressure	.983	1.185	2	.553
	ModeRank	.955	3.212	2	.201
	RankHealPowerful	.810	14.784	2	.001
	RankShieldPowerful	.978	1.556	2	.459
	RankShockPowerful	.944	4.021	2	.134
	RankBombPowerful	.981	1.333	2	.514
	RankTeleportPowerful	.999	.047	2	.977
	RankHealEaseOfUse	.922	5.717	2	.057
	RankShieldEaseOfUse	.979	1.482	2	.477
	RankShockEaseOfUse	.962	2.699	2	.259
	RankBombEaseOfUse	.914	6.316	2	.043
	RankTeleportEaseOfUse	.994	.419	2	.811
	RankHealConnected	.995	.320	2	.852
	RankShieldConnected	.996	.308	2	.857
	RankShockConnected	.860	10.584	2	.005
	RankBombConnected	.865	10.165	2	.006
	RankTeleportConnected	.976	1.680	2	.432
	RankHealFavourite	.960	2.833	2	.243
	RankShieldFavourite	.998	.138	2	.933
	RankShockFavourite	.925	5.478	2	.065
	RankBombFavourite	.904	7.053	2	.029
	RankTeleportFavourite	.992	.565	2	.754

Mauchly's Test of Sphericity[a]

Within Subjects Effect	Measure	Epsilon[b]		
		Greenhouse-Geisser	Huynh-Feldt	Lower-bound
GameMode	IoSConnected	.978	1.000	.500
	Competence	.908	.930	.500
	Autonomy	.993	1.000	.500
	Immersion	.953	.978	.500
	IntuitiveControls	.946	.971	.500
	Empathy	.922	.946	.500
	NegativeFeelings	.998	1.000	.500
	Engagement	.791	.806	.500
	Interest	.859	.878	.500
	Effort	.958	.984	.500
	Pressure	.983	1.000	.500
	ModeRank	.957	.983	.500
	RankHealPowerful	.840	.858	.500
	RankShieldPowerful	.978	1.000	.500
	RankShockPowerful	.947	.972	.500
	RankBombPowerful	.981	1.000	.500
	RankTeleportPowerful	.999	1.000	.500
	RankHealEaseOfUse	.927	.951	.500
	RankShieldEaseOfUse	.979	1.000	.500
	RankShockEaseOfUse	.964	.990	.500
	RankBombEaseOfUse	.921	.944	.500
	RankTeleportEaseOfUse	.994	1.000	.500
	RankHealConnected	.995	1.000	.500
	RankShieldConnected	.996	1.000	.500
	RankShockConnected	.877	.897	.500
	RankBombConnected	.881	.902	.500
	RankTeleportConnected	.977	1.000	.500
	RankHealFavourite	.962	.988	.500
	RankShieldFavourite	.998	1.000	.500
	RankShockFavourite	.930	.954	.500
	RankBombFavourite	.913	.935	.500
	RankTeleportFavourite	.992	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: GameMode

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Multivariate[a,b]

Within Subjects Effect		Value	F	Hypothesis df	Error df	Sig.
GameMode	Pillai's Trace	1.073	4.050	64.000	224.000	.000
	Wilks' Lambda	.212	4.057[c]	64.000	222.000	.000
	Hotelling's Trace	2.364	4.063	64.000	220.000	.000
	Roy's Largest Root	1.413	4.947[d]	32.000	112.000	.000

Multivariate[a,b]

Within Subjects Effect		Partial Eta Squared
GameMode	Pillai's Trace	.536
	Wilks' Lambda	.539
	Hotelling's Trace	.542
	Roy's Largest Root	.586

a. Design: Intercept
Within Subjects Design: GameMode

b. Tests are based on averaged variables.

c. Exact statistic

d. The statistic is an upper bound on F that yields a lower bound on the significance level.

Univariate Tests

Source	Measure		Type III Sum of Squares	df
GameMode	IoSConnected	Sphericity Assumed	10.583	2
		Greenhouse-Geisser	10.583	1.956
		Huynh-Feldt	10.583	2.000
		Lower-bound	10.583	1.000
	Competence	Sphericity Assumed	.176	2
		Greenhouse-Geisser	.176	1.815
		Huynh-Feldt	.176	1.860
		Lower-bound	.176	1.000
	Autonomy	Sphericity Assumed	.605	2
		Greenhouse-Geisser	.605	1.985
		Huynh-Feldt	.605	2.000
		Lower-bound	.605	1.000
	Immersion	Sphericity Assumed	.421	2
		Greenhouse-Geisser	.421	1.906
		Huynh-Feldt	.421	1.957
		Lower-bound	.421	1.000
	IntuitiveControls	Sphericity Assumed	1.637	2
		Greenhouse-Geisser	1.637	1.891
		Huynh-Feldt	1.637	1.941
		Lower-bound	1.637	1.000
	Empathy	Sphericity Assumed	.822	2
		Greenhouse-Geisser	.822	1.844
		Huynh-Feldt	.822	1.891
		Lower-bound	.822	1.000
	NegativeFeelings	Sphericity Assumed	.377	2
		Greenhouse-Geisser	.377	1.996
		Huynh-Feldt	.377	2.000
		Lower-bound	.377	1.000
	Engagement	Sphericity Assumed	5.376	2
		Greenhouse-Geisser	5.376	1.582
		Huynh-Feldt	5.376	1.612
		Lower-bound	5.376	1.000
	Interest	Sphericity Assumed	7.659	2
		Greenhouse-Geisser	7.659	1.718
		Huynh-Feldt	7.659	1.756
		Lower-bound	7.659	1.000
	Effort	Sphericity Assumed	13.978	2
		Greenhouse-Geisser	13.978	1.917

Univariate Tests

Source	Measure		Mean Square	F
GameMode	IoSConnected	Sphericity Assumed	5.292	5.867
		Greenhouse-Geisser	5.411	5.867
		Huynh-Feldt	5.292	5.867
		Lower-bound	10.583	5.867
	Competence	Sphericity Assumed	.088	.202
		Greenhouse-Geisser	.097	.202
		Huynh-Feldt	.095	.202
		Lower-bound	.176	.202
	Autonomy	Sphericity Assumed	.302	.553
		Greenhouse-Geisser	.305	.553
		Huynh-Feldt	.302	.553
		Lower-bound	.605	.553
	Immersion	Sphericity Assumed	.210	.927
		Greenhouse-Geisser	.221	.927
		Huynh-Feldt	.215	.927
		Lower-bound	.421	.927
	IntuitiveControls	Sphericity Assumed	.818	2.673
		Greenhouse-Geisser	.866	2.673
		Huynh-Feldt	.843	2.673
		Lower-bound	1.637	2.673
	Empathy	Sphericity Assumed	.411	1.758
		Greenhouse-Geisser	.446	1.758
		Huynh-Feldt	.435	1.758
		Lower-bound	.822	1.758
	NegativeFeelings	Sphericity Assumed	.189	.694
		Greenhouse-Geisser	.189	.694
		Huynh-Feldt	.189	.694
		Lower-bound	.377	.694
	Engagement	Sphericity Assumed	2.688	7.649
		Greenhouse-Geisser	3.397	7.649
		Huynh-Feldt	3.334	7.649
		Lower-bound	5.376	7.649
	Interest	Sphericity Assumed	3.829	5.681
		Greenhouse-Geisser	4.459	5.681
		Huynh-Feldt	4.361	5.681
		Lower-bound	7.659	5.681
	Effort	Sphericity Assumed	6.989	11.537
		Greenhouse-Geisser	7.292	11.537

Univariate Tests

Source	Measure		Sig.	Partial Eta Squared
GameMode	IoSConnected	Sphericity Assumed	.004	.076
		Greenhouse-Geisser	.004	.076
		Huynh-Feldt	.004	.076
		Lower-bound	.018	.076
	Competence	Sphericity Assumed	.818	.003
		Greenhouse-Geisser	.797	.003
		Huynh-Feldt	.802	.003
		Lower-bound	.655	.003
	Autonomy	Sphericity Assumed	.576	.008
		Greenhouse-Geisser	.575	.008
		Huynh-Feldt	.576	.008
		Lower-bound	.459	.008
	Immersion	Sphericity Assumed	.398	.013
		Greenhouse-Geisser	.394	.013
		Huynh-Feldt	.397	.013
		Lower-bound	.339	.013
	IntuitiveControls	Sphericity Assumed	.073	.036
		Greenhouse-Geisser	.076	.036
		Huynh-Feldt	.074	.036
		Lower-bound	.106	.036
	Empathy	Sphericity Assumed	.176	.024
		Greenhouse-Geisser	.179	.024
		Huynh-Feldt	.178	.024
		Lower-bound	.189	.024
	NegativeFeelings	Sphericity Assumed	.501	.010
		Greenhouse-Geisser	.501	.010
		Huynh-Feldt	.501	.010
		Lower-bound	.408	.010
	Engagement	Sphericity Assumed	.001	.097
		Greenhouse-Geisser	.002	.097
		Huynh-Feldt	.002	.097
		Lower-bound	.007	.097
	Interest	Sphericity Assumed	.004	.074
		Greenhouse-Geisser	.007	.074
		Huynh-Feldt	.006	.074
		Lower-bound	.020	.074
	Effort	Sphericity Assumed	.000	.140
		Greenhouse-Geisser	.000	.140

Univariate Tests

Source	Measure		Type III Sum of Squares	df
		Huynh-Feldt	13.978	1.969
		Lower-bound	13.978	1.000
	Pressure	Sphericity Assumed	5.176	2
		Greenhouse-Geisser	5.176	1.967
		Huynh-Feldt	5.176	2.000
		Lower-bound	5.176	1.000
	ModeRank	Sphericity Assumed	18.583	2
		Greenhouse-Geisser	18.583	1.914
		Huynh-Feldt	18.583	1.966
		Lower-bound	18.583	1.000
	RankHealPowerful	Sphericity Assumed	10.194	2
		Greenhouse-Geisser	10.194	1.680
		Huynh-Feldt	10.194	1.716
		Lower-bound	10.194	1.000
	RankShieldPowerful	Sphericity Assumed	16.083	2
		Greenhouse-Geisser	16.083	1.957
		Huynh-Feldt	16.083	2.000
		Lower-bound	16.083	1.000
	RankShockPowerful	Sphericity Assumed	22.694	2
		Greenhouse-Geisser	22.694	1.894
		Huynh-Feldt	22.694	1.945
		Lower-bound	22.694	1.000
	RankBombPowerful	Sphericity Assumed	22.028	2
		Greenhouse-Geisser	22.028	1.963
		Huynh-Feldt	22.028	2.000
		Lower-bound	22.028	1.000
	RankTeleportPowerful	Sphericity Assumed	24.694	2
		Greenhouse-Geisser	24.694	1.999
		Huynh-Feldt	24.694	2.000
		Lower-bound	24.694	1.000
	RankHealEaseOfUse	Sphericity Assumed	1.750	2
		Greenhouse-Geisser	1.750	1.855
		Huynh-Feldt	1.750	1.902
		Lower-bound	1.750	1.000
	RankShieldEaseOfUse	Sphericity Assumed	32.194	2
		Greenhouse-Geisser	32.194	1.959
		Huynh-Feldt	32.194	2.000
		Lower-bound	32.194	1.000

Univariate Tests

Source	Measure		Mean Square	F
		Huynh-Feldt	7.099	11.537
		Lower-bound	13.978	11.537
	Pressure	Sphericity Assumed	2.588	4.779
		Greenhouse-Geisser	2.631	4.779
		Huynh-Feldt	2.588	4.779
		Lower-bound	5.176	4.779
	ModeRank	Sphericity Assumed	9.292	10.520
		Greenhouse-Geisser	9.708	10.520
		Huynh-Feldt	9.453	10.520
		Lower-bound	18.583	10.520
	RankHealPowerful	Sphericity Assumed	5.097	5.409
		Greenhouse-Geisser	6.068	5.409
		Huynh-Feldt	5.940	5.409
		Lower-bound	10.194	5.409
	RankShieldPowerful	Sphericity Assumed	8.042	8.927
		Greenhouse-Geisser	8.218	8.927
		Huynh-Feldt	8.042	8.927
		Lower-bound	16.083	8.927
	RankShockPowerful	Sphericity Assumed	11.347	13.283
		Greenhouse-Geisser	11.981	13.283
		Huynh-Feldt	11.670	13.283
		Lower-bound	22.694	13.283
	RankBombPowerful	Sphericity Assumed	11.014	12.822
		Greenhouse-Geisser	11.222	12.822
		Huynh-Feldt	11.014	12.822
		Lower-bound	22.028	12.822
	RankTeleportPowerful	Sphericity Assumed	12.347	14.696
		Greenhouse-Geisser	12.355	14.696
		Huynh-Feldt	12.347	14.696
		Lower-bound	24.694	14.696
	RankHealEaseOfUse	Sphericity Assumed	.875	.873
		Greenhouse-Geisser	.944	.873
		Huynh-Feldt	.920	.873
		Lower-bound	1.750	.873
	RankShieldEaseOfUse	Sphericity Assumed	16.097	20.444
		Greenhouse-Geisser	16.434	20.444
		Huynh-Feldt	16.097	20.444
		Lower-bound	32.194	20.444

Univariate Tests

Source	Measure		Sig.	Partial Eta Squared
		Huynh-Feldt	.000	.140
		Lower-bound	.001	.140
	Pressure	Sphericity Assumed	.010	.063
		Greenhouse-Geisser	.010	.063
		Huynh-Feldt	.010	.063
		Lower-bound	.032	.063
	ModeRank	Sphericity Assumed	.000	.129
		Greenhouse-Geisser	.000	.129
		Huynh-Feldt	.000	.129
		Lower-bound	.002	.129
	RankHealPowerful	Sphericity Assumed	.005	.071
		Greenhouse-Geisser	.009	.071
		Huynh-Feldt	.008	.071
		Lower-bound	.023	.071
	RankShieldPowerful	Sphericity Assumed	.000	.112
		Greenhouse-Geisser	.000	.112
		Huynh-Feldt	.000	.112
		Lower-bound	.004	.112
	RankShockPowerful	Sphericity Assumed	.000	.158
		Greenhouse-Geisser	.000	.158
		Huynh-Feldt	.000	.158
		Lower-bound	.001	.158
	RankBombPowerful	Sphericity Assumed	.000	.153
		Greenhouse-Geisser	.000	.153
		Huynh-Feldt	.000	.153
		Lower-bound	.001	.153
	RankTeleportPowerful	Sphericity Assumed	.000	.171
		Greenhouse-Geisser	.000	.171
		Huynh-Feldt	.000	.171
		Lower-bound	.000	.171
	RankHealEaseOfUse	Sphericity Assumed	.420	.012
		Greenhouse-Geisser	.413	.012
		Huynh-Feldt	.415	.012
		Lower-bound	.353	.012
	RankShieldEaseOfUse	Sphericity Assumed	.000	.224
		Greenhouse-Geisser	.000	.224
		Huynh-Feldt	.000	.224
		Lower-bound	.000	.224

Univariate Tests

Source	Measure		Type III Sum of Squares	df
	RankShockEaseOfUse	Sphericity Assumed	39.000	2
		Greenhouse-Geisser	39.000	1.927
		Huynh-Feldt	39.000	1.980
		Lower-bound	39.000	1.000
	RankBombEaseOfUse	Sphericity Assumed	36.694	2
		Greenhouse-Geisser	36.694	1.841
		Huynh-Feldt	36.694	1.888
		Lower-bound	36.694	1.000
	RankTeleportEaseOfUse	Sphericity Assumed	34.194	2
		Greenhouse-Geisser	34.194	1.988
		Huynh-Feldt	34.194	2.000
		Lower-bound	34.194	1.000
	RankHealConnected	Sphericity Assumed	.750	2
		Greenhouse-Geisser	.750	1.991
		Huynh-Feldt	.750	2.000
		Lower-bound	.750	1.000
	RankShieldConnected	Sphericity Assumed	22.694	2
		Greenhouse-Geisser	22.694	1.991
		Huynh-Feldt	22.694	2.000
		Lower-bound	22.694	1.000
	RankShockConnected	Sphericity Assumed	10.028	2
		Greenhouse-Geisser	10.028	1.754
		Huynh-Feldt	10.028	1.795
		Lower-bound	10.028	1.000
	RankBombConnected	Sphericity Assumed	25.750	2
		Greenhouse-Geisser	25.750	1.762
		Huynh-Feldt	25.750	1.803
		Lower-bound	25.750	1.000
	RankTeleportConnected	Sphericity Assumed	12.861	2
		Greenhouse-Geisser	12.861	1.954
		Huynh-Feldt	12.861	2.000
		Lower-bound	12.861	1.000
	RankHealFavourite	Sphericity Assumed	2.250	2
		Greenhouse-Geisser	2.250	1.924
		Huynh-Feldt	2.250	1.976
		Lower-bound	2.250	1.000
	RankShieldFavourite	Sphericity Assumed	7.000	2
		Greenhouse-Geisser	7.000	1.996

Univariate Tests

Source	Measure		Mean Square	F
	RankShockEaseOfUse	Sphericity Assumed	19.500	26.371
		Greenhouse-Geisser	20.238	26.371
		Huynh-Feldt	19.699	26.371
		Lower-bound	39.000	26.371
	RankBombEaseOfUse	Sphericity Assumed	18.347	24.279
		Greenhouse-Geisser	19.930	24.279
		Huynh-Feldt	19.437	24.279
		Lower-bound	36.694	24.279
	RankTeleportEaseOfUse	Sphericity Assumed	17.097	22.110
		Greenhouse-Geisser	17.199	22.110
		Huynh-Feldt	17.097	22.110
		Lower-bound	34.194	22.110
	RankHealConnected	Sphericity Assumed	.375	.372
		Greenhouse-Geisser	.377	.372
		Huynh-Feldt	.375	.372
		Lower-bound	.750	.372
	RankShieldConnected	Sphericity Assumed	11.347	13.283
		Greenhouse-Geisser	11.397	13.283
		Huynh-Feldt	11.347	13.283
		Lower-bound	22.694	13.283
	RankShockConnected	Sphericity Assumed	5.014	5.314
		Greenhouse-Geisser	5.717	5.314
		Huynh-Feldt	5.587	5.314
		Lower-bound	10.028	5.314
	RankBombConnected	Sphericity Assumed	12.875	15.461
		Greenhouse-Geisser	14.615	15.461
		Huynh-Feldt	14.280	15.461
		Lower-bound	25.750	15.461
	RankTeleportConnected	Sphericity Assumed	6.431	6.963
		Greenhouse-Geisser	6.583	6.963
		Huynh-Feldt	6.431	6.963
		Lower-bound	12.861	6.963
	RankHealFavourite	Sphericity Assumed	1.125	1.127
		Greenhouse-Geisser	1.170	1.127
		Huynh-Feldt	1.139	1.127
		Lower-bound	2.250	1.127
	RankShieldFavourite	Sphericity Assumed	3.500	3.628
		Greenhouse-Geisser	3.507	3.628

Univariate Tests

Source	Measure		Sig.	Partial Eta Squared
	RankShockEaseOfUse	Sphericity Assumed	.000	.271
		Greenhouse-Geisser	.000	.271
		Huynh-Feldt	.000	.271
		Lower-bound	.000	.271
	RankBombEaseOfUse	Sphericity Assumed	.000	.255
		Greenhouse-Geisser	.000	.255
		Huynh-Feldt	.000	.255
		Lower-bound	.000	.255
	RankTeleportEaseOfUse	Sphericity Assumed	.000	.237
		Greenhouse-Geisser	.000	.237
		Huynh-Feldt	.000	.237
		Lower-bound	.000	.237
	RankHealConnected	Sphericity Assumed	.690	.005
		Greenhouse-Geisser	.689	.005
		Huynh-Feldt	.690	.005
		Lower-bound	.544	.005
	RankShieldConnected	Sphericity Assumed	.000	.158
		Greenhouse-Geisser	.000	.158
		Huynh-Feldt	.000	.158
		Lower-bound	.001	.158
	RankShockConnected	Sphericity Assumed	.006	.070
		Greenhouse-Geisser	.008	.070
		Huynh-Feldt	.008	.070
		Lower-bound	.024	.070
	RankBombConnected	Sphericity Assumed	.000	.179
		Greenhouse-Geisser	.000	.179
		Huynh-Feldt	.000	.179
		Lower-bound	.000	.179
	RankTeleportConnected	Sphericity Assumed	.001	.089
		Greenhouse-Geisser	.001	.089
		Huynh-Feldt	.001	.089
		Lower-bound	.010	.089
	RankHealFavourite	Sphericity Assumed	.327	.016
		Greenhouse-Geisser	.325	.016
		Huynh-Feldt	.326	.016
		Lower-bound	.292	.016
	RankShieldFavourite	Sphericity Assumed	.029	.049
		Greenhouse-Geisser	.029	.049

Univariate Tests

Source	Measure		Type III Sum of Squares	df
Error(GameMode)		Huynh-Feldt	7.000	2.000
		Lower-bound	7.000	1.000
	RankShockFavourite	Sphericity Assumed	12.111	2
		Greenhouse-Geisser	12.111	1.860
		Huynh-Feldt	12.111	1.908
		Lower-bound	12.111	1.000
	RankBombFavourite	Sphericity Assumed	7.444	2
		Greenhouse-Geisser	7.444	1.825
		Huynh-Feldt	7.444	1.871
		Lower-bound	7.444	1.000
	RankTeleportFavourite	Sphericity Assumed	10.028	2
		Greenhouse-Geisser	10.028	1.984
		Huynh-Feldt	10.028	2.000
		Lower-bound	10.028	1.000
	IoSConnected	Sphericity Assumed	128.083	142
		Greenhouse-Geisser	128.083	138.871
		Huynh-Feldt	128.083	142.000
		Lower-bound	128.083	71.000
	Competence	Sphericity Assumed	61.972	142
		Greenhouse-Geisser	61.972	128.898
		Huynh-Feldt	61.972	132.091
		Lower-bound	61.972	71.000
	Autonomy	Sphericity Assumed	77.617	142
		Greenhouse-Geisser	77.617	140.969
		Huynh-Feldt	77.617	142.000
		Lower-bound	77.617	71.000
	Immersion	Sphericity Assumed	32.221	142
		Greenhouse-Geisser	32.221	135.311
		Huynh-Feldt	32.221	138.946
		Lower-bound	32.221	71.000
	IntuitiveControls	Sphericity Assumed	43.474	142
		Greenhouse-Geisser	43.474	134.272
		Huynh-Feldt	43.474	137.835
		Lower-bound	43.474	71.000
	Empathy	Sphericity Assumed	33.205	142
		Greenhouse-Geisser	33.205	130.939
		Huynh-Feldt	33.205	134.271
		Lower-bound	33.205	71.000

Univariate Tests

Source	Measure		Mean Square	F
		Huynh-Feldt	3.500	3.628
		Lower-bound	7.000	3.628
	RankShockFavourite	Sphericity Assumed	6.056	6.520
		Greenhouse-Geisser	6.511	6.520
		Huynh-Feldt	6.348	6.520
		Lower-bound	12.111	6.520
	RankBombFavourite	Sphericity Assumed	3.722	3.871
		Greenhouse-Geisser	4.079	3.871
		Huynh-Feldt	3.980	3.871
		Lower-bound	7.444	3.871
	RankTeleportFavourite	Sphericity Assumed	5.014	5.314
		Greenhouse-Geisser	5.054	5.314
		Huynh-Feldt	5.014	5.314
		Lower-bound	10.028	5.314
Error(GameMode)	IoSConnected	Sphericity Assumed	.902	
		Greenhouse-Geisser	.922	
		Huynh-Feldt	.902	
		Lower-bound	1.804	
	Competence	Sphericity Assumed	.436	
		Greenhouse-Geisser	.481	
		Huynh-Feldt	.469	
		Lower-bound	.873	
	Autonomy	Sphericity Assumed	.547	
		Greenhouse-Geisser	.551	
		Huynh-Feldt	.547	
		Lower-bound	1.093	
	Immersion	Sphericity Assumed	.227	
		Greenhouse-Geisser	.238	
		Huynh-Feldt	.232	
		Lower-bound	.454	
	IntuitiveControls	Sphericity Assumed	.306	
		Greenhouse-Geisser	.324	
		Huynh-Feldt	.315	
		Lower-bound	.612	
	Empathy	Sphericity Assumed	.234	
		Greenhouse-Geisser	.254	
		Huynh-Feldt	.247	
		Lower-bound	.468	

Univariate Tests

Source	Measure		Sig.	Partial Eta Squared
		Huynh-Feldt	.029	.049
		Lower-bound	.061	.049
	RankShockFavourite	Sphericity Assumed	.002	.084
		Greenhouse-Geisser	.003	.084
		Huynh-Feldt	.002	.084
		Lower-bound	.013	.084
	RankBombFavourite	Sphericity Assumed	.023	.052
		Greenhouse-Geisser	.027	.052
		Huynh-Feldt	.026	.052
		Lower-bound	.053	.052
	RankTeleportFavourite	Sphericity Assumed	.006	.070
		Greenhouse-Geisser	.006	.070
		Huynh-Feldt	.006	.070
		Lower-bound	.024	.070
Error(GameMode)	IoSConnected	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	Competence	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	Autonomy	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	Immersion	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	IntuitiveControls	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	Empathy	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		

Univariate Tests

Source	Measure		Type III Sum of Squares	df
	NegativeFeelings	Sphericity Assumed	38.586	142
		Greenhouse-Geisser	38.586	141.698
		Huynh-Feldt	38.586	142.000
		Lower-bound	38.586	71.000
	Engagement	Sphericity Assumed	49.895	142
		Greenhouse-Geisser	49.895	112.342
		Huynh-Feldt	49.895	114.476
		Lower-bound	49.895	71.000
	Interest	Sphericity Assumed	95.724	142
		Greenhouse-Geisser	95.724	121.956
		Huynh-Feldt	95.724	124.690
		Lower-bound	95.724	71.000
	Effort	Sphericity Assumed	86.024	142
		Greenhouse-Geisser	86.024	136.102
		Huynh-Feldt	86.024	139.794
		Lower-bound	86.024	71.000
	Pressure	Sphericity Assumed	76.899	142
		Greenhouse-Geisser	76.899	139.656
		Huynh-Feldt	76.899	142.000
		Lower-bound	76.899	71.000
	ModeRank	Sphericity Assumed	125.417	142
		Greenhouse-Geisser	125.417	135.906
		Huynh-Feldt	125.417	139.583
		Lower-bound	125.417	71.000
	RankHealPowerful	Sphericity Assumed	133.806	142
		Greenhouse-Geisser	133.806	119.289
		Huynh-Feldt	133.806	121.853
		Lower-bound	133.806	71.000
	RankShieldPowerful	Sphericity Assumed	127.917	142
		Greenhouse-Geisser	127.917	138.946
		Huynh-Feldt	127.917	142.000
		Lower-bound	127.917	71.000
	RankShockPowerful	Sphericity Assumed	121.306	142
		Greenhouse-Geisser	121.306	134.493
		Huynh-Feldt	121.306	138.071
		Lower-bound	121.306	71.000
	RankBombPowerful	Sphericity Assumed	121.972	142
		Greenhouse-Geisser	121.972	139.372

Univariate Tests

Source	Measure		Mean Square	F
	NegativeFeelings	Sphericity Assumed	.272	
		Greenhouse-Geisser	.272	
		Huynh-Feldt	.272	
		Lower-bound	.543	
	Engagement	Sphericity Assumed	.351	
		Greenhouse-Geisser	.444	
		Huynh-Feldt	.436	
		Lower-bound	.703	
	Interest	Sphericity Assumed	.674	
		Greenhouse-Geisser	.785	
		Huynh-Feldt	.768	
		Lower-bound	1.348	
	Effort	Sphericity Assumed	.606	
		Greenhouse-Geisser	.632	
		Huynh-Feldt	.615	
		Lower-bound	1.212	
	Pressure	Sphericity Assumed	.542	
		Greenhouse-Geisser	.551	
		Huynh-Feldt	.542	
		Lower-bound	1.083	
	ModeRank	Sphericity Assumed	.883	
		Greenhouse-Geisser	.923	
		Huynh-Feldt	.899	
		Lower-bound	1.766	
	RankHealPowerful	Sphericity Assumed	.942	
		Greenhouse-Geisser	1.122	
		Huynh-Feldt	1.098	
		Lower-bound	1.885	
	RankShieldPowerful	Sphericity Assumed	.901	
		Greenhouse-Geisser	.921	
		Huynh-Feldt	.901	
		Lower-bound	1.802	
	RankShockPowerful	Sphericity Assumed	.854	
		Greenhouse-Geisser	.902	
		Huynh-Feldt	.879	
		Lower-bound	1.709	
	RankBombPowerful	Sphericity Assumed	.859	
		Greenhouse-Geisser	.875	

Univariate Tests

Source	Measure		Sig.	Partial Eta Squared
	NegativeFeelings	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	Engagement	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	Interest	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	Effort	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	Pressure	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	ModeRank	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankHealPowerful	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankShieldPowerful	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankShockPowerful	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankBombPowerful	Sphericity Assumed		
		Greenhouse-Geisser		

Univariate Tests

Source	Measure		Type III Sum of Squares	df
		Huynh-Feldt	121.972	142.000
		Lower-bound	121.972	71.000
	RankTeleportPowerful	Sphericity Assumed	119.306	142
		Greenhouse-Geisser	119.306	141.905
		Huynh-Feldt	119.306	142.000
		Lower-bound	119.306	71.000
	RankHealEaseOfUse	Sphericity Assumed	142.250	142
		Greenhouse-Geisser	142.250	131.673
		Huynh-Feldt	142.250	135.055
		Lower-bound	142.250	71.000
	RankShieldEaseOfUse	Sphericity Assumed	111.806	142
		Greenhouse-Geisser	111.806	139.087
		Huynh-Feldt	111.806	142.000
		Lower-bound	111.806	71.000
	RankShockEaseOfUse	Sphericity Assumed	105.000	142
		Greenhouse-Geisser	105.000	136.825
		Huynh-Feldt	105.000	140.567
		Lower-bound	105.000	71.000
	RankBombEaseOfUse	Sphericity Assumed	107.306	142
		Greenhouse-Geisser	107.306	130.721
		Huynh-Feldt	107.306	134.038
		Lower-bound	107.306	71.000
	RankTeleportEaseOfUse	Sphericity Assumed	109.806	142
		Greenhouse-Geisser	109.806	141.158
		Huynh-Feldt	109.806	142.000
		Lower-bound	109.806	71.000
	RankHealConnected	Sphericity Assumed	143.250	142
		Greenhouse-Geisser	143.250	141.355
		Huynh-Feldt	143.250	142.000
		Lower-bound	143.250	71.000
	RankShieldConnected	Sphericity Assumed	121.306	142
		Greenhouse-Geisser	121.306	141.378
		Huynh-Feldt	121.306	142.000
		Lower-bound	121.306	71.000
	RankShockConnected	Sphericity Assumed	133.972	142
		Greenhouse-Geisser	133.972	124.526
		Huynh-Feldt	133.972	127.428
		Lower-bound	133.972	71.000

Univariate Tests

Source	Measure		Mean Square	F
		Huynh-Feldt	.859	
		Lower-bound	1.718	
	RankTeleportPowerful	Sphericity Assumed	.840	
		Greenhouse-Geisser	.841	
		Huynh-Feldt	.840	
		Lower-bound	1.680	
	RankHealEaseOfUse	Sphericity Assumed	1.002	
		Greenhouse-Geisser	1.080	
		Huynh-Feldt	1.053	
		Lower-bound	2.004	
	RankShieldEaseOfUse	Sphericity Assumed	.787	
		Greenhouse-Geisser	.804	
		Huynh-Feldt	.787	
		Lower-bound	1.575	
	RankShockEaseOfUse	Sphericity Assumed	.739	
		Greenhouse-Geisser	.767	
		Huynh-Feldt	.747	
		Lower-bound	1.479	
	RankBombEaseOfUse	Sphericity Assumed	.756	
		Greenhouse-Geisser	.821	
		Huynh-Feldt	.801	
		Lower-bound	1.511	
	RankTeleportEaseOfUse	Sphericity Assumed	.773	
		Greenhouse-Geisser	.778	
		Huynh-Feldt	.773	
		Lower-bound	1.547	
	RankHealConnected	Sphericity Assumed	1.009	
		Greenhouse-Geisser	1.013	
		Huynh-Feldt	1.009	
		Lower-bound	2.018	
	RankShieldConnected	Sphericity Assumed	.854	
		Greenhouse-Geisser	.858	
		Huynh-Feldt	.854	
		Lower-bound	1.709	
	RankShockConnected	Sphericity Assumed	.943	
		Greenhouse-Geisser	1.076	
		Huynh-Feldt	1.051	
		Lower-bound	1.887	

Univariate Tests

Source	Measure		Sig.	Partial Eta Squared
		Huynh-Feldt		
		Lower-bound		
	RankTeleportPowerful	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankHealEaseOfUse	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankShieldEaseOfUse	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankShockEaseOfUse	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankBombEaseOfUse	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankTeleportEaseOfUse	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankHealConnected	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankShieldConnected	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankShockConnected	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		

Univariate Tests

Source	Measure		Type III Sum of Squares	df
	RankBombConnected	Sphericity Assumed	118.250	142
		Greenhouse-Geisser	118.250	125.092
		Huynh-Feldt	118.250	128.031
		Lower-bound	118.250	71.000
	RankTeleportConnected	Sphericity Assumed	131.139	142
		Greenhouse-Geisser	131.139	138.711
		Huynh-Feldt	131.139	142.000
		Lower-bound	131.139	71.000
	RankHealFavourite	Sphericity Assumed	141.750	142
		Greenhouse-Geisser	141.750	136.582
		Huynh-Feldt	141.750	140.307
		Lower-bound	141.750	71.000
	RankShieldFavourite	Sphericity Assumed	137.000	142
		Greenhouse-Geisser	137.000	141.721
		Huynh-Feldt	137.000	142.000
		Lower-bound	137.000	71.000
	RankShockFavourite	Sphericity Assumed	131.889	142
		Greenhouse-Geisser	131.889	132.060
		Huynh-Feldt	131.889	135.468
		Lower-bound	131.889	71.000
	RankBombFavourite	Sphericity Assumed	136.556	142
		Greenhouse-Geisser	136.556	129.579
		Huynh-Feldt	136.556	132.819
		Lower-bound	136.556	71.000
	RankTeleportFavourite	Sphericity Assumed	133.972	142
		Greenhouse-Geisser	133.972	140.868
		Huynh-Feldt	133.972	142.000
		Lower-bound	133.972	71.000

Univariate Tests

Source	Measure		Mean Square	F
	RankBombConnected	Sphericity Assumed	.833	
		Greenhouse-Geisser	.945	
		Huynh-Feldt	.924	
		Lower-bound	1.665	
	RankTeleportConnected	Sphericity Assumed	.924	
		Greenhouse-Geisser	.945	
		Huynh-Feldt	.924	
		Lower-bound	1.847	
	RankHealFavourite	Sphericity Assumed	.998	
		Greenhouse-Geisser	1.038	
		Huynh-Feldt	1.010	
		Lower-bound	1.996	
	RankShieldFavourite	Sphericity Assumed	.965	
		Greenhouse-Geisser	.967	
		Huynh-Feldt	.965	
		Lower-bound	1.930	
	RankShockFavourite	Sphericity Assumed	.929	
		Greenhouse-Geisser	.999	
		Huynh-Feldt	.974	
		Lower-bound	1.858	
	RankBombFavourite	Sphericity Assumed	.962	
		Greenhouse-Geisser	1.054	
		Huynh-Feldt	1.028	
		Lower-bound	1.923	
	RankTeleportFavourite	Sphericity Assumed	.943	
		Greenhouse-Geisser	.951	
		Huynh-Feldt	.943	
		Lower-bound	1.887	

Univariate Tests

Source	Measure		Sig.	Partial Eta Squared
	RankBombConnected	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankTeleportConnected	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankHealFavourite	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankShieldFavourite	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankShockFavourite	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankBombFavourite	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		
	RankTeleportFavourite	Sphericity Assumed		
		Greenhouse-Geisser		
		Huynh-Feldt		
		Lower-bound		

Tests of Within-Subjects Contrasts

Source	Measure	GameMode	Type III Sum of Squares	df	Mean Square
GameMode	IoSConnected	Linear	10.563	1	10.563
		Quadratic	.021	1	.021
	Competence	Linear	.063	1	.063
		Quadratic	.113	1	.113
	Autonomy	Linear	.012	1	.012
		Quadratic	.593	1	.593
	Immersion	Linear	.117	1	.117
		Quadratic	.303	1	.303
	IntuitiveControls	Linear	.340	1	.340
		Quadratic	1.297	1	1.297
	Empathy	Linear	.527	1	.527
		Quadratic	.295	1	.295
	NegativeFeelings	Linear	.340	1	.340
		Quadratic	.037	1	.037
	Engagement	Linear	4.605	1	4.605
		Quadratic	.771	1	.771
	Interest	Linear	7.228	1	7.228
		Quadratic	.431	1	.431
	Effort	Linear	7.585	1	7.585
		Quadratic	6.392	1	6.392
	Pressure	Linear	1.313	1	1.313
		Quadratic	3.863	1	3.863
	ModeRank	Linear	7.563	1	7.563
		Quadratic	11.021	1	11.021
	RankHealPowerful	Linear	.111	1	.111
		Quadratic	10.083	1	10.083
	RankShieldPowerful	Linear	3.063	1	3.063
		Quadratic	13.021	1	13.021
	RankShockPowerful	Linear	16.674	1	16.674
		Quadratic	6.021	1	6.021
	RankBombPowerful	Linear	10.028	1	10.028
		Quadratic	12.000	1	12.000
	RankTeleportPowerful	Linear	9.507	1	9.507
		Quadratic	15.188	1	15.188
	RankHealEaseOfUse	Linear	.063	1	.063
		Quadratic	1.688	1	1.688
	RankShieldEaseOfUse	Linear	9.507	1	9.507
		Quadratic	22.688	1	22.688

Tests of Within-Subjects Contrasts

Source	Measure	GameMode	F	Sig.	Partial Eta Squared
GameMode	IoSConnected	Linear	10.282	.002	.126
		Quadratic	.027	.870	.000
	Competence	Linear	.110	.741	.002
		Quadratic	.374	.543	.005
	Autonomy	Linear	.022	.881	.000
		Quadratic	1.089	.300	.015
	Immersion	Linear	.426	.516	.006
		Quadratic	1.703	.196	.023
	IntuitiveControls	Linear	1.330	.253	.018
		Quadratic	3.636	.061	.049
	Empathy	Linear	1.751	.190	.024
		Quadratic	1.770	.188	.024
	NegativeFeelings	Linear	1.301	.258	.018
		Quadratic	.131	.718	.002
	Engagement	Linear	10.106	.002	.125
		Quadratic	3.120	.082	.042
	Interest	Linear	7.687	.007	.098
		Quadratic	1.056	.308	.015
	Effort	Linear	12.589	.001	.151
		Quadratic	10.496	.002	.129
	Pressure	Linear	2.300	.134	.031
		Quadratic	7.542	.008	.096
	ModeRank	Linear	7.789	.007	.099
		Quadratic	13.854	.000	.163
	RankHealPowerful	Linear	.088	.768	.001
		Quadratic	16.302	.000	.187
	RankShieldPowerful	Linear	2.961	.090	.040
		Quadratic	16.969	.000	.193
	RankShockPowerful	Linear	17.984	.000	.202
		Quadratic	7.705	.007	.098
	RankBombPowerful	Linear	10.474	.002	.129
		Quadratic	15.778	.000	.182
	RankTeleportPowerful	Linear	11.067	.001	.135
		Quadratic	18.492	.000	.207
	RankHealEaseOfUse	Linear	.050	.823	.001
		Quadratic	2.226	.140	.030
	RankShieldEaseOfUse	Linear	10.548	.002	.129
		Quadratic	33.690	.000	.322

Tests of Within-Subjects Contrasts

Source	Measure	GameMode	Type III Sum of Squares	df	Mean Square
	RankShockEaseOfUse	Linear	36.000	1	36.000
		Quadratic	3.000	1	3.000
	RankBombEaseOfUse	Linear	35.007	1	35.007
		Quadratic	1.688	1	1.688
	RankTeleportEaseOfUse	Linear	16.674	1	16.674
		Quadratic	17.521	1	17.521
	RankHealConnected	Linear	.000	1	.000
		Quadratic	.750	1	.750
	RankShieldConnected	Linear	17.361	1	17.361
		Quadratic	5.333	1	5.333
	RankShockConnected	Linear	9.507	1	9.507
		Quadratic	.521	1	.521
	RankBombConnected	Linear	25.000	1	25.000
		Quadratic	.750	1	.750
	RankTeleportConnected	Linear	12.840	1	12.840
		Quadratic	.021	1	.021
	RankHealFavourite	Linear	.563	1	.563
		Quadratic	1.688	1	1.688
	RankShieldFavourite	Linear	.250	1	.250
		Quadratic	6.750	1	6.750
	RankShockFavourite	Linear	8.028	1	8.028
		Quadratic	4.083	1	4.083
	RankBombFavourite	Linear	.694	1	.694
		Quadratic	6.750	1	6.750
	RankTeleportFavourite	Linear	4.694	1	4.694
		Quadratic	5.333	1	5.333
Error(GameMode)	IoSConnected	Linear	72.938	71	1.027
		Quadratic	55.146	71	.777
	Competence	Linear	40.438	71	.570
		Quadratic	21.535	71	.303
	Autonomy	Linear	38.988	71	.549
		Quadratic	38.630	71	.544
	Immersion	Linear	19.580	71	.276
		Quadratic	12.641	71	.178
	IntuitiveControls	Linear	18.160	71	.256
		Quadratic	25.315	71	.357
	Empathy	Linear	21.381	71	.301
		Quadratic	11.824	71	.167

Tests of Within-Subjects Contrasts

Source	Measure	GameMode	F	Sig.	Partial Eta Squared
	RankShockEaseOfUse	Linear	42.600	.000	.375
		Quadratic	4.733	.033	.063
	RankBombEaseOfUse	Linear	36.288	.000	.338
		Quadratic	3.087	.083	.042
	RankTeleportEaseOfUse	Linear	21.993	.000	.237
		Quadratic	22.222	.000	.238
	RankHealConnected	Linear	.000	1.000	.000
		Quadratic	.780	.380	.011
	RankShieldConnected	Linear	19.369	.000	.214
		Quadratic	6.566	.013	.085
	RankShockConnected	Linear	7.418	.008	.095
		Quadratic	.860	.357	.012
	RankBombConnected	Linear	22.188	.000	.238
		Quadratic	1.392	.242	.019
	RankTeleportConnected	Linear	12.049	.001	.145
		Quadratic	.027	.871	.000
	RankHealFavourite	Linear	.487	.487	.007
		Quadratic	2.003	.161	.027
	RankShieldFavourite	Linear	.258	.613	.004
		Quadratic	7.022	.010	.090
	RankShockFavourite	Linear	7.502	.008	.096
		Quadratic	5.185	.026	.068
	RankBombFavourite	Linear	.552	.460	.008
		Quadratic	10.143	.002	.125
	RankTeleportFavourite	Linear	4.741	.033	.063
		Quadratic	5.948	.017	.077
Error(GameMode)	IoSConnected	Linear			
		Quadratic			
	Competence	Linear			
		Quadratic			
	Autonomy	Linear			
		Quadratic			
	Immersion	Linear			
		Quadratic			
	IntuitiveControls	Linear			
		Quadratic			
	Empathy	Linear			
		Quadratic			

Tests of Within-Subjects Contrasts

Source	Measure	GameMode	Type III Sum of Squares	df	Mean Square
	NegativeFeelings	Linear	18.576	71	.262
		Quadratic	20.009	71	.282
	Engagement	Linear	32.349	71	.456
		Quadratic	17.547	71	.247
	Interest	Linear	66.763	71	.940
		Quadratic	28.961	71	.408
	Effort	Linear	42.781	71	.603
		Quadratic	43.243	71	.609
	Pressure	Linear	40.533	71	.571
		Quadratic	36.366	71	.512
	ModeRank	Linear	68.938	71	.971
		Quadratic	56.479	71	.795
	RankHealPowerful	Linear	89.889	71	1.266
		Quadratic	43.917	71	.619
	RankShieldPowerful	Linear	73.438	71	1.034
		Quadratic	54.479	71	.767
	RankShockPowerful	Linear	65.826	71	.927
		Quadratic	55.479	71	.781
	RankBombPowerful	Linear	67.972	71	.957
		Quadratic	54.000	71	.761
	RankTeleportPowerful	Linear	60.993	71	.859
		Quadratic	58.313	71	.821
	RankHealEaseOfUse	Linear	88.438	71	1.246
		Quadratic	53.813	71	.758
	RankShieldEaseOfUse	Linear	63.993	71	.901
		Quadratic	47.813	71	.673
	RankShockEaseOfUse	Linear	60.000	71	.845
		Quadratic	45.000	71	.634
	RankBombEaseOfUse	Linear	68.493	71	.965
		Quadratic	38.813	71	.547
	RankTeleportEaseOfUse	Linear	53.826	71	.758
		Quadratic	55.979	71	.788
	RankHealConnected	Linear	75.000	71	1.056
		Quadratic	68.250	71	.961
	RankShieldConnected	Linear	63.639	71	.896
		Quadratic	57.667	71	.812
	RankShockConnected	Linear	90.993	71	1.282
		Quadratic	42.979	71	.605

Tests of Within-Subjects Contrasts

Source	Measure	GameMode	F	Sig.	Partial Eta Squared
	NegativeFeelings	Linear			
		Quadratic			
	Engagement	Linear			
		Quadratic			
	Interest	Linear			
		Quadratic			
	Effort	Linear			
		Quadratic			
	Pressure	Linear			
		Quadratic			
	ModeRank	Linear			
		Quadratic			
	RankHealPowerful	Linear			
		Quadratic			
	RankShieldPowerful	Linear			
		Quadratic			
	RankShockPowerful	Linear			
		Quadratic			
	RankBombPowerful	Linear			
		Quadratic			
	RankTeleportPowerful	Linear			
		Quadratic			
	RankHealEaseOfUse	Linear			
		Quadratic			
	RankShieldEaseOfUse	Linear			
		Quadratic			
	RankShockEaseOfUse	Linear			
		Quadratic			
	RankBombEaseOfUse	Linear			
		Quadratic			
	RankTeleportEaseOfUse	Linear			
		Quadratic			
	RankHealConnected	Linear			
		Quadratic			
	RankShieldConnected	Linear			
		Quadratic			
	RankShockConnected	Linear			
		Quadratic			

Tests of Within-Subjects Contrasts

Source	Measure	GameMode	Type III Sum of Squares	df	Mean Square
	RankBombConnected	Linear	80.000	71	1.127
		Quadratic	38.250	71	.539
	RankTeleportConnected	Linear	75.660	71	1.066
		Quadratic	55.479	71	.781
	RankHealFavourite	Linear	81.938	71	1.154
		Quadratic	59.813	71	.842
	RankShieldFavourite	Linear	68.750	71	.968
		Quadratic	68.250	71	.961
	RankShockFavourite	Linear	75.972	71	1.070
		Quadratic	55.917	71	.788
	RankBombFavourite	Linear	89.306	71	1.258
		Quadratic	47.250	71	.665
	RankTeleportFavourite	Linear	70.306	71	.990
		Quadratic	63.667	71	.897

Tests of Within-Subjects Contrasts

Source	Measure	GameMode	F	Sig.	Partial Eta Squared
	RankBombConnected	Linear			
		Quadratic			
	RankTeleportConnected	Linear			
		Quadratic			
	RankHealFavourite	Linear			
		Quadratic			
	RankShieldFavourite	Linear			
		Quadratic			
	RankShockFavourite	Linear			
		Quadratic			
	RankBombFavourite	Linear			
		Quadratic			
	RankTeleportFavourite	Linear			
		Quadratic			

Tests of Between-Subjects Effects

Transformed Variable: Average

Source	Measure	Type III Sum of Squares	df	Mean Square	F
Intercept	IoSConnected	6600.167	1	6600.167	2477.243
	Competence	1380.167	1	1380.167	684.106
	Autonomy	1305.375	1	1305.375	752.405
	Immersion	2721.982	1	2721.982	769.152
	IntuitiveControls	1095.001	1	1095.001	557.092
	Empathy	1208.894	1	1208.894	1165.062
	NegativeFeelings	6037.796	1	6037.796	3088.581
	Engagement	1170.174	1	1170.174	1154.037
	Interest	1731.168	1	1731.168	862.219
	Effort	3026.635	1	3026.635	974.403
	Pressure	5551.549	1	5551.549	1766.354
	ModeRank	864.000	1	864.000	.
	RankHealPowerful	864.000	1	864.000	.
	RankShieldPowerful	864.000	1	864.000	.
	RankShockPowerful	864.000	1	864.000	.
	RankBombPowerful	864.000	1	864.000	.
	RankTeleportPowerful	864.000	1	864.000	.
	RankHealEaseOfUse	864.000	1	864.000	2.158E+18
	RankShieldEaseOfUse	864.000	1	864.000	2.878E+18
	RankShockEaseOfUse	864.000	1	864.000	8.633E+18
	RankBombEaseOfUse	864.000	1	864.000	4.317E+18
	RankTeleportEaseOfUse	864.000	1	864.000	4.317E+18
	RankHealConnected	864.000	1	864.000	.
	RankShieldConnected	864.000	1	864.000	.
	RankShockConnected	864.000	1	864.000	.
	RankBombConnected	864.000	1	864.000	.
	RankTeleportConnected	864.000	1	864.000	8.633E+18
	RankHealFavourite	864.000	1	864.000	.
	RankShieldFavourite	864.000	1	864.000	.
	RankShockFavourite	864.000	1	864.000	2.158E+18
	RankBombFavourite	864.000	1	864.000	.
	RankTeleportFavourite	864.000	1	864.000	.
Error	IoSConnected	189.167	71	2.664	
	Competence	143.241	71	2.017	
	Autonomy	123.181	71	1.735	
	Immersion	251.265	71	3.539	
	IntuitiveControls	139.555	71	1.966	
	Empathy	73.671	71	1.038	

Tests of Between-Subjects Effects

Transformed Variable: Average

Source	Measure	Sig.	Partial Eta Squared
Intercept	IoSConnected	.000	.972
	Competence	.000	.906
	Autonomy	.000	.914
	Immersion	.000	.915
	IntuitiveControls	.000	.887
	Empathy	.000	.943
	NegativeFeelings	.000	.978
	Engagement	.000	.942
	Interest	.000	.924
	Effort	.000	.932
	Pressure	.000	.961
	ModeRank	.	1.000
	RankHealPowerful	.	1.000
	RankShieldPowerful	.	1.000
	RankShockPowerful	.	1.000
	RankBombPowerful	.	1.000
	RankTeleportPowerful	.	1.000
	RankHealEaseOfUse	.000	1.000
	RankShieldEaseOfUse	.000	1.000
	RankShockEaseOfUse	.000	1.000
	RankBombEaseOfUse	.000	1.000
	RankTeleportEaseOfUse	.000	1.000
	RankHealConnected	.	1.000
	RankShieldConnected	.	1.000
	RankShockConnected	.	1.000
	RankBombConnected	.	1.000
	RankTeleportConnected	.000	1.000
	RankHealFavourite	.	1.000
	RankShieldFavourite	.	1.000
	RankShockFavourite	.000	1.000
	RankBombFavourite	.	1.000
	RankTeleportFavourite	.	1.000
Error	IoSConnected		
	Competence		
	Autonomy		
	Immersion		
	IntuitiveControls		
	Empathy		

Tests of Between-Subjects Effects

Transformed Variable: Average

Source	Measure	Type III Sum of Squares	df	Mean Square	F
	NegativeFeelings	138.796	71	1.955	
	Engagement	71.993	71	1.014	
	Interest	142.554	71	2.008	
	Effort	220.536	71	3.106	
	Pressure	223.149	71	3.143	
	ModeRank	.000	71	.000	
	RankHealPowerful	.000	71	.000	
	RankShieldPowerful	.000	71	.000	
	RankShockPowerful	.000	71	.000	
	RankBombPowerful	.000	71	.000	
	RankTeleportPowerful	.000	71	.000	
	RankHealEaseOfUse	1.284E-013	71	1.004E-013	
	RankShieldEaseOfUse	1.213E-013	71	1.003E-013	
	RankShockEaseOfUse	1.071E-013	71	1.001E-013	
	RankBombEaseOfUse	1.142E-013	71	1.002E-013	
	RankTeleportEaseOfUse	1.142E-013	71	1.002E-013	
	RankHealConnected	.000	71	.000	
	RankShieldConnected	.000	71	.000	
	RankShockConnected	.000	71	.000	
	RankBombConnected	.000	71	.000	
	RankTeleportConnected	1.071E-013	71	1.001E-013	
	RankHealFavourite	.000	71	.000	
	RankShieldFavourite	.000	71	.000	
	RankShockFavourite	1.284E-013	71	1.004E-013	
	RankBombFavourite	.000	71	.000	
	RankTeleportFavourite	.000	71	.000	

Tests of Between-Subjects Effects

Transformed Variable: Average

Source	Measure	Sig.	Partial Eta Squared
	NegativeFeelings		
	Engagement		
	Interest		
	Effort		
	Pressure		
	ModeRank		
	RankHealPowerful		
	RankShieldPowerful		
	RankShockPowerful		
	RankBombPowerful		
	RankTeleportPowerful		
	RankHealEaseOfUse		
	RankShieldEaseOfUse		
	RankShockEaseOfUse		
	RankBombEaseOfUse		
	RankTeleportEaseOfUse		
	RankHealConnected		
	RankShieldConnected		
	RankShockConnected		
	RankBombConnected		
	RankTeleportConnected		
	RankHealFavourite		
	RankShieldFavourite		
	RankShockFavourite		
	RankBombFavourite		
	RankTeleportFavourite		

Parameter Estimates

Dependent Variable	Parameter	B	Std. Error	t
IOSConnectedByGame.A: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	Intercept	5.264	.161	32.760
IOSConnectedByGame.B: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	Intercept	5.514	.144	38.294
IOSConnectedByGame.C: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	Intercept	5.806	.125	46.619
CompetenceAvgA	Intercept	2.565	.116	22.107
CompetenceAvgB	Intercept	2.495	.108	23.206
CompetenceAvgC	Intercept	2.523	.123	20.519
AutonomyAvgA	Intercept	2.486	.115	21.629
AutonomyAvgB	Intercept	2.384	.107	22.271
AutonomyAvgC	Intercept	2.505	.121	20.724
ImmersionAvgA	Intercept	3.605	.142	25.353
ImmersionAvgB	Intercept	3.497	.135	25.808
ImmersionAvgC	Intercept	3.548	.130	27.309
IntuitiveControlsAvgA	Intercept	2.148	.108	19.943
IntuitiveControlsAvgB	Intercept	2.361	.109	21.566
IntuitiveControlsAvgC	Intercept	2.245	.111	20.316
EmpathyAvgA	Intercept	2.452	.092	26.784
EmpathyAvgB	Intercept	2.313	.075	30.670
EmpathyAvgC	Intercept	2.331	.083	28.203
NegativeFeelingsAvgA	Intercept	5.248	.100	52.711
NegativeFeelingsAvgB	Intercept	5.269	.119	44.281
NegativeFeelingsAvgC	Intercept	5.345	.103	51.836
EngagementAvgA	Intercept	2.549	.108	23.695
EngagementAvgB	Intercept	2.243	.080	28.039
EngagementAvgC	Intercept	2.191	.077	28.586
InterestAvgA	Intercept	3.087	.147	21.028
InterestAvgB	Intercept	2.768	.112	24.671
InterestAvgC	Intercept	2.639	.112	23.620
EffortAvgA	Intercept	4.094	.146	27.963
EffortAvgB	Intercept	3.500	.135	25.932

Parameter Estimates

Dependent Variable	Parameter	Sig.	95% Confidence Interval	
			Lower Bound	Upper Bound
IOSConnectedByGame.A: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	Intercept	.000	4.943	5.584
IOSConnectedByGame.B: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	Intercept	.000	5.227	5.801
IOSConnectedByGame.C: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	Intercept	.000	5.557	6.054
CompetenceAvgA	Intercept	.000	2.333	2.796
CompetenceAvgB	Intercept	.000	2.281	2.710
CompetenceAvgC	Intercept	.000	2.278	2.768
AutonomyAvgA	Intercept	.000	2.257	2.715
AutonomyAvgB	Intercept	.000	2.171	2.598
AutonomyAvgC	Intercept	.000	2.264	2.746
ImmersionAvgA	Intercept	.000	3.321	3.888
ImmersionAvgB	Intercept	.000	3.227	3.767
ImmersionAvgC	Intercept	.000	3.289	3.807
IntuitiveControlsAvgA	Intercept	.000	1.933	2.363
IntuitiveControlsAvgB	Intercept	.000	2.143	2.579
IntuitiveControlsAvgC	Intercept	.000	2.025	2.466
EmpathyAvgA	Intercept	.000	2.270	2.635
EmpathyAvgB	Intercept	.000	2.163	2.464
EmpathyAvgC	Intercept	.000	2.167	2.496
NegativeFeelingsAvgA	Intercept	.000	5.049	5.446
NegativeFeelingsAvgB	Intercept	.000	5.031	5.506
NegativeFeelingsAvgC	Intercept	.000	5.139	5.551
EngagementAvgA	Intercept	.000	2.334	2.763
EngagementAvgB	Intercept	.000	2.084	2.403
EngagementAvgC	Intercept	.000	2.038	2.344
InterestAvgA	Intercept	.000	2.794	3.379
InterestAvgB	Intercept	.000	2.544	2.992
InterestAvgC	Intercept	.000	2.416	2.861
EffortAvgA	Intercept	.000	3.802	4.386
EffortAvgB	Intercept	.000	3.231	3.769

Parameter Estimates

Dependent Variable	Parameter	Partial Eta Squared
IOSConnectedByGame.A: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	Intercept	.938
IOSConnectedByGame.B: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	Intercept	.954
IOSConnectedByGame.C: Reflecting on your experiences with the version of the game you just completed, select the diagram that best represents how connected the game made you feel with your partner while playing:	Intercept	.968
CompetenceAvgA	Intercept	.873
CompetenceAvgB	Intercept	.884
CompetenceAvgC	Intercept	.856
AutonomyAvgA	Intercept	.868
AutonomyAvgB	Intercept	.875
AutonomyAvgC	Intercept	.858
ImmersionAvgA	Intercept	.901
ImmersionAvgB	Intercept	.904
ImmersionAvgC	Intercept	.913
IntuitiveControlsAvgA	Intercept	.849
IntuitiveControlsAvgB	Intercept	.868
IntuitiveControlsAvgC	Intercept	.853
EmpathyAvgA	Intercept	.910
EmpathyAvgB	Intercept	.930
EmpathyAvgC	Intercept	.918
NegativeFeelingsAvgA	Intercept	.975
NegativeFeelingsAvgB	Intercept	.965
NegativeFeelingsAvgC	Intercept	.974
EngagementAvgA	Intercept	.888
EngagementAvgB	Intercept	.917
EngagementAvgC	Intercept	.920
InterestAvgA	Intercept	.862
InterestAvgB	Intercept	.896
InterestAvgC	Intercept	.887
EffortAvgA	Intercept	.917
EffortAvgB	Intercept	.905

Parameter Estimates

Dependent Variable	Parameter	B	Std. Error	t
EffortAvgC	Intercept	3.635	.143	25.507
PressureAvgA	Intercept	5.260	.131	40.209
PressureAvgB	Intercept	4.881	.156	31.260
PressureAvgC	Intercept	5.069	.131	38.641
ModeARank	Intercept	2.069	.100	20.790
ModeBRank	Intercept	2.319	.086	27.026
ModeCRank	Intercept	1.611	.085	18.909
Rank each version of the Heal ability according to which seemed the most powerful? - A - Injection	Intercept	1.819	.111	16.435
Rank each version of the Heal ability according to which seemed the most powerful? - B - Projector	Intercept	2.306	.076	30.465
Rank each version of the Heal ability according to which seemed the most powerful? - C - Beam	Intercept	1.875	.091	20.717
Rank each version of the Shield ability according to which seemed the most powerful? - A - Orb	Intercept	1.681	.095	17.783
Rank each version of the Shield ability according to which seemed the most powerful? - B - Wall	Intercept	2.347	.084	27.847
Rank each version of the Shield ability according to which seemed the most powerful? - C - Directed	Intercept	1.972	.095	20.803
Rank each version of the Shock ability according to which seemed the most powerful? - A - Projector	Intercept	1.778	.082	21.658
Rank each version of the Shock ability according to which seemed the most powerful? - B - Beam	Intercept	1.764	.085	20.737
Rank each version of the Shock ability according to which seemed the most powerful? - C - Embedded Axe	Intercept	2.458	.099	24.888
Rank each version of the Bomb ability according to which seemed the most powerful? - A - Pre-armed	Intercept	1.569	.095	16.608
Rank each version of the Bomb ability according to which seemed the most powerful? - B - Kirk must arm	Intercept	2.333	.084	27.805
Rank each version of the Bomb ability according to which seemed the most powerful? - C - Hit with axe	Intercept	2.097	.089	23.615
Rank each version of the Teleport ability according to which seemed the most powerful? - A - Scotty clicks once	Intercept	1.556	.088	17.634

Parameter Estimates

Dependent Variable	Parameter	Sig.	95% Confidence Interval	
			Lower Bound	Upper Bound
EffortAvgC	Intercept	.000	3.351	3.920
PressureAvgA	Intercept	.000	4.999	5.521
PressureAvgB	Intercept	.000	4.569	5.192
PressureAvgC	Intercept	.000	4.807	5.330
ModeARank	Intercept	.000	1.871	2.268
ModeBRank	Intercept	.000	2.148	2.491
ModeCRank	Intercept	.000	1.441	1.781
Rank each version of the Heal ability according to which seemed the most powerful? - A - Injection	Intercept	.000	1.599	2.040
Rank each version of the Heal ability according to which seemed the most powerful? - B - Projector	Intercept	.000	2.155	2.456
Rank each version of the Heal ability according to which seemed the most powerful? - C - Beam	Intercept	.000	1.695	2.055
Rank each version of the Shield ability according to which seemed the most powerful? - A - Orb	Intercept	.000	1.492	1.869
Rank each version of the Shield ability according to which seemed the most powerful? - B - Wall	Intercept	.000	2.179	2.515
Rank each version of the Shield ability according to which seemed the most powerful? - C - Directed	Intercept	.000	1.783	2.161
Rank each version of the Shock ability according to which seemed the most powerful? - A - Projector	Intercept	.000	1.614	1.941
Rank each version of the Shock ability according to which seemed the most powerful? - B - Beam	Intercept	.000	1.594	1.933
Rank each version of the Shock ability according to which seemed the most powerful? - C - Embedded Axe	Intercept	.000	2.261	2.655
Rank each version of the Bomb ability according to which seemed the most powerful? - A - Pre-armed	Intercept	.000	1.381	1.758
Rank each version of the Bomb ability according to which seemed the most powerful? - B - Kirk must arm	Intercept	.000	2.166	2.501
Rank each version of the Bomb ability according to which seemed the most powerful? - C - Hit with axe	Intercept	.000	1.920	2.274
Rank each version of the Teleport ability according to which seemed the most powerful? - A - Scotty clicks once	Intercept	.000	1.380	1.731

Parameter Estimates

Dependent Variable	Parameter	Partial Eta Squared
EffortAvgC	Intercept	.902
PressureAvgA	Intercept	.958
PressureAvgB	Intercept	.932
PressureAvgC	Intercept	.955
ModeARank	Intercept	.859
ModeBRank	Intercept	.911
ModeCRank	Intercept	.834
Rank each version of the Heal ability according to which seemed the most powerful? - A - Injection	Intercept	.792
Rank each version of the Heal ability according to which seemed the most powerful? - B - Projector	Intercept	.929
Rank each version of the Heal ability according to which seemed the most powerful? - C - Beam	Intercept	.858
Rank each version of the Shield ability according to which seemed the most powerful? - A - Orb	Intercept	.817
Rank each version of the Shield ability according to which seemed the most powerful? - B - Wall	Intercept	.916
Rank each version of the Shield ability according to which seemed the most powerful? - C - Directed	Intercept	.859
Rank each version of the Shock ability according to which seemed the most powerful? - A - Projector	Intercept	.869
Rank each version of the Shock ability according to which seemed the most powerful? - B - Beam	Intercept	.858
Rank each version of the Shock ability according to which seemed the most powerful? - C - Embedded Axe	Intercept	.897
Rank each version of the Bomb ability according to which seemed the most powerful? - A - Pre-armed	Intercept	.795
Rank each version of the Bomb ability according to which seemed the most powerful? - B - Kirk must arm	Intercept	.916
Rank each version of the Bomb ability according to which seemed the most powerful? - C - Hit with axe	Intercept	.887
Rank each version of the Teleport ability according to which seemed the most powerful? - A - Scotty clicks once	Intercept	.814

Parameter Estimates

Dependent Variable	Parameter	B	Std. Error	t
Rank each version of the Teleport ability according to which seemed the most powerful? - B - Portals	Intercept	2.375	.087	27.235
Rank each version of the Teleport ability according to which seemed the most powerful? - C - Scotty clicks, Kirk confirms	Intercept	2.069	.089	23.206
Rank each version of the Heal ability according to which was the easiest to use? - A - Injection	Intercept	1.958	.107	18.248
Rank each version of the Heal ability according to which was the easiest to use? - B - Projector	Intercept	2.125	.084	25.366
Rank each version of the Heal ability according to which was the easiest to use? - C - Beam	Intercept	1.917	.096	19.884
Rank each version of the Shield ability according to which was the easiest to use? - A - Orb	Intercept	1.514	.088	17.117
Rank each version of the Shield ability according to which was the easiest to use? - B - Wall	Intercept	2.458	.079	31.132
Rank each version of the Shield ability according to which was the easiest to use? - C - Directed	Intercept	2.028	.088	22.940
Rank each version of the Shock ability according to which was the easiest to use? - A - Projector	Intercept	1.583	.081	19.559
Rank each version of the Shock ability according to which was the easiest to use? - B - Beam	Intercept	1.833	.077	23.932
Rank each version of the Shock ability according to which was the easiest to use? - C - Embedded Axe	Intercept	2.583	.090	28.672
Rank each version of the Bomb ability according to which was the easiest to use? - A - Pre-Armed	Intercept	1.444	.093	15.609
Rank each version of the Bomb ability according to which was the easiest to use? - B - Kirk must Arm	Intercept	2.125	.071	29.869
Rank each version of the Bomb ability according to which was the easiest to use? - C - Must hit with Axe	Intercept	2.431	.086	28.321
Rank each version of the Teleport ability according to which was the easiest to use? - A - Scotty clicks once	Intercept	1.458	.081	17.915
Rank each version of the Teleport ability according to which was the easiest to use? - B - Portals	Intercept	2.403	.085	28.122
Rank each version of the Teleport ability according to which was the easiest to use? - C - Scotty clicks, Kirk confirms	Intercept	2.139	.087	24.611
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - A - Injection	Intercept	1.958	.100	19.630

Parameter Estimates

Dependent Variable	Parameter	Sig.	95% Confidence Interval	
			Lower Bound	Upper Bound
Rank each version of the Teleport ability according to which seemed the most powerful? - B - Portals	Intercept	.000	2.201	2.549
Rank each version of the Teleport ability according to which seemed the most powerful? - C - Scotty clicks, Kirk confirms	Intercept	.000	1.892	2.247
Rank each version of the Heal ability according to which was the easiest to use? - A - Injection	Intercept	.000	1.744	2.172
Rank each version of the Heal ability according to which was the easiest to use? - B - Projector	Intercept	.000	1.958	2.292
Rank each version of the Heal ability according to which was the easiest to use? - C - Beam	Intercept	.000	1.724	2.109
Rank each version of the Shield ability according to which was the easiest to use? - A - Orb	Intercept	.000	1.338	1.690
Rank each version of the Shield ability according to which was the easiest to use? - B - Wall	Intercept	.000	2.301	2.616
Rank each version of the Shield ability according to which was the easiest to use? - C - Directed	Intercept	.000	1.852	2.204
Rank each version of the Shock ability according to which was the easiest to use? - A - Projector	Intercept	.000	1.422	1.745
Rank each version of the Shock ability according to which was the easiest to use? - B - Beam	Intercept	.000	1.681	1.986
Rank each version of the Shock ability according to which was the easiest to use? - C - Embedded Axe	Intercept	.000	2.404	2.763
Rank each version of the Bomb ability according to which was the easiest to use? - A - Pre-Armed	Intercept	.000	1.260	1.629
Rank each version of the Bomb ability according to which was the easiest to use? - B - Kirk must Arm	Intercept	.000	1.983	2.267
Rank each version of the Bomb ability according to which was the easiest to use? - C - Must hit with Axe	Intercept	.000	2.259	2.602
Rank each version of the Teleport ability according to which was the easiest to use? - A - Scotty clicks once	Intercept	.000	1.296	1.621
Rank each version of the Teleport ability according to which was the easiest to use? - B - Portals	Intercept	.000	2.232	2.573
Rank each version of the Teleport ability according to which was the easiest to use? - C - Scotty clicks, Kirk confirms	Intercept	.000	1.966	2.312
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - A - Injection	Intercept	.000	1.759	2.157

Parameter Estimates

Dependent Variable	Parameter	Partial Eta Squared
Rank each version of the Teleport ability according to which seemed the most powerful? - B - Portals	Intercept	.913
Rank each version of the Teleport ability according to which seemed the most powerful? - C - Scotty clicks, Kirk confirms	Intercept	.884
Rank each version of the Heal ability according to which was the easiest to use? - A - Injection	Intercept	.824
Rank each version of the Heal ability according to which was the easiest to use? - B - Projector	Intercept	.901
Rank each version of the Heal ability according to which was the easiest to use? - C - Beam	Intercept	.848
Rank each version of the Shield ability according to which was the easiest to use? - A - Orb	Intercept	.805
Rank each version of the Shield ability according to which was the easiest to use? - B - Wall	Intercept	.932
Rank each version of the Shield ability according to which was the easiest to use? - C - Directed	Intercept	.881
Rank each version of the Shock ability according to which was the easiest to use? - A - Projector	Intercept	.843
Rank each version of the Shock ability according to which was the easiest to use? - B - Beam	Intercept	.890
Rank each version of the Shock ability according to which was the easiest to use? - C - Embedded Axe	Intercept	.920
Rank each version of the Bomb ability according to which was the easiest to use? - A - Pre-Armed	Intercept	.774
Rank each version of the Bomb ability according to which was the easiest to use? - B - Kirk must Arm	Intercept	.926
Rank each version of the Bomb ability according to which was the easiest to use? - C - Must hit with Axe	Intercept	.919
Rank each version of the Teleport ability according to which was the easiest to use? - A - Scotty clicks once	Intercept	.819
Rank each version of the Teleport ability according to which was the easiest to use? - B - Portals	Intercept	.918
Rank each version of the Teleport ability according to which was the easiest to use? - C - Scotty clicks, Kirk confirms	Intercept	.895
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - A - Injection	Intercept	.844

Parameter Estimates

Dependent Variable	Parameter	B	Std. Error	t
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - B - Projector	Intercept	2.083	.094	22.083
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - C - Beam	Intercept	1.958	.096	20.451
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - A - Orb	Intercept	2.236	.092	24.385
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - B - Wall	Intercept	2.222	.087	25.625
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - C - Directed	Intercept	1.542	.088	17.456
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - A - Projector	Intercept	2.222	.097	22.828
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - B - Beam	Intercept	2.069	.075	27.642
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - C - Embedded Axe	Intercept	1.708	.105	16.196
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - A - Pre-Armed	Intercept	2.458	.099	24.888
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - B - Kirk must arm	Intercept	1.917	.071	27.138
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - C - Must hit with Axe	Intercept	1.625	.092	17.744
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - A - Scotty clicks once	Intercept	2.292	.096	23.932
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - B - Portals	Intercept	2.014	.085	23.676
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - C - Scotty clicks, Kirk confirms	Intercept	1.694	.096	17.620
Rank each version of the Heal ability according to which was your favourite? - A - Injection	Intercept	2.000	.105	19.109

Parameter Estimates

Dependent Variable	Parameter	Sig.	95% Confidence Interval	
			Lower Bound	Upper Bound
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - B - Projector	Intercept	.000	1.895	2.271
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - C - Beam	Intercept	.000	1.767	2.149
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - A - Orb	Intercept	.000	2.053	2.419
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - B - Wall	Intercept	.000	2.049	2.395
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - C - Directed	Intercept	.000	1.366	1.718
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - A - Projector	Intercept	.000	2.028	2.416
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - B - Beam	Intercept	.000	1.920	2.219
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - C - Embedded Axe	Intercept	.000	1.498	1.919
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - A - Pre-Armed	Intercept	.000	2.261	2.655
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - B - Kirk must arm	Intercept	.000	1.776	2.057
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - C - Must hit with Axe	Intercept	.000	1.442	1.808
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - A - Scotty clicks once	Intercept	.000	2.101	2.483
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - B - Portals	Intercept	.000	1.844	2.183
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - C - Scotty clicks, Kirk confirms	Intercept	.000	1.503	1.886
Rank each version of the Heal ability according to which was your favourite? - A - Injection	Intercept	.000	1.791	2.209

Parameter Estimates

Dependent Variable	Parameter	Partial Eta Squared
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - B - Projector	Intercept	.873
Rank each version of the Heal ability according to which made you feel the most connected to your partner? - C - Beam	Intercept	.855
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - A - Orb	Intercept	.893
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - B - Wall	Intercept	.902
Rank each version of the Shield ability according to which made you feel the most connected to your partner? - C - Directed	Intercept	.811
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - A - Projector	Intercept	.880
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - B - Beam	Intercept	.915
Rank each version of the Shock ability according to which made you feel the most connected to your partner? - C - Embedded Axe	Intercept	.787
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - A - Pre-Armed	Intercept	.897
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - B - Kirk must arm	Intercept	.912
Rank each version of the Bomb ability according to which made you feel the most connected to your partner? - C - Must hit with Axe	Intercept	.816
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - A - Scotty clicks once	Intercept	.890
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - B - Portals	Intercept	.888
Rank each version of the Teleport ability according to which made you feel the most connected to your partner? - C - Scotty clicks, Kirk confirms	Intercept	.814
Rank each version of the Heal ability according to which was your favourite? - A - Injection	Intercept	.837

Parameter Estimates

Dependent Variable	Parameter	B	Std. Error	t
Rank each version of the Heal ability according to which was your favourite? - B - Projector	Intercept	2.125	.088	24.060
Rank each version of the Heal ability according to which was your favourite? - C - Beam	Intercept	1.875	.095	19.793
Rank each version of the Shield ability according to which was your favourite? - A - Orb	Intercept	1.917	.096	19.884
Rank each version of the Shield ability according to which was your favourite? - B - Wall	Intercept	2.250	.094	23.849
Rank each version of the Shield ability according to which was your favourite? - C - Directed	Intercept	1.833	.093	19.761
Rank each version of the Shock ability according to which was your favourite? - A - Projector	Intercept	1.861	.087	21.415
Rank each version of the Shock ability according to which was your favourite? - B - Beam	Intercept	1.806	.085	21.144
Rank each version of the Shock ability according to which was your favourite? - C - Embedded axe	Intercept	2.333	.105	22.293
Rank each version of the Bomb ability according to which was your favourite? - A - Pre-Armed	Intercept	1.806	.100	18.028
Rank each version of the Bomb ability according to which was your favourite? - B - Kirk must arm	Intercept	2.250	.078	28.663
Rank each version of the Bomb ability according to which was your favourite? - C - Must hit with axe	Intercept	1.944	.103	18.958
Rank each version of the Teleport ability according to which was your favourite? - A - Scotty clicks once	Intercept	1.708	.092	18.654
Rank each version of the Teleport ability according to which was your favourite? - B - Portals	Intercept	2.222	.091	24.388
Rank each version of the Teleport ability according to which was your favourite? - C - Scotty clicks, Kirk confirms	Intercept	2.069	.098	21.213

Parameter Estimates

Dependent Variable	Parameter	Sig.	95% Confidence Interval	
			Lower Bound	Upper Bound
Rank each version of the Heal ability according to which was your favourite? - B - Projector	Intercept	.000	1.949	2.301
Rank each version of the Heal ability according to which was your favourite? - C - Beam	Intercept	.000	1.686	2.064
Rank each version of the Shield ability according to which was your favourite? - A - Orb	Intercept	.000	1.724	2.109
Rank each version of the Shield ability according to which was your favourite? - B - Wall	Intercept	.000	2.062	2.438
Rank each version of the Shield ability according to which was your favourite? - C - Directed	Intercept	.000	1.648	2.018
Rank each version of the Shock ability according to which was your favourite? - A - Projector	Intercept	.000	1.688	2.034
Rank each version of the Shock ability according to which was your favourite? - B - Beam	Intercept	.000	1.635	1.976
Rank each version of the Shock ability according to which was your favourite? - C - Embedded axe	Intercept	.000	2.125	2.542
Rank each version of the Bomb ability according to which was your favourite? - A - Pre-Armed	Intercept	.000	1.606	2.005
Rank each version of the Bomb ability according to which was your favourite? - B - Kirk must arm	Intercept	.000	2.093	2.407
Rank each version of the Bomb ability according to which was your favourite? - C - Must hit with axe	Intercept	.000	1.740	2.149
Rank each version of the Teleport ability according to which was your favourite? - A - Scotty clicks once	Intercept	.000	1.526	1.891
Rank each version of the Teleport ability according to which was your favourite? - B - Portals	Intercept	.000	2.041	2.404
Rank each version of the Teleport ability according to which was your favourite? - C - Scotty clicks, Kirk confirms	Intercept	.000	1.875	2.264

Parameter Estimates

Dependent Variable	Parameter	Partial Eta Squared
Rank each version of the Heal ability according to which was your favourite? - B - Projector	Intercept	.891
Rank each version of the Heal ability according to which was your favourite? - C - Beam	Intercept	.847
Rank each version of the Shield ability according to which was your favourite? - A - Orb	Intercept	.848
Rank each version of the Shield ability according to which was your favourite? - B - Wall	Intercept	.889
Rank each version of the Shield ability according to which was your favourite? - C - Directed	Intercept	.846
Rank each version of the Shock ability according to which was your favourite? - A - Projector	Intercept	.866
Rank each version of the Shock ability according to which was your favourite? - B - Beam	Intercept	.863
Rank each version of the Shock ability according to which was your favourite? - C - Embedded axe	Intercept	.875
Rank each version of the Bomb ability according to which was your favourite? - A - Pre-Armed	Intercept	.821
Rank each version of the Bomb ability according to which was your favourite? - B - Kirk must arm	Intercept	.920
Rank each version of the Bomb ability according to which was your favourite? - C - Must hit with axe	Intercept	.835
Rank each version of the Teleport ability according to which was your favourite? - A - Scotty clicks once	Intercept	.831
Rank each version of the Teleport ability according to which was your favourite? - B - Portals	Intercept	.893
Rank each version of the Teleport ability according to which was your favourite? - C - Scotty clicks, Kirk confirms	Intercept	.864

Estimated Marginal Means

GameMode

Estimates

Measure	GameMode	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
IoSConnected	1	5.264	.161	4.943	5.584
	2	5.514	.144	5.227	5.801
	3	5.806	.125	5.557	6.054
Competence	1	2.565	.116	2.333	2.796
	2	2.495	.108	2.281	2.710
	3	2.523	.123	2.278	2.768
Autonomy	1	2.486	.115	2.257	2.715
	2	2.384	.107	2.171	2.598
	3	2.505	.121	2.264	2.746
Immersion	1	3.605	.142	3.321	3.888
	2	3.497	.135	3.227	3.767
	3	3.548	.130	3.289	3.807
IntuitiveControls	1	2.148	.108	1.933	2.363
	2	2.361	.109	2.143	2.579
	3	2.245	.111	2.025	2.466
Empathy	1	2.452	.092	2.270	2.635
	2	2.313	.075	2.163	2.464
	3	2.331	.083	2.167	2.496
NegativeFeelings	1	5.248	.100	5.049	5.446
	2	5.269	.119	5.031	5.506
	3	5.345	.103	5.139	5.551
Engagement	1	2.549	.108	2.334	2.763
	2	2.243	.080	2.084	2.403
	3	2.191	.077	2.038	2.344
Interest	1	3.087	.147	2.794	3.379
	2	2.768	.112	2.544	2.992
	3	2.639	.112	2.416	2.861
Effort	1	4.094	.146	3.802	4.386
	2	3.500	.135	3.231	3.769
	3	3.635	.143	3.351	3.920
Pressure	1	5.260	.131	4.999	5.521
	2	4.881	.156	4.569	5.192
	3	5.069	.131	4.807	5.330
ModeRank	1	2.069	.100	1.871	2.268
	2	2.319	.086	2.148	2.491
	3	1.611	.085	1.441	1.781

Estimates

Measure	GameMode	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
RankHealPowerful	1	1.819	.111	1.599	2.040
	2	2.306	.076	2.155	2.456
	3	1.875	.091	1.695	2.055
RankShieldPowerful	1	1.681	.095	1.492	1.869
	2	2.347	.084	2.179	2.515
	3	1.972	.095	1.783	2.161
RankShockPowerful	1	1.778	.082	1.614	1.941
	2	1.764	.085	1.594	1.933
	3	2.458	.099	2.261	2.655
RankBombPowerful	1	1.569	.095	1.381	1.758
	2	2.333	.084	2.166	2.501
	3	2.097	.089	1.920	2.274
RankTeleportPowerful	1	1.556	.088	1.380	1.731
	2	2.375	.087	2.201	2.549
	3	2.069	.089	1.892	2.247
RankHealEaseOfUse	1	1.958	.107	1.744	2.172
	2	2.125	.084	1.958	2.292
	3	1.917	.096	1.724	2.109
RankShieldEaseOfUse	1	1.514	.088	1.338	1.690
	2	2.458	.079	2.301	2.616
	3	2.028	.088	1.852	2.204
RankShockEaseOfUse	1	1.583	.081	1.422	1.745
	2	1.833	.077	1.681	1.986
	3	2.583	.090	2.404	2.763
RankBombEaseOfUse	1	1.444	.093	1.260	1.629
	2	2.125	.071	1.983	2.267
	3	2.431	.086	2.259	2.602
RankTeleportEaseOfUse	1	1.458	.081	1.296	1.621
	2	2.403	.085	2.232	2.573
	3	2.139	.087	1.966	2.312
RankHealConnected	1	1.958	.100	1.759	2.157
	2	2.083	.094	1.895	2.271
	3	1.958	.096	1.767	2.149
RankShieldConnected	1	2.236	.092	2.053	2.419
	2	2.222	.087	2.049	2.395
	3	1.542	.088	1.366	1.718

Estimates

Measure	GameMode	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
RankShockConnected	1	2.222	.097	2.028	2.416
	2	2.069	.075	1.920	2.219
	3	1.708	.105	1.498	1.919
RankBombConnected	1	2.458	.099	2.261	2.655
	2	1.917	.071	1.776	2.057
	3	1.625	.092	1.442	1.808
RankTeleportConnected	1	2.292	.096	2.101	2.483
	2	2.014	.085	1.844	2.183
	3	1.694	.096	1.503	1.886
RankHealFavourite	1	2.000	.105	1.791	2.209
	2	2.125	.088	1.949	2.301
	3	1.875	.095	1.686	2.064
RankShieldFavourite	1	1.917	.096	1.724	2.109
	2	2.250	.094	2.062	2.438
	3	1.833	.093	1.648	2.018
RankShockFavourite	1	1.861	.087	1.688	2.034
	2	1.806	.085	1.635	1.976
	3	2.333	.105	2.125	2.542
RankBombFavourite	1	1.806	.100	1.606	2.005
	2	2.250	.078	2.093	2.407
	3	1.944	.103	1.740	2.149
RankTeleportFavourite	1	1.708	.092	1.526	1.891
	2	2.222	.091	2.041	2.404
	3	2.069	.098	1.875	2.264

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	Mean Difference (I-J)	Std. Error	Sig.[b]
IoSConnected	1	2	-.250	.157	.115
		3	-.542*	.169	.002
	2	1	.250	.157	.115
		3	-.292	.149	.054
	3	1	.542*	.169	.002
		2	.292	.149	.054
Competence	1	2	.069	.096	.474
		3	.042	.126	.741
	2	1	-.069	.096	.474
		3	-.028	.106	.794
	3	1	-.042	.126	.741
		2	.028	.106	.794
Autonomy	1	2	.102	.118	.393
		3	-.019	.124	.881
	2	1	-.102	.118	.393
		3	-.120	.128	.349
	3	1	.019	.124	.881
		2	.120	.128	.349
Immersion	1	2	.108	.077	.165
		3	.057	.088	.516
	2	1	-.108	.077	.165
		3	-.051	.073	.487
	3	1	-.057	.088	.516
		2	.051	.073	.487
IntuitiveControls	1	2	-.213*	.102	.041
		3	-.097	.084	.253
	2	1	.213*	.102	.041
		3	.116	.089	.198
	3	1	.097	.084	.253
		2	-.116	.089	.198
Empathy	1	2	.139	.076	.072
		3	.121	.091	.190
	2	1	-.139	.076	.072
		3	-.018	.073	.808
	3	1	-.121	.091	.190
		2	.018	.073	.808

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	95% Confidence Interval for Difference[b] Lower Bound	95% Confidence Interval for Difference[b] Upper Bound
IoSConnected	1	2	-.562	.062
		3	-.878	-.205
	2	1	-.062	.562
		3	-.588	.005
	3	1	.205	.878
		2	-.005	.588
Competence	1	2	-.123	.262
		3	-.209	.292
	2	1	-.262	.123
		3	-.239	.184
	3	1	-.292	.209
		2	-.184	.239
Autonomy	1	2	-.134	.338
		3	-.265	.228
	2	1	-.338	.134
		3	-.375	.134
	3	1	-.228	.265
		2	-.134	.375
Immersion	1	2	-.045	.262
		3	-.117	.232
	2	1	-.262	.045
		3	-.196	.095
	3	1	-.232	.117
		2	-.095	.196
IntuitiveControls	1	2	-.417	-.009
		3	-.265	.071
	2	1	.009	.417
		3	-.062	.293
	3	1	-.071	.265
		2	-.293	.062
Empathy	1	2	-.013	.291
		3	-.061	.303
	2	1	-.291	.013
		3	-.163	.128
	3	1	-.303	.061
		2	-.128	.163

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	Mean Difference (I-J)	Std. Error	Sig.[b]
NegativeFeelings	1	2	-.021	.087	.811
		3	-.097	.085	.258
	2	1	.021	.087	.811
		3	-.076	.089	.392
	3	1	.097	.085	.258
		2	.076	.089	.392
Engagement	1	2	.306*	.109	.006
		3	.358*	.112	.002
	2	1	-.306*	.109	.006
		3	.052	.069	.453
	3	1	-.358*	.112	.002
		2	-.052	.069	.453
Interest	1	2	.319*	.129	.015
		3	.448*	.162	.007
	2	1	-.319*	.129	.015
		3	.129	.116	.270
	3	1	-.448*	.162	.007
		2	-.129	.116	.270
Effort	1	2	.594*	.141	.000
		3	.459*	.129	.001
	2	1	-.594*	.141	.000
		3	-.135	.118	.254
	3	1	-.459*	.129	.001
		2	.135	.118	.254
Pressure	1	2	.379*	.114	.001
		3	.191	.126	.134
	2	1	-.379*	.114	.001
		3	-.188	.127	.143
	3	1	-.191	.126	.134
		2	.188	.127	.143
ModeRank	1	2	-.250	.165	.135
		3	.458*	.164	.007
	2	1	.250	.165	.135
		3	.708*	.139	.000
	3	1	-.458*	.164	.007
		2	-.708*	.139	.000

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	95% Confidence Interval for Difference[b]	
			Lower Bound	Upper Bound
NegativeFeelings	1	2	-.194	.152
		3	-.267	.073
	2	1	-.152	.194
		3	-.253	.100
	3	1	-.073	.267
		2	-.100	.253
Engagement	1	2	.088	.523
		3	.133	.582
	2	1	-.523	-.088
		3	-.086	.190
	3	1	-.582	-.133
		2	-.190	.086
Interest	1	2	.063	.575
		3	.126	.770
	2	1	-.575	-.063
		3	-.103	.361
	3	1	-.770	-.126
		2	-.361	.103
Effort	1	2	.313	.876
		3	.201	.717
	2	1	-.876	-.313
		3	-.370	.099
	3	1	-.717	-.201
		2	-.099	.370
Pressure	1	2	.151	.607
		3	-.060	.442
	2	1	-.607	-.151
		3	-.442	.065
	3	1	-.442	.060
		2	-.065	.442
ModeRank	1	2	-.579	.079
		3	.131	.786
	2	1	-.079	.579
		3	.431	.986
	3	1	-.786	-.131
		2	-.986	-.431

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	Mean Difference (I-J)	Std. Error	Sig.[b]
RankHealPowerful	1	2	-.486*	.167	.005
		3	-.056	.188	.768
	2	1	.486*	.167	.005
		3	.431*	.125	.001
	3	1	.056	.188	.768
		2	-.431*	.125	.001
RankShieldPowerful	1	2	-.667*	.152	.000
		3	-.292	.170	.090
	2	1	.667*	.152	.000
		3	.375*	.152	.016
	3	1	.292	.170	.090
		2	-.375*	.152	.016
RankShockPowerful	1	2	.014	.135	.918
		3	-.681*	.160	.000
	2	1	-.014	.135	.918
		3	-.694*	.165	.000
	3	1	.681*	.160	.000
		2	.694*	.165	.000
RankBombPowerful	1	2	-.764*	.155	.000
		3	-.528*	.163	.002
	2	1	.764*	.155	.000
		3	.236	.145	.107
	3	1	.528*	.163	.002
		2	-.236	.145	.107
RankTeleportPowerful	1	2	-.819*	.151	.000
		3	-.514*	.154	.001
	2	1	.819*	.151	.000
		3	.306*	.153	.049
	3	1	.514*	.154	.001
		2	-.306*	.153	.049
RankHealEaseOfUse	1	2	-.167	.167	.321
		3	.042	.186	.823
	2	1	.167	.167	.321
		3	.208	.145	.156
	3	1	-.042	.186	.823
		2	-.208	.145	.156

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	95% Confidence Interval for Difference[b]	
			Lower Bound	Upper Bound
RankHealPowerful	1	2	-.818	-.154
		3	-.429	.318
	2	1	.154	.818
		3	.182	.679
	3	1	-.318	.429
		2	-.679	-.182
RankShieldPowerful	1	2	-.970	-.364
		3	-.630	.046
	2	1	.364	.970
		3	.071	.679
	3	1	-.046	.630
		2	-.679	-.071
RankShockPowerful	1	2	-.255	.283
		3	-1.001	-.361
	2	1	-.283	.255
		3	-1.024	-.365
	3	1	.361	1.001
		2	.365	1.024
RankBombPowerful	1	2	-1.073	-.455
		3	-.853	-.203
	2	1	.455	1.073
		3	-.052	.525
	3	1	.203	.853
		2	-.525	.052
RankTeleportPowerful	1	2	-1.121	-.518
		3	-.822	-.206
	2	1	.518	1.121
		3	.001	.610
	3	1	.206	.822
		2	-.610	-.001
RankHealEaseOfUse	1	2	-.499	.166
		3	-.329	.413
	2	1	-.166	.499
		3	-.081	.498
	3	1	-.413	.329
		2	-.498	.081

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	Mean Difference (I-J)	Std. Error	Sig.[b]
RankShieldEaseOfUse	1	2	-.944*	.142	.000
		3	-.514*	.158	.002
	2	1	.944*	.142	.000
		3	.431*	.142	.003
	3	1	.514*	.158	.002
		2	-.431*	.142	.003
RankShockEaseOfUse	1	2	-.250	.129	.057
		3	-1.000*	.153	.000
	2	1	.250	.129	.057
		3	-.750*	.146	.000
	3	1	1.000*	.153	.000
		2	.750*	.146	.000
RankBombEaseOfUse	1	2	-.681*	.141	.000
		3	-.986*	.164	.000
	2	1	.681*	.141	.000
		3	-.306*	.128	.019
	3	1	.986*	.164	.000
		2	.306*	.128	.019
RankTeleportEaseOfUse	1	2	-.944*	.142	.000
		3	-.681*	.145	.000
	2	1	.944*	.142	.000
		3	.264	.152	.087
	3	1	.681*	.145	.000
		2	-.264	.152	.087
RankHealConnected	1	2	-.125	.169	.462
		3	.000	.171	1.000
	2	1	.125	.169	.462
		3	.125	.162	.442
	3	1	.000	.171	1.000
		2	-.125	.162	.442
RankShieldConnected	1	2	.014	.155	.929
		3	.694*	.158	.000
	2	1	-.014	.155	.929
		3	.681*	.149	.000
	3	1	-.694*	.158	.000
		2	-.681*	.149	.000

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
RankShieldEaseOfUse	1	2	-1.229	-.660
		3	-.829	-.198
	2	1	.660	1.229
		3	.147	.714
	3	1	.198	.829
		2	-.714	-.147
RankShockEaseOfUse	1	2	-.508	.008
		3	-1.305	-.695
	2	1	-.008	.508
		3	-1.042	-.458
	3	1	.695	1.305
		2	.458	1.042
RankBombEaseOfUse	1	2	-.962	-.399
		3	-1.313	-.660
	2	1	.399	.962
		3	-.560	-.051
	3	1	.660	1.313
		2	.051	.560
RankTeleportEaseOfUse	1	2	-1.229	-.660
		3	-.970	-.391
	2	1	.660	1.229
		3	-.039	.567
	3	1	.391	.970
		2	-.567	.039
RankHealConnected	1	2	-.462	.212
		3	-.342	.342
	2	1	-.212	.462
		3	-.198	.448
	3	1	-.342	.342
		2	-.448	.198
RankShieldConnected	1	2	-.295	.323
		3	.380	1.009
	2	1	-.323	.295
		3	.383	.978
	3	1	-1.009	-.380
		2	-.978	-.383

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	Mean Difference (I-J)	Std. Error	Sig.[b]
RankShockConnected	1	2	.153	.138	.272
		3	.514*	.189	.008
	2	1	-.153	.138	.272
		3	.361*	.155	.023
	3	1	-.514*	.189	.008
		2	-.361*	.155	.023
RankBombConnected	1	2	.542*	.145	.000
		3	.833*	.177	.000
	2	1	-.542*	.145	.000
		3	.292*	.130	.028
	3	1	-.833*	.177	.000
		2	-.292*	.130	.028
RankTeleportConnected	1	2	.278	.153	.075
		3	.597*	.172	.001
	2	1	-.278	.153	.075
		3	.319*	.154	.042
	3	1	-.597*	.172	.001
		2	-.319*	.154	.042
RankHealFavourite	1	2	-.125	.169	.462
		3	.125	.179	.487
	2	1	.125	.169	.462
		3	.250	.150	.101
	3	1	-.125	.179	.487
		2	-.250	.150	.101
RankShieldFavourite	1	2	-.333*	.167	.049
		3	.083	.164	.613
	2	1	.333*	.167	.049
		3	.417*	.160	.011
	3	1	-.083	.164	.613
		2	-.417*	.160	.011
RankShockFavourite	1	2	.056	.137	.686
		3	-.472*	.172	.008
	2	1	-.056	.137	.686
		3	-.528*	.170	.003
	3	1	.472*	.172	.008
		2	.528*	.170	.003

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
RankShockConnected	1	2	-.122	.428
		3	.138	.890
	2	1	-.428	.122
		3	.052	.670
	3	1	-.890	-.138
		2	-.670	-.052
RankBombConnected	1	2	.252	.831
		3	.481	1.186
	2	1	-.831	-.252
		3	.032	.552
	3	1	-1.186	-.481
		2	-.552	-.032
RankTeleportConnected	1	2	-.028	.584
		3	.254	.940
	2	1	-.584	.028
		3	.012	.627
	3	1	-.940	-.254
		2	-.627	-.012
RankHealFavourite	1	2	-.462	.212
		3	-.232	.482
	2	1	-.212	.462
		3	-.050	.550
	3	1	-.482	.232
		2	-.550	.050
RankShieldFavourite	1	2	-.666	-.001
		3	-.244	.410
	2	1	.001	.666
		3	.097	.736
	3	1	-.410	.244
		2	-.736	-.097
RankShockFavourite	1	2	-.217	.328
		3	-.816	-.128
	2	1	-.328	.217
		3	-.867	-.189
	3	1	.128	.816
		2	.189	.867

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	Mean Difference (I-J)	Std. Error	Sig.[b]
RankBombFavourite	1	2	-.444*	.148	.004
		3	-.139	.187	.460
	2	1	.444*	.148	.004
		3	.306*	.153	.049
	3	1	.139	.187	.460
		2	-.306*	.153	.049
RankTeleportFavourite	1	2	-.514*	.154	.001
		3	-.361*	.166	.033
	2	1	.514*	.154	.001
		3	.153	.165	.358
	3	1	.361*	.166	.033
		2	-.153	.165	.358

Pairwise Comparisons

Measure	(I) GameMode	(J) GameMode	95% Confidence Interval for Difference[b]	
			Lower Bound	Upper Bound
RankBombFavourite	1	2	-.739	-.150
		3	-.512	.234
	2	1	.150	.739
		3	.001	.610
	3	1	-.234	.512
		2	-.610	-.001
RankTeleportFavourite	1	2	-.822	-.206
		3	-.692	-.030
	2	1	.206	.822
		3	-.176	.482
	3	1	.030	.692
		2	-.482	.176

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	.939	1.917[a]	64.000	8.000	.164	.939
Wilks' lambda	.061	1.917[a]	64.000	8.000	.164	.939
Hotelling's trace	15.334	1.917[a]	64.000	8.000	.164	.939
Roy's largest root	15.334	1.917[a]	64.000	8.000	.164	.939

Each F tests the multivariate effect of GameMode. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic