BALANCING ACT: THE EFFECT OF DYNAMIC DIFFICULTY ADJUSTMENT IN COMPETITIVE MULTIPLAYER VIDEO GAMES

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B. Games & Interactive Entertainment, Honours (IT).

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Submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy

School of Electrical Engineering and Computer Science
Faculty of Science and Engineering
Queensland University of Technology

2016

Keywords

Challenge; Competitive; Dynamic difficulty adjustment; Game design; Intrinsic motivation; Multiplayer; Player balancing; Player experience; Self-determination theory; Video games

Abstract

Unbalanced challenge is an issue in video games that can have negative effects on enjoyment and the player experience. Theories of optimal experience such as Flow and intrinsic motivation such as Self-Determination Theory agree that a match between user skill and task difficulty are important for improving the user's experience. Research into singleplayer games has demonstrated methods such as Dynamic Difficulty Adjustment (DDA) that balance challenge in response to real-time player performance can have a positive effect on the player experience. However, such methods cannot be directly applied to the context of competitive multiplayer games due to the generation of challenge through player vs player conflict.

This thesis has investigated the largely unexplored area of Multiplayer Dynamic Difficulty Adjustment (MDDA); game features that attempt to directly manipulate the performance of certain players to balance differently skilled players in a multiplayer match. Through a formal review of MDDA features in existing commercial competitive multiplayer games, a framework of MDDA "instances" was created to allow the classification of differing designs and implementations of MDDA. This was further validated using a combination of interviews and an online survey which gave insight into player values of MDDA as well as highlighting player awareness of MDDA as an area in need of further examination.

Two experiments were conducted to test the effect of MDDA designed to assist low-performing players as well as the influence of awareness on performance and the player experience. These revealed MDDA to be effective at balancing performance but its presence not a guarantee of improved experience. However, awareness of MDDA was found to improve aspects of the player experience such as competence and flow and affect the performance of assisted low-performing players. Collectively, these studies have provided a much better understanding of MDDA and awareness with industry-relevant applications and contributions to better inform the design of MDDA for optimal experience.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

DDA: Dynamic Difficulty Adjustment

EDA: Electrodermal Activity

FPS: First-Person Shooter (game genre)

FSS: Flow State Scales

GEQ: Game Experience Questionnaire

IMI: Intrinsic Motivation Inventory

MDDA: Multiplayer Dynamic Difficulty Adjustment

PENS: Player Experience of Needs Satisfaction

SDT: Self-Determination Theory

UT3: Unreal Tournament 3 (game)

List of Publications

Baldwin, A., Johnson, D., Wyeth, P., & Sweetser, P. (2013). **A framework of dynamic difficulty adjustment in competitive multiplayer video games**. IEEE Consumer Electronics Society's International Games Innovations Conference, IGIC, 16–19. doi:10.1109/IGIC.2013.6659150

Baldwin, A., Johnson, D., & Wyeth, P. a. (2014). **The effect of multiplayer dynamic difficulty adjustment on the player experience of video games**. Proceedings of the Extended Abstracts of the 32nd Annual ACM Conference on Human Factors in Computing Systems - CHI EA '14, 1489–1494. doi:10.1145/2559206.2581285

Baldwin, A., Johnson, D., & Wyeth, P. (2016). **Crowd-Pleaser: Player Perspectives of Multiplayer Dynamic Difficulty Adjustment in Video Games**. In Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play. ACM.

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

QUT Verified Signature

Signature:

Date: 9-12-2016

Acknowledgements

I am first indebted to my primary supervisor Daniel Johnson for his direction and forward momentum over the numerous speed bumps I was so prone to encountering. I am forever grateful for his guidance and unnervingly near-instantaneous responses to emails that ensured I was never lost for too long. I would also like to thank my associate supervisor Peta Wyeth for her assistance and boundless positivity along the way.

I am grateful to the crew of the Games Research and Interaction Design lab at QUT for their both direct and indirect contributions to my research. I am privileged to have had their comradery and friendship throughout my time at QUT.

I would like to thank my parents for their unending support and encouragement over the years, within and outside this thesis.

Finally, I would like to thank the Science and Engineering Faculty and school of Computer Human Interaction at Queensland University of Technology for their support, funding and opportunities through my candidature.

Chapter 1: Introduction

This chapter provides the background (section 1.1), context (section 1.2) and purpose of this research (section 1.3). Following this, the significance and scope of the research are provided (section 1.4) as well as an outline of the remaining chapters of this thesis (section 1.5).

1.1 BACKGROUND

In 2012, nine of out every ten households in Australia had a device used to play games (Jeffery Brand & Todhunter, 2015). Video games have become not just a leading form of entertainment, but also a shared social experience. In 2015, 54% of people who play games at least 3 hours per week in the US will play a multiplayer mode at least weekly, and of those people an average of 6.5 hours will be spent playing online and 5 hours playing with others in-person (Entertainment Software Assotiation, 2015). As access to broadband internet increases, playing and competing with others has become easier than ever before as former barriers such as distance become less important to enabling multiplayer gameplay.

However, with the growth of multiplayer games comes design issues unique to this form of play. Huizinga (1955) characterises play as an agreement between participants for certain activities be to interpreted as playful within the bounds of a game; often referred to as a "magic circle" for which bounds may be more or less clearly defined (Montola, 2005). Widely acknowledged as a key component of optimal experience of games is the necessity for a balance between task difficulty and user skill (Csikszentmihalyi, 1990; E. L. Deci & Ryan, 1985; Ryan, Rigby, & Przybylski, 2006; Sweetser & Wyeth, 2005). Similarly, satisfying player needs for a sense of competence is important for long-term player engagement (Kazakova, Cauberghe, Pandelaere, & De Pelsmacker, 2014). Singleplayer games allow for carefully constructed difficulty curves designed to increase at a rate approximately matched to the typical player's improvement in skill and experience (Salen & Zimmermen, 2003), or provide options such as manually adjustable difficulty settings. However, challenge in competitive multiplayer games is generated through player vs player conflict. This presents an issue for designers as players of differing skill levels compete together with the potential to experience widely varied degrees of challenge.

In a series of interviews with first-person shooter game players, Clarke and Duimering (2006) found the most cited positive elements to playing with other people was for social interaction with friends and the challenge to beat others. However, the most frequently stated negative aspect to playing with others was the issue of mismatched skills as weaker opponents provide little challenge while stronger opponents can result in frustration (Clarke & Duimering, 2006). In these cases, intrinsic motivation can be difficult to optimise as sufficient feelings of competency are not achieved (Przybylski, Rigby, & Ryan, 2010). As feelings of competence and improved intrinsic motivation can lead to an increase in desire to return to an activity (Harackiewicz, Abrahams, & Wageman, 1987), this is an important consideration for entertainment products such as video games. In particular, the retention of players is an important concern for multiplayer video games (Shores, He, Swanenburg, Kraut, & Riedl, 2014) as many of these games shift to "service" business models relying upon long-term player engagement to generate income through optional purchases or in-game advertisements. While methods such as TrueSkill player matchmaking (Herbrich, Minka, & Graepel, 2007) have succeeded in grouping similarly skilled players together to reduce this issue, the requirements for large player populations and restriction to online play limits the contexts in which it can be used.

In singleplayer gameplay, one potential solution to balancing difficulty and player skill has already seen promising research and implementation into successful commercial games. Dynamic Difficulty Adjustment (DDA) is a method whereby the game system will dynamically modify the degree of challenge experienced by players through adjusting game variables such as weapons (Castellano et al., 2009), enemy effectiveness (Olesen, Yannakakis, & Hallam, 2008) or environmental obstacles (Pedersen, Togelius, & Yannakakis, 2009). As the challenge in competitive multiplayer games is sourced from opposing players, these variables are not directly applicable to this context. However, a similar method is already appearing in commercial multiplayer games with one key difference – instead of modifying challenge from game systems, the potential performance of players themselves is adjusted. We refer to this as Multiplayer Dynamic Difficulty Adjustment (MDDA) and have described it as:

> *"A gameplay feature in competitive multiplayer video games designed to reduce the difference in challenge experienced by all players through adjusting the potential performance of certain players."*

Popular competitive multiplayer games such as Call of Duty: Modern Warfare 2 (Infinity Ward, 2009) already make use of these features through implementations such as assisting low-performing players by providing temporary damage resistance or increased movement speed. However, research into MDDA's effects on player experience has only begun in recent years and to date has explored relatively fragmented aspects such as control assistance (S. Bateman, Mandryk, Stach, & Gutwin, 2011) and strength of assistance (Cechanowicz, Gutwin, Bateman, Mandryk, & Stavness, 2014) without a unified foundational understanding of MDDA as a whole. This presents an opportunity for exploratory research to both discover the range of MDDA implementations possible and lay groundwork for research into the specific aspects unique to its context in competitive multiplayer games.

1.2 CONTEXT

Development costs of "triple-A" (blockbuster) video games continue to grow, with development and marketing expenses reaching into the hundreds of millions of dollars (Pitcher, 2014). With skyrocketing budgets come increased risk, and the near-necessity of ensuring a game will be a success even before release. This leads to a fundamental need to understand and optimise the player experience during a game's design, but tight deadlines can limit a developer's ability to explore, research and test all the options.

This research is a contribution towards the goal of improving the understanding of how design affects the player experience and vice versa. As the popularity of competitive multiplayer gameplay continues to grow an increasingly large variety of new players are engaging in multiplayer gameplay. Developers have already demonstrated awareness that an issue exists in unbalanced player performance and implemented a variety of MDDA techniques in multi-million selling franchises and games such as Mario Kart 7 (Nintendo, 2011). However, prior research has yet to classify the variety and effects of these features with most literature focused on game-specific implementations (Hunicke & Chapman, 2004) or specific user cases (S.

Bateman et al., 2011) rather than a collective view of dynamic player balancing as a whole.

1.3 PURPOSES

The program of research contained in this thesis seeks to provide a foundation that allows for further formalised research into the differing types of MDDA and their effects. This has been accomplished through the creation of the MDDA Framework (Stage 1 and 2); a guide for the classification of differing types of MDDA features. The framework is presented not just as a tool for academic research but also as a simple method for both initial design and post-hoc categorisation of MDDA in video game development. Additionally, the first steps into exploration of the effects of MDDA on the player experience and performance are presented to better inform MDDA design and allow for a more thorough understanding of how differing implementations of MDDA can influence these outcomes (Stage 3 and 4).

1.4 SIGNIFICANCE AND SCOPE

As discussed in section 1.1, MDDA features can already be found in existing commercial competitive multiplayer games. As the games industry rapidly evolves, a greater understanding of the design, implementation and effects of these features is needed to optimise the player experience and avoid uninformed use of MDDA that has the potential to introduce more issues than it solves.

This research starts at a broad level through first investigating the range of MDDA possible through a formal review of existing features in order to create the MDDA Framework (Stage 1). Through follow-up interviews and a survey, the framework is refined and improved along with a general exploration of player experience and preferences with the distinction between the experience of recipients and non-recipients of MDDA effects (Stage 2). Using these results, experimental testing is used to assess the general effect of a common form of MDDA (player shield-assistance) as well as further focus on the distinctive component of player awareness of MDDA due to the uncertainty over its impact on gameplay (Stage 3). Finally, a fine-grained examination of the effects of differing implementations of MDDA awareness allows for a more conclusive understanding of its influence over different aspects of intrinsic motivation, performance and behaviour (Stage 4).

1.5 THESIS OUTLINE

Chapter 2: Literature Review provides a background of relevant research beginning with the concepts of optimal experience and intrinsic motivation, before delving into the importance of challenge, methods of balancing challenge in video games and measures of the player experience. Together these are used to form a theoretical background and inform the direction of the research contained within this research.

Chapter 3: Research Design explains the course of research chosen for this thesis, beginning with the core research questions. This chapter includes discussion and reasoning of the methodologies and processes chosen throughout each research stage, and how the design of each stage has been informed by the previous stages. An overview of the ethical considerations of this program are also provided.

Chapter 4: Stage 1 contains the first study aimed at addressing Research Question 1, covering the examination of existing MDDA instances in commercial competitive multiplayer games using a formal review. From the iterative analysis of the differences and variety of MDDA uncovered, a set of components and attributes common to all discovered MDDA instances are described. These are used to inform and the creation of a preliminary MDDA Framework for use in successive stages and as a practical outcome of this research.

Chapter 5: Stage 2 reports the use of interviews and an online survey with players of multiplayer games to seek further refinement of the MDDA framework and begin investigating player preferences of MDDA design to contribute to Research Questions 1 and 2. From the dual perspective of low and high-performing players, player values are identified as well as an issue with the Visibility component of the MDDA Framework created in Stage 1. This is transformed into a new subjective Awareness component and introduces a new research question.

Chapter 6: Stage 3 describes an experimental study into the effects of MDDA and awareness of MDDA on the player experience and performance for Research Questions 2 and 4. The study detailed involves groups of participants playing multiple conditions of a competitive multiplayer first-person shooter game and reporting their experiences using the Player Experience of Needs Satisfaction (PENS) survey measures. The psychophysiological measures of arousal is obtained via Electrodermal Activity (EDA) to support player experience findings, but instead uncovers a discrepancy between what it reported by the survey and the arousal and performance results.

Chapter 7: Stage 4 involves a second experimental study in response to Stage 3's findings centred around the effects of awareness on performance and the player experience for Research Questions 3 and 4. Using a range of player experience measures from PENS, Intrinsic Motivation Inventory (IMI), Game Experience Questionnaire (GEQ) and Flow State Scales (FSS), this study finds improvements in the player experience in response to increased awareness of MDDA. The use of interviews also reveals themes to assist interpretation and reveal further player preferences for the optimal design of MDDA.

Chapter 8: Discussion and Conclusions contains a summary of the full program of research and findings related to each research questions. An overall discussion highlights general conclusions and well as the design implications of this work for the creation and use of MDDA in competitive multiplayer video games. An overview of the limitations of this work is also included, as well as the contributions, areas for future research and final conclusions.

2 Literature Review

This literature review begins with a broad background on the state of research into video games (section 2.1), followed by investigation into the concepts of flow and optimal experience (section 2.2) and how they apply to games. The key aspect of challenge from these topics is further explored (2.3) along with research into methods of balancing challenge in singleplayer (section 2.4) and multiplayer games (section 2.5), including dynamic difficulty adjustment. Finally, the different methods of measuring intrinsic motivation and the player experience (section 2.6) is discussed along with a summary and look at the implications for this research study (section 2.7)

2.1 THE STATE OF VIDEO GAME RESEARCH

Video games are a relatively young form of media and entertainment, and as such game-related research has grown significantly in recent years (Björk, 2008). While the expansion of knowledge in this area is desirable, the rapid rate has the side effect of game research being approached as simply a variant of other social scientific research with no widely established methodologies (Clarke & Duimering, 2006). For example, Bernhaupt and Linard (2010) suggest that many current methods of evaluating user experience in games is based on Human-Computer Interaction (HCI) methods that may not take into account game-specific differences such the purpose of entertainment. They argue that measures grounded in usability research more often focused on software and hardware interfaces and consumer devices such as mobile phones. Conversely, other methods of evaluation such as Ryan, Rigby and Przybylski's (2006) 'Player Experience of Need Satisfaction' survey have a basis in human psychology factors around motivation, rather than just ease of use. This demonstrates Phillips' (2006) statement that "There have been few attempts to formalize a language of gaming experiences. None has achieved broad acceptance", which indicates a large fragmentation between the terminology used in the field as well as the lack of a standardised way of measuring player experience and design-related concepts exclusive to games.

2.2 FLOW AND OPTIMAL EXPERIENCE

Optimal player experience in video games is often connected to the concept of ‘flow’, defined by Csikszentmihalyi (1990) as the “holistic sensation that people feel when they act with total involvement”. ‘Flow’ describes optimal experience in any activity, including but not limited to video games. For flow to occur, the level of challenge provided by the activity must be balanced against the participant’s skill in overcoming the challenges so as not to result in boredom from too little challenge or frustration from too much challenge. Nakamura and Csikzentmihalyi (2002) specify the characteristics of flow as the following:

- The individual is in a state of intense and focused concentration on what he or she is doing.
- A merging of action and awareness takes place.
- The individual experiences a loss of reflective self-consciousness.
- The individual feels a deep sense of control.
- The individual’s temporal experience is distorted.
- Worries and ruminative thoughts disappear.
- The individual enters a state of autotelic motivation indicated by the fact that engagement in the activity is perceived as rewarding in and of itself.

The model of flow originated from the examination of intrinsic motivation in athletes, musicians, artists and chess players for which extrinsic rewards were minimal (Csikszentmihalyi, 2000). The act of partaking in the activity was found to be fulfilling and enjoyable on its own. Keller and Bless’ (2008) research demonstrates one of the most significant effects and benefits of flow to be an increase in intrinsic motivation (the willingness to perform a task for personal enjoyment or pleasure). Study participants subjectively described activities to be rewarding when flow was achieved, irrespective of any external rewards from completion of the activity. Similarly, research into flow experienced by marathon runners found that flow during a race was related to future running motivation (Schüler & Brunner, 2009).

The tenets of flow have been used to directly inform the design of games such as exer-games (games designed for physical activity) for children (Sheehan & Katz, 2012). Nacke and Lindley (2008) suggest the design criteria for flow in games as being concentrated on the sequence, pace and challenge difficulty. It has become a goal in game design to maintain players in the "flow zone" as an optimal state, but this goal is confounded by the range of players of differing skill levels that may engage with the same game (Chen, 2007). As a result, Chen (2007) suggests a game should strive to adapt to different players' own individual flow zones in order to appeal to a broader audience.

The concept of flow was more formally adapted to video games by Sweetser and Wyeth (2005) as a set of guidelines to inform and optimise game design for improved player experience. The elements identified as supporting GameFlow were concentration, challenge, player skills, control, clear goals, feedback, immersion and social interaction. These suggest a minimisation of boundaries to reaching the flow state (clear goals, concentration, immersion, control) alongside difficulty regulation (player skills, challenge, feedback). GameFlow has since been adapted to suit the needs of a variety of game-related research areas to inform improved design and intrinsic motivation. For example, the 'EGameFlow' adaption aims to measure a learner's enjoyment of educational games (Fu, Su, & Yu, 2009), while 'Pervasive GameFlow' is used in the analysis of player enjoyment in pervasive gaming (Jegers, 2009). As a medium most commonly used for entertainment purposes, achieving flow can be seen as an ideal effect of a successful game while GameFlow provides the necessary components to achieve this.

Calleja (2007) introduces the concept of "incorporation" as a means of explaining player involvement or immersion within a digital game; a desired effect across optimal experience theories including GameFlow. These are characterised as six frames of incorporation: tactical, affective, narrative, spatial, performative and shared for the purpose of more clearly identifying the ways in which a player may achieve the often vague notion of immersion (G Calleja, 2007). As with Flow, incorporation is noted as a subjective experience (Gordon Calleja, 2007) and thus not able to be universally quantified.

In response to the subjectivity of experience, player modelling (Georgios N Yannakakis, Spronck, Loiacono, & André, n.d.) suggests a way of individually identifying player characteristics with the potential for customised play experiences. Paired with procedural content generation (i.e., the ability for an algorithm to generate new content based on variable rules), there is the potential for gameplay to be customised for individual players (Pedersen, Togelius, & Yannakakis, 2010). This highlights the subjective nature of optimal experience to the individual, including components for flow such as balanced challenge that are dependent on the skill of the player.

2.3 CHALLENGE & SKILL

As a key factor associated with the experience of flow (Csikszentmihalyi, 1990), the balance between challenge and skill has been noted across player experience literature as a critical component of optimal player enjoyment. Further flow research by Keller and Bless (2008) argues that the common thread between factors that contribute to flow is 'regulatory compatibility' between a person's skill and the structural or environmental characteristics of the task at hand; notably task demands and framing. Malone (1981) characterises challenge as providing a goal whose attainment *is not guaranteed* by the player; again highlighting the dependency of challenge on subjective ability. While not exclusively referring to video games, the specific example of matching a game player's skill and competencies to the difficulty level of the game task is offered to improve enjoyment of the task. While Keller and Bless (2008) note that flow may not necessarily be achieved through this matching alone, intrinsic motivation and subjective experience will see a positive effect with participants willing to spend additional time in this state of regulatory compatibility.

Andrade, Ramalho, Gomes and Corruble (2006) questioned players about the main feature of an entertaining game, to which the participants noted the challenge presented as a key issue. Research into the psychological needs of players that must be satisfied in order to achieve optimal experience echoes the significance of challenge, with Przybylski, Rigby and Ryan (2010) explaining its importance in the design of arcade games to hold the interest and loyalty of players:

> "The pacing of challenges was designed so players could continually experience enhanced competence as they progressed in the game, with challenges increasing apace with player ability. This balancing of game

> difficulty and player skill was critical to the success of arcade games; if the challenges underwhelmed players, they would lead to boredom, and if they overwhelmed the player, they would generate frustration."

Abuhamdeh and Csikszentmihalyi (2012) explored the link between challenge and enjoyment of intrinsically motivating activities. While further confirmation of this link was obtained, they note challenge more strongly predicted the enjoyment of goal-directed intrinsically-motivated activities than those which were not goal-directed. This suggests the importance of activity purpose and context, with entertainment-driven video games most often falling into the category of goal-driven intrinsically-motivated activities with some exceptions.

The 'competence' component of Self-Determination Theory (SDT) references both the need for challenge *and* feelings of effectance for an improved experience (E. L. Deci & Ryan, 1975). While it is expected that a level of challenge significantly higher than a player's skill level would reduce enjoyment and feelings of fulfilment, the inclusion of both challenge and the user's subjective feeling of effectance highlights the symbiotic link between them indicating that a lack of challenge can also diminish feelings of competence and lowered intrinsic motivation. Cox, Cairns, Shah and Carroll (2012) echo this in a video game context by arguing that challenge alone will not improve a player's experience or immersion, but also requires the player to perceive themselves as possessing the necessary expertise to overcome it. In the context of competitive sports, Vallerand (1983) found male hockey players experienced greater competence when provided positive performance feedback compared to no feedback, even when performance did not vary. Missura and Gartner (2009) present this positive perception of one's performance as "the drive" to continue play fuelled by mastery of skills. In essence, player-perceived competence is positively related to motivation for continued play (Przybylski, Deci, Rigby, & Ryan, 2014).

Intrinsic motivation as measured by SDT (E. L. Deci & Ryan, 1980) has since been directly applied to video games as Player Experience of Needs Satisfaction (PENS) (Ryan et al., 2006). As video game play is largely a form of entertainment, intrinsic motivation is necessary for continued play and can be seen a goal of high-quality game design. Yannakakis and Hallam (2007) sought to provide increased enjoyment and play longevity through intrinsic motivation by designing better opponent artificial intelligence behaviour. A core element of this was finding the appropriate level of challenge through a balance of player successes to failures to improve feelings of competence.

Pederson, Togelius and Yannakakis (2009) investigated the relationship between the level design parameters of platform games and the level of challenge and frustration experienced by players. Through the creation of a neural network model they were able to map specific level design elements to player behaviour and emotion. Through the use of the game Super Mario Bros. as a base and 480 gameplay sessions, they were able to attain 77.77% accuracy for predicting challenge and 88.66% for frustration as increases in challenge resulted in subsequent increases in frustration. However, it is noted that it is through the simplistic gameplay of Super Mario Bros. that this degree of accuracy can be obtained, while other games and genres may involve significantly more variables with such high accuracy potentially less likely (Pedersen et al., 2009).

2.4 SINGLEPLAYER CHALLENGE BALANCING

2.4.1 Static Challenge Balancing

Game 'balancing' describes the matching of player skills to the difficulty of the obstacles and challenges to be overcome (Koster, 2004). As a player will become more familiar and competent with game's mechanics with practice, a fundamental component of game design is creating a "well-shaped difficulty curve" (Aponte, Levieux, & Natkin, 2011). This describes a gradually increasing the level of challenge presented to the player over the course of the game at a pace that closely matches their improved skill. As 'difficulty' is related to the skill of the individual, an iterative design process is usually employed requiring playtesting to tune the right level of challenge at any particular point during gameplay (Aponte et al., 2011). In singleplayer gameplay, elements such as AI behaviour, attack damage output, avatar health, control input assistance and other systems may be manipulated to regulate the level of challenge.

As a common method of attempting to affect challenge in first-person shooter games Vicencio-Moriera and colleagues (2014) tested a variety of aim-assistance techniques. They suggest aiming speed and accuracy to be the key differentiator between novice and expert players, with automated assistance to these metrics expected to improve performance. By testing a variety of mathematical models for applying aim-assistance such as “sticky” targeting (the aim cursor will stall over targets) and bullet magnetism (bullets will be attracted towards targets where they would otherwise miss) in different scenarios they would no single best method was able to be declared. Instead, the game context affected player performance with each method. While Vicencio-Moriera and colleagues’ (2014) work demonstrates the ability for performance to be successfully affected by aim-assist methods, no recording of the resulting player experience was performed and it is therefore unknown if the balanced challenge was indeed improving the player’ enjoyment.

As the static difficulty curve over the game relies upon the assumption of the player’s initial skill, some games provide additional difficulty mode options to account for some players beginning with a higher or lower than average skill level. However, this relies on the player correctly estimating their own abilities. Alexander, Sear and Oikonomou (2013) found that both casual and experienced players frequently choose difficulty settings not suited to their play style or competency. Consequently, they suggest designers provide recommendations for difficulty selections based on play style to reduce the frequency of players unintentionally hindering their enjoyment.

2.4.2 Dynamic Difficulty Adjustment

Missura and Gartner (2009) state that an “ideal game should be able to adjust its difficulty dynamically, governed by the player’s performance”. Reactive systems that adjust to player performance used in some singleplayer games are referred to in literature as ‘Dynamic Difficulty Adjustment’ (DDA) (Hunicke & Chapman, 2004). Andrade, Santana and Jussieu (2005) specify three requirements for a dynamic balancing system to fulfil:

- Rapid adaption to the player’s initial level of skill or competency.
- Track evolution and regression in the player’s performance.
- Remain believable in the elements that are modified.

While individual features vary between specific games and genres, challenge for individual players may be affected through the adjustment of player mechanic variables (C. Bateman, 2009). These include player avatar attributes (e.g., health, speed), abilities (e.g., environmental interaction, weapons), feedback (e.g., heads-up display) and environmental design. Adjusting environmental (level) design has proven to have a significant effect on challenge, player behaviour and enjoyment in singleplayer gameplay (Guttler & Johansson, 2003). For example, Sorenson and Pasquier (2010) found that they could improve the player experience through a procedural system that modified aspects of the level to specifically tailor it to individual players to match challenge to player skill.

Pedersen, Togelius and Yannakakis (2010) used an open-source version of the platform game Super Mario Bros for similar purposes utilising a procedural system that would tweak individual level design elements such as the width between gaps the player is required to jump across. Certain parts of the environment were chosen for this based on the findings of their previous research around predicting challenge and frustration (Pedersen et al., 2009). Through the 'personalised' level design, participants engaged in similar gameplay and tasks, but with varied difficulty required for successful completion dependant on player competency.

However, Denisova and Cairns (2015) note the risk of players failing to experience a true sense of challenge when DDA is used. Using immersion as the dependent variable, they tested a simple application of DDA through an adaptive timer. A more positive player experience was found in the adaptive condition but they note the danger that a player's perception of fairness may be an issue after repeated play; an area lacking thorough exploration in DDA research.

Psychophysiological measures may also be used to dynamically balance challenge rather using direct in-game performance monitoring. Rani, Sarkar and Liu (2005) tested a dynamic version of the simple game Pong, which responded to anxiety as measured by a combination of electrocardiogram, impedance cardiogram, photoplethysmogram, heart sound, electrodermal activity and electromyogram. Their results found in some cases balancing based on physiological responses was more effective than performance feedback, but this was not the case for all participants (Rani et al., 2005). A similar method of adaptive game difficulty proposed by Chanel and colleagues (2011) uses electro-encephalogram psychophysiological signals to determine the need for difficulty adjustment. This method was also based on the detection of emotional states and was tested using the game Tetris, with a "medium" difficulty found to lead to higher pleasure, motivation and amusement than low-difficulty but lower arousal and pressure than high difficulty. However, another notable finding was the reduction in engagement should the game difficulty not change after consecutive plays (G Chanel et al., 2011); highlighting the potential negative effects of difficulty that may be too balanced.

While the above methods of DDA have demonstrated the potential for DDA to positively affect the player experience through more balanced challenge, Bowey, Birk and Mandryk (2015) were able to induce similar results without direct challenge adjustment. Effective use of DDA would usually result in differing player scores as challenge is increased or decreased in response to player behaviour. However, using a replicated popular puzzle game (Bejewelled), Bowey and colleagues (2015) instead directly manipulated the 'leaderboard' ranking of players without adjusting gameplay. They found increasing a player's leaderboard position above actual recorded performance led to improvements in feelings of competence, autonomy, presence, enjoyment and positive affect compared to reducing the player's score. This demonstrates the impact of feedback on player experience and perception of performance. Consequently, this suggests feedback must be carefully controlled when testing balancing features to avoid confusing the influence of feedback on player experience with the effects of performance balancing.

A key constant throughout much of the research and testing of DDA systems is the focus on singleplayer gameplay in which challenge is provided by environmental obstacles and AI opponents that can be tightly controlled by the designers. As competitive multiplayer games generates challenge from the comparison of skill in human players, different method of challenge balancing are required.

2.5 MULTIPLAYER CHALLENGE BALANCING

Brand (2011) conducted a random-sample survey of 1252 Australian households (3533 people) in which 70% of surveyed players reported enjoying playing games with other people, making multiplayer gameplay a significant factor in the design of current games. Competitive multiplayer video games may typically be classified as goal-driven intrinsically-motivated activities for which has been demonstrated as a strong predictor of enjoyment (S. Abuhamdeh & Csikszentmihalyi, 2012). Clarke and Duimering's (2006) interviews with frequent multiplayer game participants found the highest reported negative aspect of multiplayer gameplay to be mismatched skill levels between players. As challenge in competitive multiplayer gameplay is provided by direct competition between players, the negative effect on the player experience can be attributed to the presence of too much or too little challenge due to mismatched player ability and competence. Vorderer, Hartmann and Klimmt (2003) state that:

> "Engagement in competitive situations holds the risk to lose, which would cause negative emotions and reduce the enjoyment. Playing computer games is therefore expected to be fun only if a sufficient portion of the competitive game situations is mastered by the player."

While at a simplistic level this may suggest absolute certainty of a "win" or successful outcome would hold an optimal experience, Abuhamdeh, Csikszentmihalyi and Jalal (2014) note that while competence may be maximised, a lack of uncertainty of outcome will reduce overall enjoyment. Through testing using a competitive zero-sum game, suspense of the outcome is important and resulted in players choosing games rated as relatively high in suspense. This again emphasises that unbalanced challenge is not just an issue for low-performing players experiencing low competence, but also high-performing players who may lack suspense and outcome uncertainty even if high competence is achieved.

Game balancing in a multiplayer context can be seen as more difficult than singleplayer due to the primary source of challenge being player versus player competition, as well as the reduced designer control over learning and difficulty curves. The Game Approachability Principles (GAP) created by Desurvire and Wiberg (2010) focus on a set of design guidelines to optimise usability for new or inexperienced players of a game, noting that early difficulties can lower intrinsic motivation and lead to a loss of interest from players. It is noted that these are ideal for early game levels or tutorials; elements often missing from traditional multiplayer game modes. As a result, usability principles such as these are usually missing or unable to be implemented in a multiplayer context to the same degree as in single player games.

Tauer and Harackiewicz (2004) conducted studies into intrinsic motivation with youths playing a basketball training game. Player enjoyment was found to be correlated with performance; influencing the resulting intrinsic motivation. Poor performance from new or inexperienced players in a multiplayer context can therefore have a harmful effect on intrinsic motivation, without the presence of traditional tutorials and usability guidelines such as GAP to provide initial risk-free learning for the player.

2.5.1 Multiplayer Matchmaking

An existing method in place for balancing challenge in competitive multiplayer gameplay is 'TrueSkill', a feature in use by the online game service Xbox Live. TrueSkill collects user data using a variety of game and genre-specific variables to give players a generalised skill ranking for the game based on their past multiplayer match performance (Herbrich & Graepel, 2006). Using this data, the system attempts to match players with similar rankings together in future matches. This system may or may not be visible to the players themselves as Herbrich and Graepel (2006) note the potential for exploitation by players attempting to manipulate the system. For example, players may intentionally play poorly in several matches followed by a sudden switch back to high performance, leading the system to reward them further for their 'significant' success. To combat this, the system may only use data from the past several matches instead of on a match-to-match basis for better normalisation but consequently will be more likely to discount genuine major successes.

The TrueSkill system was implemented in Microsoft's Game Clan Matchmaking patent (Shi, 2008) and is widely used across Xbox 360 online games, but certain limitations are in effect. As the system focuses on data collected across multiple matches in order to provide statistically average skill rankings, it is unable to react to in-game unbalanced performance such as that which may come from simply have an "off day". Graepel and Herbrich (2006) also highlight the success of matching similarly competent players is dependent on the individual game's online player population at any point in time. Due to the priority of the matchmaking system in filling a minimum number of player slots in a match within a given timeframe, if not enough similarly skilled players are waiting for a match it is forced to loosen its skill restrictions. This results in a broader range of player skill rankings matched together, and an increased chance for unbalanced challenge levels experienced by players (DeLong et al., 2011). The balancing act between prioritising player network connections and player skill can produce negative effects on player enjoyment when skewed, as reflected in the implementation by major game companies such as Bungie for their multiplayer first-person shooter game Destiny (Bungie, 2014). Upon introducing skill-based matchmaking in Destiny, player complaints increased as the prioritisation of skill over connection speed resulted in players reporting network issues that negatively affected play (Sarkar, 2016).

Real-world testing of TrueSkill by Graepel and Herbrich (Herbrich & Graepel, 2006) in the popular online multiplayer first-person shooter game Halo 2 (Bungie Studios, 2004) used the system to attempt to predict the outcome of matches based on the players' rankings. From the four game modes tested the frequency of prediction errors ranged between 29.94% and 37.17%. Increased errors for smaller teams and free-for-all matches demonstrates TrueSkill's dependency on high numbers of players to correctly select players of equivalent skill. Additionally, the contextual circumstances of individual matches and human 'random factor' makes it less effective for fewer players. It must also be noted that Halo 2 (Bungie Studios, 2004) was the most highly populated online multiplayer shooter on Xbox at that time, potentially making this a 'best case' scenario.

2.5.2 Dynamic Difficulty Adjustment in Multiplayer Gameplay

Some existing games use more direct methods similar to Dynamic Difficulty Adjustment (DDA) in a multiplayer context. A prominent example of this is present in the four-player co-operative first-person shooter game Left 4 Dead (Valve South, 2008). Left 4 Dead uses an artificial intelligence "Director" which modifies game elements such as enemy types and spawn locations based on player performance and behaviour. This includes increasing or decreasing enemy challenges and encouraging co-operative gameplay through punishing locational player separation. These occur in the context of the players competing against enemy agents or environmental obstacles much like singleplayer DDA.

The Mario Kart multiplayer racing game series has attempted to balance challenge by utilising an algorithm that assists weaker players through the increased chance to receive better weaponry to improve performance, thereby increasing competitiveness and ensuring a challenge is still posed to stronger players (Castell &

Jenson, 2007). While this method uses item selection as the basis for dynamic balancing, certain other racing games such as Burnout 3: Takedown (Criterion Games, 2004) have used “always-on” systems that adjust player car speed relative to other players. This mechanic has been referred to as “rubber-banding” (Tijs, Brokken, & IJsselsteijn, 2008); referencing the elastic increase in speed for players further behind.

In contrast, many modern first-person shooter video games such as Call of Duty: Modern Warfare 2 (Infinity Ward, 2009) also provide ‘perks’ to reward high-performing player such as enhanced weaponry as a long-term motivational system. A potential consequence of this is that this may increase frustration for less competent players when competing against more skilled opponents, demonstrating the need for further testing to find the balance of benefits and negative effects on the player experience. Recent entries in the Call of Duty series have implemented a system known as ‘death streaks’ to oppose this, providing limited assistance to low-performing players such as health or speed boosts.

However, these type of dynamic balancing techniques can affect the resulting player experience; particularly when accounting for wider performance differences (Gerling, Miller, Mandryk, Birk, & Smeddinck, 2014). Bateman and colleagues (2011) modified game control parameters in an effort to balance challenge in a multiplayer point-and-shoot style motion control game. Players were required to aim at a screen with a Wii remote and shoot targets while competing against another player. To balance challenge, the relative performance between weaker and stronger players was normalised through assisting the control input of weaker players. The aiming cursor of the weaker player was modified to behave in one of three different ways to make aiming easier through variations of ‘sticky’ or magnetic targeting in which the cursor would automatically snap or drift to a target if brought within a certain distance of it. Assisted aiming provided easier targeting input for weaker players, while no assistance was provided to more competent players. These were tested in both static (i.e., unchanging one gameplay began) and adaptive forms (changing degree of assistance during play) with the adaptive system preferred by players. Bateman and colleagues (2011) noted several key factors in measuring the success of their own player control solution to balancing including the perceptibility of the techniques, ways in which they alter the game mechanics and the degree to which they affect players’ sense of fun.

From their observational and interview data, Bateman and colleagues (2011) state that the targeting assistance techniques used were not perceived by players, did not affect player ratings of fairness and perhaps most importantly improved the sense of fun for assisted players without affecting fun for non-assisted players. This provides a strong argument for balancing challenge through the adjustment of player performance in multiplayer gameplay. The advantage of this method in particular is that players of different skill levels can play competitively together with comparable challenge, whereas methods such as TrueSkill (Herbrich & Graepel, 2006) attempt to initially match similarly skilled players together but cannot act once a match has started and assume a player is always performing at their past statistical ‘average’.

Following on from their research into differing methods of aim-assistance in first-person shooter games as a means of affecting performance (Vicencio-Moreira et al., 2014), Gutwin, Vicencio-Moriera and Mandryk (2016) noted the unknown effects of assistance on skill development such as its potential use in competitive multiplayer contexts. While testing was performed using singleplayer scenarios, that they found skill development was not hindered for the assisted group of player compared to a control group while feelings of competence were improved with assistance. This provides encouraging results for the potential of assistance in multiplayer gameplay.

However, there also exists the potential for dynamic difficulty adjustment to negatively affect feelings of competence should a player externally attribute success to the system rather than internalise it. Nicholls (1984) notes that a person’s perceived competence is a mediator of performance as people are motivated to exhibit high performance to other and avoid being seen as lower in ability. Feelings of embarrassment can result from higher perceived effort for the same task (i.e., struggling to compete against higher-performing players for the same goal), leading to a reduction in motivation to continue (Nicholls, 1984). This highlights the potential benefits of improving performance in order to foster better intrinsic motivation. However, perception of lowered effort for a task can be associated with feelings of guilt (Nicholls, 1984), such as that which may occur when receiving assistance from a dynamic multiplayer balancing feature. Overall, this demonstrates the importance of managing feelings of competence and the associated danger that may arise from artificially manipulating performance using dynamic balancing systems in multiplayer gameplay.

The potential for these effects may be closely related to the degree to which a player is aware of the dynamic balancing being applied in a multiplayer context. A study looking at performance balancing in a racing game found that more “aggressive” applications that normalised performance with greater effectiveness increased the stronger players’ feelings that the opposing (weaker) players had an unfair advantage (Cechanowicz et al., 2014). However, feelings of competence and relatedness were not affected for the stronger players and, in fact, were improved for the lower-performing players. In spite of the reduced perception of fairness, these more aggressive methods were still preferred to weaker balancing features. This suggests that while fairness may colour a player’s perception of the use of balancing, it does not override the resulting player experience benefits of balanced performance.

A study by Gerling and colleagues (2014) used balancing via differing control input related to physical abilities. Able-bodied players using dance mat input controls competed in a dance game against players with mobility disabilities using motion-based inputs from a wheelchair captured by the Kinect camera motion-tracking system. It was suggested that visibility of the adaptive balancing may hinder the weaker player’s ability to internally attribute success to their own ability, with the more negative experience resulting from awareness of balancing while also unable to beat the stronger player.

However, further research by some of the same authors looking explicitly at the effect of dynamic balancing disclosure on player experience did not find that player awareness of the balancing had any negative effect on their experience in more traditional gameplay (Depping, Mandryk, Li, Gutwin, & Vicencio-moreira, 2016). Depping and colleagues suggest the awareness of the balancing may provide the stronger players with justification for their reduced performance, while the weaker players may be more likely to over-attribute success internally. Consequently, it is their recommendation that disclosing the presence of dynamic balancing may be the safer option as the potential for negative effects on feelings of fairness is greater should players stumble upon it when concealed (Depping et al., 2016). However, performance was still noted in both studies as the most important factor affecting the experience with greater balance improving player experience scales including competence and enjoyment.

2.6 MEASURING THE PLAYER EXPERIENCE

The player experience of games is often interpreted from a psychological perspective, mirroring the analysis of other activities and entertainment driven by intrinsic motivation (Ryan et al., 2006). This allows the use of a range of qualitative and quantitative measures with a focus on player self-reporting, with common methodologies including the use of surveys and interviews. Additionally, psychophysiological measures can allow objective insight into a player's experience during the act of play.

2.6.1 Survey Method

Self-Determination Theory (SDT) (E. L. Deci & Ryan, 1985) describes the components necessary for intrinsic motivation or the desire to participate in an activity for its own sake rather than an extrinsic reward. This theory has seen wide support and validation across numerous contexts (E. Deci, Vallerand, Pelletier, & Ryan, 1991; Kazakova et al., 2014; Ryan & Deci, 2000), including in the analysis of video game play. The stated three needs of SDT are:

- Autonomy – the sense of volition or willingness when doing a task (Deci & Ryan, 1980).
- Competence – the need for challenge and feelings of effectance (Deci, 1975).
- Relatedness – when a person feels connected to others (La Guardia, Ryan, Couchman, & Deci, 2000), including both human players in a multiplayer context or computer-controlled AI characters in singleplayer gameplay.

Ryan, Rigby and Przybylski (2006) then tested the application of SDT to video games as a means of empirical player motivation testing on the basis that player motivations in video games largely mirror those used in everyday life. Therefore, player behaviour within video games is driven by the need to fulfil basic human needs and could be measured from a psychological perspective. They were able to confirm SDT's constructs of competence, autonomy and relatedness were able to predict player motivation (Ryan et al., 2006), while also finding an association with presence (the sense of being within the game world) and the degree of which control input is intuitive. Together, these five constructs are contained in Ryan, Rigby and

Przybylski's (2006) measure of intrinsic motivation in games, known as Player Experience of Need Satisfaction (PENS). Testing of the PENS measure found motivation for continued play and needs satisfaction were successfully accounted for (Ryan, et al., 2006). While introduced more recently in the past decade, research using PENS such as that by Vella, Johnson and Hides (2015) as support for investigating player wellbeing, and Johnson and Gardner (2010) in matching personality and game genre preference have provided further validation of its consistency and value in exploring player experience. Bruhlmann and Schmid (2015) also echo this with consistent and invariant results in the PENS measure when tested across different games.

In addition to SDT and PENS is the Intrinsic Motivation Inventory (IMI) (Ryan, 1982), a similar multi-dimensional measure of user experience. This measure has been validated in several studies with the benefit of generalised questionnaire wording that enables it to be applied to a broad spectrum of contexts and tasks (McAuley, Duncan, & Tammen, 1989). Notably, only the first component (Interest / Enjoyment) specifically measures intrinsic motivation with further components providing more specific supplementary support of positive predictors of intrinsic motivation (E. L. Deci, Eghrari, Patrick, & Leone, 1994). The IMI has been used in game research studies such as an investigation of comparative student motivation to either construct or play a memory game (Vos, Van Der Meijden, & Denessen, 2011), and virtual rehabilitation environments using game-like systems to motivate exercise (Mihelj et al., 2012).

Much like PENS and IMI, survey measures of flow have also been created as a method of determining whether an activity has achieved the requirements of the theory. The Flow Scales (Jackson & Eklund, 2002) enable the measurement of flow at two levels; either dispositional (frequency of flow experience) or state (extent of flow in a particular task or activity). Commonly these scales have been used in sports and exercise as a means of determining whether an athlete has entered a flow state during physical activity (Jackson & Marsh, 1996), with validity tested and confirmed to demonstrate invariance of factor forms, loadings and covariances (Wang, Liu, & Khoo, 2009). However, while initially focused on exercise Kivikangas and Puttonen (2006) provided support for its use in the study of flow games and in combination with psychophysiological measures. As previously discussed, flow and optimal player experience in games has been commonly linked together, and the ability to measure the degree of flow achieved during gameplay is important for allowing not just flow-informed design but post-hoc analysis of the player experience.

A recent measure for player engagement is the Game Engagement Questionnaire (Brockmyer et al., 2009). This functions as a "self-report measure of an individual's potential for becoming engaged in video game-play at differing levels" (Brockmyer, et al., 2009) using a 19-item framework to provide a detailed view of the player's own sense of immersion (crossing over with 'presence' in the PENS theory). The GEQ has seen wide use in games research as a generalised measure of player experience in both games for entertainment (Gerling, Klauser, & Niesenhaus, 2011) as well as adaption to serious games such as in educational contexts (De Grove, Van Looy, & Courtois, 2010)

As a broader measure of enjoyment, the Game Experience Questionnaire (GEQ) (IJsselsteijn, de Kort, Poels, Jurgelionis, & Bellotti, 2007) uses survey reporting to provide a general indication of a player's overall experience specific to video games. The GEQ uses three modules: the core questionnaire, social presence module and post-game module in order to provide a wide-ranging view of the player's thoughts, mood and experience. These modules are answered in above order upon completion of play, with each focusing on the reporting of different components including flow, immersion and positive and negative affect.

2.6.2 Interview Method

Interviews, whether individual or in groups, allow for both structured and unstructured data gathering with the freedom to encounter unexpected findings. Where more structured forms of data collection such as surveys or likert-scales may require the researcher to predefine the topics or possible range of responses, interviews can allow participants themselves to introduce ideas and subsequently discover new, unexpected information (Braun & Clarke, 2006). For example, Clarke and Duimering (2006) uses exploratory interviews with players of first-person shooter games to explore their perceptions of positive and negative aspects of the genre. This method allowed players to offer responses of what they considered good or bad design for a range of broad topics, to which Clarke and Duimering (2006) identified frequently cited elements between participants. Kaye and Bryce (2012) similarly used thematic analysis of interviews to investigate the influence of social context of games. In this case, they use the exploratory themes to identify and suggest areas in need of further empirical research. This holds benefits for exploratory research in particular by reducing reliance on preconceived outcomes; allowing for new concepts and ideas to guide the research focus organically.

Due to the exploratory nature of finding themes, analysis can be challenging when searching for meaning in the data (Guest, MacQueen, & Namey, 2011). Thematic analysis is a widely-used qualitative method of providing an account of large quantities of data (Braun & Clarke, 2006), such as that collected by interviews, discussions, focus groups or open text responses to surveys. Thematic analysis is used to capture both implicit and explicit ideas from the overall data set (Guest et al., 2011). However a lack of rigor can be a danger (Muir-Cochrane & Fereday, 2006) due to the sometimes informal methods of qualitative data analysis and loose definition of thematic analysis (Vaismoradi, Turunen, & Bondas, 2013). In the effort to provide a more formalised approach to thematic analysis, the following process and phases were laid out by Braun and Clarke (2006) and Vaismoradi, Turunen and Bondas (2013):

1. Familiarisation of data, including the transcribing, reading and noting down of initial ideas.
2. Generation of initial codes by coding interesting features and ideas systematically across the full data set.
3. The search for themes through collation of codes and relevant data.
4. Review of themes by cross-checking against coded extracts and generation of a thematic map.
5. Definition and naming of the themes from refinement of the specifics for each theme.
6. Production of the report using compelling and relevant example extracts and relation back to the research questions.

A very similar method was also provided by Muir-Cochrane and Fereday (2006) followed the same basic steps, but also highlighting the iterative nature of the process and need to test the reliability of the codes with another researcher. This is of high importance due to the inherent reliability concerns when a single researcher applies only their interpretations to a large body of data (Guest et al., 2011); supporting the notion that introducing other researchers without a direct connection to the work can reduce the potential biases or subjectivity of the process (Muir-Cochrane & Fereday, 2006). Content analysis holds structural similarities to thematic analysis by similarly searching for overarching themes but attempts to quantify them through inclusion of the frequency at which that theme appears (Vaismoradi et al., 2013).

2.6.3 Psychophysiological Measures

The objective measure of optimal video game design differs from other areas of Human-Computer Interaction (HCI) research due to the focus on user or player experience as opposed to usability (Mandryk, Atkins, & Inkpen, 2006). Where other field may focus on efficiency and performance, the goal of enjoyment for most video games presents a difficult challenge to measure objectively. In the past 15 years, physiological signals have begun to see used as a method to gauge player states when engaged in play, such as anxiety and frustration (R Bernhaupt, Ijsselsteijn, Mueller, Tscheligi, & Wixon, 2008). The advantages of physiological measures include the study participant's lack of voluntary control over these signals and independence from cultural, gender and age-related biases (Liu, Agrawal, Sarkar, & Chen, 2009).

Mandryk and Inkpen (2004) note the potential of psychophysiological measures as a more objective measure of player experience; an area where games may differ from other areas of human-computer interaction research due to the focus on enjoyment rather than productivity or performance. They were able to determine a difference in arousal as measured by Electrodermal Activity (EDA) between gameplay conditions which correlated to the recorded subjective experience; indicating the potential for physiological response analysis as a means of evaluating player experience. Additionally, due to the real-time recording of physiological data, significant events can be mapped to particular points in play, providing an indication of what triggered the reaction. For example, a participant may subjectively report their play experience to be 'frustrating', while physiological signal spike at specific points in play can provide a much clearer indication of the cause and frequency.

A potential confounding factor of psychophysiological measures for the measurement of player experience in video games is the effect of factors external to gameplay features or mechanics. For example, Ravaja and colleagues (2006) noted higher physiological arousal for players competing with friends as opposed to strangers; an objective reading but not motivated by the game itself. This highlights the need for strict control of the context of testing where analysis of recorded data is likely to occur later and the potential for incorrect interpretations of the source of an effect.

As was previously discussed, physiological responses have been used as an alternative method of challenge balancing based on emotional states, although the current high costs and impracticality of most recording equipment has prevented use in mainstream commercial games to date. However, with biometric use in human-computer interaction research becoming more common Mirza-babaei and colleagues (2013) have suggested using biometric "storyboards" to find user experience issues during games user testing. This leverages the use of real-time data collection from one or more biometric measures synchronised with gameplay and was used to inform design decisions that were demonstrated to improve the player experience. A natural obstacle of this approach results from the unwieldy nature of equipment required for precise physiological recordings and associated setup time.

Physiological signals are separated into two categories: those originating from the peripheral nervous system such as heart rate variability (HRV), electromyography (EMG) and electrodermal activity (EDA), and those from the central nervous system such as electroencephalography (EEG) (G Chanel et al., 2011). For use as measures, it is best to avoid signals with data that participants can actively affect if possessing knowledge of what is being recorded. For example, Nacke, Kalyn, Lough and Mandryk (2011) tested the use of biofeedback as a control device for gameplay. In this study participants had easy control over EMG readings to control play while EDA was not able to be consciously influenced by participants, indicating EDA to be a more effective measure when avoidance of player influence in data collection may be an issue.

EDA, also known as galvanic skin response (GSR) measures skin conductance as the mean value provides an indication of arousal level (Lang, Greenwald, Bradley, & Hamm, 1993). Electrical resistance between two electrode sensors placed on a participant's skin can reduce in response to emotions or reactions to stimuli such as stress, surprise and frustration (G Chanel et al., 2011); experiences commonly found in video game play. This has contributed to its use as a real-time measure for player experience and game research both alone and in conjunction with other physiological measures (Mandryk & Atkins, 2007). Arousal indicates an emotionally affective experience ranging from calmness to extreme excitement (Nacke & Lindley, 2008). Recorded data is controlled by the production of sweat in 'eccrine' sweat glands, which is directly controlled by the human sympathetic nervous system, indicating the emotional state of the player.

Wu and Lin (2011) demonstrated EDA and arousal can react to stress changes caused by game challenge or difficulty, with player arousal state scaling with challenge, providing a useful measure for flow. However, they also found that EDA more positively correlated with negative game events such as frustration than positive game events such as success, with an increase in EDA following successive failures during gameplay. Drachen and colleagues (2010) found a similar correlation between EDA and negative affect (frustration) when testing first-person shooter video games, but did not find a link with challenge as measured by the In-Game Experience Questionnaire (IJsselsteijn, Poels, & de Kort, 2008) Due to this range of responses captured in EDA data, it is suggested that it should be paired with other player experience measures to assist in the interpretation of results for game research (Kivikangas et al., 2011). This confirmation of the interpretation of EDA data may be less important in certain circumstances where the source of player affect is less important than acknowledgement of its presence, such as a study by Giakoumis and colleagues (2011) in which low EDA was used to indicate boredom.

Research intentions are used to determine whether data will be analysed using a phasic (mapping changes in arousal to specific events) or tonic method (examining average arousal over a period of time). This is reliant on whether researchers wish to determine the effect of specific short-term events, or general differences in experience between conditions. Ravaja and colleagues (Ravaja, Saari, Salminen, Laarni, & Kallinen, 2006) highlight an advantage of phasic analysis as the ability to investigate changes in emotion or attention to in-game events, including those too subtle to be consciously registered by the player and therefore reported using traditional subjective measures such as surveys. However, Ravaja and colleagues (Ravaja, Saari, Salminen, et al.,

2006) note that physiological responses may reflect more than one psychological process. This suggests the potential for data misinterpretation; particularly when relying on a single measure without supporting data from other sources. Consequently, a combination of self-report and psychophysiological measures are commonly used together when evaluating the emotional and experiential effects of games.

2.7 SUMMARY AND IMPLICATIONS

The literature surrounding player experience has been largely built from psychological theories of optimal experience such as Flow (Csikszentmihalyi, 1990) and intrinsic motivation such as Self-Determination Theory (E. L. Deci & Ryan, 1985). The importance of balanced challenge in video games is highlighted by the fact that feelings of competence (resulting from well-balanced challenge) will increase enjoyment and motivation to play. To date, the best means of balancing are not yet clear. Existing methods of multiplayer balancing such as matchmaking have limitations such as the requirement of online play (Herbrich & Graepel, 2006). However, while dynamic balancing techniques such as Dynamic Difficulty Adjustment (Hunicke & Chapman, 2004) demonstrate promise in singleplayer gameplay, the adaption to competitive multiplayer gameplay as Multiplayer Dynamic Difficulty Adjustment (MDDA) requires a different approach. The generation of challenge through player vs player interaction in competitive multiplayer games necessitates that dynamic challenge adjustment be applied to player performance, with existing research demonstrating positive player experience results (S. Bateman et al., 2011). However, MDDA does not yet contain a formalised method of classification or clear differentiation between the variety of designs and implementations. This makes it difficult to determine the effectiveness or optimal design of differing solutions. Nevertheless, a range of strongly validated qualitative and quantitative methods and measures such as thematic analysis, PENS (Ryan et al., 2006) and psychophysiological measures including EDA allow for investigation of the resulting player experience.

3 Research Design

3.1 RESEARCH STRUCTURE AND SCOPE

As noted in the literature review, player balancing in multiplayer video games is a field only recently gaining attention in research. While research on challenge and components of intrinsic motivation such as Self-Determination Theory highlight the importance of player balancing, research into its use in multiplayer design and player experience effects are still at an early stage. Given that little direct research has been conducted in this field, it was important that the program of research be flexible and reactive in order to respond to findings and important revelations.

To this end, the initial creation of three high-level primary research questions (RQ1, 2 and 3) was paired with a four-stage research structure. Each stage addresses one or more primary research questions, while allowing the findings from each stage to influence focuses, measures and methods of the subsequent stages as data revealed new threads. This resulted in the addition of the fourth research question (RQ4) at the conclusion of Stage 2.

Primary Research Questions:

- RQ1: What are the different types and implementations of MDDA?
- RQ2: How does the presence of MDDA affect the performance and the player experience of:
  - RQ2a: low-performing players?
  - RQ2b: high-performing players?
- RQ3: How can the use of MDDA be better optimized for improved player balancing and experience? *(includes incorporation of RQ1, 2 and 4 findings)*
- RQ4: How does awareness of MDDA affect the performance and the player experience of:
  - RQ4a: low-performing players?
  - RQ4b: high-performing players?

3.2 RESEARCH STAGES

The following chart presents an overview of the four research stages, aims and research questions addressed.

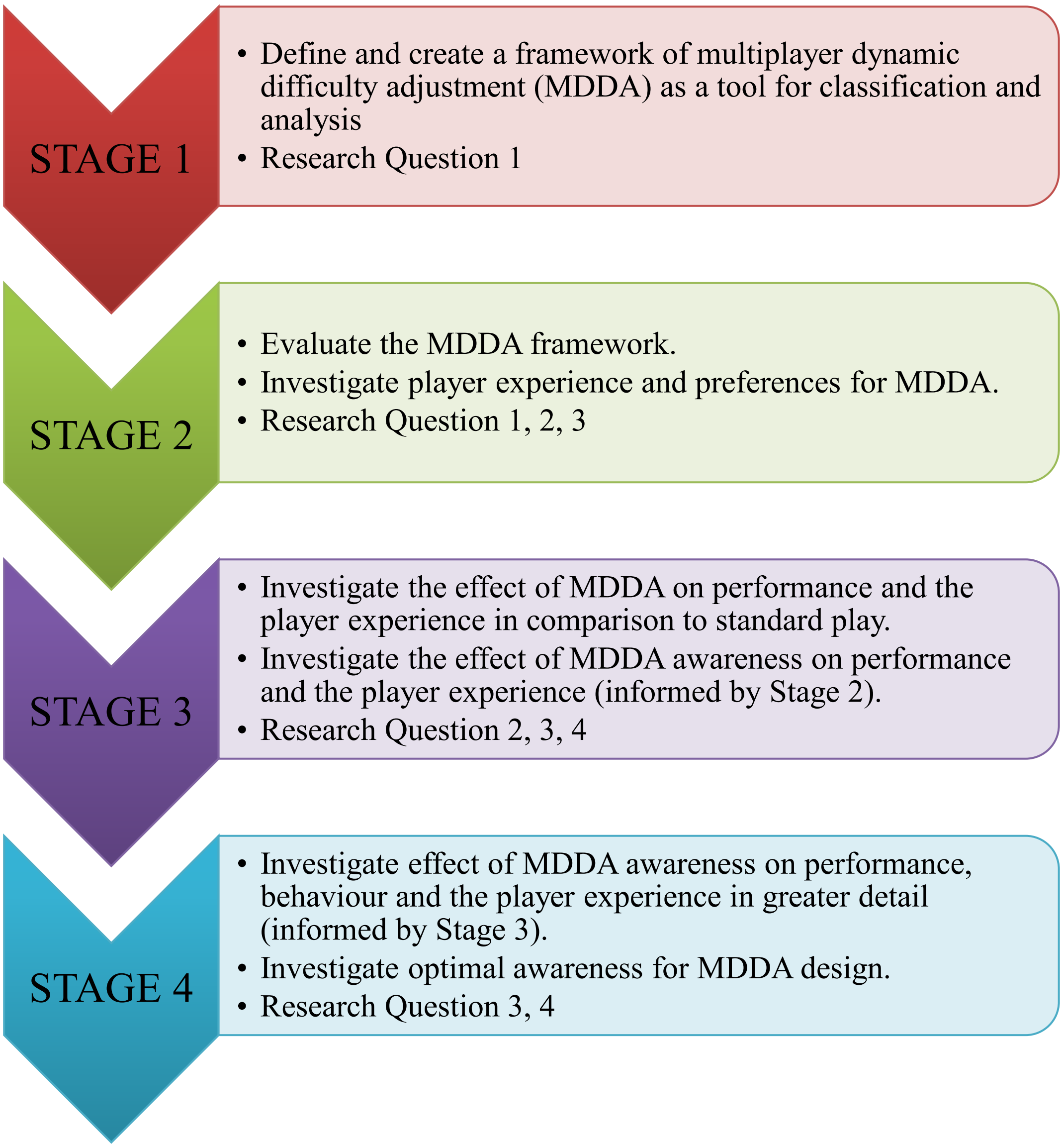

Figure 1. Research Design – Summary of stages

3.2.1 STAGE 1 - Defining and Creating a Multiplayer Dynamic Difficulty Adjustment (MDDA) Framework

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Research Aim:
Create a framework of MDDA.

No method of classifying MDDA features or similar was present in existing research, which presents a problem for examining MDDA in detail and determining the effects of differing types and methods in further stages of this path of research. For the purpose of building an initial understanding of the range of types of MDDA available for player balancing, a formal review of existing commercial competitive multiplayer games was conducted. The use of a formal review allowed thorough exploration of a large number of differing implementations of MDDA across multiple genres and games of differing quality.

Using the data collected, iterative rounds of comparing and contrasting MDDA features between games allowed the creation of a preliminary MDDA framework. While open to revisions, the framework provides a basis for further stages of this research program through the use of a common set of classification labels and a lens through which to describe MDDA features and identify key components. Additionally, the library of game data collected provides a useful reference for MDDA examples and games utilising the feature for use in later stages.

3.2.2 STAGE 2 – Evaluating and Revising the MDDA Framework

Research Aim:
Evaluate framework and investigate player experience and preferences of MDDA.

Following the internal creation of a preliminary MDDA framework from existing commercial games in Stage 1, external input and feedback from multiplayer video game players was necessary to strengthen and refine it, as well as searching for any missing components. A mixed-methods approach of interviews and a larger-scale online survey were chosen for this purpose.

Semi-structured interviews first investigated the issue of unbalanced challenge in competitive multiplayer gameplay to further confirm this as issue for players that negatively affects their enjoyment. A similar method was adopted to that used by Clarke and Duimering (2006) for investigating multiplayer experiences by encouraging views expressed by participants to be supported by anecdotes. Through open discussion, player opinions and experiences of MDDA features in games were explored. Opinions and insights regarding the different components of the MDDA framework were also recorded to assist in the interpretation of the following survey results. This provided additional reasoning not able to be captured in the quantitative survey responses.

The online survey used a larger sample size to gain a more structured view of how players of multiplayer games perceive differing types of MDDA features as classified by the MDDA framework. Seven-point numbered -scale questions examined player preferences for each framework component and attribute through an explanation of that framework component and game examples. While a limitation of ratings-based questionnaires including the numbered-scale used in this study is the potential to include differing interpretations or biases by participants (Miller, Linn, & Gronlund, 2012), they are able to provide information on the degree of an effect or agreement rather than a binary choice. Participants were required to rate how each MDDA framework component and attribute would affect their player experience from two perspectives: as a low-performing (assisted) player and as high-performing (unassisted) player. The separation of perspectives follows the theme established in player balancing research of examining not just the experience of players directly affected by performance adjustments, but the other players in a match too (S. Bateman et al., 2011). These dual perspectives also allow framework attributes that may have differing effects on low and high-performing players to be identified. The use of a within-groups design in which all participants answered from both perspective was important due to the relative nature of performance for MDDA. As the use of MDDA and separation of "low" and "high" performance is dependent on the relative performance of other players in a match, participants are likely to occupy both positions in different matches or games. This allowed a more direct comparison between how the influence of MDDA may differ for the same people in different positions.

A final portion of the survey was introduced to collect further feedback and critiques of the MDDA framework through open text responses to search for any additional refinements or additions.

3.2.3 STAGE 3 – Investigating the Effect of MDDA

Research Aim:
Investigate the effect of MDDA and awareness of MDDA on performance and the player experience.

The creation and revision of the MDDA Framework in Stages 1 and 2 provided the basis for commencing experimental studies of MDDA's effects on performance and the player experience in actual gameplay. However, Stage 2's results revealed conflicting participant preferences and opinions regarding player awareness of the presence and effects of MDDA. In response, investigation of this particular component was deemed necessary for satisfying Research Question 3 for optimal MDDA design. This new focus prompted the addition of Research Question 4:

- RQ4: How does awareness of MDDA affect the performance and the player experience of:
    - RQ4a: low-performing players?
    - RQ4b: high-performing players?

As Stage 2 results indicated low or high-performing players' awareness of the MDDA instance would negatively impact the performance of the other group, three conditions of the experimental study were planned:

1. A standard match with no MDDA.
2. A match with MDDA but no participant awareness of its presence or effects.
3. A match with MDDA in which all participants are aware of its presence and effects.

This allows examination of not just the effect of MDDA compared to standard play, but also awareness of MDDA compared to no awareness. Survey method was selected to record the subjective player experience using the PENS measure of player needs linked to intrinsic motivation (Ryan et al., 2006). PENS uses 21 items separated into 5 subscales (competence, autonomy, relatedness, presence, intuitive controls). Participants rate questions such as “I feel very capable and effective when playing” on a 7-point scale from “do not agree” to “strongly agree”. The scores from each question set are averaged to provide overall scores for each subscale.

As MDDA balances player challenge through influencing the potential performance of players, gameplay recording was chosen as an unobtrusive method of acquiring player score data and determining the effectiveness of the MDDA in reducing performance variance. As commonly used in the games included in Stage 1’s formal review and the preferences and concerns of participants in Stage 2’s results, the MDDA was intended to reduce variance in performance but not eliminate entirely. Complete balance or “flat” performance between participants would affect match outcomes; eliminating the effect of skill while also potentially increasing the likelihood of the MDDA being discovered in Match Condition 2.

While the subjective player experience was collected through the survey, biometric electrodermal activity (EDA) data were recorded during gameplay and analysed tonically to measure arousal. The recording of involuntary psychophysiological responses provides a real-time indication of player experience not influenced by past recollections (as is the case for survey responses). However, due to the broad potential interpretations of psychophysiological data such as EDA, the data cannot be used alone and was instead selected to provide supplementary support for survey and performance data as a further indication of challenge, tension and excitement (Nacke et al., 2011). The advantage of EDA over other physiological measures is its easier application and less ambiguous readings compared to similar measures such heart or facial muscle activity (Kivikangas et al., 2011). Frijda (1986) notes a correlation between EDA and the difficulty of a task, with increased skin conductance matching higher difficulties. Consequently, EDA has been used as a supporting measure in other games research focusing on differences in game difficulty or challenge such as that by Chanel and colleagues (2011).

Several requirements were established for the selection of an appropriate competitive multiplayer game for this study. In order to be considered, a game must:

- Allow participants to compete simultaneously as individuals.

- Be available in Australia with a classification of MA15+ or below to minimise research ethics concerns for younger participants.
- Have a commercial release from at least 2005 (the beginning of the "seventh generation of video games") in order to be representative of a modern game.
- Have a "positive" Metacritic rating (CBS Interactive Inc., 2013) in order to minimise the effects of poor game quality on the recorded experience.
- Be playable on Windows 7 PCs in order to function in the research lab allocated for this study.
- Use keyboard and mouse controls in order to allow EDA sensors without gameplay interference. Required sensor attachment on the palm of a hand was found to cause interference with console-style controllers.
- Allow modification in order to implement the MDDA feature.
- Have simple, memorable gameplay objectives.
- Be broadly representative of a standard or "typical" multiplayer game.

Based on thesis requirements, the PC game Unreal Tournament III (UT3) (Epic Games, 2007) was selected due to its broad representation of the first-person shooter (FPS) genre. First-person shooters were an included genre in the formal review conducted in Stage 1, as well as the most popular competitive multiplayer genre indicated by participants in Stage 2's survey (see section 5.3.1). UT3 uses simplistic core gameplay mechanics common to all first-person shooter games, minimizing the "learning curve" for participants to feel comfortable understanding and controlling the game. Additionally, Unreal Tournament III was received positively by critics (CBS Interactive, 2011) upon release; reducing the potential for poor game quality unintentionally influencing the player experience.

A limit of four players per experiment session was chosen as a balance between representing the typical player population of local multiplayer gameplay and the required setup time and management. While it is suspected that results may vary across differing player populations, most modern game consoles such as Xbox One, Xbox 360, Nintendo Wii, PlayStation 3 and PlayStation 4 support a maximum of four simultaneous players in local play on a single machine (individual games may be restricted to fewer players). This provides a common benchmark for offline player populations, although online play can support larger numbers of players but would not be feasible for the scope and data collection of this study. Consideration of these factors were intended to replicate a typical multiplayer gameplay session a player may experience in everyday life; however an unavoidable limitation of the research design is the context of play in a specialised laboratory. This holds the potential to influence player experience including EDA recordings; however Chanel, Kivikangas and Ravaja (2012) note in a similar study involving social gameplay that physiological responses did not vary between environments including a testing lab. They do note however that social interaction may potentially be greater in a home environment. Consequently, participant communication was limited during Stages 3 and 4's experimental studies.

MDDA Instance Design

In the 'Deathmatch' game mode used, performance is dependent on players staying alive and scoring more "kills". Consequently, a player is deemed low-performing if the number of kills they have scored is notably below their opponents. Similarly, any assistance provided by an MDDA instance should improve the player's likelihood of surviving and increased ability to defeat other players.

Five different MDDA instances were pilot tested to determine potential issues and select an appropriate form of performance assistance for low-performing players to use in this study. The "strength" of the balancing effect was also limited to avoid removing any performance difference and thereby controlling match result rankings; a scenario not representative of MDDA instances recorded in the formal review. The MDDA instances tested and issues noted were:

- **Increased weapon damage:** player weapons would deal greater damage to opposing players.
    - Testing indicated this may be ineffective in some circumstances in which the low-performing player has large difficulties with input control. As any assistance to performance is still dependent on the ability to successfully aim and shoot opposing players, inability to do so would result in no change to player performance.
- **Receiving more powerful weapons:** players receive more powerful weapons immediately without having to find them in the game environment.

    - A similar issue to the above “increased weapon damage” MDDA was noted in which better weapons may not result in increased performance if the player was not able to use them competently. However, a larger issue with this MDDA implementation was the increased likelihood of participant noticing the difference in weapons possessed by themselves or opposing players; thereby interfering with the “no awareness” match condition.

- **Increased movement speed:** avatar movement speed would increase allowing faster navigation of the environment and increased potential to avoid enemy fire.
    - This was found to be unsuitable for the selected game of Unreal Tournament 3 due to its already rapid movement speed. Testing indicated low-performing players receiving this assistance were likely to lose control of the avatar and increase accidental deaths through running off platforms or into dangers.
- **Scalable shield:** players would receive extra shield points to protect from damage based on the score difference between them and the match leader, with a greater score difference leading to greater shield points.
    - A major issue was discovered with this scalable system in which matches with a single player performing much higher than the others could result in other players receiving inordinate amounts of shield. This had the resulting effect of the low-performing players seeming near-invincible, and preventing them scoring against each other. Consequently, all player scores would drop and result in a reinforcement loop.
- **Static shield:** players would receive a single-use set number of shield points to protect from damage when the score difference between them and the match leader exceeds a certain value, which is only re-awarded on each ‘respawn’ (i.e., reappear and rejoin play in the match after dying).
    - This instance design corrected the issues discovered in the ‘scalable shield’ MDDA instance by preventing a reinforcement loop. The only noted potential issue was the limitation in the amount of performance

assistance when an exceptionally high difference in player skill levels was recorded.

Following testing, the ‘static shield’ MDDA instance was selected to be used in this study for several reasons beyond direct design issues. Firstly, the design of the ‘static shield’ MDDA was able to be more closely mapped to participant preferences for specific MDDA Framework attributes identified Stage 2. However, due to the need to avoid participant awareness of the presence of MDDA in some conditions, some participant preferences could not be incorporated in the MDDA instance employed. Specifically, the preferred Visibility attributes and ‘action required’ attribute of User Action was suspected to greatly increase the potential for participants to become aware of the MDDA in certain conditions. Additionally, this form of MDDA design (damage resistance) is also present in the example games of Call of Duty: Modern Warfare 2 and Mario Kart used during Study 2’s interviews and survey which helped to maintain consistency between studies.

The static shield MDDA instance used was triggered when a player’s score fell more than 7 points below the leader’s score. When this occurred, the player was assisted by providing an additional 50 shield points in addition to the standard 100 health points. This allowed the assisted player to take more damage before being defeated, and consequently improve their ability to survive combat encounters long enough to defeat their opponent. To avoid any interference with the damage resistance effect, all health and shield pick-up items were removed from the game environment. This reduces the potential for participants to incorrectly attribute shield assistance to item pick-ups vice versa.

The MDDA instance used has the following mapping to the MDDA framework established in Stages 1 and 2:

- **Determination:** During gameplay – the instance activates based on real-time player performance.
- **Automation:** Applied by system – the instance is chosen and activated by the game system.
- **Recipient:** Individual – the instance will only be applied to individual players, rather than groups.

- **Skill Dependency:** Skill independent – the player receives the benefit of taking more damage to defeat and does not need to act with skill in order to receive performance benefits.
- **User Action:** Action not required – the instance activates immediately without user input.
- **Duration:** Single use - the shield is applied once the player respawns in the match.
- **Awareness:** Unaware (Match 2); Partial awareness (Match 3) – participants are informed of the presence and rules, but are not informed during gameplay which players are currently receiving assistance.

Experimental Design Considerations

In order to obtain data as accurately as possible while minimising interference from external factors, it was important for the experiment design and gameplay to replicate a typical multiplayer gameplay session as closely as possible. The following considerations and solutions were implemented for this purpose:

POTENTIAL ISSUE:	SOLVED BY:
Game design inconsistencies, quality or bugs influencing player experience.	• Using positively-received commercial game for testing (Unreal Tournament III). • Installing all game, performance and bug-fix updates. • Maintaining same game version across all participant groups.
Increasing familiarity with game mechanics or 'practise' influencing data across the matches.	• Order of matches randomised for each group of participants. • Unreal Tournament III game selected for simple mechanics and controls to reduce learning curve. • Single-objective gameplay mode (score as many kills as possible). • Game settings and controls locked to prevent player manipulation. • Printed control scheme for UT3 available at all times for each participant.
Social interaction influencing player experience or awareness of MDDA. Some participants already known to each other while others were strangers.	• Talking or communication prohibited once study begins; both during gameplay and between matches. • Player names represented as random number during gameplay.
EDA sensors interfering with experience and comfort.	• EDA sensor contacts were attached to the palm of the hand the participant used with the keyboard rather than the mouse hand during gameplay. This hand does not change position once in play (all required keys are within range without movement),

POTENTIAL ISSUE:	SOLVED BY:
	minimising the likelihood of cabled tangling or interfering with performance. • Participants were informed that in the event the sensors become detached during play, to ignore it and continue play as normal until the match ends. The researcher would then reattach the sensors only between matches.
Participant movement interfering with EDA sensor data.	• Prior testing confirmed that attachment to keyboard hand reduced movement artefacts compared to use on the mouse hand. • Participants were requested to refrain from unnecessary movement in their chairs during gameplay, such as foot-tapping.
Participant awareness of MDDA in Match Condition 2 when not desired.	• Participants informed at the beginning of their session that they will be playing 3 matches; two standard and one with a different feature that will be announced before that match (in reality, only one is 'standard'). • Participant awareness is checked using the survey after each match to ensure participants did not attribute performance or receiving shields to MDDA. • MDDA presence hidden during gameplay.

Table 1. Stage 3 experimental design considerations

3.2.4 STAGE 4 – Investigating Optimal Awareness of MDDA

Research Aim:
Investigate the effect of MDDA awareness on performance, behaviour and the player experience in greater detail, as well as optimal awareness.

Player experience survey results in Stage 3 showed little difference in subjective experience between match conditions, with the PENS constructs failing to demonstrate statistically significant effects between match conditions. However, unassisted (high-performing) players continued to report a better experience than assisted (low-performing) players in spite of successful performance adjustment by the MDDA instance. Alongside significantly different EDA readings between conditions, this suggests another factor external to personal performance may be influencing participants' player experience and feelings of competency.

In order to break down the variables further, a second experiment was designed using a similar structure to Stage 3 but with differing measures and conditions to capture more detail. In particular, two new awareness conditions were introduced – a condition in which only assisted players are aware, and one in which only unassisted players are aware. Additionally, personal performance was hidden from participants to reduce the influence of reported performance influencing their feeling of competency.

As the PENS survey method responses in Stage 3 did not indicate clear differences in responses between conditions, a wider variety of survey measures (see section 2.6.1) were used in addition to the PENS. The first of these was enjoyment construct from the Intrinsic Motivation Inventory (IMI) as a clearer indication of whether enjoyment as a whole was affected by the awareness of MDDA (see Appendix D). This component indicates enjoyment and interest in an activity, but also forms the core measure of intrinsic motivation in the IMI (E. L. Deci et al., 1994) with the additional supporting components excluded to avoid excessive experiment session times. The short version of the Flow State Scale (FSS) (Jackson & Eklund, 2002) was also added (sample questions available in Appendix E). This provides nine questions that cover each of the components of flow and, given the use of flow theory in the design of games (Chen, 2007), provides a useful and industry-recognised indication of optimal experience. Klarkowski and colleagues (2015) raise a potential issue of FSS in game research indicating flow has been induced in very low-challenge “boredom” conditions due to the potential high indications of control in these situations. However, this was not expected as an issue in this study due to the absence of an exceptionally low challenge or engagement condition and rapid pace of the chosen game. Finally, the challenge construct from the Game Experience Questionnaire (GEQ) (IJsselsteijn, de Kort, Poels, Jurgelionis, & Bellotti, 2007) was also included (see Appendix F). While a measure of competence is retained from PENS which covers the balance between challenge and skill, a separate measure of challenge may provide a further indication of the effectiveness of performance balancing.

Participant performance from scores data were once again collected using server gameplay recordings, but with the additional inclusion of ‘deaths’. This allowed more detail in determining not just how successful each participant was towards the goal of obtaining the most number of kills, but also whether they were able to survive longer or prevent their opponents from scoring as frequently. Additionally, semi-structured group interviews were conducted at the conclusion of each experiment session to capture further insights not included by the survey (see Appendix G for example questions). This round-table discussion between participants was used to allow for gameplay events and behaviour to be discussed, and through thematic analysis determine themes in participant experiences and preferences of awareness and MDDA design. This allows for greater richness of interpretation for more thorough understanding of quantitative results; an important requirement for accurately responding to the research questions in exploratory research.

Thematic analysis was chosen in order to extract the distinct ideas and concepts contained within the data set (Guest et al., 2011). However, Boyatzis (1998) notes that while thematic analysis is commonly used as a qualitative analytic method, it can vary is method and lack formality. To address this, the methodology chosen to analyse the interview data follows the six-phase process laid out by Braun and Clarke (2006) (see section 2.6.2) which has been successfully used for qualitative analysis in the field of player experience and games (Hussain & Griffiths, 2009; Kaye & Bryce, 2012; King & Delfabbro, 2015). Coding inter-reliability was checked with another researcher using Cohen's kappa to improve coding rigour and reduce researcher interpretation bias (Fleiss & Cohen, 1973) .

As the interviews would allow for more thorough exploration of the player experience and behaviour, arousal from EDA biometric readings was not deemed necessary to duplicate from Stage 3. The length of this study was extended compared to Stage 3 as the number of match conditions was increased to 4 to account for the increased awareness conditions while retaining the same 10 minute length per match for consistency, as well as the addition of the interviews. As extensive setup time is required for EDA across multiple participants per session along with interviews providing more detailed player experience information, the costs to time and participant fatigue (which can affect arousal readings) outweighed the potential benefits and were not considered to provide a substantial contribution to the research questions.

Experimental Design Considerations

Similar to Stage 3, a range of potential issues and experiment considerations were noted during the design of the methodology. The following solutions and preventative measures were used to minimise effects that may influence the results and ability to address the research questions. Due to design similarities with Stage 3, some potential issues are echoed here.

POTENTIAL ISSUE:	SOLVED BY:
Game design inconsistencies, quality or bugs influencing player experience.	• Using positively-received commercial game for testing (Unreal Tournament III). • Ensuring game has been available for at least 3 years to allow time for updates and big-fixes. • Maintaining same game version across all participant groups.
Increasing familiarity with game mechanics or 'practise' influencing data across the matches.	• Order of match conditions 2, 3 and 4 randomised for each group of participants. • Unreal Tournament III game selected for simple mechanics and controls to reduce learning curve. • Single-objective gameplay mode (score as many kills as possible). • Game settings and controls locked to prevent player manipulation. • Printed control scheme for UT3 available at all times for each participant.
Social interaction influencing player experience or awareness of MDDA. Some participants already known to each other while others were strangers.	• Talking or communication prohibited once study begins; both during gameplay and between matches. • Player names represented as random number during gameplay.
Participant awareness of MDDA in Match Condition 1, 2 or 3 (depending on whether player is assisted or not).	• Participants informed at the beginning of their session that they will be playing 4 matches; two standard and two with different features they will be notified of before that match (in reality, all matches are identical in terms of features). • Participant awareness is checked using the survey after each match to ensure participants did not attribute performance or receiving shields to MDDA. • MDDA presence hidden during gameplay. • Paper instructions provided are not in view of other participants to avoid noticing differences in instructions received. • Paper instructions were handed out in the same order each time to avoid the impression of the researcher specifically singling out certain participants for different instructions. • Papers instruct participants to leave the paper on their desk for the researcher to collect rather than handing them back or holding them up, which may have potentially allowed other participants to see their contents.
Viewing of score or match ranking affecting reporting of player experience in survey following match (e.g., changing post-match feelings of competence). Since conducting this study, the presence of player performance feedback has been demonstrated to affect the PENS and IMI measures independently of changes in gameplay (Bowey et al., 2015), verifying this concern.	• Score and player ranking removed from in-game Heads-Up Display (HUD), preventing participants from seeing individual performance compared to other participants. • Scoreboard and game menu keyboard commands removed to prevent participants from being able to open their ranking during gameplay. • Disconnect the game server after 10 minutes rather than letting the game end normally. At the conclusion of a match during normal play, the game would usually announce winners and

	MEASURES / METHOD	COMPONENT / DATA COLLECTED
STAGE 1	Formal review	Existing MDDA use in commercial games
STAGE 2	Interview: semi-structured (audio recording)	Player experience / preferences MDDA Framework feedback Player insights
	Survey	Player experience / preferences MDDA Framework feedback
STAGE 3	Survey: Player Experience of Needs Satisfaction (PENS)	Competence Autonomy Relatedness Presence
	Biometric: Electrodermal Activity (EDA)	Arousal
	Gameplay: video recording	Performance
STAGE 4	Survey: Player Experience of Needs Satisfaction (PENS)	Competence Relatedness
	Survey: Intrinsic Motivation Inventory (IMI)	Enjoyment
	Survey: Game Experience Questionnaire (GEQ)	Challenge
	Survey: Flow State Scale (FSS)	Flow
	Gameplay: video recording	Performance
	Interview: semi-structured (audio recording) with Thematic Analysis	Player experience / preferences Player behaviour Player insights

POTENTIAL ISSUE:	SOLVED BY:
	losers, display the player ranking and present the scoreboard. • Use a hidden key combination to forcefully close the game rather than 'exiting' normally. 'Exiting' through the game menu would usually display the scoreboard of the match.

Table 2. Stage 4 experimental design considerations

3.2.5 Research Stage Methodology Summary

Table 3. Summary of research methodologies

3.3 ETHICS AND LIMITATIONS

All studies in this research were evaluated as low-risk with no added risks beyond normal interaction with technology and games. Ethical approval was granted by the QUT Ethics Committee for four studies:

- Stage 2: Face-to-face interviews
- Stage 2: Online survey
- Stage 3: Experimental study including gameplay, survey and biometrics
- Stage 4: Experimental study including gameplay, survey and group interview

Participation remained voluntary at all times, and participants were also informed in all studies that consent may be withdrawn at any time during participation and any collected data destroyed.

The experimental studies in Stage 3 and 4 notably involved deception regarding information about gameplay rules, which was revealed in the debriefing at the conclusion of the study and deemed to be low-risk. As the game used for the study holds an MA15+ classification in Australia for high violence, participation was restricted to ages 17+ if a student of QUT, and 18+ if external to QUT to best satisfy low-risk human ethics requirements.

All participants were provided with information regarding the content of the studies prior to participation, as well as receiving contact information for QUT Counselling Services.

4 STAGE 1 - Defining and Creating an MDDA Framework

4.1 INTRODUCTION

In order to better understand the effect of dynamic difficulty adjustment (DDA) in competitive multiplayer video games, it was imperative to first establish a scope and definition for these features. Stage 1 of this program of research sought to answer Research Question 1:

- RQ1: What are the different types and implementations of MDDA?

As no formal method of classification or categorisation of these features exists, a formal review process was established to investigate the variety of multiplayer DDA features and use an iterative sorting process to create a framework of these features as a basis for each successive stage of research.

4.1.1 Defining Multiplayer Dynamic Difficulty Adjustment (MDDA)

As previously noted in the literature review (Chapter 2), reactive systems such as Dynamic Difficulty Adjustment (DDA) have been tested across singleplayer games in order to dynamically balance challenge through the manipulation of AI agent behaviour (Andrade et al., 2005) and the game environment (Hunicke & Chapman, 2004) in real-time during play. However, these techniques cannot be directly applied to multiplayer gameplay in which challenge is provided by competition between human players. Consequently, differentiation in terminology for dynamic difficulty systems in a competitive multiplayer context is necessary to prevent confusion and inclusion of irrelevant systems and mechanics not applicable to multiplayer video games.

For this program of study, the term Multiplayer Dynamic Difficulty Adjustment (MDDA) has been chosen. This reflects both its similar intent to DDA in affecting challenge based on player performance, but with the clear differentiation of context. For the purpose of identifying and examining MDDA, an MDDA ‘instance’ has therefore been defined as:

> *A gameplay feature in competitive multiplayer video games designed to reduce the difference in challenge experienced by all players through adjusting the potential performance of certain players.*

An example of MDDA is present in the combat racing game Mario Kart 7 (Nintendo, 2011) in which the chance of receiving a more effective weapon is increased for players ranked lower in the race at the time of picking up a weapon box. Through the use of more effective weapons, the level of challenge and skill required for low-performing players to improve their ranking is reduced, while high-performing players experience increased challenge as they defend against more powerful weapons.

4.2 METHOD

In spite of the relatively young age of video games as an entertainment medium, the link between balanced challenge and optimal player experience has been well established in research as demonstrated in section 2.3. In response, game designers and developers have already implemented a variety of game features and mechanics in commercial games that fall under the umbrella of MDDA. These have ranged in method and form, and subsequently received mixed responses from players and critics in terms of their value and success.

In order to deconstruct MDDA instances for the purpose of creating a comprehensive framework of MDDA, a formal review of these existing instances of MDDA in modern commercial games was necessary.

4.2.1 Game Selection Method

In order to investigate instances of MDDA already in use with current games, a total of 180 games were selected using the online game review aggregator website Metacritic (CBS Interactive Inc., 2013). Metacritic was used to guide selection of games for analysis due to its common usage within related studies (Koeffel et al., 2010) as an objective indication of game quality. Normalized game quality scores out of 100 are assigned by Metacritic from approved game review publications and web sites.

Prior to the formal review to identify MDDA instances, an initial investigation of the incidence of competitive multiplayer in different genres was undertaken. This initial investigation was also conducted via Metacritic's game summary information which lists the number of players supported by a game. For games supporting multiple players, a brief search of their gameplay modes was conducted to confirm the competitive format of multiplayer (as opposed to co-operative). By ensuring the formal review sample used games from differing genres in which competitive multiplayer gameplay is a common feature, the most broadly-applicable results could be found within the limitations of scope for this study.

The three genres with the highest proportion of competitive multiplayer gameplay modes were found and identified as: First-Person Shooter, Racing and Fighting. Sixty games with competitive multiplayer gameplay modes were selected from each of these three genres for a total sample of 180 games. To provide a broader range of games of differing quality, 30 games critically received as 'positive' (Metacritic rating of greater than 75), and 30 games with a quality of 'mixed' or 'negative' (Metacritic rating of 75 or less) were selected within each genre.

In order to prevent outdated or duplicate data, the following criteria were used to filter the selection of games:

- Games had to be commercially available for PC or home console. Mobile games were not included due to the relative infancy of widespread mobile gaming at the time, as well as the tendency for mobile games to be rapidly updated with changing feature sets.
- Games had to have an initial release date between 2003 (the year in which the first unified multiplayer online game services of Xbox Live, Steam and PlayStation Network were released) and 2011. Games released prior to 2003 may have limited representation of modern games and features.
- Only the most recent version of a game with multiple iterations or re-releases was selected to limit duplicate results from functionally identical games.

Identification of MDDA instances in the 180 games was conducted through sourcing information regarding the features, rules and mechanics associated with competitive multiplayer game modes. For each game, this process was conducted through the analysis of professional written reviews, previews, news and developer interviews; gameplay videos; and observations while playing the games. Additionally, searches were undertaken of online forums related to each game and questions were also posed to experienced players of each game via the forums. If an MDDA instance was identified or suggested by players, this was then investigated through gameplay to confirm its legitimacy.

4.2.2 MDDA Instance Analysis

As MDDA instances are game mechanics which act as modifiers to game rules in response to certain contextual conditions, the three major components of a game mechanic (Adams, 2010) were noted for each instance:

- **Condition:** the context that activates the instance's effects, such as when or how the decision to use MDDA is made.
- **Process:** the game rules affected or modified by the MDDA instance in an effort to reduce the difference in challenge experienced by players.
- **Entity:** the target, breadth and limitations of the effect, including which players are affected by the MDDA instance.

Once the data for all identified MDDA instances was collated, any game or genre-specific mechanics were abstracted to provide a genre-independent analysis of the way in which they affect the player. In this manner, MDDA instances were generalized beyond the game or genre from which they were identified. For example, both steering assistance in a racing game and aim-assistance in a shooter game may be abstracted to 'control accuracy assistance'. Through the generalization of game-specific features, iterative categorisation was used to sort MDDA instances across different games and genres.

After all instances of MDDA were collated, the elements were iteratively reviewed and analysed for three rounds. In each round further distinctions were identified in many elements as shown in Figure 2 below. For example, within the 'entity' component of the MDDA instance two different groupings were identified: the 'recipient' of the instance's capability adjustment and the 'duration' of the instance in either time or number of uses. If a component did not apply to all MDDA instances, it was considered a game-specific application of an individual MDDA instance and not a component of MDDA as a whole. For example, while the MDDA instances used in many games involved the manipulation of player avatar health, this could not be considered a classification component of MDDA as some other games did not contain any form of health or player avatar. As a result, 'effect on health' would be a game-specific implementation of MDDA but not a universal component of MDDA instances.

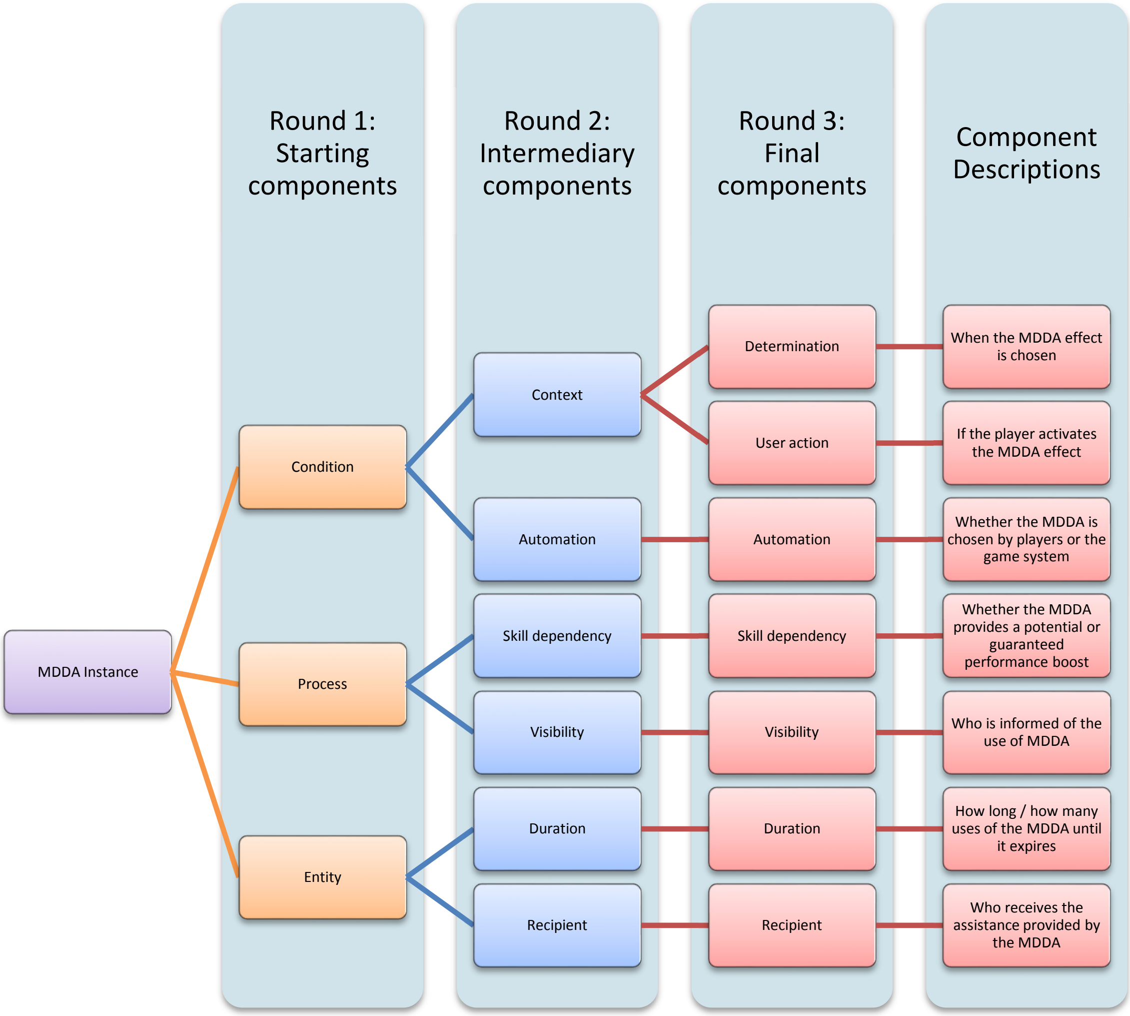


Figure 2. Stage 1 - Framework component iterations from formal review

An example of how two prominent MDDA instances from the formal review were described in terms of these starting components (Round 1) are provided in Table 4 below, followed by their final mapping to the preliminary framework in Section 4.3.3.

STARTING COMPONENT	Mortal Kombat 9 'X-Ray Move'	Call of Duty: Modern Warfare 2 'Painkiller Death Streak'
Condition	Players have access to a special move that requires a fixed-size meter to charge before it may be activated. The charging speed of this meter is controlled by the game system. It will fill slowly when successfully damaging an opponent, but will fill much quicker if receiving damage. Once it has filled, players can choose to execute the X-Ray Move at their convenience.	After dying a certain number of times in succession without scoring against an opposing player, the game system will provide the player with the 'Painkiller' Death Streak (providing this has been previously enabled outside of gameplay in the game options menu). This assistance will execute automatically without player control during gameplay.
Process	The X-Ray Move meter is always visible along the lower portion of the screen for both players and highlights when charging. Pressing the gamer controller triggers executes the X-Ray Move with the potential to deal significantly greater damage than any other attack, along with an accompanying visual notification and spectacle to highlight this. However, in order to successfully execute the player must be located in a certain position relative to their opponent and use timing to avoid it being blocked.	When activated, the 'Painkiller' Death Streak will provide the player with significantly increased damage resistance against the attacks of opposing players. This is accompanied by an interface notification of its activation and provides a guarantee of increased survivability during its use.
Entity	The X-Ray Move may be executed successfully or unsuccessfully once by an individual player before the meter empties and must be recharged.	The 'Painkiller' Death Streak affects only an individual player, including during team-based game modes. The damage resistance provided lasts for a set period of time before automatically deactivating.

Table 4. Stage 1 - Example MDDA instance classification from starting components

Once a new component was identified and tested against all collated MDDA instances, the possible values or 'attributes' of that component in each game was recorded. For example, the 'recipient' component was found to be valid through the ability to determine the recipient of the MDDA instance's effects across all games in the formal review. Two possible attributes of that component were recorded across all collated MDDA instances, as the 'recipient' could be described for all games as either an individual or a team. Consequently, the possible 'attributes' of the Recipient 'component' are Individual, or Team.

By identifying the components common to all MDDA instances, as well as the possible attributes of each component, a framework for classifying and identifying the instances was formed.

A chart of all games included in the formal review is available in Appendix A.

4.3 RESULTS - PRELIMINARY MDDA FRAMEWORK (V1)

4.3.1 Overview

The MDDA Framework provides a list of components that all MDDA contain, and their associated possible attributes. MDDA instances can be described by the attribute value(s) assigned to each component. An overview of the MDDA framework can be seen in Table 4 and more detail relating to each component (including example MDDA instances from the formal review) is provided in the following section 4.3.3.

4.3.2 Framework Chart

SYSTEM COMPONENT	ATTRIBUTES
1. Determination	• During gameplay • Pre-gameplay
2. Automation	• Applied by system • Applied by player(s)
3. Recipient	• Individual • Team
4. Skill Dependency	• Skill dependent • Skill independent
5. User Action	• Action required • Action not required
6. Duration	• Single use • Multi-use • Time-based
7. Visibility	• Visible to recipient only • Visible to non-recipients only • Visible to all players • Not visible

Table 5. Stage 1 - MDDA Framework summary

4.3.3 Framework Definitions

1. Determination

The Determination component refers to the game state or time in which the decision to use the MDDA instance is made. The attributes of this component are:

- *Pre-gameplay*: the decision to use the instance is made before the multiplayer game match commences. In this scenario, the need to adjust the performance of certain players would be determined by their past performance in the game relative to the players they now face.
  - EXAMPLE: Mortal Kombat 9 allows players to adjust a health handicap for players prior to a match commencing.
- *During gameplay*: the decision to use the instance is made in real-time during the multiplayer match. This would be appropriate if a player is currently performing significantly higher or lower than his/her opponents during play, irrespective of performance in past matches.
  - EXAMPLE: Mario Kart 7 will use an algorithm to adjust item selection based on real-time ranking during gameplay.

2. Automation

This component indicates whether the decision to use the MDDA instance is automated by the game system or chosen by the player(s) themselves. The attributes of this component are:

- *Applied by system (automated)*: the game system automatically determines the need for an MDDA instance and applies it. This relies on the game possessing a means of determining relative player performance, either simply through the difference in player score or a more complex method such as TrueSkill's player rankings (Herbrich & Graepel, 2006).
  - EXAMPLE: Mario Kart 7's item selection is chosen by the system without player input or the choice to disable it.
- *Applied by player(s) (manual)*: players choose to use an MDDA instance based on their own judgment. This is currently widely applied in the fighting

game genre, with players able to choose to distribute health handicaps before a match begins by providing increased player health for low-performing players.

  - EXAMPLE: Forza Motorsport 3 allows players to individually choose driving assists such as braking assistance.

3. Recipient

The recipient of an MDDA instance refers to the player(s) intended to be affected by the instance. The attributes of this component are:

- *Individual*: the instance is intended to affect a single player. This may be used both in individual and team-based gameplay modes in which the performance of an individual player is notably dissimilar to opposing players.
  - EXAMPLE: Super Smash Bros. Brawl will provide an individual player with a 'Final Smash' special move should they fall more than 5 kills behind other players.
- *Team*: the instance is intended to affect a group of players. This would only be possible in team-based gameplay modes.
  - EXAMPLE: Mario Kart Wii's team modes take team ranking into account for item selection, improving the chances of receiving better items and weapons when ranked lower relative to opposing teams.

4. Skill Dependency

This component indicates whether the low-performing players are required to act with some degree of skill in order to improve performance. The attributes of this component are:

- *Skill dependent*: the player(s) must respond, react or make-use-of the effects of the MDDA instance with a degree of skill in order for it to impact their performance. This refers to the instance effects having no direct impact on player performance, but instead providing the opportunity for an improvement or reduction in performance. For example, providing increased movement speed in a first-person shooter game does not guarantee a higher number of player 'kills' but may allow the player a better chance to do so if they act with skill.

  - EXAMPLE: Call of Duty: Modern Warfare 3's "Dead Man's Hand Death Streak" mechanic allows a downed player to crawl around and detonate an explosive strapped to them, potentially allowing them to defeat another player or their killer. This relies on player skill to successfully chase and damage the opposing player for any effect on performance to occur.

- *Skill independent*: the player(s) do not need to act with any degree of skill in order for their performance to be affected by the effects of the MDDA instance. In this case the effect applied is linked to the objective and winning conditions of the game by adjusting the player's performance irrespective of their behaviour. For example, increasing a player's health in a shooter game in which score is a function of number of kills scored against player deaths ensures the player will survive more damage without the player needing to act in a skilful manner for the benefit to occur.
  - EXAMPLE: Call of Duty: Modern Warfare 2's "Painkiller Death Streak" mechanic dramatically improve damage resistance for 10 seconds upon respawning in a match, improving the player's ability to survive irrespective of behaviour.

5. *User Action*

This component dictates whether the intended recipient of the MDDA instance is required to interact with the interface in order to initiate the instance's effects. The attributes of this component are:

- *Action required*: the recipient must interact with the interface in order for the effects of the instance to begin. For example, pressing a certain button to activate a speed boost item provided to the recipient in a racing game.

- EXAMPLE: Forza Motorsport 3’s driver assist mechanics to provide steering and braking assistance require the player to manually switch these on in order for them to be present in gameplay.

- *Action not required*: the effects of the instance will commence without player interaction with the interface. For example, the game automatically activating a speed boost in a racing game without user input.
  - EXAMPLE: Mario Kart 7’s item selection algorithm will improve the chances of receiving more effective items and weapons for low-ranking players without user input or control.

6. Duration

This component indicates the time-based property of the MDDA instance. The attributes of this component are:

- *Single-use*: the effects of the instance occur at a single moment. For example, a single boost to the player’s health.
  - EXAMPLE: Call of Duty: Modern Warfare 3’s “Martyrdom Death Streak” drops a live grenade upon the player’s death, potentially damaging nearby opposing players. The grenade is dropped a single time the instant the player is defeated.
- *Multi-use*: the effects of the instance may occur multiple times. For example, the player is given three health boosts he/she may activate over the course of the game.
  - EXAMPLE: ModNation Racers may provide low-performing players with 3 homing missiles to use at will against opposing players.
- *Time-based*: the effects of the instance occur continuously over a certain timeframe. For example, the player’s health will recharge gradually over 30 seconds of play before the instance ends.
  - EXAMPLE: Mario Kart 7 may provide a low-performing player with the “Bullet Bill” item, dramatically improving their speed and adding invincibility for several seconds.

7. Visibility

This refers to whether players of the game are provided with feedback regarding the presence of the MDDA instance. The attributes of this component are:

- *Visible to recipient only*: feedback is provided to the recipient of the instance, with the intention to inform him/her of the potential performance adjustments enacted by the instance. This may occur via visual, audio, or tactile means within the game such as a text notification in the game's Heads-Up Display (HUD) informing the player of the presence of the MDDA instance.
    - EXAMPLE: Call of Duty: Modern Warfare 2 will prominently display "Death Streak" on the assisted player's screen when a "Death Streak" mechanic is activated.
- *Visible to non-recipients only*: feedback is provided to the non-recipients that the target player or team is being affected by the instance. This can occur through the same methods listed above, but can additionally include the identity of the recipient. However, the recipient is not provided feedback.
- *Visible to all players*: feedback is provided to all players in the match (whether the beneficiary or not) that a certain player or team is the recipient of the instance.
    - EXAMPLE: Mortal Kombat 9 displays the both players' X-Ray special move meter on the screen for all players to witness its effects.
- *Not visible*: no feedback is provided to any players in the match that the instance is in effect. While experienced players may be able to deduce the presence of an MDDA instance through observed variations to the game rules, no intentional feedback is provided to the recipient or non-recipients as to the instance's presence or effects.
    - EXAMPLE: Burnout 3 does not display or inform players of the adjustments made to car speed based on player ranking in the current race.

4.3.4 Example MDDA Instances Described Using Framework

Mortal Kombat 9 – 'X-Ray Move'

Mortal Kombat 9 (NetherRealm Studios, 2011) is a fighting game in which the winner of a match is determined by causing damage to the opposing player until their health bar is depleted. This game contains MDDA in the form of 'X-ray moves'; special attacks that cause more damage than any other move, but must be timed correctly in order to successfully initiate. These are charged by an on-screen meter that fills slowly when dealing damage, but rapidly when receiving damage. As a result, lower-performing players have the opportunity to use their 'X-ray move' more than high-performing players. This instance can be described using the MDDA framework with the following component attributes:

4. **COMPONENT: Determination** – ATTRIBUTE: During gameplay

   The ability to use the X-ray move is charged in real-time during gameplay and is not influenced by performance in previous matches.

5. **COMPONENT: Automation** – ATTRIBUTE: Applied by system

   The game system monitors damage being received and dealt, and adjusts the speed the X-ray move meter fills in response.

6. **COMPONENT: Recipient** – ATTRIBUTE: Individual

   This is a one-on-one match, so the X-ray move meter only applies to an individual.

7. **COMPONENT: Skill Dependency** – ATTRIBUTE: Skill dependent

   The X-ray move causes a large amount of damage, but will only successfully activate if the player is correctly positioned and uses good timing to catch their opponent. The meter is reset to empty if the player does not successfully make contact with their opponent.

8. **COMPONENT: User Action** – ATTRIBUTE: Action required

   The X-ray move is required to be activated by the player through pressing a specific set of buttons.

9. **COMPONENT: Duration** – ATTRIBUTE: Single use

Once the X-ray move has been activated once, the meter resets to empty before beginning to fill again.

10. **COMPONENT: Visibility** – ATTRIBUTE: Visible to all players

    The X-ray move meters are visible to both players on screen at all times, and when an X-ray move is activated the game highlights its effect and which player has used it.

Call of Duty: Modern Warfare 2 – 'Painkiller Death Streak'

Call of Duty: Modern Warfare 2 (Infinity Ward, 2009) is a first-person shooter game in which the winner in the 'Team Deathmatch' mode is determined by the team that scores the most number of kills against the opposing team. MDDA exists in the form of 'death streaks'; different types of assistance activated by dying several times in a row without scoring. One of these is called the 'Painkiller' death streak, and will double the individual player's health for 10 seconds after 'respawning' in the match after being killed. This instance can be described using the MDDA framework with the following component attributes:

1. **COMPONENT: Determination** – ATTRIBUTE: During gameplay

   The painkiller death streak will activate after successive deaths in a single match, and is not influenced by previous matches.

2. **COMPONENT: Automation** – ATTRIBUTE: Applied by system

   The system keeps track of the player's deaths and will activate the death streak automatically upon the next 'respawn'.

3. **COMPONENT: Recipient** – ATTRIBUTE: Individual

   The painkiller death streak applies only to the individual irrespective of team performance.

4. **COMPONENT: Skill Dependency** – ATTRIBUTE: Skill independent

   Performance in Team Deathmatch mode is based on scoring kills and avoiding deaths. Doubling the player's health guarantees the player will survive longer than they would without this assistance, irrespective of their performance during activation.

5. **COMPONENT: User Action** – ATTRIBUTE: Action not required

   The painkiller death streak will activate automatically after respawning.

6. **COMPONENT: Duration** – ATTRIBUTE: Time-based

   The player's health will reset back to normal 10 seconds after activation of the death streak.

7. **COMPONENT: Visibility** – ATTRIBUTE: Visible to recipient only

   On-screen text will inform the player that the painkiller death streak has been activated, but other players will not be informed.

4.4 DISCUSSION

During the collection of the MDDA instances in the formal review, a notable trend was discovered. While the definition of MDDA encompasses features designed to reduce the difference in challenge between players through affecting performance, all MDDA instances found in the formal review focused on assisting low-performing players. No MDDA instances were recorded that involved reducing the performance of high-performing players through adding hindrance.

This may reflect reluctance by designers to give the appearance of "punishing" high-performing players for being more successful at attaining the winning conditions of a game, as this may provide conflicting motivations or discouragement from highly skilled play. As a player's skill level is only likely to improve or retain its level after continued play, high-performing players may frequently or repeatedly be hindered as they continue playing the game into the future. By instead assisting low-performing players, the appearance of "punishment" for skilful play is not present and does not conflict with the objectives required to meet the winning condition.

4.5 STAGE 1 SUMMARY

The content covered in Stage 1 has delineated how the MDDA framework was developed through the process of a formal review of existing MDDA features in competitive multiplayer video games and described the various components and attributes of the framework. Through the creation of the preliminary MDDA framework, a better understanding of the current implementations, design and analysis of MDDA instances has been made possible.

With the framework providing a basis for further investigation of MDDA, the following Stage 2 chapter describes the next step in validation and revision of the MDDA framework.

5 STAGE 2 – Evaluating and Revising the MDDA Framework

5.1 INTRODUCTION

Stage 2 of this program of research focused on Research Questions 1 and 2:

- RQ1: What are the different types and implementations of MDDA?
- RQ2: How does the presence of MDDA affect the performance and the player experience of:
    - RQ2a: low-performing players?
    - RQ2b: high-performing players?

As Stage 1 resulted in the construction of a preliminary MDDA framework from the examination of existing MDDA instances, Stage 2 was intended to focus on testing and refinement the framework in order to ensure RQ1 was thoroughly answered and ensure no components or attributes had not been accounted for in the formal review. Additionally, exploration into RQ2 could begin through investigating the effects of differing components and attributes of the framework on the player experience.

To accomplish these goals, a three-phase mixed-method process was devised:

1. Interviews with experienced game players to discover any potential missing or problematic framework components unaccounted for in the formal review (RQ1) and investigate their view on the use and effects of MDDA on their player experience (RQ2) to support interpretation of survey responses.
2. An online survey with a larger sample of game players, again seeking any issues or missing components of the framework (RQ1). However, a greater focus is placed on investigating the effect of individual framework components and attributes on enjoyment (RQ2) and to inform the direction of successive stages of the research project. Insights collected in the interviews is used to assist in interpretation of survey data.
3. Revision and implementation of the findings in an updated version of the framework (RQ1).

5.2 METHOD

5.2.1 Interview Method

Individual face-to-face interviews were conducted at Queensland University of Technology with 15 players of competitive multiplayer video games with data collection involving audio recordings and researcher notes. Questions were designed to investigate their competitive multiplayer preferences, experiences with differing types of MDDA and opinions regarding differing attributes of the MDDA Framework. Each interview lasted between 20 and 50 minutes. Participants were not informed of the specific purpose of the interview or the research topic with the interview simply titled "Player Experience of Competitive Multiplayer Video Games".

Participants were aged 17+ with the requirement that they have played one or more competitive multiplayer video games within the last 12 months. Recruitment was conducted through local video game-related groups and societies in Brisbane, Australia. The most commonly played multiplayer game genres were shooter, racing, MOBA (multiplayer online battle arena), strategy and fighting games, with participants reporting between 5 and 30 hours per week multiplayer gameplay within the past 12 months.

Interview questions were open-ended with participants encouraged to anecdotally recite specific examples of the points raised. This was intended to encourage self-reflection and enable participants to speak from and relate their answers to personal experience, as well as provide more detail and context to their answers. Reasoning and concerns commonly expressed by multiple participants were then used to assist in the interpretation of the following online survey (see section 5.2.2) by providing insights not able to be obtained through examination of survey data alone.

Questions were grouped within the three parts below.

INTERVIEW PART 1: Player Background & Unbalanced Challenge

The focus of this stage investigated player background in order to determine context for their opinions, as well as find additional validation outside of literature of the negative effect of unbalanced challenge on the player experience.

Question topics covered:

- Player background as a point of reference including competitive multiplayer game experience, preferred genres and play history.
- Conditions for optimal enjoyment in a multiplayer match, as a means of determining the importance of balanced skill levels to players.
    - Responses to questions in this set were additionally noted as either being 'with' or 'without' prompting. Subjective player experience issues that were voiced by the participants without the need for a direct question of their opinion on a point were listed as 'no prompting', while information gained once the interviewer directly inquired after the participant's opinion are listed as 'with prompting'. For example, when asked what factors lead them to not enjoy a multiplayer match, if the participant stated that playing with or against players of lesser skill negatively affected their experience then this statement was counted as 'without prompting'. If this point was not raised by the participant before the end of the set of questions, the interviewer would then directly ask how playing with or against players of lesser skill affected their experience. Their response to this is then listed as 'with prompting'. This distinction provides an indication of the subjective importance of an issue, with points raised by participants without prompting assumed to be of higher importance to the participant.
- Conditions for lowered enjoyment in a multiplayer match, framed as the opposite of the prior question set in order to expand on answers in more detail.
    - Up to and including this point no questions explicitly mentioned unbalanced challenge, player skill or experience level. This allowed the participant to raise these points as a detractor to their enjoyment

themselves if they had personally experienced it and avoid the researcher steering their response.

INTERVIEW PART 2: Effect of MDDA on the Player Experience

The effect of both real and hypothetical MDDA instances and their component attributes on the player experience.

Question topics covered:

- MDDA instances the participants had encountered in games they had played, and the effect on their enjoyment and behaviour.
- Hypothetical MDDA instances framed as a potential variant of existing Mario Kart and Call of Duty: Modern Warfare 2 MDDA instances.
    - Participants were asked about the effect of these instances on enjoyment and player behaviour. Question phrasing used a third-person hypothetical 'player' rather than asking directly about the participant's own experience. This encouraged participants to relate their opinions of the experience of both assisted low-performing players and unassisted high-performing players, rather than just the group they traditionally fall in. Participants were not informed of the framework itself.

INTERVIEW PART 3: MDDA Framework Improvements

Investigation of MDDA framework, using a print-out of the framework.

Question topics covered:

- Any potential missing, unclear or problematic framework components or attributes.
- Final thoughts from the participant of MDDA instances and the games in which they have encountered them.

5.2.2 Survey Method

Following the findings of the interviews, an online survey was conducted with a larger sample size (154 participants). Much like the interviews, the survey investigated how MDDA instances (at the time referred to as ‘competence normalising techniques’) containing each component and attribute of the preliminary MDDA framework may affect the player experience. Numbered scales were used in order to better quantify the result, while the use of Mario Kart and Call of Duty: Modern Warfare 2 game examples were once again used for consistency. Additionally, open-ended questions allowed participants to suggest and contribute any components or attributes perceived as missing.

Participants were required to be aged 17 or over with any level of multiplayer game experience. The survey was advertised via email to faculty and students of an Australian university, as well as on social media such as Facebook and the official Xbox, PlayStation and Nintendo forums with a link provided for participants to share with friends. The survey consisted of three major sections (full survey available in Appendix B).

SURVEY PART 1: Participant Background

To establish background context to each participant’s answers, demographic information regarding age, gender and competitive multiplayer game preferences was collected.

Participants were also asked to rate their experience level playing competitive multiplayer video games on a numbered scale from 1 (not at all experienced) to 7 (extremely experienced). The use of “experience level” in opposition to asking for self-rated performance was chosen due to the potential variance in performance between different game genres. For example, while a participant may be a high-performing player in certain first-person shooter games, they may be low-performing in racing games and as such lower their self-reported performance rating.

SURVEY PART 2: Framework Components and Attributes

The concept and definition of multiplayer dynamic difficulty adjustment was then explained, as well as the goal of these features in balancing challenge.

All seven MDDA framework components and their associated attributes were explained one at a time using the definitions in section 4.3.3 with an example MDDA instance from the games Mario Kart 7 (Nintendo, 2011) and Call of Duty: Modern Warfare 2 (Infinity Ward, 2009).

Each of the seven components and their associated attribute were presented to participants, who were asked to rate the effect of that MDDA attribute on their player experience using a 7-point numbered scale ranging from “1 - very negatively” to “7 - very positively”. Participants were asked to evaluate each MDDA attribute from the perspective of both a low performing player (receiving assistance from the MDDA instance) and a high performing player (in which they would be playing against the player receiving assistance from the MDDA instance). As a player’s performance is relative to that of the other players in a match, they are likely to occupy the positions of both a low and high-performing player in different matches or games as their opponents vary. This makes it important to record the opinions of players from the perspective of both positions for within-groups comparison.

Example questions for the Determination component:

- If you were a low-performing player, how would your experience be affected by being assisted with an MDDA instance that was applied:
    - Pre-gameplay: (numbered scale from 1-very negatively to 7- very positively)
    - During gameplay: (numbered scale from 1-very negatively to 7- very positively)
- If you were a high-performing player, how would your experience by affected by other players below your skill level being assisted with an MDDA instance that was assigned:
    - Pre-gameplay: (numbered scale from 1-very negatively to 7- very positively)
    - During gameplay: (numbered scale from 1-very negatively to 7- very positively)

SURVEY PART 3: Framework Feedback

A complete list of the framework was presented, with open-ended questions exploring any potential components or attributes participants felt were missing from the framework.

5.3 RESULTS

5.3.1 Participant Background and Perception of MDDA

Interview

The interviews were conducted with 15 participants (individually indicated by participant codes N#), 11 of whom were undergraduate students at Queensland University of Technology.

Part 1 of the interviews sought to confirm the issue of unbalanced challenge negatively affecting enjoyment in competitive multiplayer games. Table 5 below indicates the number of participants (n = 15) who expressed lowered enjoyment competing against players of differing skill levels relative to their own. "No prompting" indicates the participant stated the issue without being directly asked about the effect of competing against other players of differing skill levels, and "with prompting" for remaining participants who agreed when directly asked once the interview could not progress further without raising the topic.

Lowered enjoyment against players:	Participants - agreed (no prompting)	Participants - agreed (with prompting)	Participants - did not agree	Example participant quotes
With differing skill levels (both more or less skilled)	13	1	1	"When they [other players] aren't about the same skill it's not as fun or competitive because you can predict who will win."
More skilled	9	5	1	"Getting steamrolled [defeated by a large margin] by someone way better than you isn't fun. If it happens repeatedly you don't get time to learn how to improve."
Less skilled	11	1	3	"Stomping [easily defeating] new or bad players gets boring; there's no challenge and it probably sucks for them too."

Table 6. Stage 2 – Interview responses for skill preference

The following Table 6 indicates participant perception of the effect of MDDA, using MDDA features in Mario Kart and Call of Duty: Modern Warfare 2 as examples.

Perception of MDDA based on existing games	Participant agreed (n = 15)	Example participant quotes
Positive effect on enjoyment	12	"It makes it more fun for novices, and to play with them."
Negative effect on enjoyment	1	"It's not as competitive if they're being helped."
No effect on enjoyment	2	"It can add variety, but I don't think it really changes how much I enjoyed it."
Believe MDDA instances affect end result ranking.	7	"If they're helped [by MDDA instance] right near the end of a match it can change it."
Does not believe MDDA instances affect end result ranking.	8	"It brings the scores closer but doesn't change the order."
Believe match result ranking affects enjoyment.	10	"Of course if I do better it probably means I was having more fun because I was winning."
Believe match result ranking has no relation to enjoyment.	5	"I don't really care if I win or lose, and I don't think knowing makes it more or less satisfying."

Table 7. Stage 2 – Interview responses for MDDA preference

Survey

Of the 154 valid participant responses collected, an average age of 23.70 (SD = 7.30) was recorded with 129 male and 32 female respondents; indicating a gender bias may be present in the results. Some participants did not complete the survey, in which case responses up to the last full page completed were stored and any further incomplete responses removed, with 125 participants completing all pages of the survey.

Participants had first played a competitive multiplayer video games an average of 9.44 years ago and 91.56% have played within the last year. An average of 9.96 hours (SD = 9.20) of competitive multiplayer gameplay was played per week by participants, while the most popular platform for playing competitive multiplayer games online was PC (including Windows, Mac, Linux and other operating systems) with 87.01% of participants, followed by Xbox 360 on 42.21% and PlayStation 3 with 31.17%. First-Person Shooters was the most popular genre for competitive multiplayer gameplay, played by 83.77%. Participants rated their experience level playing competitive multiplayer games an average of 5.28 (SD = 1.58) from '1 – not at all experienced' to '7 – extremely experienced'.

Participants were asked their enjoyment competing against players of differing skill levels relative to their own from '1 – not at all enjoyable' to '7 – extremely enjoyable'. Enjoyment competing against players above their skill level was rated an average of 4.22 (SD = 1.63), about the same skill level an average of 5.99 (SD = 1.28) and below their skill level an average of 4.59 (SD = 1.50) (see Figure 3).

An effect was recorded for enjoyment between relative skill levels ($F_{2,316}$ = 79.248, $p < .001$, $\eta_p^2 = .334$) with participants preferring to compete against similarly skilled opponents compared to those higher ($p < .001$) or lower-skilled ($p < .001$). However, a statistically significant difference in enjoyment was not recorded between competing against player higher or lower-skilled ($p = .089$).

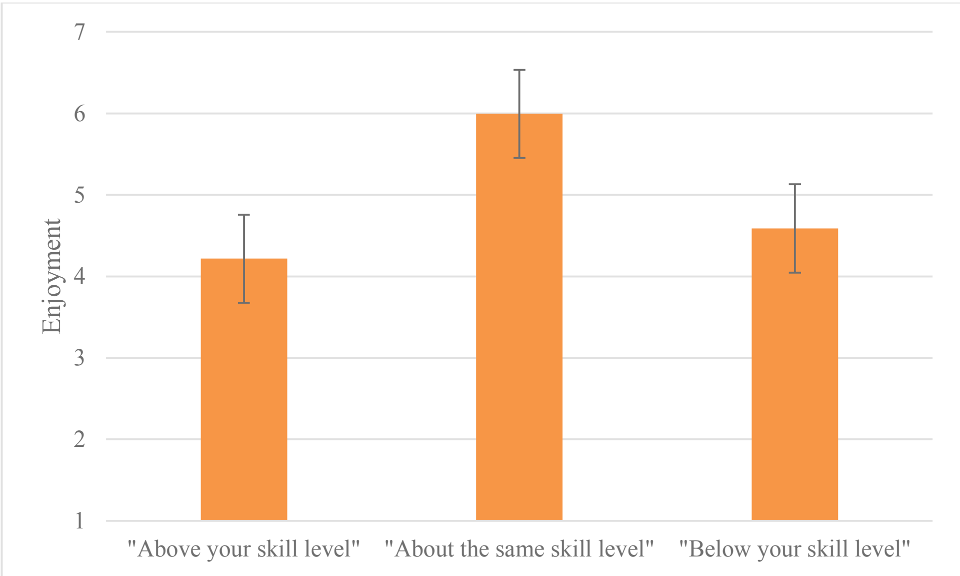


Figure 3. Stage 2 – Enjoyment competing against differently skilled players

5.3.2 Framework Components and Attributes

Table 7 below summarises interview responses to a series of questions regarding hypothetical versions of MDDA instances in two existing competitive multiplayer games – Mario Kart 7 (Nintendo, 2011) and Call of Duty: Modern Warfare 2 (Infinity Ward, 2009). Participants were asked for their opinion and feelings regarding the effect of these MDDA instances on their enjoyment, with varying component attributes based on the MDDA framework. As participants used imagined play experiences to indicate their preferences, there is the potential for these results to differ from real-world gameplay and should be interpreted as such.

		No. of participants who feel:		
Component	**Attribute**	**Positively**	**Negatively**	**Undecided**
Determination	Pre-gameplay	10	2	3
	Gameplay	12	2	1
Automation	Applied by system	7	6	2
	Applied by player	11	1	3
Recipient	Individual	14	1	0
	Team	10	3	2
Skill Dependency	Skill dependent	9	5	1
	Skill independent	8	3	4
User Action	Action required	14	0	1
	Action not required	11	2	3
Duration	Single-use	12	1	2
	Multi-use	11	2	2
	Time-based	10	2	3
Visibility	Visible to recipient	13	0	2
	Visible to non-recipients	6	4	5
	Not visible	4	8	3

Table 8. Stage 2 – Interview responses to framework components

The following results indicate survey participants' ratings of the effect of each component attribute on their player experience from 1 (very negatively) to 7 (very positively) from the perspectives of low and high performing players. Statistical analysis was conducted using a two-way repeated measures ANOVA, with the within-subjects factors of component attribute (2 or 3 depending on component) and performance (2) and a dependent variable of player experience.

Significance was tested using Wilks' Lambda with an alpha of $p < 0.05$, with Bonferroni adjustment used for comparisons of attribute and performance. No outliers were present for any components, as assessed by examination of studentised residuals for values greater than ±3. Normality was tested by dividing skew and kurtosis of studentised residuals by their standard error, to which none exceeded ±3. Mauchly's test of sphericity was used to confirm no violations of the assumption of sphericity were present in three-factor components (Duration and Visibility). As the use of parametric tests on Likert and numbered-scale data can be controversial (Jamieson, 2004), the non-parametric Friedman's test was used to check all results. The pattern of results was substantively the same with both parametric and non-parametric analyses and the non-parametric results are reported herein. Additional insights and quotes from interview participants are also noted for each framework component.

Recipient Component

Attribute	Perspective	Mean	Std. Deviation	N
Individual	Low-performing (assisted)	4.5664	1.58140	143
	High-performing (unassisted)	4.0210	1.54950	143
Team	Low-performing (assisted)	4.1189	1.58554	143
	High-performing (unassisted)	3.1818	1.61261	143

Table 9. Stage 2 – Survey responses to Recipient component

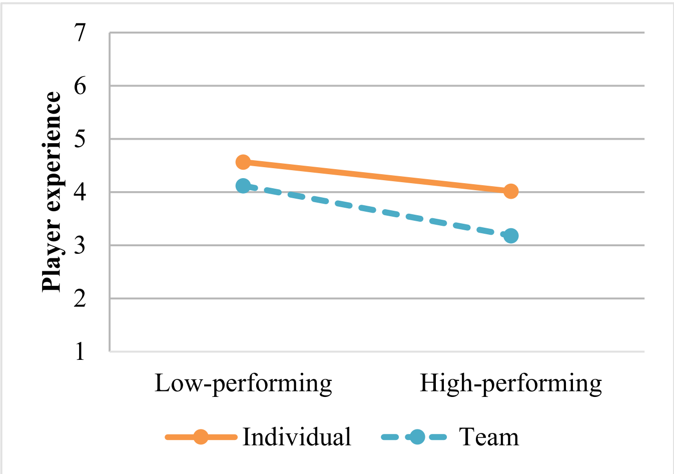


Figure 4. Stage 2 – Recipient component

For the Recipient component, there was a main effect for performance level as the attributes were rated higher from the low-performing perspective than the high-performing perspective ($F_{1,142} = 44.03$, $p < .001$, $\eta_p^2 = .237$). A main effect on attribute was also found ($F_{1,142} = 28.90$, $p < .001$, $\eta_p^2 = .169$), and these effects were qualified by a significant interaction between attribute and performance level on player experience ($F_{1,142} = 7.75$, $p = .006$, $\eta_p^2 =$

.052) (see Figure 4). The Individual attribute was seen as having a more positive influence from the low-performing perspective than the high-performing perspective ($F_{1,142}$ = 24.816, p < .001, η_p^2 = .149), with the same true for the Team attribute ($F_{1,142}$ = 38.392, p < .001, η_p^2 = .213). The Individual attribute was seen as having a more positive influence than the Team attribute from the low-performing perspective ($F_{1,142}$ = 12.425, p = .001, η_p^2 = .080), as well as the high-performing perspective ($F_{1,142}$ = 31.406, p < .001, η_p^2 = .181), however the difference was more pronounced for high performing players.

13 of 15 interview participants attributed a preference for individual recipients to the desire to "*limit any assistance to just the person who needs it*" (N2) and avoid "*boosting [the performance of] a whole team just because some players aren't as good*". N4 stated: "*if I was on a team and not doing very well, it would be embarrassing if my whole team got helped because my score was bad*".

Determination Component

Attribute	Perspective	Mean	Std. Deviation	N
Pre-gameplay	Low-performing (assisted)	4.2000	1.60954	150
	High-performing (unassisted)	3.8667	1.54862	150
During gameplay	Low-performing (assisted)	4.7067	1.70883	150
	High-performing (unassisted)	3.7800	1.60899	150

Table 10. Stage 2 – Survey responses to Determination component

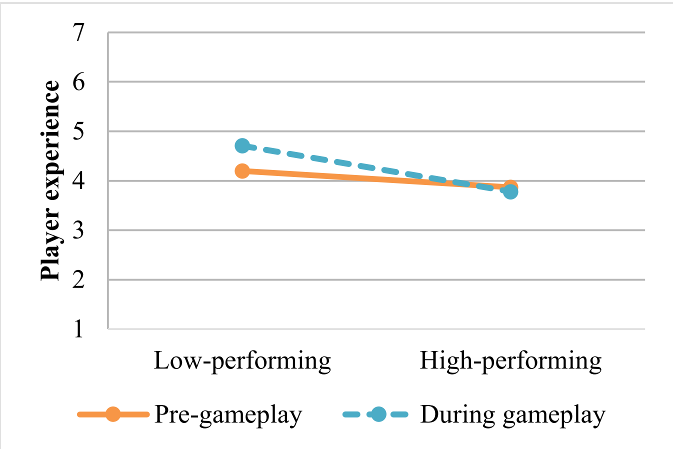


Figure 5. Stage 2 – Determination component

For the Determination component, there was a main effect for performance level as the attributes were rated higher from the low-performing perspective than the high-performing perspective ($F_{1,149}$ = 32.889, p < .001, η_p^2 = .181). A main effect on attribute was also found ($F_{1,149}$ = 3.933, p =

.049, η_p^2 = .026), and these effects were qualified by a significant interaction between attribute and performance level on player experience ($F_{1,149}$ = 20.062, p < .001, η_p^2 = .119) (see Figure 5). The Pre-Gameplay attribute was seen as having a more positive influence from the low-performing perspective than the high-performing perspective ($F_{1,149}$ = 6.512, p = .012, η_p^2 = .042), with the same true for the During Gameplay attribute ($F_{1,149}$ = 54.186, p < .001, η_p^2 = .267). The During Gameplay attribute was seen as having a more positive influence than the Pre-Gameplay attribute from the low-performing perspective ($F_{1,149}$ = 15.613, p < .001, η_p^2 = .095), while the high-performing perspective did not distinguish between pre-gameplay and during-gameplay.

A majority of interview participants (10) commented that the Determination of an MDDA instance doesn't really matter to non-recipient (high-performing players) because "*the low-scoring guys are being helped anyway, so it doesn't matter when that's chosen if it's going to happen anyway*" (N8). Several participants indicated that low-performing players may prefer the MDDA to be enacted during gameplay "*because if you are having a really good day or you've gotten better, you still want the chance to win on your own skill*" (N12), with 11 participants raising the point that performance is not always consistent between matches. Three participants also noted the potential for reduced self-esteem from pre-gameplay MDDA, with N4 noting "*if you're already marked to be helped before the match starts it's like it's already telling you you're not good enough*".

Automation Component

Attribute	Perspective	Mean	Std. Deviation	N
Applied by system	Low-performing (assisted)	4.6454	1.56358	141
	High-performing (unassisted)	3.9220	1.56785	141
Applied by player(s)	Low-performing (assisted)	4.1418	1.60616	141
	High-performing (unassisted)	3.7660	1.57950	141

Table 11. Stage 2 – Survey responses to Automation component

For the Automation component, there was a main effect for performance level as the attributes were rated higher from the low-performing perspective than the high-performing perspective ($F_{1,140} = 36.441$, $p < .001$, $\eta_p^2 = .207$). A main effect on attribute was also found ($F_{1,140} = 4.709$, $p = .032$, $\eta_p^2 = .033$), and these were qualified by a significant interaction between attribute and performance level on player experience ($F_{1,140} = 5.009$, $p = .027$, $\eta_p^2 = .035$) (see Figure 6). The Applied By System attribute was seen as having a more positive influence from the low-performing perspective than the high-performing perspective ($F_{1,140} = 43.733$, $p < .001$, $\eta_p^2 = .238$), with the same true for the Applied By Player(s) attribute ($F_{1,140} = 8.475$, $p = .004$, $\eta_p^2 = .057$). The Applied By System attribute was seen as having a more positive influence than the Applied By Player(s) attribute from the low-performing perspective ($F_{1,140} = 9.014$, $p = .003$, $\eta_p^2 = .060$), while the high-performing perspective did not distinguish between system or player applied.

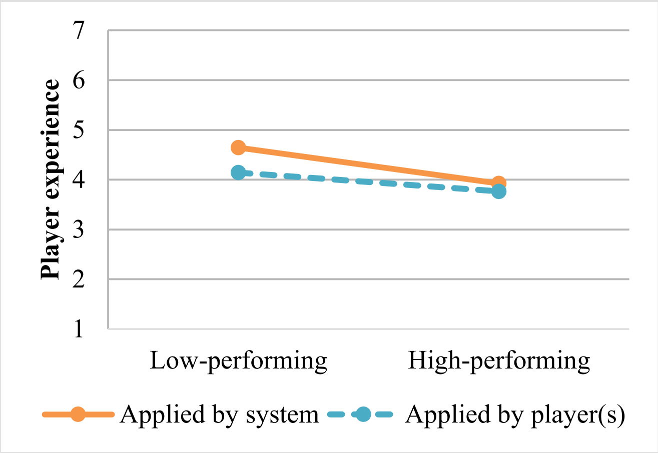


Figure 6. Stage 2 – Automation component

Twelve participants commented that MDDA applied by the system (automated) may be "*more fair because it's not biased*" (N1). This was supplemented by concerns from 8 participants that MDDA applied by players might "*not be accurate*" (N15) or that some players might "*try to exploit it by giving themselves a boost so they can win*" (N1). These concerns were noted by 4 participants to be more applicable to online play against strangers, because "*if you're playing with your friends then it doesn't matter as much since you know the other guys*" (N8).

Skill Dependency Component

Attribute	Perspective	Mean	Std. Deviation	N
Skill dependent	Low-performing (assisted)	4.4478	1.56353	134
	High-performing (unassisted)	4.6045	1.50197	134
Skill independent	Low-performing (assisted)	4.5672	1.60098	134
	High-performing (unassisted)	3.5896	1.55700	134

Table 12. Stage 2 – Survey responses to Skill Dependency component

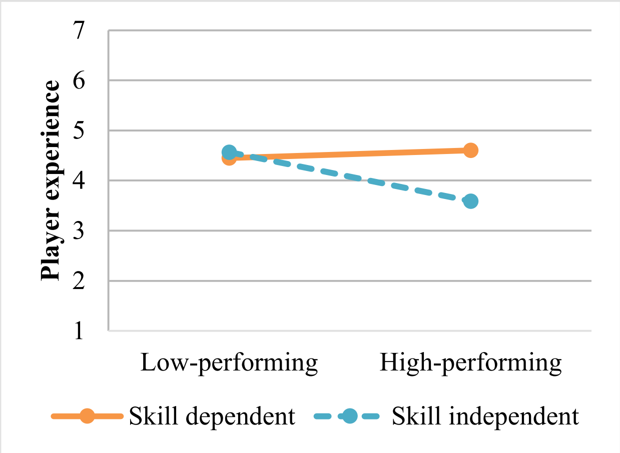


Figure 7. Stage 2 – Skill Dependency component

For the Skill Dependency component, there was a main effect for performance level as the attributes were rated higher from the low-performing perspective than the high-performing perspective ($F_{1,133} = 21.230$, $p < .001$, $\eta_p^2 = .138$). A main effect on attribute was also found ($F_{1,133} = 12.940$, $p < .001$, $\eta_p^2 = .089$), and these were qualified by a significant interaction between attribute and performance level ($F_{1,133} = 29.567$, $p < .001$, $\eta_p^2 = .182$) (see Figure 7). The Skill Independent attribute was seen as having a more positive influence from the low-performing perspective than the high-performing perspective ($F_{1,133} = 55.858$, $p < .001$, $\eta_p^2 = .296$) while the low-performing perspective and the high-performing perspective did not differ on the Skill Dependent attribute. The Skill Dependent attribute was seen as having a more positive influence than the Skill Independent attribute from the high-performing perspective ($F_{1,133} = 45.670$, $p < .001$, $\eta_p^2 = .256$), while in contrast the low-performing perspective did not distinguish between the attributes.

Eleven interview participants indicated that high-performing players may dislike skill independent MDDA as it "*might look a bit like cheating someone's score gets better without them having to actually play any better*" (N2). Three participants highlighted that this may be more notable for "*eSports (professional players) and competitions or really serious players*" (N15) who may view it as "*unfair*" (N7).

User Action Component

Attribute	Perspective	Mean	Std. Deviation	N
Action required	Low-performing (assisted)	4.5231	1.39331	130
	High-performing (unassisted)	4.3923	1.42239	130
Action not required	Low-performing (assisted)	4.4077	1.65514	130
	High-performing (unassisted)	3.6615	1.56786	130

Table 13. Stage 2 – Survey responses to User Action component

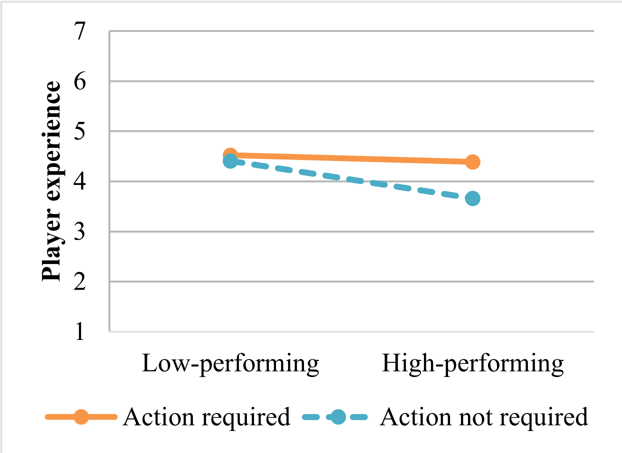


Figure 8. Stage 2 – User Action component

For the User Action component, there was a main effect for performance level as the attributes were rated higher from the low-performing perspective than the high-performing perspective ($F_{1,129}$ = 23.969, p < .001, η_p^2 = .157). A main effect on attribute was also found ($F_{1,129}$ = 11.191, p = .001, η_p^2 = .080), and these were qualified by a significant interaction between attribute and performance level ($F_{1,129}$ = 17.222, p < .001, η_p^2 = .118) (see Figure 8). The Action Not Required attribute was seen as having a more positive influence from the low-performing perspective than the high-performing perspective ($F_{1,129}$ = 43.912, p < .001, η_p^2 = .254), while the low-performing perspective and the high-performing perspective did not differ on the Action Required attribute. The Action Required attribute was seen as having a more positive influence than the Action Not Required attribute from the high-performing perspective ($F_{1,129}$ = 27.849, p < .001, η_p^2 = .178) while the low-performing perspective did not distinguish between these attributes.

Interview participant N1 commented that low-performing players might "*need to be helped anyway, so it should probably be automatic*", while 6 participants indicated that high-performing players may prefer user action be required so "*then the losing players can choose to not use it if they want to try and play just with skill instead*" (N12).

Duration Component

Attribute	Perspective	Mean	Std. Deviation	N
Single-use	Low-performing (assisted)	4.5827	1.25635	127
	High-performing (unassisted)	4.5276	1.25247	127
Multi-use	Low-performing (assisted)	4.9921	1.42815	127
	High-performing (unassisted)	3.7795	1.44152	127
Time-based	Low-performing (assisted)	4.6850	1.52597	127
	High-performing (unassisted)	4.1890	1.49461	127

Table 14. Stage 2 – Survey responses to Duration component

Mauchly's test of sphericity indicated that the assumption of sphericity was met for attribute ($X^2(2) = 2.012$, $p = .366$) and the two-way interaction ($X^2(2) = 2.524$, $p = .283$).

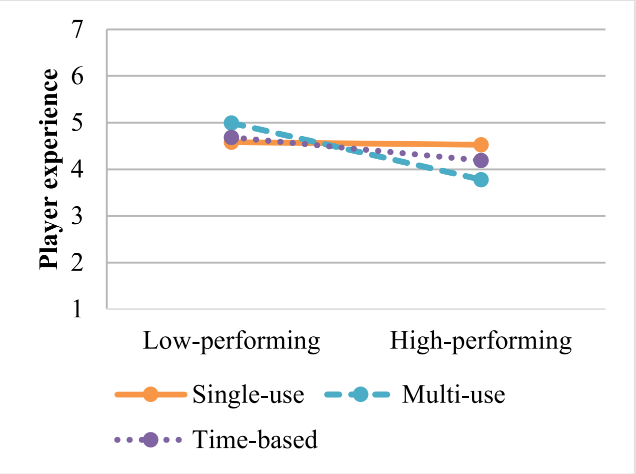


Figure 9. Stage 2 – Duration component

For the Duration component, there was a main effect for performance level as the attributes were rated higher from the low-performing perspective than the high-performing perspective ($F_{1,126} = 29.198$, $p < .001$, $\eta_p^2 = .188$), which was qualified by a significant interaction between attribute and performance level ($F_{2,252} = 36.008$, $p < .001$, $\eta_p^2 = .222$) (see Figure 9). The Multi-Use attribute was seen as having a more positive influence from the low-performing perspective than the high-performing perspective ($F_{1,126} = 70.603$, $p < .001$, $\eta_p^2 = .359$), with the same true for the Time-Based attribute ($F_{1,126} = 11.659$, $p = .001$, $\eta_p^2 = .085$). The low-performing perspective and the high-performing perspective did not differ on the Single-Use attribute. An effect was present for the low-performing perspective ($F_{2,252} = 6.455$, $p = .002$, $\eta_p^2 = .049$) who saw the Multi-Use attribute as having a more positive influence than both the Single-Use ($p = .002$) and Time-Based ($p = .033$) attributes. An effect was also present for the high-performing perspective ($F_{2,252} = 22.044$, $p < .001$, $\eta_p^2 = .149$) who saw the Single-Use attribute as having a more positive influence than the Multi-Use ($p < .001$) and Time-Based ($p = .011$) attributes, while Multi-Use was also seen as having a more positive influence than Time-Based ($P = .001$).

Five interview participants indicated that low-performing players may prefer multi-use MDDA instances so "*they have a few chances to use it properly*". However, N1 also expressed that *"obviously low-performing would want that because there would be more performance gain, but the high-performing players might not like that since it gives more boosts" and "could provide too much assistance so winning doesn't take skill*". Concerns from 3 participants were also noted that multi-use MDDA may be *"more open to abuse and exploitation, like if someone purposely played badly to then get something they could use multiple times over the rest of the match to win*" (N11).

Visibility Component

Attribute	Perspective	Mean	Std. Deviation	N
Visible to recipient	Low-performing (assisted)	5.0794	1.34226	126
	High-performing (unassisted)	3.8492	1.55470	126
Visible to non-recipient	Low-performing (assisted)	3.9206	1.49454	126
	High-performing (unassisted)	4.3571	1.66596	126
Not visible	Low-performing (assisted)	3.8810	1.93332	126
	High-performing (unassisted)	3.6111	1.88031	126

Table 15. Stage 2 – Survey responses to Visibility component

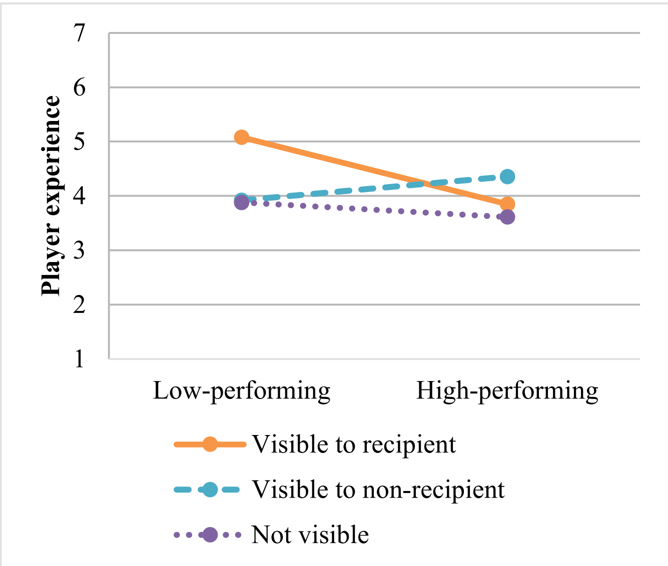


Figure 10. Stage 2 – Visibility component

Mauchly's test of sphericity indicated that the assumption of sphericity was met for the two-way interaction ($X2(2) = 4.239$, $p = .120$), but not attribute ($X2(2) = 49.790$, $p < .001$) so Greenhouse-Geisser adjustment has been used with an epsilon of .751.

For the Visibility component, there was a main effect for performance level

($F_{1,125}$ = 17.104, p < .001, η_p^2 = .120) as the attributes were rated higher from the low-performing perspective than the high-performing perspective. A main effect on attribute was also found ($F_{1.503,187.870}$ = 10.236, p < .001, η_p^2 = .076), and these were qualified by a significant interaction between attribute and performance level ($F_{2,250}$ = 47.005, p < .001, η_p^2 = .273) (see Figure 10). The Visible to Recipient attribute was seen as having a more positive influence from the low-performing perspective than the high-performing perspective ($F_{1,125}$ = 79.362, p < .001, η_p^2 = .388), with the same true for the Not Visible attribute ($F_{1,125}$ = 5.056, p = .026, η_p^2 = .039). However, the Visible to Non-Recipients was seen as having a more positive influence from the high-performing perspective than the low-performing perspective ($F_{1,125}$ = 10.384, p = .002, η_p^2 = .077). An effect was present for the low-performing perspective ($F_{1.631,203.887}$ = 28.078, p < .001, η_p^2 = .183) who saw the Visible to Recipient (themselves) attribute as having a more positive influence than both the Visible to Non-Recipients (p < .001) and Not Visible (p < .001) attributes. An effect was also present for the high-performing perspective ($F_{1.720,215.010}$ = 8.956, p < .001, η_p^2 = .067) who saw the Visible to Non-Recipient (themselves) attribute as having a more positive influence than both the Visible to Recipients (p = .005) and Not Visible (p = .002) attributes.

One participant commented that as a low-performing player, "*I would want to be told if I was being helped so I know that it's not just my skill*" (N6) while another stated "*I would probably be able to use it better if I knew what the assistance was*" (N9). However, they may not wish it to be visible to high-performing players as "*that would make me a target and they'd probably try to hunt me down*" (N9). Four participants also admitted that "*if I saw someone being helped I'd probably avoid them*" (N5) while 3 more expressed the upside that "*it would be really satisfying to take them down*" (N11).

5.3.3 Framework Feedback

No additional framework components or attributes unaccounted for were suggested by survey participants. However, some confusion was expressed regarding the Visibility component. Three survey participants and two interview participants questioned whether extended play in a game could result in players becoming aware of the presence of the MDDA instance even if the Visibility component used the ‘Not visible’ attribute. As one participant noted, Mario Kart does not make the used of MDDA visible during gameplay, but many players are aware from observation over time. This contributed to the MDDA framework revision in section 4.10 below.

5.4 DISCUSSION

5.4.1 Unbalanced Challenge and MDDA

Interview participants indicated competing with differently skilled players to be an issue negatively affecting their enjoyment of competitive multiplayer games, with 13 of 15 raising this issue without any prior mention of unbalanced challenge or the topic of the interviews. Similarly, survey participants rated competing against players of the same skill level as more enjoyable than those of higher or lower relative skill. This was expected due to the overwhelming research support for balanced challenge providing an improved experience such as in SDT (E. L. Deci & Ryan, 1985), Flow (Csikszentmihalyi, 1990) and GameFlow (Sweetser & Wyeth, 2005). However, the high number of interview participants who raised unbalanced skill levels as an issue provides further support that this is an ongoing problem still affecting many current multiplayer games in spite of existing uses of performance balancing methods such as matchmaking or current implementations of MDDA. Interestingly, a difference was not found for enjoyment between competing against relatively lower or higher-skilled players, demonstrating the issue does not simply affect low-performing players who may be new or inexperienced, but also high-performing players. This further supports the hypothesis that MDDA may hold potential to improve the experience of both sets of players in a match, highlighting the importance of determining the player experience effects for both groups in further stages of this research project.

Interview participants indicated a generally positive view of MDDA as a feature in games and most believed personal performance had an impact on their enjoyment. However, they were more split when questioned whether they believed MDDA had an effect on match outcomes which may reflect the variety of MDDA implementations used if different games. For example, Mario Kart's strong MDDA effects could be seen as having a higher impact on final match results than those in Mortal Kombat 9 (NetherRealm Studios, 2011). The use of MDDA that affects end results was not spoken of as positively with the issue of "fairness" and potential for exploitation raised.

5.4.2 Components and Attributes

When questioned on the effect different MDDA component attributes would have on their play experience, a general trend emerged. From the perspective of low-performing (assisted) players, survey participants consistently rated almost all forms of MDDA instances as having a more positive effect than as high-performing (unassisted) players. As the presence of MDDA instances are expected to have the largest effect on low-performing players, this result was predictable.

Examination of the significant attribute preference patterns between components indicate three major trends:

1. Player control over the instance;
2. Personal benefit from the effects of the instance;
3. Player awareness of the instances' presence and effects.

Control

A trend across the four components of Duration, Skill Dependency, User Action and Visibility provided an indication that players would prefer increased control over the presence, action and properties of the MDDA instance when in the position of a high-performing player (i.e., when not the recipient of the technique's assistance). Participants reported a more positive experience for instances that were visible to non-recipients, skill dependent, had a limited duration (single-use or time-based) and required user-action to activate. These suggest a more positive influence from instances that provide limited or only potential performance assistance within user control. This would result in techniques being more transparent in their presence and systems. However, as the low-performing recipient of assistance provided by an MDDA instance, participants reported largely the opposite with a more positive view of more hidden instances that are not visible to non-recipients and provide an immediate performance boost without interaction required. This suggests a desire for skill to still play the primary role in a player's performance occupying the perspective of a high-performing player, while from a low-performing player's perspective they may not be as confident that any performance gain could be achieved if left only as an opportunity rather than an immediate effect.

Participants agreed on one particular component affecting control as both low and high-performing players; both as a recipient and non-recipient participants preferred the need for activation of an MDDA instance to be automated by the game system rather than chosen by players. This contradicts the findings of the interviews where system-automated instances were viewed with more suspicion. Due to system-automated instances being reported much more positively from the perspective of low-performing players than high-performing, the impartial decision made by the game system may be seen as a better means of regulating an instance's effects in contrast to leaving the decision up to players themselves; both recipient and non-recipient. Pride may also factor into this, with the potential social embarrassment of manually applying assistance from an MDDA instance making low-performing players feel less positive than when the system is in control.

Several interview participants cited the potential for MDDA to be exploited by experienced players, such as intentional poor performance early in a match when automated or applying unneeded assistance to oneself when selected by player. This was also stated as a reason for reduced agreement on whether skill dependent or independent (Skill Dependency component) MDDA instances improved the experience in the interviews. Skill independent assistance was seen by some participants as being less fair or open to exploitation due to its more guaranteed effect on performance. However, skill dependent instances may not be utilised effectively by the low-performing players it is intended to assist. Some participants suggested using skill dependent instances for players performing only slightly worse than their opponents, while skill independent instances may be more effective for players performing substantially lower than others.

Personal Benefit

Trends were found between attributes that may affect the degree of personal benefit received for the Duration, Recipient, Skill Dependency and Visibility components. From the low-performing perspective, players were more likely to report a positive effect on enjoyment from component attributes that may provide more personal benefit to the recipient (e.g., the multi-use option for the Duration attribute, as opposed to only single-use or time-based). However, a more positive effect was reported from a high-performing player's perspective for attributes which could allow high-performing players to minimize or nullify its effects. For example, an MDDA instance made visible to non-recipients would allow high-performing players to adapt to, target or take advantage of a low-performing player marked as being assisted.

Consistent with concerns over the potential for exploitation, participants were positive about instances made visible to the recipient but divided on whether it should be visible to non-recipients. Concerns raised by interview participants centred around the unintentional effect of making MDDA recipients a target for ‘punishment’ by high-performing players, with some admitting they may be likely to engage in this behaviour. However, interview participants were also divided in their opinion about whether they should be invisible to all players. Two reasons were stated for feeling negative about invisible instances; the first was potential for confusion due to the slight change in game rules or properties when an instance is in effect, such as a particular player taking more than the usual amount of damage to defeat. The second was whether an MDDA instance could really remain unknown to experienced players, as those with more experience may recognise when an instance is present even without direct feedback. This was seen as again allowing for exploitation by high-performing players. For example, an MDDA instance made visible to non-recipients would allow high-performing players to adapt to, target or take advantage of the marked low-performing player. Together, this paints a picture of players feeling positively about the influence of MDDA instances in general, but primarily when they personally receive some benefit during play, or may reduce the benefit to others.

However, the more positive response to attributes that may minimize the benefits to low-performing players from the perspective of a high-performing players runs contradictory to the intent of MDDA in balancing player performance. As balanced challenge and user skill have been thoroughly demonstrated as key factors in achieving flow (Csikszentmihalyi, 1990) and a sense of competence as key for intrinsic motivation (Ryan et al., 2006), this may indicate an area in which player preferences do not match the player experience in practise. Consequently, when placing complete faith in players’ abilities to align preferences with optimal experience there is a risk of players unintentionally harming their own experience in the pursuit of improved performance and increased chances of ‘winning’. Testing of balancing in a multiplayer first-person shooter game by Vicencio-Moreira, Mandryk and Gutwin (2015) confirmed this possibility, with the most positive experience noted by both low and high-performing players when performance was most balanced in spite of the negative effect on the stronger player’s score.

Both low and high-experience players preferred the MDDA instance to be applied to only an individual player rather than an entire team. This could be explained by the concern that high-performing players on a generally low-performing team may also receive unnecessary assistance from the instance. One participant additionally suggested a degree of embarrassment may result from an entire team being assisted due to specific low-performing players, and may tie in with the below preferences for player awareness.

Awareness

The Visibility component provided mixed results between the perspectives of low and high-performing players with differing attributes reported as having a positive effect on enjoyment. From both perspectives, the preferred attribute was that which would give them personal awareness of the presence or effects of the MDDA instance in that role. As low-performing players (the recipients), MDDA visible to recipient was seen more positively; an expected result to allow the recipient of assistance to potentially make better use of the performance enhancement. Similarly, viewed as high-performing players (non-recipients), MDDA visible to non-recipients was rated higher which echoes the values for personal benefit. This may be due to a sense of fairness through better knowledge of MDDA, but also provide the opportunity to adjust strategy to compensate for its effects.

Combined with interview responses, it is very clear that players do not wish for MDDA to be ‘hidden’ from view when they are playing. However, survey participants expressed a lower preference for MDDA to be visible to *other* players in the match. From the low-performing perspective players did not indicate a positive effect on their experience when non-recipients were aware, while from the high-performing perspective players did indicate a positive effect if recipients were aware. Again, this suggests a bias towards the attributes with the greatest potential to maintain or improve one’s own performance, and is supported by the need for feelings of competence (Ryan et al., 2006). Gerling and colleagues (2014) suggest these preferences may not reflect an optimal experience, as visibility of balancing may weaken an assisted player’s internal attribution of success through the perception that their ability alone was not responsible. However, this may not have as much of an effect on the stronger unassisted players who can attribute reduced performance to the balancing if aware

(2014). In contrast, Depping and colleagues (2016) found disclosure of skill assistance to not have negative effects as players may still internally attribute success when assisted, and attribute reduced performance to the balancing system when competing against assisted players. They suggest it may be best to avoid hiding performance balancing to avoid the feeling of unfairness if hidden MDDA were to be discovered by the players. These conflicting views highlight the potential for player preferences to differ from actual gameplay experience.

5.5 REVISION OF THE MDDA FRAMEWORK

Across the survey and interviews, it became increasingly apparent that the participants believe a player's awareness of an MDDA instance's presence and effects has a strong influence on the player experience. The Visibility attribute was found to be insufficient in addressing this, with survey and interview participants expressing confusion as to how the technique would be communicated to the player.

One of the example MDDA instances used in both the interviews and survey was the weapon selection mechanic in the racing game Mario Kart. During gameplay, if a player hits a weapon box they will receive a weapon which appears to be chosen by random selection, but is influenced by their current ranking in the race so more powerful or offensive weapons will be granted to lower performing players. While the weapon selection animation makes the selection appear to be random and the game makes no mention of the MDDA instance, most interview participants were aware of the influence ranking has on weapon selection due to observation over multiple races. In the preliminary MDDA framework, this would be reported as having the "not visible to anyone" level of the Visibility attribute due to the game not intentionally informing the player of the technique. As a result, the framework would not be able to account for cases in which players can be aware of a technique that is not intentionally communicated to them, and similarly situations in which a player does not notice or correctly interpret a technique that is made visible. This is echoed in the findings of Bateman, Mandryk, Stach and Gutwin (2011), who noted unassisted players were able to notice a change in the performance of players with targeting assistance, although this was in a simpler target shooting game.

Due to the resulting awareness of the MDDA instance by the player not being guaranteed by the Visibility attribute, Visibility has been removed from the framework in favour of a new 'Awareness' attribute. As indicated by the interview and survey results, Awareness is suspected to have a major effect on the player experience irrespective of the other attributes. To compensate, Awareness is the only attribute to be varied *for each player* and *must be measured* from the player experience, in comparison to the other attributes which are defined by the system or designer.

The following definitions and levels of the Awareness attribute have been amended to the MDDA framework:

5.5.1 Awareness - Player Component

The Awareness component indicates the awareness of both of the recipients and non-recipients of the MDDA instance's presence and effects on gameplay. Unlike the other attributes, awareness is subjective and measured during or post-play rather than defined prior to activation of the technique. This may be affected by a player's experience with the game, understanding of its mechanics and the MDDA instance's implementation.

A player's initial awareness of the *presence* of an MDDA instance is binary, as they either know of the existence of MDDA in the game match or not. However, their degree awareness of the effects of MDDA exists along a continuum, in comparison to the fixed states of the other components. An example of different points along the continuum is presented in Figure 11.

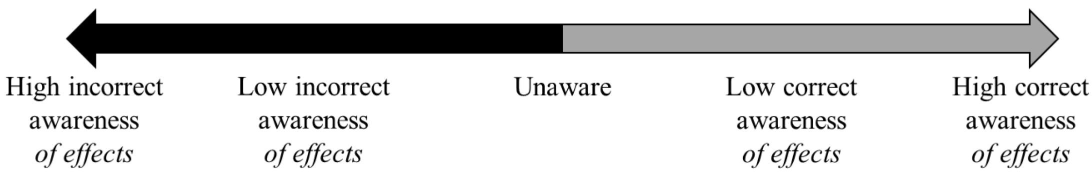


Figure 11. Stage 2 – Awareness effects continuum

- **High incorrect awareness of effects** – the player is aware of an MDDA instance but has an entirely incorrect understanding of its effects.
- **Low incorrect awareness of effects** – the player is aware of an MDDA instance but has an incorrect understanding of many of its effects.
- **Unaware** – the player is unaware of the MDDA instance's effect.
- **Low correct awareness of effects** – the player is aware of some aspects of the MDDA instance but lacks a full understanding.
- **High correct awareness of effects** – the player is fully aware of the MDDA instance's effects.

In addition to the degree to which a player is aware of the presence and effects of the MDDA instance, a second layer is present through awareness of the recipient of the MDDA instance's effects. This continuum is represented in Figure 12 below.

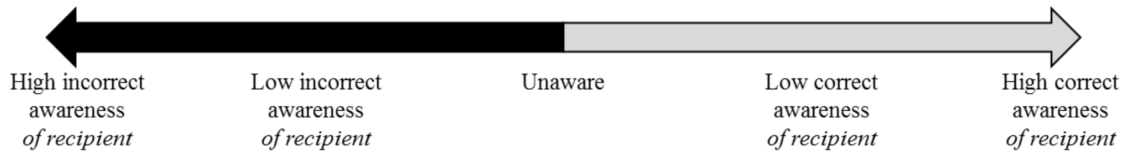


Figure 12. Stage 2 – Awareness recipient continuum

- **High incorrect awareness of recipient** – the player is completely incorrect about which players are the recipient of the MDDA's effects (i.e., they believe the players receiving assistance are not and vice versa)
- **Low incorrect awareness of recipient** – the player is incorrect about some of the players they believe are or aren't the recipient of the MDDA.
- **Unaware** – the player is not aware of which players have MDDA.
- **Low correct awareness** – the player is aware of some of the recipients.
- **High correct awareness** – the player is aware or most or all of the recipients of the MDDA.

Collectively, these two continuums provide the 'x' and 'y' axis of a matrix that may be used to represent the degree of awareness of the MDDA instance a player's possesses, displayed in Figure 13 below. This allows player awareness to be mapped and represented independently of designer intentions of MDDA.

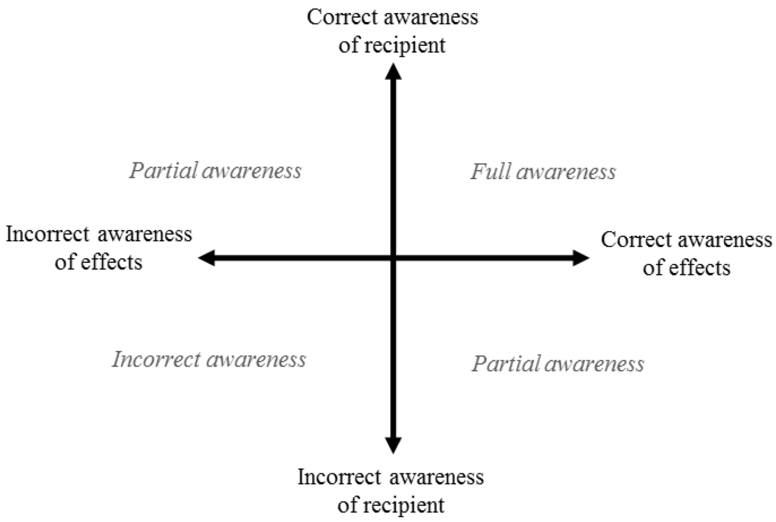


Figure 13. Stage 2 - Awareness component matrix

5.5.2 Revised MDDA Framework (v2)

With the Visibility system component replaced with the Awareness player component, the revised framework is as follows:

SYSTEM COMPONENT	ATTRIBUTES
1. Determination	• During gameplay • Pre-gameplay
2. Automation	• Applied by system • Applied by player(s)
3. Recipient	• Individual • Team
4. Skill Dependency	• Skill dependent • Skill independent
5. User Action	• Action required • Action not required
6. Duration	• Single use • Multi-use • Time-based
SUBJECTIVE COMPONENT	**ATTRIBUTES**
7. Awareness	• Two-axis matrix for the factors of effects (x) and recipient (y).

Table 16. Stage 2 - Revised MDDA Framework summary

5.6 STAGE 2 SUMMARY

Stage 2 investigated player perceptions of MDDA design varied by MDDA Framework component attributes as well as seeking external input in the refinement of the framework created in Stage 1. The series of interviews and survey conducted provided strong validation that the MDDA framework established in Stage 1 was not missing any core components or attributes (RQ1). While results were dependent on imagined play experiences linked to existing games and as such may differ from actual play, the results provide an indicated of preferences and the perceptions players have around MDDA. Player preferences for individual component attributes using MDDA examples from the popular games Call of Duty: Modern Warfare 2 and Mario Kart were found to centre around control, personal benefit and awareness (RQ2).

However, the issues raised with the Visibility component made it clear that a new interpretation of this property was needed. Unlike the other components, the game designer does not have control over the effects of this component as there is no guarantee that a player will correctly interpret the presence or associated rules of the MDDA instance. A player-centric perspective is necessary with Awareness as the replacement component to be measured directly from each individual player.

While the interviews provided additional support that unbalanced challenge was an issue negatively affecting competitive multiplayer games, the uniqueness of Awareness as a ‘player’ component and lack of consensus amongst participants over optimal attribute implementation indicated this to be a key unknown factor in need of further investigation.

6 STAGE 3 – Investigating the Effect of MDDA

6.1 INTRODUCTION

Following the creation and refinement of the MDDA framework (Stage 1), as well as gaining the insights and preferences of players (Stage 2), Stage 3 introduces an experimental study to investigate the effects of an MDDA instance in practice. By testing an actual implemented MDDA instance with participants of differing skill levels, Research Questions 2 and 4 can be addressed with the understanding that different methods of MDDA using other component attributes may produce varied results.

- RQ2: How does the **presence** of MDDA affect the performance and the player experience of:
  - RQ2a: low-performing players?
  - RQ2b: high-performing players?
- RQ4: How does **awareness** of MDDA affect the performance and the player experience of:
  - RQ4a: low-performing players?
  - RQ4b: high-performing players?

6.2 METHOD

6.2.1 Overview

Each session of this experimental study involved 2-4 participants playing together in a local multiplayer game (mimicking typical multiplayer gameplay) across three matches with varying conditions using the game Unreal Tournament 3.

Participants were required to be aged at least 17 years or older and to have played at least one multiplayer game before. The study was advertised to students in the Science and Engineering Faculty at Queensland University of Technology, as well as on local game-related Facebook groups such as the QUT Gamer Society and Brisbane Independent Game Developers' Association. Snowball sampling was also used with participants further sharing recruitment information with friends and acquaintances. The study was titled "Player Experience of Multiplayer Games", without mention of MDDA or player balancing to avoid potential biasing of participant responses. Instead, recruitment information only stated that participants would be sharing information about their experience playing several multiplayer game matches in a session lasting approximately 75 minutes total. Compensation was offered in the form of a prize draw for a $100 gift card for a store that sells videogames and other electronic equipment.

In order to address the research questions, participants played three competitive multiplayer game matches with the following conditions:

- **Match Condition 1 ('*Normal*')** – No MDDA instances present.
- **Match Condition 2 ('*MDDA – no awareness*')** – MDDA instance present, but participants not informed of its presence nor its effects.
- **Match Condition 3 ('*MDDA – full awareness of presence and effects*')** – MDDA instance present, but participants are informed of both its presence and effects prior to match start.

The three match conditions allow the comparative analysis of the player experience in terms of both the presence or absence of MDDA (RQ2), and awareness or lack of awareness of the MDDA instance (RQ2). The order of the matches 1 and 2 were arranged using Latin-Squares between each group of participants to minimize the effect of practice on recorded data.

Each game match used the same objectives, rules and environment with the exception of the presence and awareness of the MDDA instance. The game mode was called 'Deathmatch', in which participants were required to score kills against each other in order to obtain the highest final score at the end of each 10-minute match.

The 'static shield' MDDA instance (see section 3.2.3) was used in Match Conditions 2 and 3; providing participants with 50 shield points to absorb extra damage once their score had dropped more than 7 points or 'kills' behind the leader. No pre-screening for skill or performance level was performed on participants, as the risk of a group of participants with similar enough performance to result in this particular MDDA instance failing to activate was deemed low.

The game map (world environment) “Biohazard” was selected from existing UT3 maps, and modified to fulfil the study requirements. All existing health and shield items were removed from the environment to avoid interfering with the effects of the selected MDDA instance and potentially confusing participants as to whether they had received shield points via assistance or from picking them up. Additionally, the purple colour-correction filter used in the map and camera motion-blur were removed to improve visual clarity in case of participants with poor eyesight.

Participants were situated within the same room with a PC each and divider walls between each PC to prevent participants from seeing each other’s screens. Keyboard and mouse was used for control input, with a printed control scheme provided next to each PC for reference at any time. Headphones were used for sound with individual volume control.

After each match, participants reported on their player experience through a digital survey consisting of questions from the PENS survey measure. Additionally, psychophysiological arousal was recorded during play using Electrodermal Activity (EDA) skin conductance sensors.

6.2.2 Data Collection and Measures

Gameplay logging from the game server was used to record performance data in the form of player score. As the MDDA instance was designed to improve the performance of assisted participants, the scores of assisted and unassisted participants were then analysed using a mixed ANOVA to determine effects and interactions between assistance and the match conditions.

To measure the player experience and intrinsic motivation, both subjective player experience surveys and objective biometric measure were used. The Player Experience of Need Satisfaction (PENS) survey (Ryan et al., 2006), developed specifically for video games based on the tenets of Self-Determination Theory (E. L. Deci & Ryan, 1975), provides a subjective reporting of player experience and intrinsic motivation. The PENS survey consists of 7-point numbered scale questions in randomized order that provide an insight into the player experience using 5 constructs:

- Competence: the match of skill to challenge provided

- Autonomy: sense of volition and choice
- Relatedness: connection to others
- Presence: immersion in the game world
- Intuitive Controls

At the conclusion of each game match, participants completed the full PENS survey with the exception of the Intuitive Controls construct due to it being determined as irrelevant for the research aims of this study. A repeated measures mixed multivariate ANOVA statistical analysis was used to determine the resulting player experience from the four PENS constructs across the three match conditions with a between-groups factor of assistance (assisted participants and unassisted participants).

Additionally, several open-text questions were asked to test for player awareness of MDDA's presence during gameplay. Questions were disguised around general gameplay preference questions such as "did you receive any power-ups or items in the last match?", in which no items or power-ups were available beyond MDDA's effects. This was to check if the manipulation of awareness for the match conditions was successful.

Electrodermal activity (EDA) was recorded as an objective biometric measure to provide a recording of skin conductance (measured in microSiemens) as an indicating of arousal during play. Tonic analysis was performed using fixed 60-second epochs to determine the average arousal across each match.

To prepare each participant for EDA recording, the participant was taken to a sink located in the lab and required to wash their hands for 30 seconds using pH-neutral soap. Additionally, a small area on the side of their neck was cleaned using and alcohol swab and gauze. Three disposable EDA sensors were then attached; one to the side of their neck (grounding sensor), and two to the palm of the hand they used with keyboard during play (see Figure 14). Medical tape was also used to adhere the sensor firmly against the palm.

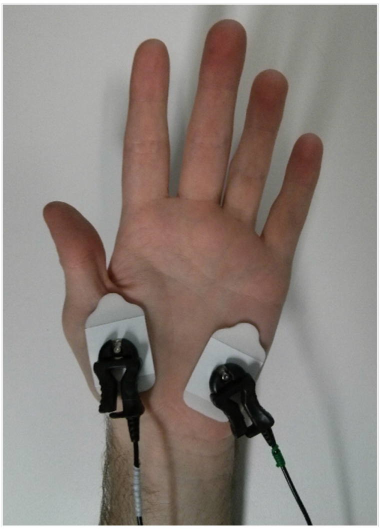


Figure 14. Stage 3 – EDA sensors

Early trials of EDA sensors revealed the least movement artefacts and sensor noise were recorded when attaching the sensors to the palm of the hand used with keyboard movement controls. When paired with a wrist-rest, less sensor noise was recorded due to reduced hand movement. Tests with the sensors on the hand used for mouse controls more frequently resulted in a loss of sensor contact during play, as well as increased movement artefacts. A mixed ANOVA was used to analyse the EDA arousal readings for each between-groups factor across the three match conditions.

6.2.3 Study Process

Each session of the study (1 group of 2-4 participants) consisted of the following steps:

1. Participants were invited inside research computer lab and seated at each PC.
2. Participants read through and completed the required Low Risk Human Ethics study consent form.
3. The researcher thanked the participants for coming and informed them that he will be reading all further instructions from a script to ensure consistency between participant groups (script available in Appendix C).
4. Participants were informed that they would be playing 3 matches of the game Unreal Tournament III, answering survey questions regarding their experience after each match and that biometric sensors would be used.
5. Participants were invited to begin completing survey ('Participant Background' section) until they reached a page requesting them to stop.
6. While others were completing the first section of the survey, EDA biometric sensors were set up for each participant.
7. Once all participants had completed the 'Participant Background' survey section and had EDA sensors attached and working, a 60 second baseline reading was recorded. Participants were requested to relax and look at a blank screen while this occurred.

8. The researcher asked all participants to refrain from communicating with the other participants from that point forward for the rest of the study.
9. The PCs were prepared for play. Participants were informed of the rules for the game match (match order was randomised between each group of participants) and instructed to take a moment to familiarise themselves with the printed control scheme.
10. Participants played first match.
11. Once the match ended, the researcher switched each PC back to the survey.
12. Participants completed the next section of the survey. If any EDA sensors had become detached during play, they were now replaced.
13. Steps 9-12 were repeated twice more, for a total of 3 matches played with the varying conditions.
14. Participants completed the rest of the survey and were then thanked for their participation, bringing the session to a close.

6.3 RESULTS

6.3.1 Participant Background

A total of 62 participants took part in this study, with an average age of 20.84 years (SD = 4.64). Of the participants, 49 were male, 11 female and 2 selected 'unspecified / prefer not to say'. As this indicates a gender bias may be present, results should be interpreted as such. However, it should be noted that this ratio is not unusual for games in the first-person shooter genre which may see up to 90% male players (Roseboom, 2015).

Participants rated their experience level playing competitive multiplayer first-person shooter video games with an average of 4.55 (SD = 1.64) from 1 ("not at all experienced") to 7 ("extremely experienced") and spent an average of 5.45 hours (SD = 6.57) playing them. During gameplay, 32 participants were the recipients of assistance provided by MDDA and 30 were unassisted with all sessions of the study containing participants with enough performance variance for the MDDA to successfully activate. Testing of participant awareness of MDDA in Match Condition 2 (MDDA with no awareness) via the "item" question (see section 6.2.2) successfully indicated no participants became aware of MDDA's presence.

6.3.2 Performance

For the "deathmatch" game mode objective of achieving the highest number of kills against other players in each 10 minute match condition, participant performance was indicated by their score (number of kills achieved). Given the MDDA feature was intended to improve the performance of assisted participants, it was expected that the mean score of assisted participants would increase in match conditions with MDDA (2 and 3) compared to Match Condition 1 without MDDA.

Performance data were analysed using a mixed ANOVA with a between-groups factor of assistance (2) and within-groups match conditions (3). Match conditions 1 ($F_{1,60} = 4.309$, $p = .042$) and 3 ($F_{1,60} = 5.333$, $p = .024$) violated Levene's test of equality of error variances. In order to correct for this, data were transformed via square root which fixed the assumption failure for all conditions ($p < .05$). Using the transformed data, Box's test of the equality of covariance matrices was satisfied ($p = .015$).

Normality was checked by dividing skew and kurtosis by their standard errors across all match conditions, which did not exceed ±1.90. No outliers were found using visual boxplot analysis. Additionally, sphericity was confirmed using Mauchly's test ($X^2(2) = 5.273$, $p = .072$).

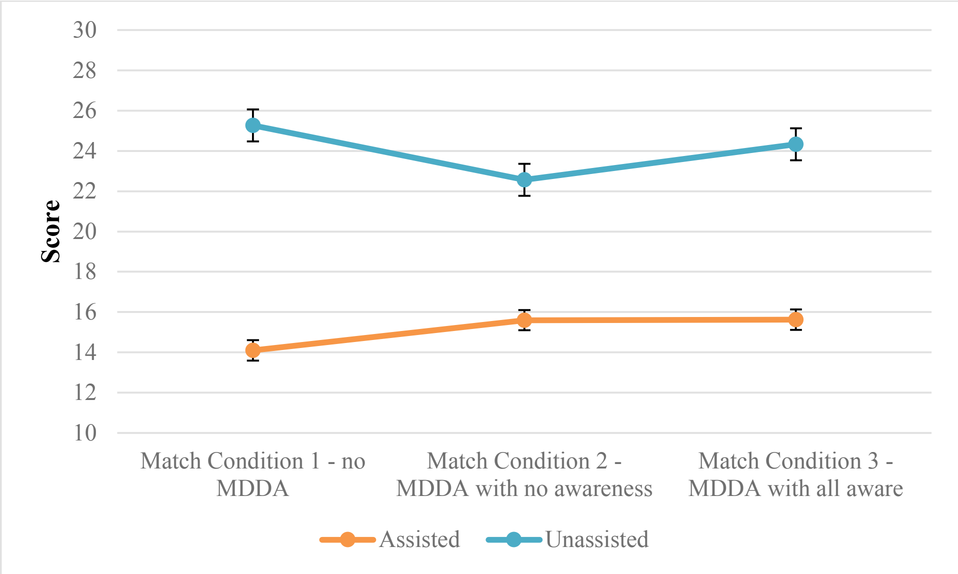


Figure 15. Stage 3 – Scores (performance)

	Between-Subjects	Mean	Std. Deviation	N
Match Condition 1 – no MDDA	Unassisted	4.9318	.98796	30
	Assisted	3.6369	.94571	32
	Total	4.2635	1.15939	62
Match Condition 2 – MDDA with no awareness	Unassisted	4.7069	.65228	30
	Assisted	3.8999	.63025	32
	Total	4.2904	.75464	62
Match Condition 3 – MDDA with all aware	Unassisted	4.8658	.82469	30
	Assisted	3.8930	.69594	32
	Total	4.3637	.89980	62

Table 17. Stage 3 – Scores (performance)

Collectively from all participants, no within-subjects effect was recorded between match conditions ($F_{2,120} = 0.729$, $p = .484$); however a between-subjects effect for assistance was present ($F_{1,60} = 32.655$, $p < .001$) and qualified by an interaction ($F_{2,120} = 4.438$, $p = .014$). (see Figure 15).

Examination of the simple main effects required Greenhouse-Geisser correction for sphericity as checked with Mauchly's test ($X^2(2) = 7.515$, $p = .023$) with an epsilon of .819. The simple main effects indicated found a significant effect for the scores between the match conditions of assisted participants ($F_{1.637,50.753} = 4.867$, $p = .017$),. The score of assisted participants was found to have increased between Match Condition 1 and 2 ($p = .015$) in which MDDA was added without awareness.

6.3.3 Survey - Player Experience

Data Preparation

As the four survey constructs (competence, autonomy, relatedness and presence) come from the PENS intrinsic motivation measure, data were analysed using a mixed multivariate ANOVA with Bonferroni adjustment across the four PENS constructs with a within-subjects factor of match condition (3) and between-subjects factor of whether the participant was assisted (2). Unassisted players are considered to be high-performing, while assisted players were the recipients of MDDA assistance due to low performance.

Checks for normal data distribution were performed by determining the skewness and kurtosis divided by standard error. All constructs and conditions were found to be within the bounds of ±3.1. This was deemed acceptable given the robustness of MANOVAs to violations of the assumption of normality.

Outliers were assessed using a combination of residuals and boxplots. With the absence of extreme outliers and examination of data points across constructs for affected participants, all data points were retained on the basis of legitimate representation of the player experience.

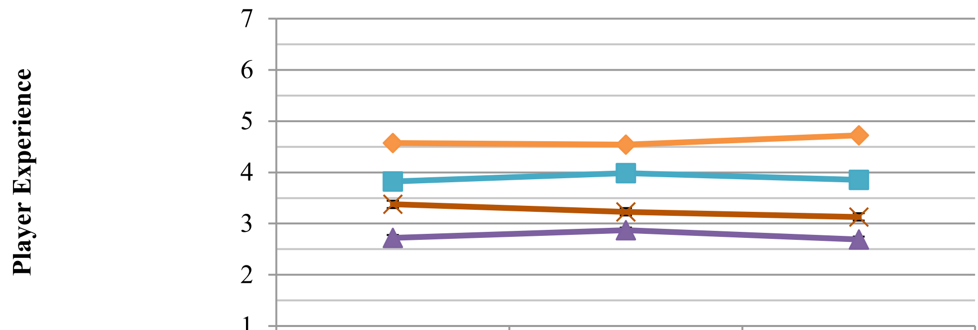
Multicollinearity was tested using Pearson correlation coefficients with the expectation of moderate correlation between the dependent variables (PENS constructs). All constructs were found to have positive correlation, with the highest between recorded Competence and Autonomy in the first match condition (.674) and lowest between Relatedness and Competence in the second match condition (.125). Due to the constraints on participant communication during the study, a lower correlation between Relatedness and the other intrinsic motivation constructs was not unexpected. No correlation between individual component questions exceeded 0.9, indicating that no multicollinearity was present in the data.

There was homogeneity of variance-covariances matrices as assessed by Box's test of equality of covariance matrices (p = .271). The assumption of homogeneity of variances using Levene's test was satisfied (p > .05) across all constructs and conditions except for Relatedness in Match Condition 2 (p = .043). All relevant analyses were performed using both the transformed and non-transformed variable, No substantive differences were found in the results and for the sake of interpretability the non-transformed variable was retained as is reported below.

Mauchly's test verified the assumption of sphericity was satisfied for all constructs including Competence ($X^2(2) = 0.698$, p = .705), Autonomy ($X^2(2) = 0.240$, p = .887), Relatedness ($X^2(2) = 0.141$, p = .932) and Presence ($X^2(2) = 1.209$, p = .546).

Reliability of the constructs was tested using Cronbach's alpha. All construct alphas were above 0.8, with the exception of Relatedness which was above 0.67. These were deemed acceptable due to the tested validity and reliability of the PENS scale and constructs in other studies (see section 2.6.1).

Multivariate Player Experience



	Normal	mDDA	mDDA - Full Awareness
COMPETENCE	4.574	4.541	4.721
AUTONOMY	3.820	3.984	3.852
RELATEDNESS	2.721	2.869	2.689
PRESENCE	3.377	3.230	3.131

Figure 16. Stage 3 – Player experience constructs

A significant multivariate between-subjects effect for assistance was found ($F_{4,57} = 10.756$, p < .001). This between-subjects factor is explored for each construct in the following sections below. However, no significant multivariate within-subjects effect of match condition was evident ($F_{8,53}$ = 1.990, p = .066), nor an interaction between match condition and assistance ($F_{8,53}$ = 1.292, p = .268).

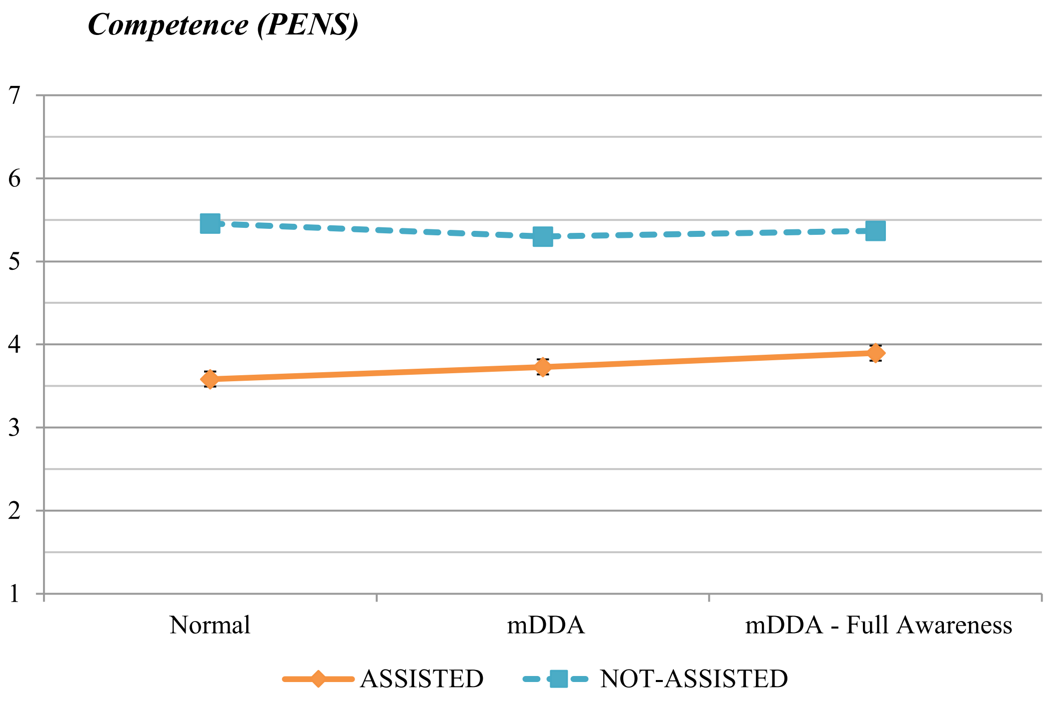


Figure 17. Stage 3 - Competence

	Assistance	Mean	Std. Deviation
Match 1 - Normal	Not assisted	5.4556	1.2910
	Assisted	3.5833	1.1823
	Total	4.4893	1.5467
Match 2 – MDDA – No awareness	Not assisted	5.3000	1.1392
	Assisted	3.7292	1.2311
	Total	4.4893	1.4190
Match 3 – MDDA – Full Awareness	Not assisted	5.3667	1.3906
	Assisted	3.8958	1.2456
	Total	4.6075	1.5023

Table 18. Stage 3 - competence

On the Competence construct, a between-subjects effect indicated unassisted participants rated their feelings of competence higher than assisted players overall ($F_{1,60}$ = 32.922, p < .001) (see Figure 17).

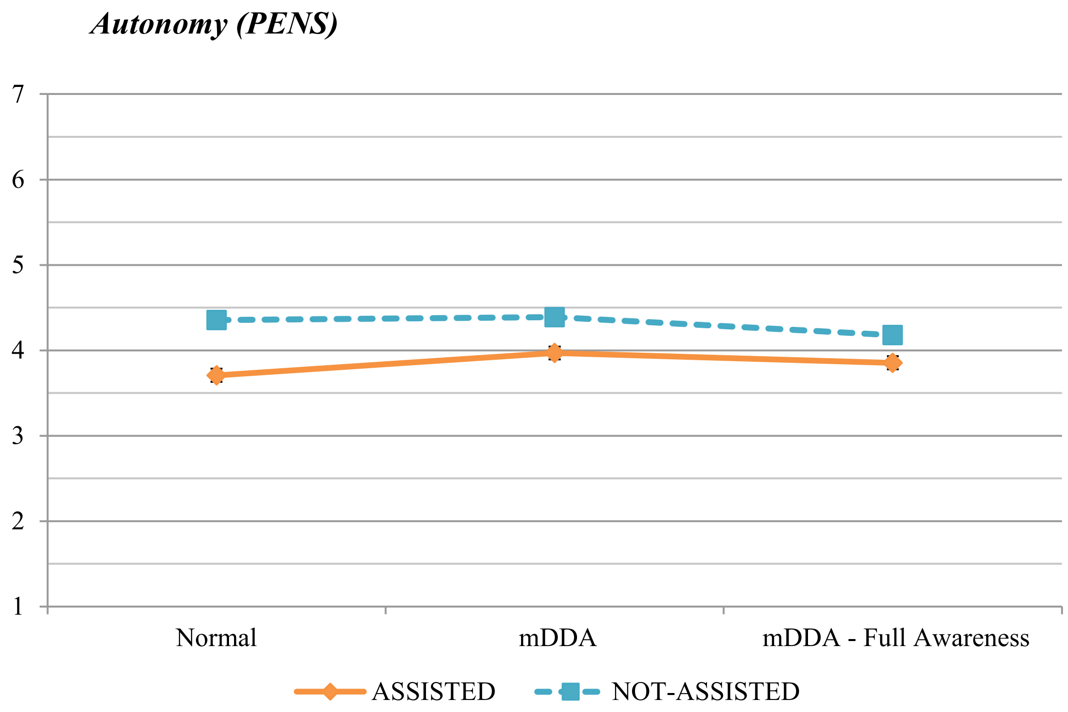


Figure 18. Stage 3 - Autonomy

	Assistance	Mean	Std. Deviation
Match Condition 1 - Normal	Not assisted	4.3556	1.1807
	Assisted	3.7083	1.4610
	Total	4.0215	1.3616
Match Condition 2 – MDDA with no awareness	Not assisted	4.3889	1.2069
	Assisted	3.9688	1.4427
	Total	4.1720	1.3398
Match Condition 3 – MDDA with full awareness	Not assisted	4.1778	1.4771
	Assisted	3.8542	1.4417
	Total	4.0108	1.4561

Table 19. Stage 3 - Autonomy

On the Autonomy construct, a between-subjects effect for assistance was not evident ($F_{1,60} = 1.954$, $p = .167$) (see Figure 18).

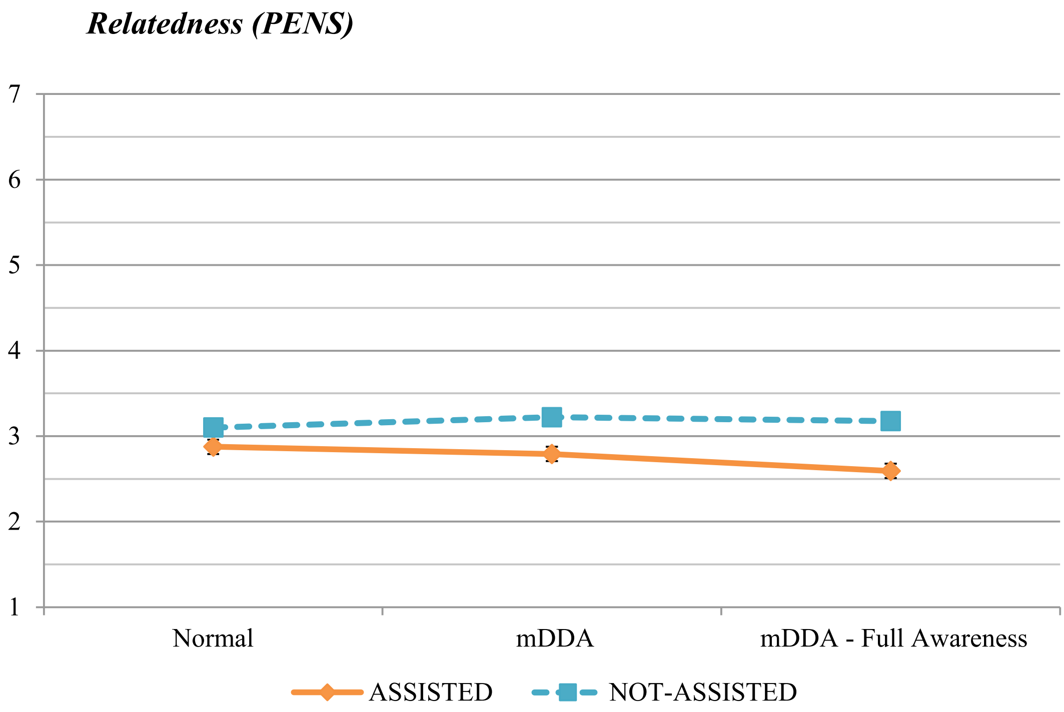


Figure 19. Stage 3 - Relatedness

	Assistance	Mean	Std. Deviation
Match Condition 1 - Normal	Not assisted	3.1000	1.5491
	Assisted	2.8750	1.1663
	Total	2.9839	1.3583
Match Condition 2 – MDDA with no awareness	Not assisted	3.2222	1.4967
	Assisted	2.7917	0.9644
	Total	3.0000	1.2588
Match Condition 3 – MDDA with full awareness	Not assisted	3.1778	1.5604
	Assisted	2.5938	1.1095
	Total	2.8763	1.3674

Table 20. Stage 3 - Relatedness

On the Relatedness construct, a between-subjects effect for assistance was not evident ($F_{1,60} = 1.785$, $p = .187$) (see Figure 19).

Presence (PENS)

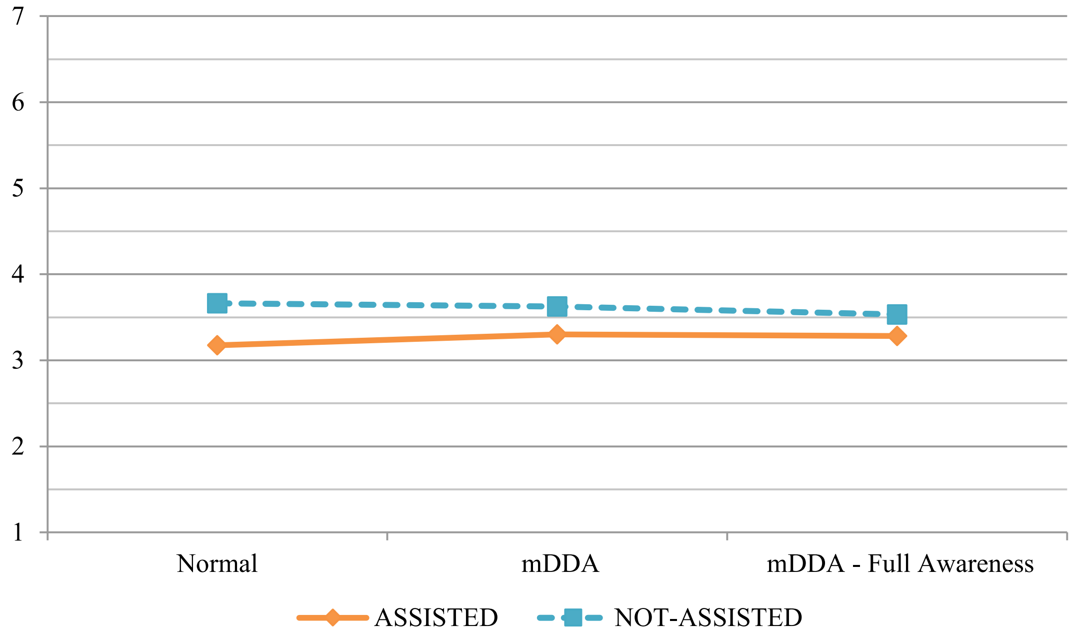


Figure 20. Stage 3 - Presence

	Assistance	Mean	Std. Deviation
Match 1 - Normal	Not assisted	3.6630	1.1790
	Assisted	3.1736	0.9184
	Total	3.4104	1.0725
Match 2 – MDDA – No awareness	Not assisted	3.6259	1.0810
	Assisted	3.3021	0.8617
	Total	3.4588	0.9795
Match 3 – MDDA – Full Awareness	Not assisted	3.5333	1.2395
	Assisted	3.2847	1.0427
	Total	3.4050	1.1395

Table 21. Stage 3 - Presence

On the Presence construct a between-subjects effect for assistance was not evident ($F_{1,60} = 1.935$, $p = .169$) (see Figure 20).

6.3.4 Electrodermal Activity – Arousal

Four outlier data points were identified in the tonic EDA data collected. Three of these points related to a single participant across all 3 match conditions, and investigation of the data recording revealed them to be attributed to poor EDA sensor contact with the participant's skin.

Data cleaning involved removing epochs caused by temporary signal loss (lack of contact between sensor and skin), while the long period of tonic analysis (10 minutes using 10 fixed-length 60 second epochs) reduced any effects of sensor noise resulting from participant movement. Participant EDA data for any particular match was discarded if greater than 15% of the data (90 seconds) required removal due to signal loss.

EDA data were analysed using a mixed ANOVA with a within-subjects factor of match condition (3) and between-subjects factor of whether the participant was assisted (2). When reading EDA data, it is important to note that skin conductance can vary between participants based on physiology and sensor contact. In order to ensure this did not affect between-groups results, data were converted to Z-scores and confirmed that the presence or absence of results did not differ from the raw data (Boucsein et al., 2012). Similarly, baselines were compared to ensure sensor "drift" (the gradual increase in arousal over the time of the study) from was not affecting results.

One participant's data in the unassisted group was removed due to their presence as the sole outlier across all three match conditions via boxplot analysis. While not an interpreted as an error in sensor contact, the recordings indicate an unusually high degree of skin conductance from that particular participant.

Data normality was confirmed as satisfactory by checking skewness and kurtosis divided by standard errors were all within ±2 and visually confirmed via histograms.

Mauchly's test indicated the assumption of sphericity was not violated ($X^2(2) = 2.276$, $p = .320$). Additionally, Levene's test was used to test the equality of error variances and satisfied in match condition 1 ($F_{1,52} = 1.778$, $p = .188$), match condition 2 ($F_{1,52} = 0.835$, $p = .365$) and match condition 3 ($F_{1,52} = 0.724$, $p = .399$). Finally, homogeneity of variance-covariances matrices was confirmed as assessed by Box's test of equality of covariance matrices ($p = .438$).

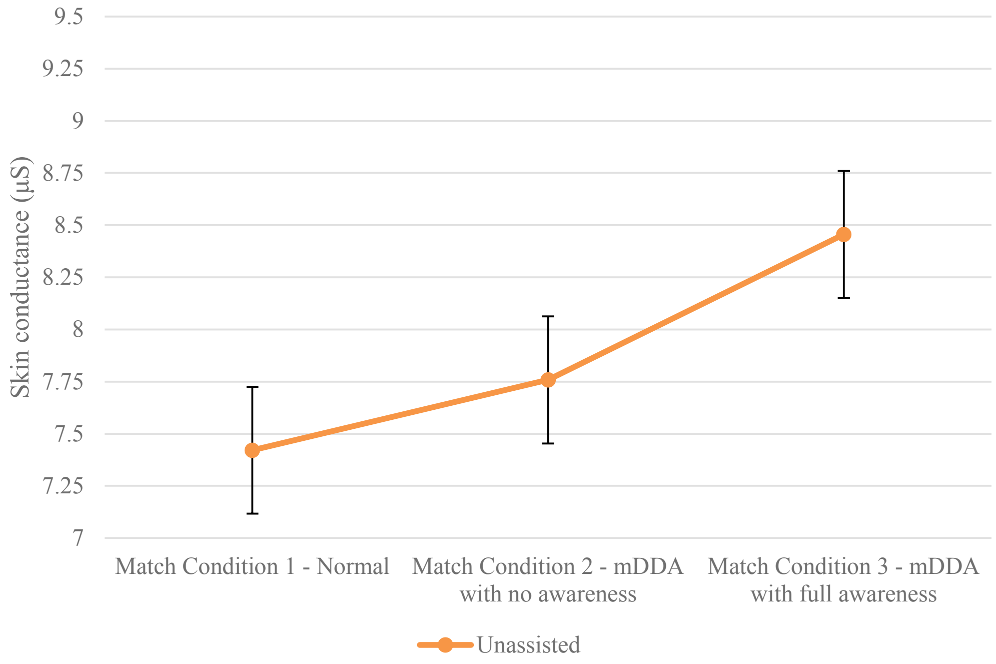


Figure 21. Stage 3 – Tonic EDA readings of Unassisted participants

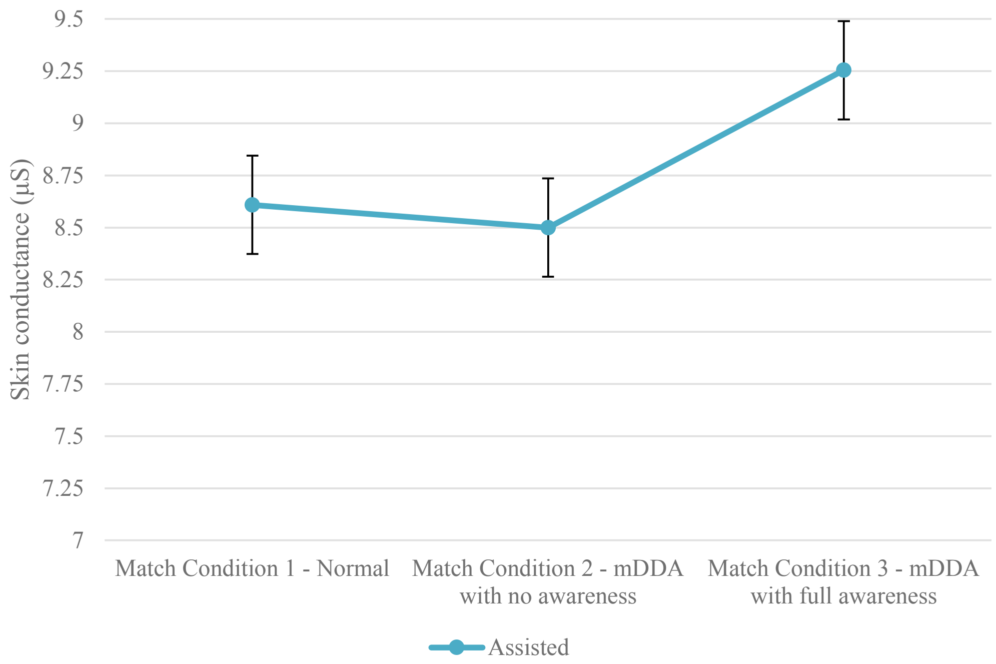


Figure 22. Stage 3 – Tonic EDA readings of Assisted participants

	Assistance	Mean	Std. Deviation	N
Match 1 - Normal	Not assisted	7.4208	3.1762	23
	Assisted	8.6086	3.7821	30
	Total	8.0931	3.5495	53
Match 2 – MDDA – No awareness	Not assisted	7.7583	3.3320	23
	Assisted	8.4998	3.5607	30
	Total	8.1780	3.4505	53
Match 3 – MDDA – Full Awareness	Not assisted	8.4552	3.3334	23
	Assisted	9.2543	3.5203	30
	Total	8.9076	3.4311	53

Table 22. Stage 3 – Tonic EDA readings

For arousal as measured by EDA; no between-groups effect was present ($F_{1,52}$ = 1.571, p = .216). However, a statistically significant within-groups effect was recorded between match conditions ($F_{2,104}$ = 7.702, p = .001) but not qualified by an interaction ($F_{2,104}$ = 0.910, p = .559) (see Figure 21). When looking at pairwise comparison between the match conditions, participants experienced an increase in arousal in match condition 3 when they were aware of MDDA compared to match condition 2 when unaware (p = .012) and match condition 1 when no MDDA was present (p = .003).

6.4 DISCUSSION

6.4.1 Effectiveness of Player Balancing

The MDDA instance used in Match Condition 2 and 3 automatically provided participants with 50 'shield' points when their score dropped 7 kills behind the match leader. During the study 32 of 62 participants were assisted by the MDDA, which resulted in a statistically significant reduction in score variance when shield assistance MDDA was present without participant knowledge (Match Condition 2) compared to an identical match without MDDA (Match Condition 1). This indicates a successful adjustment in performance and improved player performance balancing.

However, when participants were informed of the presence and effects of the MDDA instance (Match Condition 3), the performance balancing was less effective and did not achieve statistical significance compared to gameplay without MDDA. As gameplay was otherwise identical with all other game rules, objectives, environments and weapons identical between conditions, this points to participant awareness of the MDDA balancing mechanic increasing the performance gap between assisted and unassisted participants compared to hidden MDDA. There are two suspected reasons that could contribute to this effect.

Firstly, assisted participants may be experiencing self-consciousness from the knowledge that they may be receiving assistance. During gameplay, the scoreboard is hidden which prevents players from being able to compare scores in real-time or have an accurate knowledge of their current ranking. However, as it is explained that the shield will activate only for players with a score far behind the leader, the application of the assistance may act as a notification of their low performance. This can hinder self-esteem with a potential consequences on performance (Arkin, Detchon, & Maruyama, 1982; Gerling et al., 2014). Secondly, assisted players may be more likely to improve performance when aware of a difference in game rules (MDDA) through better adaption of gameplay tactics and behaviour.

In response to RQ2, the shield assistance MDDA was seen to successfully affect performance and improve player balancing. However, awareness of this MDDA similarly has the effect of reducing the effectiveness of the performance balancing (RQ4). This indicates that RQ2's answer is dependent on the design of the MDDA instance; in particular whether the player is made aware of the MDDA by the designer or becomes aware. Additionally, these results should be interpreted with the understanding that only a specific implementation of MDDA was used (shield assistance) with the potential for different designs such as those considered in the research design (see section 3.2.3) to yield different findings.

6.4.2 Player Experience

The existence and awareness of the shield assistance MDDA did not affect feelings of autonomy as measured by PENS, which was consistent between match conditions and were not significantly different between assisted and unassisted groups. Although there is the danger of interpreting the null hypothesis and further research would be required to confirm, this does go some way towards easing concerns expressed in Stage 2 that the 'interference' by MDDA real-time gameplay and manipulation of performance had the potential to reduce feelings of control and volition for participants. The lack of effect on autonomy suggests participants did not feel the use of MDDA was reducing player control. In addition, the lack of difference in presence between conditions also indicates the MDDA instance did not affect participant involvement with the game; negatively or positively.

Both the addition of MDDA and awareness did not result in a significant difference between the conditions. As performance variance was altered between the conditions, this indicates that social connectedness to other participants was not directly tied to participant performance. However, both assisted and unassisted participants rated relatedness below the ‘4’ mid-point on the 7-point numbered scale indicating a general lack of social connection. This can be attributed to some of the requirements of the study such as the ‘no talking’ rule and restriction on communication between participants necessary for maintaining the awareness conditions and avoiding EDA sensor interference. Additionally the game and objectives selected emphasise competitiveness without shared goals or reason for communication.

A between-groups effect for competence was recorded, demonstrating higher feelings of competence for unassisted participants across all match conditions. As participants were only unassisted if they were the score leader or maintaining a score within close range of the leader, it is not a surprising result that the highest-performing participants felt similarly high competence. Similarly, in order to be assisted participant performance needed to be notably behind the leader, giving an expected result of lower feelings of competence for assisted participants.

However, in spite of the reduction in score variance between all participants when MDDA was introduced (match condition 2) and therefore closer performance, this did not manifest closer feelings of competence between assisted and unassisted participants. This is a surprising result due to competence indicating “the need for challenge and feelings of effectance” (Ryan et al., 2006), which would be expected to heavily rely on performance. Therefore, another factor may be influencing participant feelings of competence when answering the survey.

A suspected reason for this lack of difference in competence between match conditions is the post-match scoreboard visible to participants prior to completing the player experience survey. Participant scores are not visible during gameplay. However, at the conclusion of each match, the game automatically displays the final scores alongside player ranking (1^{st} to 4^{th}) as well as a text and audio declaration of “Winner” or “Defeated”. Tauer and Harackiewicz (1999) found that positive or negative feedback of performance can affected perceived competence, and in this case the clear declarations of “Winner” or “Defeated” may be viewed as such. Similarly, for unassisted participants simply the acknowledgement that they "won" can increase intrinsic motivation (Johnmarshall Reeve, Olson, & Cole, 1985). For assisted participants, in spite of their improved performance with MDDA, seeing "3rd" or "4th" in every match alongside a message of "Defeated" before completing the survey may leave a more negative final feeling of competence than was actually experienced during gameplay, reducing any potential improved competence MDDA may have offered.

Overall, the results would suggest that the addition of MDDA did not affect the player experience in a meaningful way (RQ2) in spite of performance adjustment. However, with between-groups effects present and the groups themselves based on difference in performance (participants assisted if low-performing and unassisted if high-performing), this leaves some ambiguity as to the source of the player experience influence. Similarly, the addition of participant awareness of MDDA did not appear to affect the subjective player experience or intrinsic motivation (RQ4) in spite of the performance variance difference and effect on arousal discussed below.

6.4.3 Arousal

Collectively, participants experienced a significant increase in arousal when MDDA was applied and all participants were aware of its presence (match condition 3) compared to a standard match lacking MDDA (match condition 1). While this may indicate higher excitement (Nacke & Lindley, 2008), it could also be attributed to increased stress or frustration (Wu & Lin, 2011). As the PENS survey measures did not demonstrate a distinct difference in player experience between match conditions, this leaves the source of the increased arousal less clear.

If the arousal was responding to differing challenge, it is expected that while unassisted participant arousal may increase as the performance of assisted players increases, the arousal of assisted players should similarly decrease in response. However, as this is not the case it suggests another factor may be affecting arousal.

As discussed above, performance also saw a difference when participants were aware of the MDDA (match condition 3) as its effectiveness at balancing performance was reduced. Combined with the increased arousal, this suggests participant awareness of MDDA rather than the presence of MDDA itself are affecting the way participants experience with the game. One interpretation of this observation is that the awareness of this new rule to gameplay may be increasing stress on the participants to perform, with unassisted (high-performing) participants feeling more threatened by assisted (low-performing) participants due to the knowledge that they possess shields and make for more challenging opponents. On the other hand, with the awareness that receiving assistance indicates their performance in below other participants, the assisted participants may be feeling pressure as their low performance is "highlighted" by receiving shields and may act as a notification of sub-par match ranking. This would account for increased arousal from both groups, while also going some ways towards explaining the wider performance disparity as unassisted participants more readily adapt to the change in rules.

6.5 CONCLUSION & LIMITATIONS

This study successfully manipulated player performance through the use of MDDA to improve balance in player score.

However, the disparity between the unchanging player experience such as feelings of competence as recorded by the survey and the differences in performance and arousal indicate another facet of how players engage with MDDA has not been captured by the measures used in Stage 3. As acknowledged in the discussion, some limitations of this study may have had an influence on these results including participant exposure to their scores prior to completing the survey. This provides an incomplete response to the research questions (RQ2 and 4) regarding how MDDA and awareness of MDDA affects performance and the player experience.

As a post-hoc finding, the lack of reduction in feelings of autonomy and presence between matches with and without MDDA provide some evidence to alleviate participant concerns in Stage 2 that MDDA may negatively affect the sense of player control and involvement.

To better fulfil the research aims and provides answers to these questions, the following stage of research will seek to address these areas in more granular detail.

6.6 STAGE 3 SUMMARY

This chapter covered the first experimental study investigating both how MDDA and awareness of MDDA affects performance and the player experience; together covering research questions 2 and 4. The study involved participants playing three matches of the PC first-person shooter game Unreal Tournament 3, covering three conditions; a normal match, a match with MDDA but no participant awareness, and a match with MDDA and full awareness.

Survey method with questions from the PENS measure of intrinsic motivation was used to investigate the player experience as well as electrodermal activity (EDA) to record psychophysiological responses. The results found that while MDDA increased balance in player performance, player awareness of its presence negated some of this benefit. Additionally, minimal difference in player experience was found as measured by PENS. This contrasted with large differences in participant arousal found by EDA when participants were aware of MDDA, indicating participants were engaging with the game differently when aware but this difference was not captured in the experience recorded by PENS.

Consequently, it was concluded that further exploration of these differences is needed in order to answer the research questions through further experimental studies.

7 STAGE 4 – Investigating Optimal Awareness of MDDA

7.1 INTRODUCTION

Stage 3's results demonstrated that the application of MDDA was successfully able to facilitate improved performance balance, but participant awareness of MDDA may affects its success. However, player experience results did not demonstrate clear differences between the conditions in spite of a large increase in arousal when awareness was introduced.

In response, Stage 4 focuses more keenly on the effect of awareness through the introduction of more granular conditions and higher awareness of who is or is not being assisted. This study introduces a greater selection of player experience and performance measures in order to better examine the effects of awareness conditions, while also introducing the use of interviews to assist in interpretation of results. Together, these provide the means to address the following research questions:

- RQ3: How can the use of MDDA be better optimized for improved player balancing and experience?
- RQ4: How does awareness of MDDA affect the performance and the player experience of:
  - RQ4a: low-performing players?
  - RQ4b: high-performing players?

7.2 METHOD

7.2.1 Overview

The experimental method for this study followed a very similar format to Stage 3 (see section 6.2) with the exception of the varied match conditions and measures. This allowed for comparison of findings between studies.

Experiment sessions of this study were performed with groups of 3-4 participants using the same requirements and recruiting methods to Stage 3 (see section 6.2.1) to find participants both within Queensland University of Technology and externally. Participants were also required to have not previously participated in any study conducted by the researcher (Stages 2 and 3) to avoid prior knowledge of the study's focus. The same location and setup was used, with each session lasting 90 minutes and compensation offered in the form of a key to redeem the Unreal game franchise via the Steam digital distribution platform for PC (approx. $40 USD value).

To address the research questions, four match conditions were used using Latin-Square ordering to provide an equal distribution of match condition arrangements. These all contained the same 'static shield' MDDA instance (see section 3.2.3) while the within-groups conditions varied only in participant awareness:

- **Match Condition 1 ('*No awareness*')** – Participants not informed of the MDDA's presence nor its effects.
- **Match Condition 2 ('*Assisted aware*')** – Assisted participants informed that they would be assisted with MDDA and its effects.
- **Match Condition 3 ('*Unassisted aware*')** – Unassisted participants informed that opposing players would be assisted with MDDA and its effects.
- **Match Condition 4 ('*All participants aware*')** – All participants informed of MDDA and its effects, including whether they would be assisted or opposing players assisted by it.

Participants were informed of the use of MDDA via paper instructions presented prior to playing each match. These instructions would each specify that the participants were playing a "Standard" match, or a match with a feature called "Assistance" (the MDDA instance). While all matches did, in fact, contain MDDA, the use of paper instructions specifying that a "Standard" match would be played was used to prevent suspicion amongst participants that they may be receiving differing instructions in Match Conditions 2 and 3 by giving the impression that all participants were receiving the same paper instructions at the same time. The instructions presented to assisted and unassisted participants contained the same description of the MDDA instance and its effects:

> "A gameplay feature called ASSISTANCE is present in this match that will provide low-ranking players with shield points that absorb damage when falling behind."

However, an additional line differed between the instructions given to assisted and unassisted participants. Assisted participants saw:

> "Based on performance in the previous match(es), ***you will personally receive assistance*** with this feature during this match ***but other players may not***."

Unassisted participants saw:

> "Based on performance in the previous match(es), ***your opponents will receive assistance*** with this feature during this match. However, due to your performance ***you will not be assisted***."

In contrast to Stage 3, this provided greater awareness of the MDDA instance by stating not just its presence and effects, but whether the participant would or would not be the recipient of its assistance (see section 4.10.1 for Awareness component information). This placed the awareness condition at a higher degree of correct awareness on the Awareness component matrix to more clearly differentiate between aware and unaware conditions. It was expected that this change may provoke a greater difference in player experience and provide a clearer understanding of the effects of differing awareness compared to Stage 3. The paper instructions concluded by requesting the participant to enter the match type ("Standard" or "Assistance") in the appropriate text field in the survey to both confirm their understanding of the match rules and indicate their readiness to proceed with gameplay.

In order to determine which participants should be provided with the assisted or unassisted individualised instructions, participants were invited to play a 5-minute "warm-up" match to familiarise themselves with the controls. The results from this were used by the researcher to determine which participants should receive the assisted or unassisted instructions should the randomised match condition order for that session start with a condition immediately requiring those instructions to be provided.

As it was suspected that the game's automatic presentation of player scores and ranking along with a declaration of "Winner" or "Defeated" may have influenced post-match player experience survey responses in Stage 3 (see section 6.4.2), a different system of ending the match was used. To prevent this from occurring and keep participant performance hidden prior to completing the survey, the researcher instead made a screenshot of the scores from the server and forcefully disconnected the server at the 10 minute mark. This froze the game on each participant's machine, at which point the researcher asked them to remove their headphones and switched each PC back to the survey; manually bypassing the score screen so participant responses to player experience would not be affected by knowledge of actual performance. Although published after the current study was conducted, this decision was supported by research from Bowey and colleagues (2015) which demonstrated the ability for player performance feedback such as leaderboards to influence feelings of competence and relatedness.

7.2.2 Data Collection and Measures

Data collection in this study closely followed the format established in Stage 3 (see section 7.2.2) with a combination of quantitative player experience measures from surveys and performance data captured by the server. However, following the limited significant effects found in relation to the PENS survey constructs used in Stage 3, a greater variety of intrinsic motivation component measures were employed. These constructs focus on the areas of competence, challenge and enjoyment which more directly relate to the research questions and the purpose of MDDA to affect challenge and enjoyment. The chosen measures and constructs were:

- Player Experience of Needs Satisfaction (PENS) (Ryan et al., 2006):
  - Competence
  - Relatedness
- Intrinsic Motivation Inventory (IMI) (Ryan, 1982):
  - Enjoyment
- Flow State Scale (FSS) (Jackson & Eklund, 2002) – short version:
  - Flow
- Game Experience Questionnaire (GEQ) (IJsselsteijn et al., 2007):
  - Challenge

The responses were analysed using a mixed multivariate ANOVA as measures of player experience (see section 7.3.3).

In addition, two custom statements were included by the researcher for participants to rate their level of agreement using 7-point scale from "1 – do not agree" to "7 – strongly agree" and were independently analysed using mixed ANOVAs. These questions were:

- I performed well in this match.
- I felt frustrated in this match.

Following completion of all four match conditions and post-match player experience survey measures, participants were required to select the match that best describes each of four statements. This allowed an additional degree of post-gameplay reflection of preferences. These statements were:

- The match I enjoyed most was:
- The match I enjoyed least was:
- The match I feel I performed best in was:
- The match I feel I performed worst in was:

Similar awareness checks were put in place from Stage 3 using disguised questions to determine if any participants had noticed the presence of MDDA in a match that had been communicated to them as not containing MDDA (see section 6.2.1). A further check was put in place at the end of the survey questioning which matches the participant believed they may have been assisted in. Analysis of these responses indicated the awareness conditions and deception had been successful for all players in all sessions.

Following completion of the gameplay matches and survey, an audio-recorded "round-table" semi-structured interview was conducted. This included several pre-prepared questions by the researcher (see Appendix D), with the freedom for spontaneous follow-up questions to be asked in direct response to points raised by the participants. Participants were also able to freely discuss the questions and responses with each other, with the researcher only interjecting to continue to the next question or direct the discussion should it stray too far off-topic. At a certain point in the interview, the deception relating to the awareness of match conditions was revealed to determine how participants felt about the differing levels of awareness they were provided and if this new knowledge changed their perceptions of their player experience.

7.2.3 Qualitative Data Analysis

Data from the interviews was transcribed and coded using Braun and Clarke's (2006) six-phase thematic analysis process (see sections 2.6.2 and 3.2.4) to determine the overarching themes discussed by the participants and extract the key ideas in relation to the research questions. This was performed using an iterative approach, with the researcher first familiarising himself with the transcriptions (Phase 1) before establishing preliminary codes for each distinct concept evident several times across the interviews (Phase 2). The codes were generated to be indicative of unique and distinct ideas without overlapping other codes. However, due to the open-ended nature of the group interviews, some extracts of participant responses could be assigned multiple codes. For example, while the codes for the Enjoyment and code for Performance are discrete concepts, a participant response stating "I enjoyed this match more because I felt I performed better" may have both codes applied for this single passage as the extract expresses how the ideas influence each other in this context.

Several rounds of coding were performed in collaboration with a second researcher in order to generate the codes, their descriptions and check inter-reliability of interpretation to improve rigor (Muir-Cochrane & Fereday, 2006). To ensure full contextual understanding of data, all interview extracts were paired with the question the participant(s) were responding to. The secondary researcher coded approximately 10% of the interview content, followed by comparison and discussion with the primary researcher which was then used to fine-tune the codes, generate new ones, look for overlap and improve their definitions. Reliability of the coding performed by the primary and secondary researchers was then checked using Cohen's Kappa tests with a minimum threshold of 0.75 set to indicate "excellent" reliability of each code (Banerjee, Capozzoli, McSweeney, & Sinha, 1999).

The search for themes (Phase 3) followed Braun and Clarke's (2006) definition that a theme "captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set". An overall thematic map was generated containing the themes and codes that contribute to the overall major themes (Phase 4), which was subdivided into an individual map of each distinct theme present in the data and related codes (Phase 5). Some codes were found to contribute to more than one distinct theme where expressed opinions within the code diverged (e.g., where opinions contained within the code were expressed positively within one theme and a negative influence towards another). Each theme was then reported using extracts to demonstrate the ideas and concepts that built the theme and contributions from the related codes (Phase 6).

7.2.4 Study Process

Each session of the study (1 group of 3-4 participants) consisted of the following steps:

1. Participants were invited inside the research computer lab and seated at each PC.
2. Participants read through and completed the required Low Risk Human Ethics study consent form.
3. The researcher thanked the participants for coming and informed them that he will be reading all further instructions from a script to ensure consistency between participant groups (script available in Appendix E).
4. Participants were informed that the study would involve playing 4 matches of the game Unreal Tournament III, two of which would be 'standard' matches using normal rules and two which would use special features specified via paper instructions prior to each match. Participants were also informed that the order of these matches and features used were randomised for each session of the study, so they would be required to input text into the survey specified by the paper instructions before each match.
5. Participants were informed they would be answering survey questions on their experience following each, followed by a group interview discussion at the conclusion of all matches (example interview questions available in Appendix D).

6. The researcher requested that participants avoid speaking to or attempt to communicate with the other participants from that point forward until further instructions later in the session.
7. The participants were then invited to play a 5-minute “warm up” match to familiarise themselves with the controls and standard rules of the game. The researcher used the scores from this match to determine the assisted and unassisted participants for providing individual instructions to in Match Conditions 2, 3 and 4.
8. The game was exited and participants were invited to begin completing the survey (‘Participant Background’ section) until they reached a page requesting them to stop.
9. The researcher issued each participant with paper instructions containing the rules of the match, as well as text to be input in the survey.
10. Once all participants had done so, the researcher collected the papers. The researcher also noted that after 10 minutes of play, the game would stop and at that point they should remove their hands from the keyboard and mouse.
11. The PCs were prepared for play and participants were instructed to take a moment to familiarise themselves with the printed control scheme.
12. Participants played the match.
13. After 10 minutes, the researcher took a screenshot of the scores on the server PC and disconnected the game server.
14. Participants removed their hands from the keyboard and mouse, and the researcher closed the game and switched all PCs back to the survey.
15. Participants completed the next section of the survey.
16. Steps 9-15 were repeated three more times, for a total of 4 matches played with the varying conditions.
17. Participants completed the remainder of the survey and were reminded to refrain from speaking until instructed.
18. The researcher gathered the participants in the circle with a voice recorder and began the group interview.

19. At a certain point in the interview, the deception was revealed (all matches contained MDDA; only their awareness was varied).
20. Once the required questions had been answered and discussion naturally concluded, the researcher stopped the recording, thanked the participants for their time and provided them with their compensation. The researcher then brought the session to a close.

7.3 RESULTS

7.3.1 Participant Background

65 participants took part in this study with an average age of 21.83 years (SD = 4.71). Of these participants, 54 were male and 11 female which indicates a gender bias may be presents and results should be interpreted as such. As noted in Study 3 (section 6.3.1), this is not unusual for the first-person shooter genre to which the tested game (Unreal Tournament 3) belongs. Participants rated their experience level playing competitive multiplayer first-person shooter video games an average of 4.91 (SD = 1.49) from 1 (“not at all experienced”) to 7 (“extremely experienced”) and spent an average of 7.72 hours (SD = 12.80) playing them per week. During gameplay, 39 participants were the recipients of the MDDA instance’s assistance while 26 were unassisted. Due to the higher number of assisted participants than unassisted, results should be read and interpreted this limitation in mind. All sessions of the study contained enough performance variance between participants for the MDDA to successfully activate.

7.3.2 Performance

Score

Score is determined by the number of kills against other players and determines final match ranking. A player suicide (accidental self-inflicted death) counts as -1 score.

	Between-Subjects	Mean	Std. Deviation	N
Match Condition 1 – no awareness	Unassisted	28.500	8.106	26
	Assisted	13.564	6.315	39
	Total	19.538	10.184	65
Match Condition 2 – assisted aware	Unassisted	28.000	7.642	26
	Assisted	17.000	7.374	39
	Total	21.400	9.197	65
Match Condition 3 - unassisted aware	Unassisted	26.846	7.719	26
	Assisted	17.333	7.121	39
	Total	21.138	8.685	65
	Unassisted	27.885	7.480	26

Match Condition 4 – all aware	Assisted	17.051	7.437	39
	Total	21.385	9.127	65

Table 23. Stage 4 - Participant scores (kills)

Mauchly's test indicated the assumption of sphericity was not violated ($X^2(2) = 5.206$, $p = .391$). Bonferroni adjustment was used for all comparisons. No within-subjects effect was recorded for score across the match conditions ($F_{3,189} = 1.476$, $p = .223$). However, a between-subjects effect of assistance was ($F_{1,63} = 53.490$, $p < .001$) (see Figure 22) which was qualified by a significant interaction ($F_{3,189} = 4.292$, $p = .006$). Examination of the simple main effects revealed a within-subjects effect for assisted participants ($F_{3,114} = 7.578$, $p < .001$) as pairwise comparison indicated assisted participants improved their score in Match 2 (assisted aware) ($p < .001$), 3 (unassisted aware) ($p < .001$) and 4 (all aware) ($p = .011$) compared to Match 1 (no awareness).

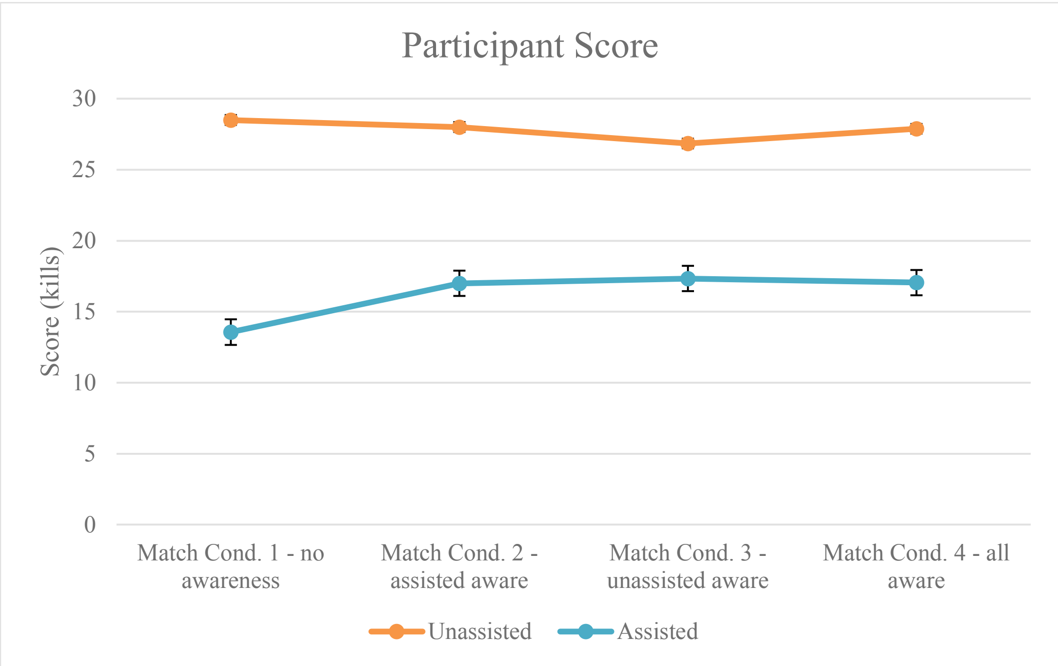


Figure 23. Stage 4 - Participant score with between-subjects factor (assistance)

Kill / Death Ratio

A participant's kill/death ratio takes into account the number of kills scored divided by deaths suffered. This provides a value indicative of not just their own score, but how much other participants were able to score by defeating them. A value of 1.0 indicates a participant died as frequently as they scored (averaging 1 kill per 'life'), while a value of less than 1.0 indicates they were killed more frequently by other participants than they themselves killed others. A higher value than 1.0 thereby indicating others were more deprived of scoring against them than they scored against others.

	Between-Subjects	Mean	Std. Deviation	N
Match Condition 1 – no awareness	Unassisted	1.471	.558	26
	Assisted	.610	.340	39
	Total	.954	.609	65
Match Condition 2 – assisted aware	Unassisted	1.313	.562	26
	Assisted	.686	.358	39
	Total	.937	.543	65
Match Condition 3 - unassisted aware	Unassisted	1.216	.515	26
	Assisted	.674	.318	39
	Total	.891	.485	65
Match Condition 4 – all aware	Unassisted	1.310	.559	26
	Assisted	.681	.354	39
	Total	.932	.541	65

Table 24. Stage 4 - Participant kill/death ratios

Mauchly's test indicated the assumption of sphericity was not violated ($X^2(2) = 9.586$, $p = .088$). Bonferroni adjustment was used for all comparisons. No within-subjects effect for K/D ratio was recorded between match conditions ($F_{3,189} = 1.245$, $p = .295$). However, a between-subjects effect was found for assistance ($F_{1,63} = 51.959$, $p < .001$) (see Figure 23) and was qualified by an interaction ($F_{3,189} = 3.822$, $p = .011$). However, simple main effects found a result slightly above the .05 significance cut-off for unassisted participants across match conditions ($F_{3,75} = 2.398$, $p = .075$).

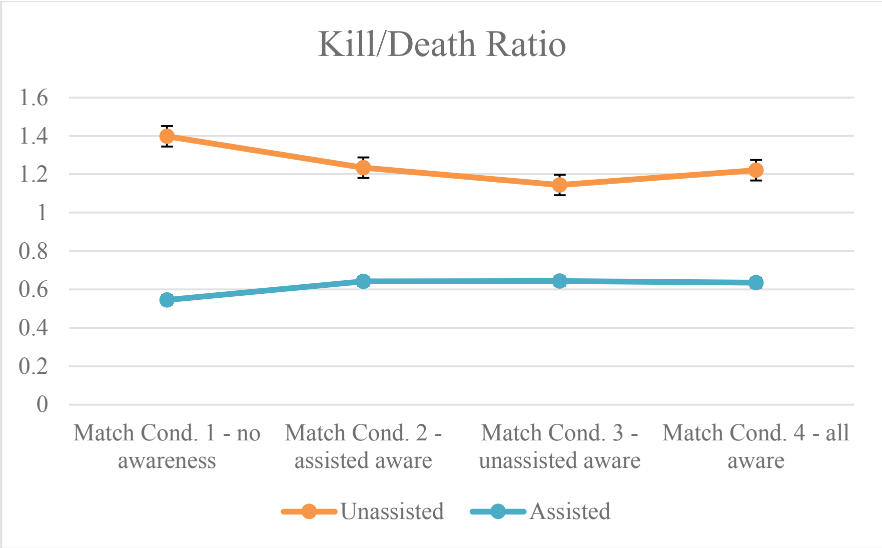


Figure 24. Stage 4 - Participant kill/death ratio with between-subjects factor (assistance)

7.3.3 Survey – Player Experience Measures

Data Preparation

Five main constructs were used in the survey: Competence (PENS), Relatedness (PENS), Enjoyment (IMI), Flow (FSS) and Challenge (GEQ). While a variety of measures were used in this survey, all constructs originated from intrinsic motivation theories and are indications of a positive player experience. This allowed the same analysis performed in Stage 3 to be repeated (see section 6.3.3); namely a repeated measures mixed multivariate ANOVA with Bonferroni adjustment across the constructs with a within-subjects factor of match condition (4) and between-subjects factor of whether the participant was assisted (2).

Reliability of the survey constructs were tested using Cronbach's alpha to ensure the relationships between the constructs as positive indicators of intrinsic motivation. All constructs exceeded a reliability alpha of .71 (PENS Relatedness) with a maximum of 0.901 for the PENS Competence construct.

Outliers were assessed using a combination of residuals and boxplots. One participant's data was flagged as the only outlier between constructs and conditions, and examination of their survey responses revealed the participant to have consistently rated all construct questions with the lowest possible score ('1'). This was deemed to be faulty data, and the participant's responses were removed across the data set. No further outliers (or participants providing 'response set' data) were present.

Checks for normal data distribution were performed by determining the skewness and kurtosis divided by standard error. A skewness of -4.208 and kurtosis of 6.987 were recorded for unassisted participants in the first match condition in the Enjoyment construct. Data transformation was performed using inverse square root, but resulted in simply reversing the skew when visually checked via histograms. Given the relative low levels of non-normality and due to the robustness of MANOVAs to normality variations the decision was made to use the untransformed Enjoyment data. All other untransformed constructs and conditions were found to be within the bounds of ±3.0.

Multicollinearity was tested using Pearson correlation coefficients with the expectation of some correlation between the dependent variables from the PENS, FSS and IMI constructs. Competence, Relatedness, Enjoyment and Flow demonstrated positive correlations with the greatest between Competence and Flow in Match Condition 3 (.759) and lowest between Competence and Relatedness in the same match (.037). However, negative correlations existed between these four constructs and GEQ's Challenge. This was an expected result, as the Challenge module questions focus predominantly on the negative effects of challenge such as pressure or frustration.

The assumption of homogeneity of variance-covariances matrices was satisfied as assessed by Box's test of equality of covariance matrices ($p = .684$). The assumption of homogeneity of variances was satisfied as assessed by Levene's test ($p > .05$) across all constructs and conditions. Mauchly's test verified the assumption of sphericity was satisfied for the constructs of Relatedness ($X^2(2) = 8.531$, $p = .129$), Enjoyment ($X^2(2) = 6.902$, $p = .228$) and Flow ($X^2(2) = 4.191$, $p = .522$). However, Competence ($X^2(2) = 22.097$, $p = .001$) and Challenge ($X^2(2) = 16.268$, $p = .006$) did not satisfy this assumption, and Greenhouse-Geisser adjustment were therefore used for these measures.

Multivariate Player Experience

A significant multivariate between-subjects effect for assistance was present ($F_{5,58} = 2.505$, $p = .040$), indicating unassisted participants (between-subjects) rated their experience somewhat more positively than assisted participants across the constructs. A significant multivariate within-subjects effect of match condition was also found ($F_{15,48} = 2.285$, $p = .016$) indicating differences on individual outcome measures between match conditions. The between-subjects and within-subjects effects are explored for each construct in the following sections. For the purpose of completeness, results are reported for all constructs including those in which an effect was not recorded (Relatedness and Challenge) with an accompanying statement.

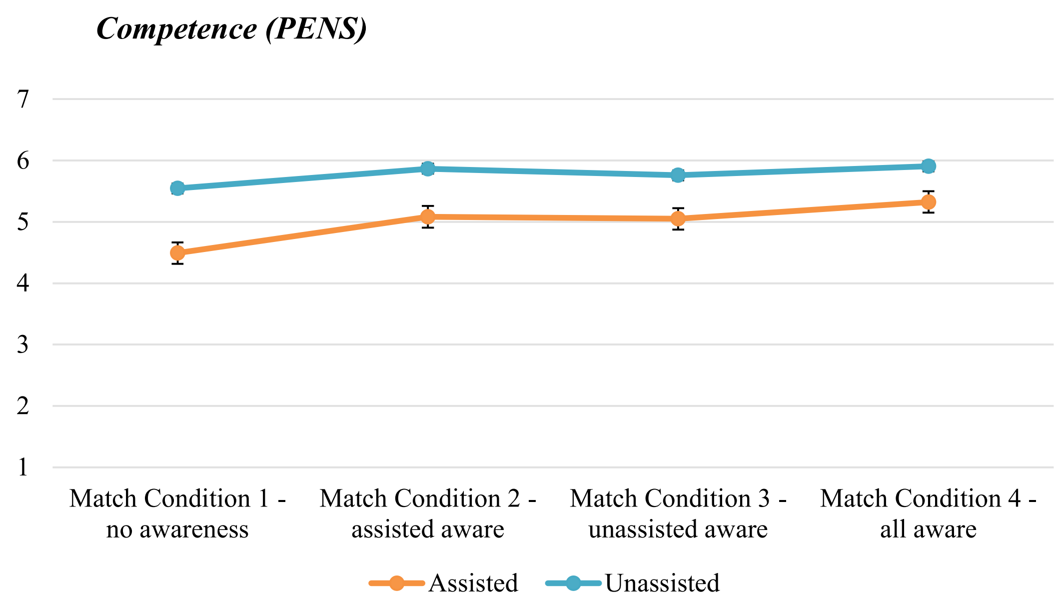


Figure 25. Stage 4 – Competence results

	Assistance	Mean	Std. Deviation	N
Match Condition 1 – no awareness	Unassisted	5.5467	1.0087	25
	Assisted	4.5812	1.1865	39
	Total	4.9583	1.2092	64
Match Condition 2 – assisted aware	Unassisted	5.8667	0.9526	25
	Assisted	5.1880	1.1103	39
	Total	5.4531	1.0957	64
Match Condition 3 – unassisted aware	Unassisted	5.7600	1.1035	25
	Assisted	5.1538	1.1441	39
	Total	5.3906	1.1586	64
Match Condition 4 – all aware	Unassisted	5.9067	1.0738	25
	Assisted	5.4359	1.1269	39
	Total	5.6198	1.1220	64

Table 25. Stage 4 – Competence results

As previously noted, Mauchly's test indicated the assumption of sphericity was violated for the PENS Competence construct. Greenhouse-Geisser was used to correct for sphericity in the following results with an epsilon of .798. Within-subjects univariate tests indicated a significant effect for competence was present ($F_{2.395,148.490} = 9.226$, $p < .001$). Compared to 'Match Condition 1 - no awareness', participants experienced higher competence in 'Match Condition 2 – assisted aware' ($p = .009$), 'Match Condition 3 – unassisted aware' ($p = .037$) and 'Match Condition 4 – all aware' ($p < .001$).

A between-subjects effect was also present ($F_{1,62} = 8.000$, $p = .006$), suggesting unassisted participants experienced higher competence than assisted participants.

Relatedness (PENS)

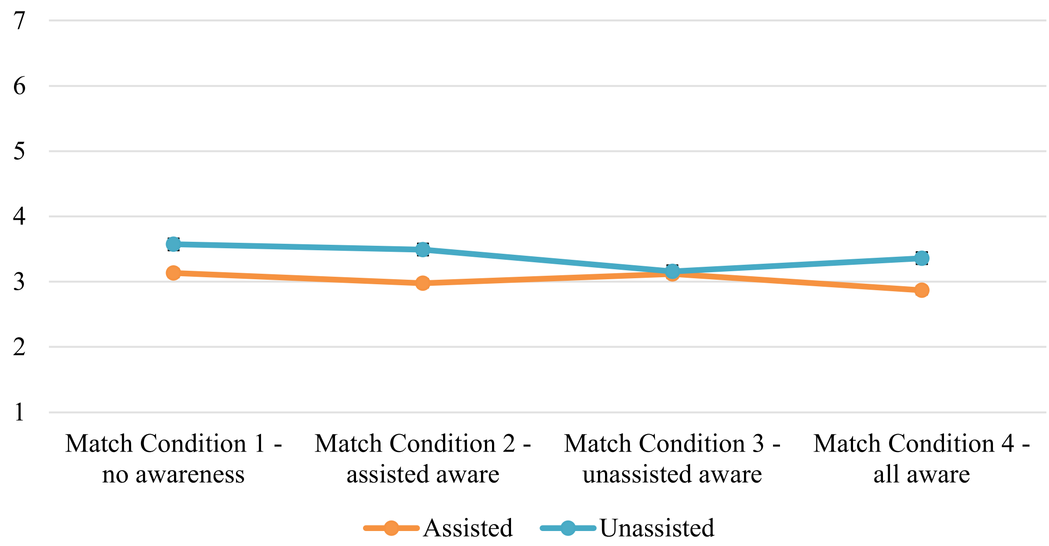


Figure 26. Stage 4 – Relatedness results

	Assistance	Mean	Std. Deviation	N
Match Condition 1 – no awareness	Unassisted	3.5733	1.4224	25
	Assisted	3.1880	1.2135	39
	Total	3.3385	1.3019	64
Match Condition 2 – assisted aware	Unassisted	3.4933	1.5218	25
	Assisted	3.0256	1.3667	39
	Total	3.2083	1.4359	64
Match Condition 3 – unassisted aware	Unassisted	3.1600	1.4692	25
	Assisted	3.1709	1.5501	39
	Total	3.1667	1.5072	64
Match Condition 4 – all aware	Unassisted	3.3600	1.5897	25
	Assisted	2.9145	1.4136	39
	Total	3.0885	1.4886	64

Table 26. Stage 4 – Relatedness results

For the PENS Relatedness construct, within-subjects univariate tests did not indicate a significant effect ($F_{3,186} = 1.422$, $p = .238$); nor a between-subjects effect ($F_{1,62} = 0.944$, $p = .335$).

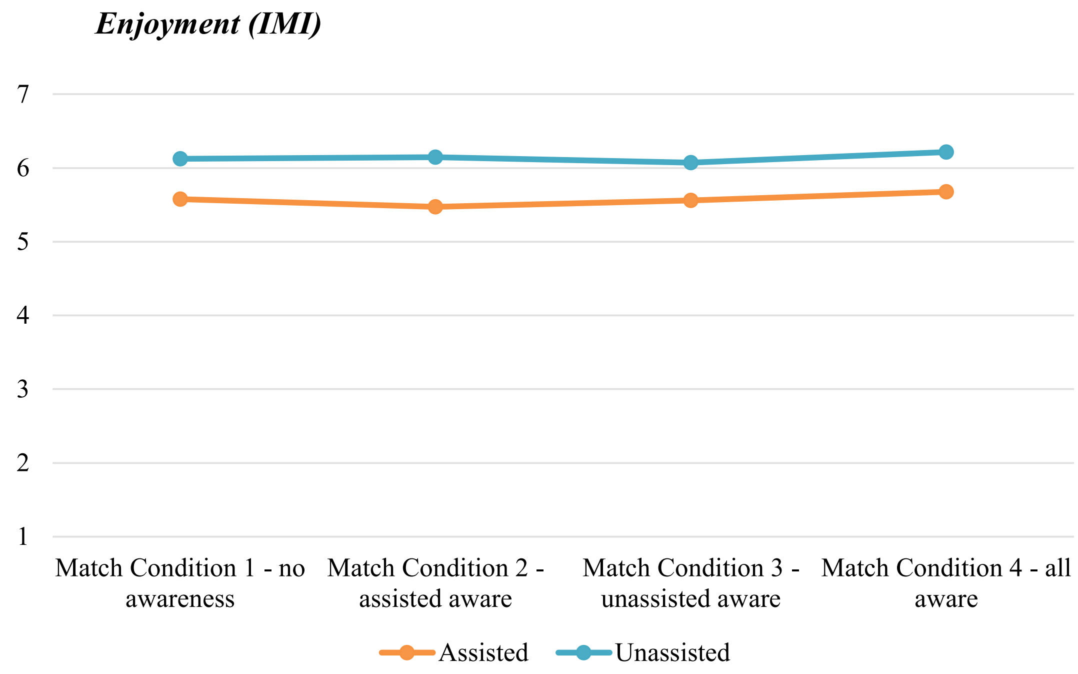


Figure 27. Stage 4 – Enjoyment results

	Assistance	Mean	Std. Deviation	N
Match Condition 1 – no awareness	Unassisted	6.1257	0.6286	25
	Assisted	5.6447	0.8087	39
	Total	5.8326	0.7752	64
Match Condition 2 – assisted aware	Unassisted	6.1486	0.6592	25
	Assisted	5.5531	0.9006	39
	Total	5.7857	0.8605	64
Match Condition 3 – unassisted aware	Unassisted	6.0743	0.7527	25
	Assisted	5.6374	0.8140	39
	Total	5.8080	0.8134	64
Match Condition 4 – all aware	Unassisted	6.2171	0.7262	25
	Assisted	5.7363	0.8985	39
	Total	5.9241	0.8624	64

Table 27. Stage 4 – Enjoyment results

For the IMI Enjoyment construct, within-subjects univariate test did not indicate a significant effect ($F_{3,186} = 0.814$, $p = .488$). However, a between-subjects effect was present ($F_{1,62} = 8.519$, $p = .005$), suggesting unassisted participants experienced higher enjoyment.

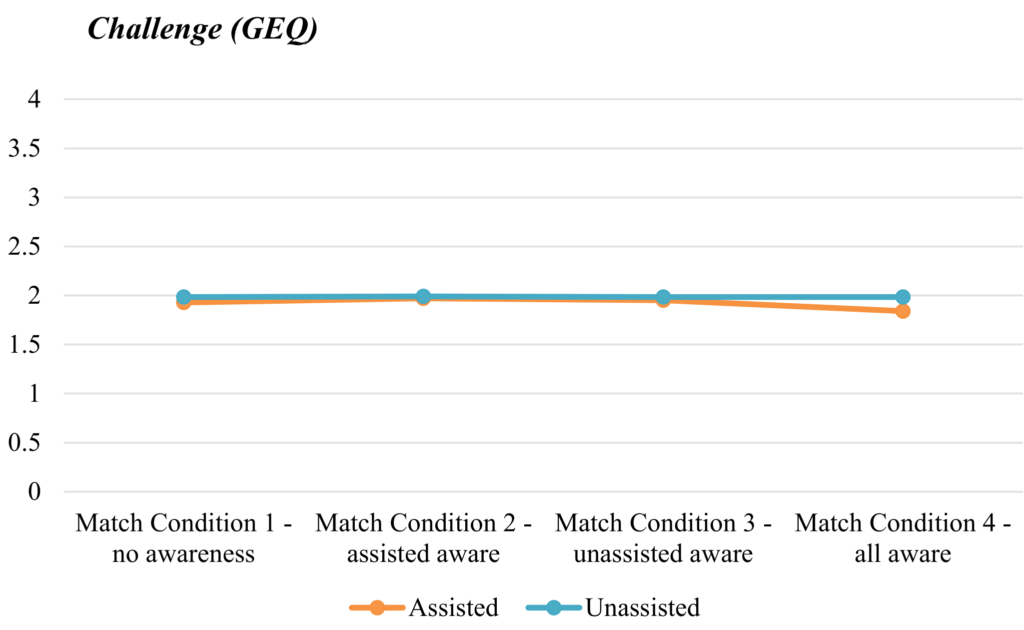


Figure 28. Stage 4 – Challenge results

	Assistance	Mean	Std. Deviation	N
Match Condition 1 – no awareness	Unassisted	1.9840	0.7915	25
	Assisted	1.8923	0.7593	39
	Total	1.9281	0.7671	64
Match Condition 2 – assisted aware	Unassisted	1.9920	0.7947	25
	Assisted	1.9282	0.8491	39
	Total	1.9531	0.8225	64
Match Condition 3 – unassisted aware	Unassisted	1.9840	0.8345	25
	Assisted	1.9026	0.9839	39
	Total	1.9344	0.9224	64
Match Condition 4 – all aware	Unassisted	1.9840	0.7787	25
	Assisted	1.7846	0.9181	39
	Total	1.8625	0.8655	64

Table 28. Stage 4 – Challenge results

As Mauchly's test previously indicated the assumption of sphericity was violated for the GEQ Challenge construct, Greenhouse-Geisser was used to correct for sphericity in the following results with an epsilon of .854. Within-subjects univariate tests did not indicate an effect for challenge ($F_{2.562,158.841} = 0.385$, $p = .732$). A between-subjects effect was also not present ($F_{1,62} = 0.304$, $p = .583$).

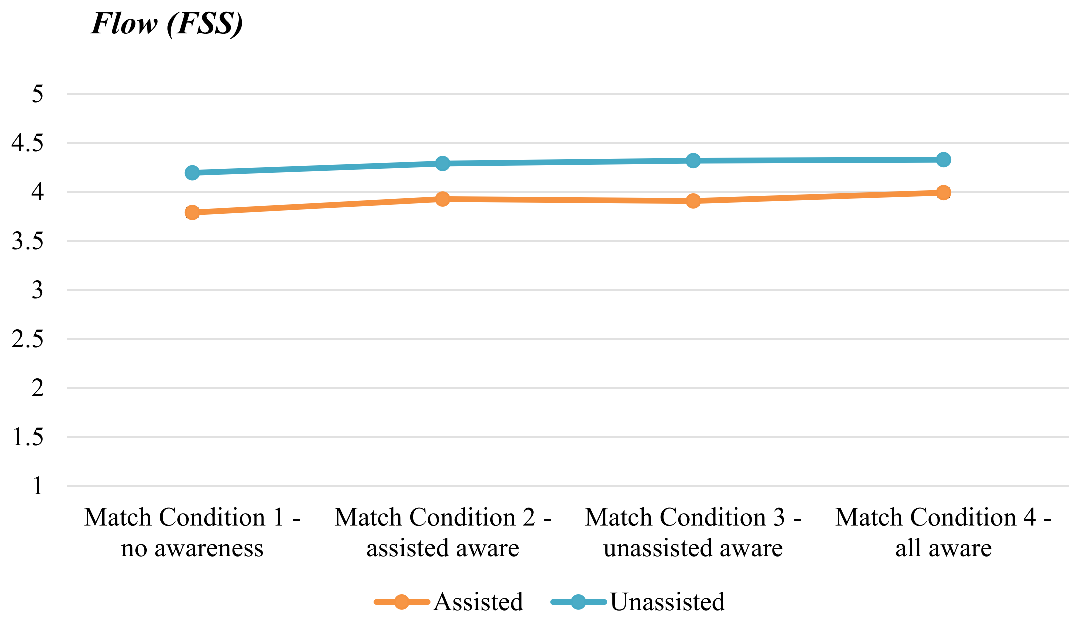


Figure 29. Stage 4 – Flow results

	Assistance	Mean	Std. Deviation	N
Match Condition 1 – no awareness	Unassisted	4.1956	0.4867	25
	Assisted	3.8547	0.4715	39
	Total	3.9878	0.5024	64
Match Condition 2 – assisted aware	Unassisted	4.2889	0.4703	25
	Assisted	3.9601	0.5350	39
	Total	4.0885	0.5320	64
Match Condition 3 – unassisted aware	Unassisted	4.3200	0.4562	25
	Assisted	3.9373	0.5554	39
	Total	4.0868	0.5484	64
Match Condition 4 – all aware	Unassisted	4.3289	0.5560	25
	Assisted	4.0142	0.5099	39
	Total	4.1372	0.5464	64

Table 29. Stage 4 – Flow results

Within-subjects univariate tests for the FSS Flow construct demonstrated a significant within-subjects effect ($F_{3,186} = 3.432$, $p = .018$) as participants experienced higher flow in ‘Match Condition 4 – all aware’ than ‘Match Condition 1 – no awareness’ ($p = .041$). A between-subjects effect was also present ($F_{1,62} = 7.117$, $p = .005$), indicating unassisted participants experienced higher flow.

Performance (custom)

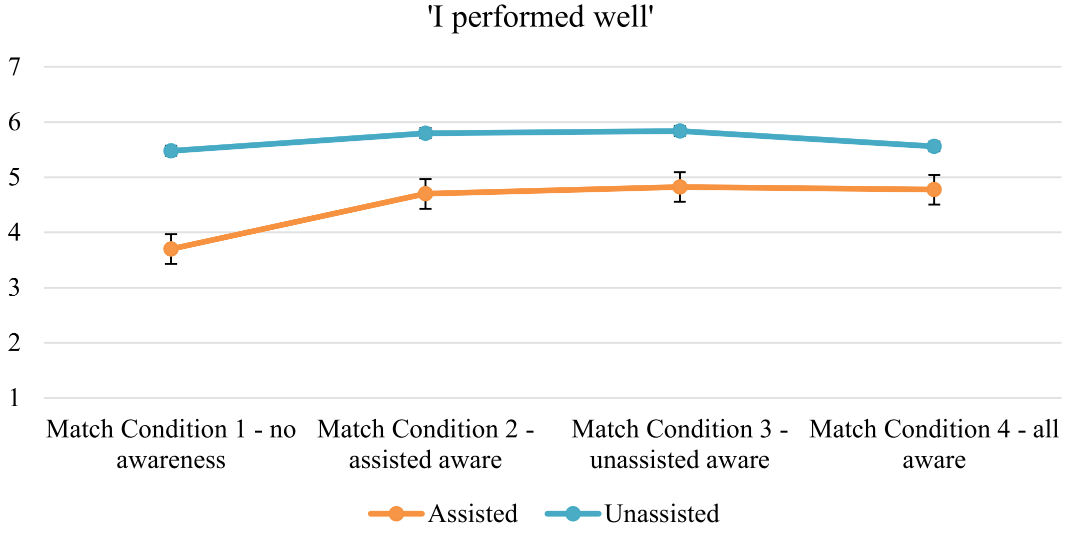


Figure 30. Stage 4 – Custom “performed well” question results

	Assistance	Mean	Std. Deviation	N
Match Condition 1 – no awareness	Unassisted	5.48	1.388	25
	Assisted	3.70	1.522	40
	Total	4.38	1.702	65
Match Condition 2 – assisted aware	Unassisted	5.80	1.041	25
	Assisted	4.70	1.713	40
	Total	5.12	1.576	65
Match Condition 3 – unassisted aware	Unassisted	5.84	1.375	25
	Assisted	4.82	1.534	40
	Total	5.22	1.546	65
Match Condition 4 – all aware	Unassisted	5.56	1.387	25
	Assisted	4.77	1.577	40
	Total	5.08	1.544	65

Table 30. Stage 4 – Custom “performed well” question results

Mauchly’s test indicated the assumption of sphericity was violated ($X^2(2) = 13.193$, $p = .022$). Consequently, Greenhouse-Geisser has been used to correct for sphericity in the following results with an epsilon of .873. In the custom “performed well” question responses, a significant effect was recorded between match conditions ($F_{2.618,162.299} = 5.144$, $p = .003$), which demonstrated participants felt they performed better in Match Conditions 2 ($p = .045$) and 3 ($p = .014$) compared to Match Condition 1. A significant between-subjects effect for assistance was present ($F_{1,62} = 17.915$, $p < .001$) indicating unassisted players received higher scores, although this was not qualified by a significant interaction ($F_{2.618,162.299} = 3.396$, $p = .108$) (see Figure 29).

Frustration (custom)

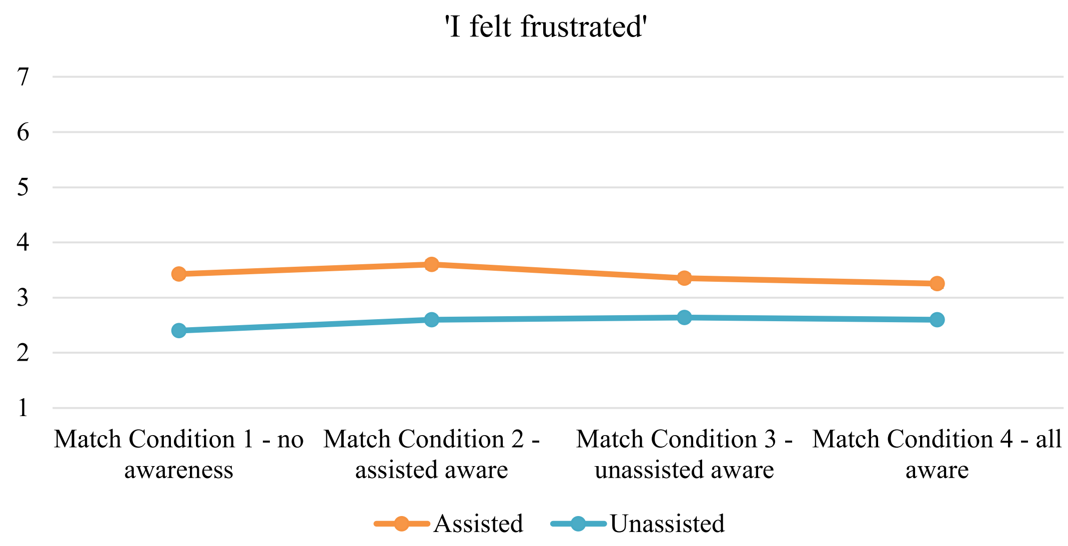


Figure 31. Stage 4 – Custom "felt frustrated" question results

	Assistance	Mean	Std. Deviation	N
Match Condition 1 – no awareness	Unassisted	2.40	1.658	25
	Assisted	3.43	1.693	40
	Total	3.03	1.741	65
Match Condition 2 – assisted aware	Unassisted	2.60	1.633	25
	Assisted	3.60	1.780	40
	Total	3.22	1.781	65
Match Condition 3 – unassisted aware	Unassisted	2.64	1.655	25
	Assisted	3.35	1.657	40
	Total	3.08	1.680	65
Match Condition 4 – all aware	Unassisted	2.60	1.683	25
	Assisted	3.25	1.660	40
	Total	3.00	1.686	65

Table 31. Stage 4 – Custom "felt frustrated" question results

Mauchly's test indicated the assumption of sphericity was not violated ($X^2(2) = 8.694$, $p = .122$) for the following results. In the custom "felt frustrated" question responses, no effect was recorded between match conditions ($F_{3,189} = 0.282$, $p = .838$) (see Figure 30). A between-subjects effect for assistance was present, indicating assisted players more strongly agreed that they felt frustrated ($F_{1,63} = 6.780$, $p = .011$) but was not qualified by an interaction ($F_{3,189} = 0.359$, $p = .783$).

7.3.4 Survey – Match Preferences

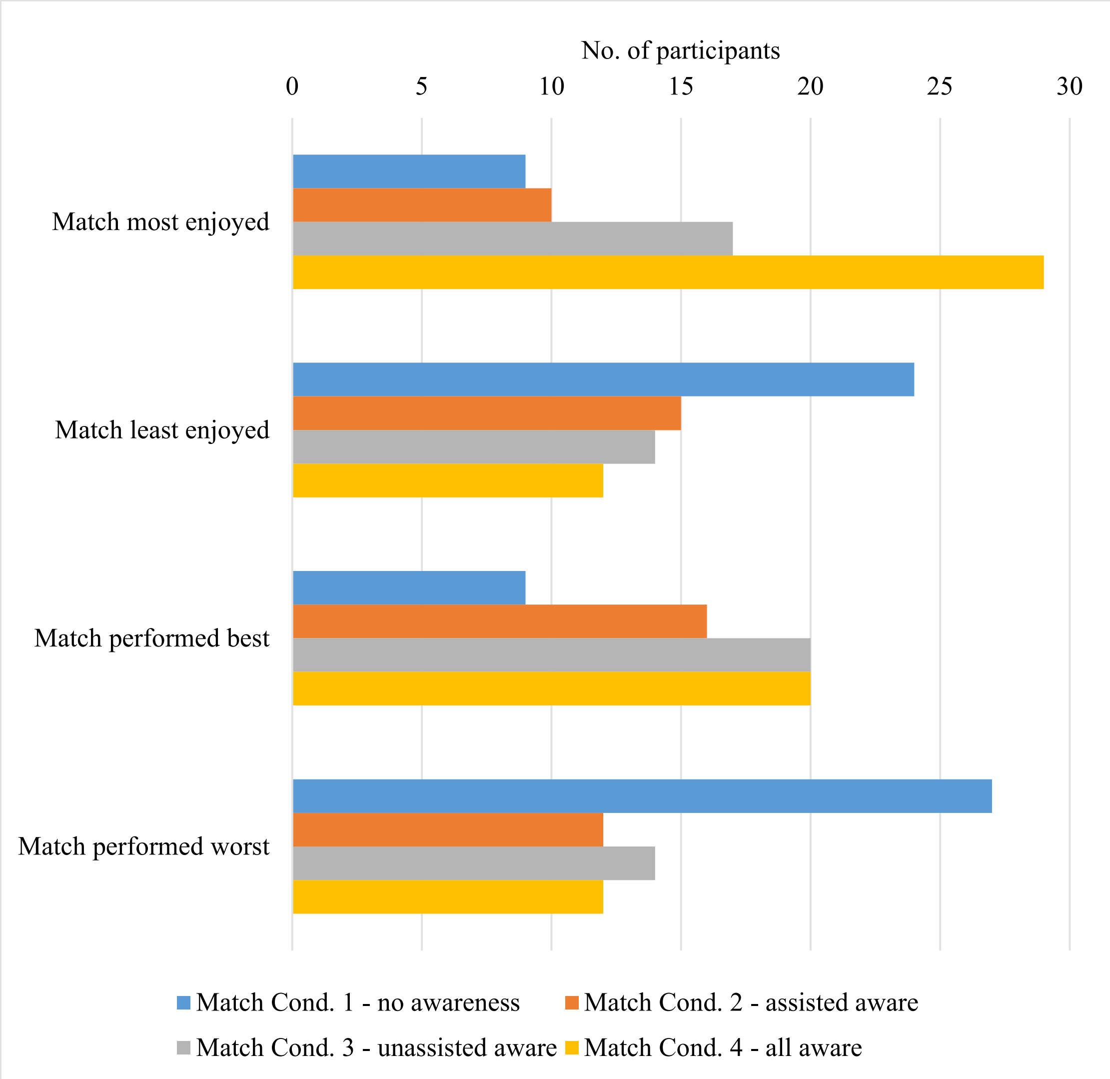


Figure 32. Stage 4 - Collective match preferences of all participants

Collectively, 29 of 65 participants stated they enjoyed Match 4 most in which all had high awareness of the presence and effects of MDDA. Match 1 was the least enjoyed, in which no participants were aware of MDDA (see Figure 31).

Participants most frequently selected Matches 3 or 4 as the one they felt they performed best in, closely followed by Match 2. These all involved either one or both of the assisted or unassisted groups possessing awareness MDDA in the match. Match 1 was most commonly selected as the match participants felt they performed worst in, and contained no awareness of MDDA.

Assisted Participants

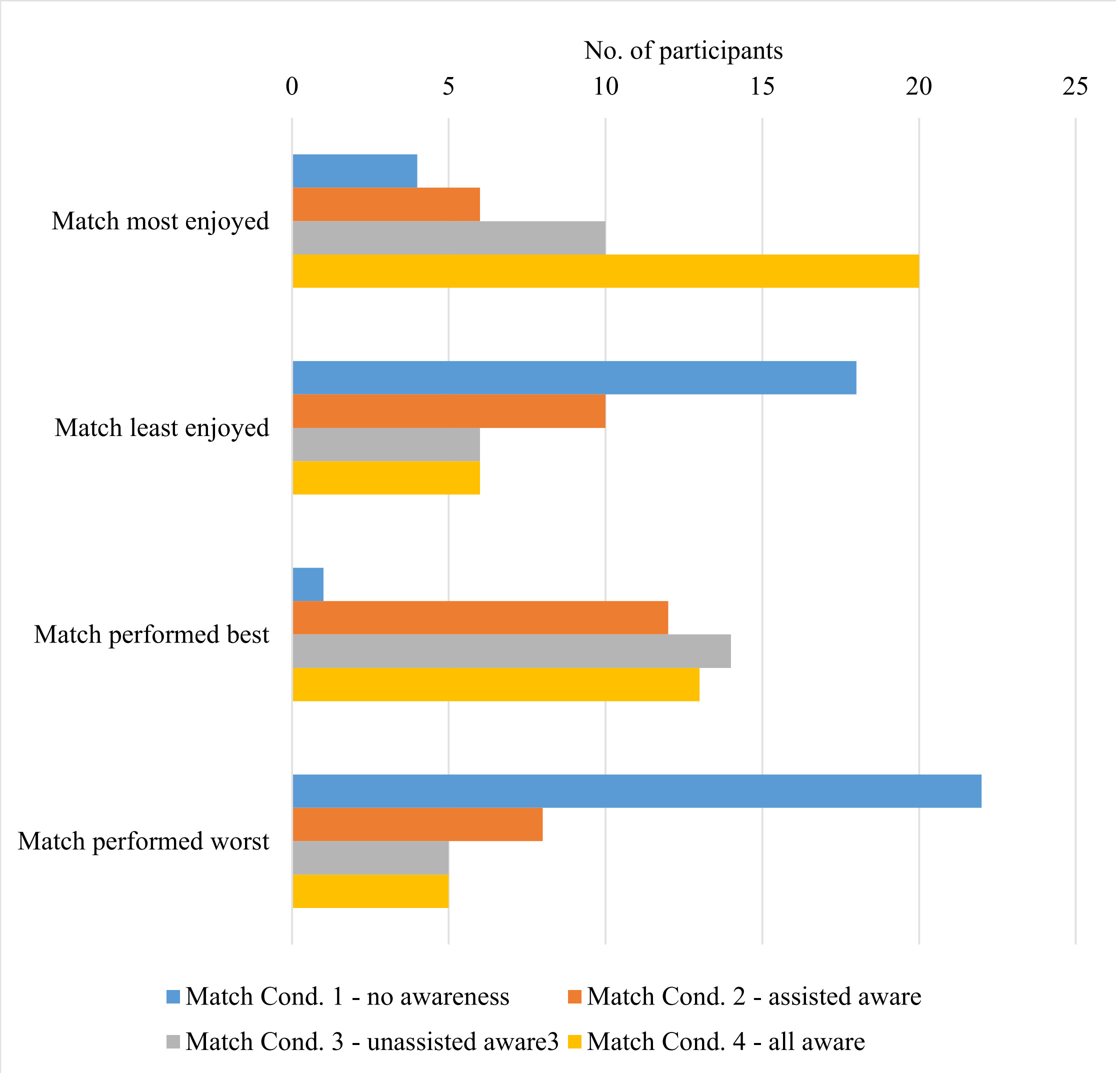


Figure 33. Stage 4 - Match preferences of assisted participants

Twenty of 45 assisted participants selected Match 4 as the condition they most enjoyed when all participants were aware of MDDA; double the next most popular choice of Match 3 when only unassisted participants were aware (see Figure 32). Match 1 in which no-one was aware was most frequently selected as the least enjoyed. Assisted participants were fairly evenly split between Matches 2, 3 and 4 as the one they felt they performed best in, with only a single participant selecting Match 1. However, nearly half the participant group felt they performed worst in Match 1.

Unassisted Participants

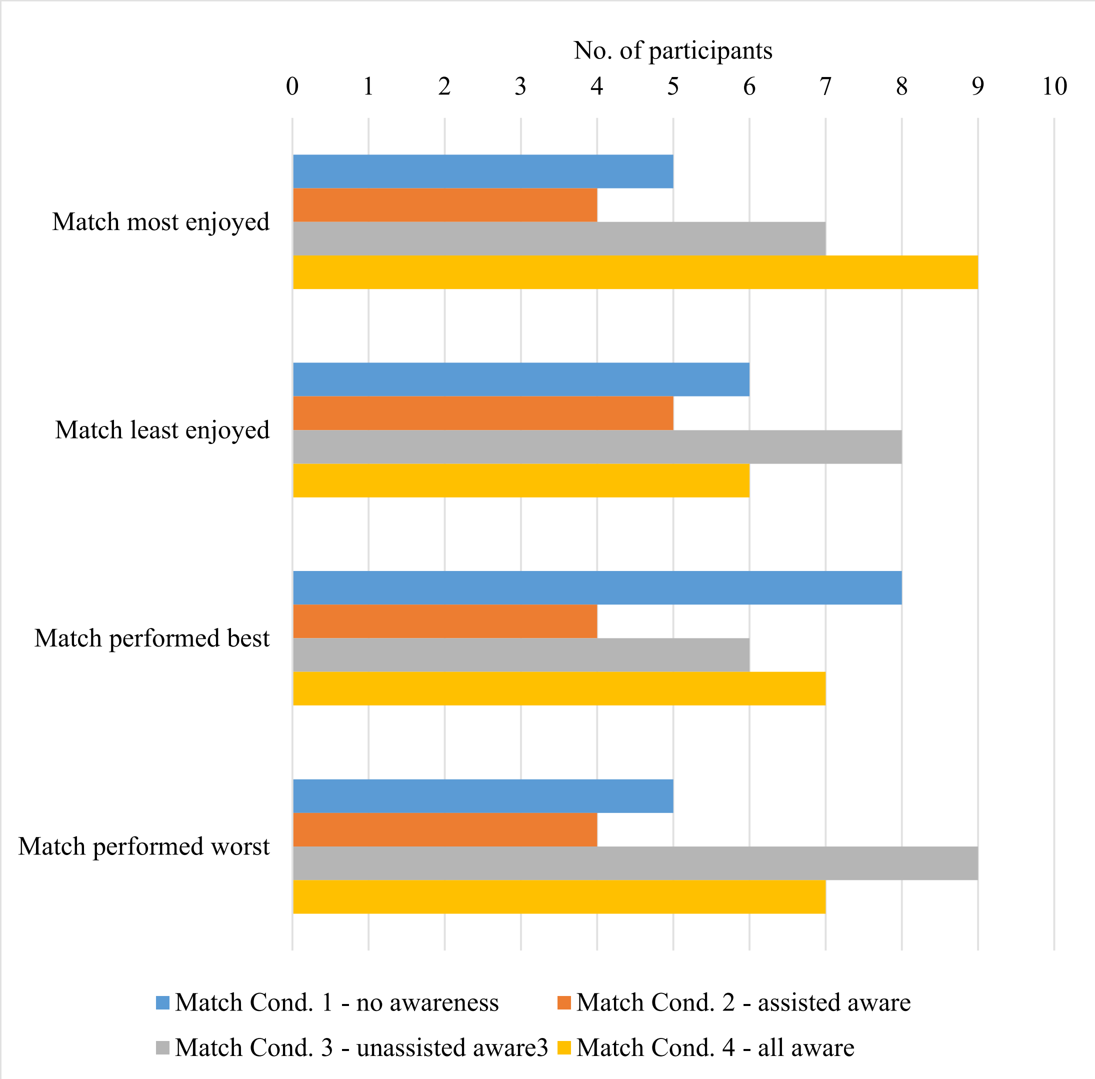


Figure 34. Stage 4 - Match preferences of unassisted participants

Unassisted participants recorded less consensus in match selections than the assisted participants. Matches 3 and 4 were the most commonly checked as the match they most enjoyed; both of which involved awareness of MDDA for unassisted participants (see Figure 33). However, the choice of match they least enjoyed was more evenly divided. The unassisted participants most frequently rated Matches 1, 3 and 4 as the ones they felt they performed best in, but again there was not a dramatic difference. However, Matches 3 and 4 were also most commonly checked as the conditions they felt they performed worst. This leaves Match 2 as the least commonly rated in all four selections without strong positive or negative selections.

7.3.5 Interviews

Each interview was conducted with the participant group (3-4 participants) from one session of the study. Direct quotes are provided in italics with the session number indicated afterwards (S#). Due to the group nature of the discussion, reliable identification of individual participants was not possible when transcribing from audio recordings.

Table 31 displays the codes were generated from the interview transcripts along with example extracts and quotes.

Code	**Definition**	**Example**
Performance	Discussion of personal or others' performance, or factors that influence performance	*"I think I did a lot better in the assisted [matches]. Like, I didn't do well but then in the 4th match I was way better"* (S3)
Awareness	Discussion of personal or others' awareness of the presence or effects of MDDA.	*"I think everyone likes to feel that everyone's on the same level when they play so I'm swaying towards telling everyone if you're going to have it [MDDA]."* (S12)
Strategy	Discussing of gameplay strategies, tactics, interactions or in-game behaviour.	*"I tried to be more stealthy, as much as you can be in UT sort of. Of course taking them head-on wouldn't work as well so I was waiting for them to come to me more and staying around the top so they wouldn't get behind me."* (S6)
Motivation	Discussion of motivations to play, make certain decisions or inform reactions.	*"It's like a confidence boost to experiment and try stuff I wouldn't otherwise cause I'm too paranoid about the really good players like [Participant]."* (S7)
Skill	Discussion of abstract skill or skilful play distinct from performance.	*"I have a problem when it means it doesn't take skill to win and just puts everyone at the same level when they shouldn't be."* (S2)
Game type	Discussion of different types of games by any differentiator such as genre, "casual" / "core", target audience, etc.	*"I think that's fine for casual games or whatever. Party games."* (S1)
Fairness	Discussion of subjective feeling of fairness of an aspect of a game or MDDA.	*"A lot of pro players would be pissed if it was giving an unfair advantage to people."* (S7)
Context	Discussion of the context in which a game is played such as who, where, why or how a game is played.	*"[P1]: Assistance would help for playing with friends though. [P2]: Oh yeah, coz you can't match-make between your mates."* (S3)
Customisation	Discussion of customisation or player control of MDDA and its design.	*"I'd like to customise it and, like if my friend is new we'd put it on or choose it like shields, or a special weapon, or maybe a map or something that makes it more even."* (S12)
Enjoyment	Discussion of enjoyment, satisfaction or feeling of reward from a game or feature.	*"But once there was assistance it was better. It's not as fun if some people are just getting destroyed."* (S11)

Cheating	Discussion of the act of cheating or exploitation while playing with MDDA.	*"People would play bad at the beginning to get it and you'd have like who teams just committing mass suicide until they game thinks they're shit and gives them a shield."* (S8)
Strength	Discussion of the strength of the balancing or assistance effects of MDDA.	*"That would be way too much if it was so strong it was just random who wins even when you're versing a beginner."* (S17)

Table 32. Stage 4 – Interview codes for thematic analysis

Themes were derived using a thematic map of the codes above linked to each of the notable ideas expressed by participants in the interview transcripts (see Figure 34) using Braun and Clarke's method (2006) (see sections 2.6.2 and 7.2.3). Five major themes were identified from supporting extracts from each of the associated codes. The grey shaded text boxes display the codes used while the rounded white text boxes contain subthemes found. Each distinct, major theme is displayed within the shaded, dotted sections and separated out in the following section.

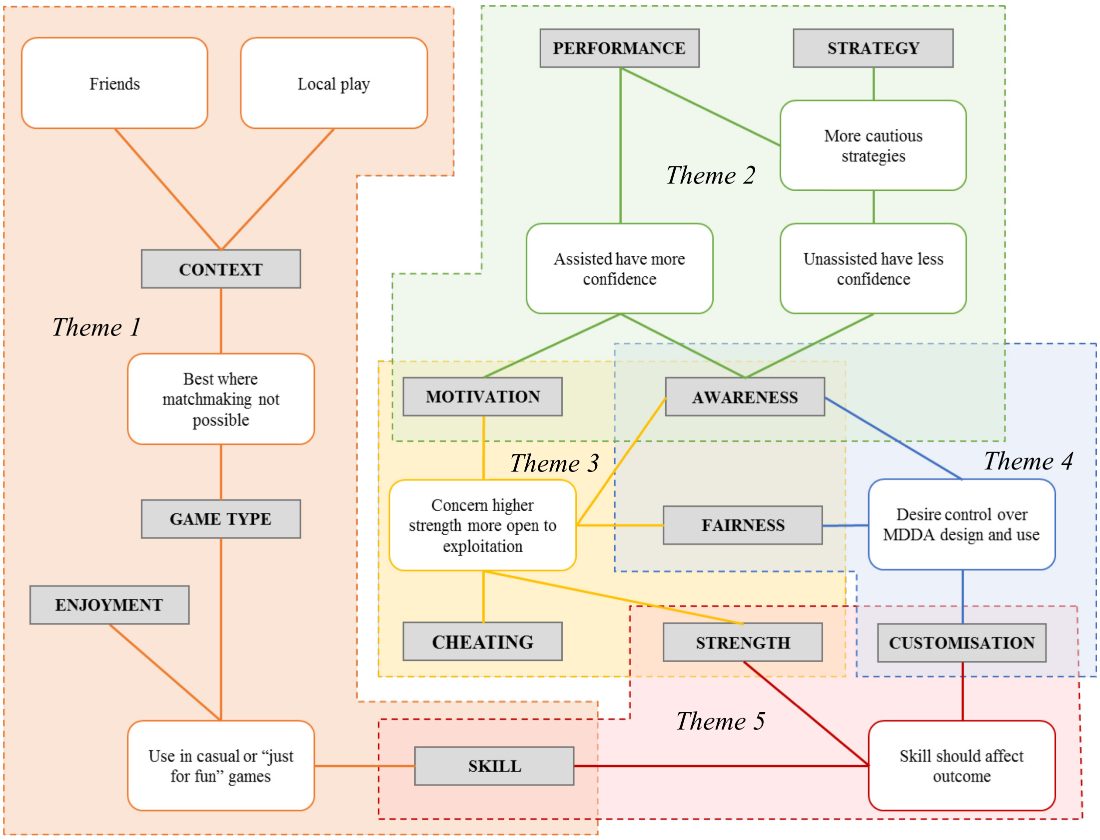


Figure 35. Stage 4 – Thematic map of interviews

The following major themes are presented with interview extracts from the associated codes that contribute to the theme. The study session number and codes associated with the extract are indicated following each quote (Session#; Codes).

Theme 1: MDDA more suited to certain contexts

Both assisted and unassisted participants expressed the perspective that MDDA would be most suitable in certain contexts and affect their desire to use this feature. It was suggested by participants that MDDA would be useful *"when you're playing to have a good time and it's not really important to win. I mean you try to but it's all in good fun"* (S12; Context, Enjoyment), *"Yeah if it's with strangers…I don't know. I'd prefer it with mates."* (S11; Context) and *"Where it's just for laughs and, like, friends"* (S4; Context). These touch on the purpose or intent for playing a multiplayer game; that is, for enjoyment or to simply "have fun" in a social situation with friends. It was suggested that MDDA would be beneficial in these situations because *"you don't know how shit some of your friends are going to be so you need something to help balance the game"* (S11; Skill, Context). Participants noted that playing with friends was a situation in which matchmaking (a different performance-balancing method) was not possible, as *"my friends are ranked all over the place so some are good, some aren't but it's not like you're going to kick a mate out because they're not good enough"* (S14; Skill; Context).

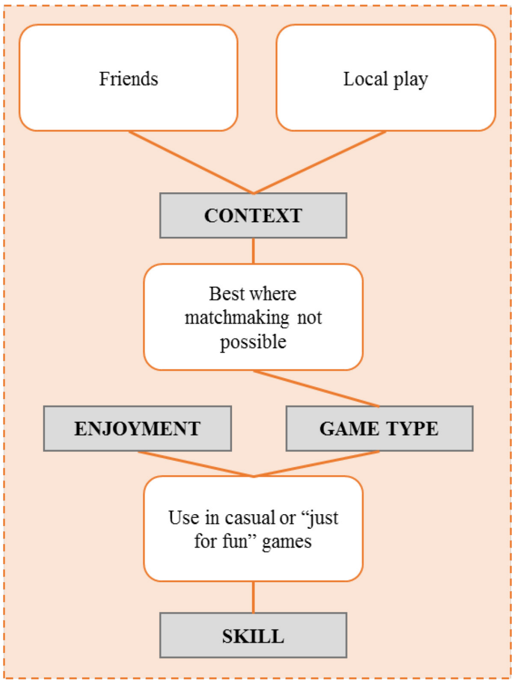


Figure 36. Stage 4 - Theme 1 chart

The context of playing with friends was also frequently paired with the type of game played, such as: *"I think they're great in some games. Party games and things like Mario Party or, you know, like Wii style games were you're with friends and having a laugh"* (S6; Context, Game Type, Enjoyment) or *"Yeah Mario Kart is more casual though so I wouldn't care as much. It makes it more fun if you're just playing with buds and it doesn't matter who wins. But not in a shooter or something competitive"* (S3; Context, Game Type, Enjoyment). Some other participants also echoed the preference that MDDA may not be suited to more "competitive" or "skill-based" games such as *"I think that's fine for casual games or whatever. Party games. Where it's not all competitive"* (S1; Game Type; Context). Some participants followed this with the suggestion that *"You could have something like a casual playlist and a competitive playlist in the actual game. Use it in the casual"* (S9; Game Type).

THEME 1 SUMMARY: MDDA features are preferred in certain contexts of play, such as when deliberately choosing to play with others who may be of differing skill levels (e.g., friends) or when skill-based outcomes are not as important.

Theme 2: Awareness of MDDA can affect confidence

Participants stated that awareness of the presence of MDDA had an effect on the pressure they felt and confidence; consequently influencing their in-game behaviour, performance or strategies. For example, unassisted participants expressed *"The assisted ones* [matches in which they were aware] *were kind of…more stressful in a way? Just knowing that some players had shields"* (S12; Awareness) and *"I wasn't as careful of that in standard matches, because –no offense- I didn't feel like they were as much of a threat"* (S10; Awareness, Strategy). This was often specified by unassisted participants as reasoning for using more cautious strategies in the matches they were aware of MDDA (3 and 4), such as *"well obviously I didn't want to run straight into someone assisted like with the shield so I was being more, I was trying to be more aware. Not like super tactical but less run and gun"* (S4; Awareness, Motivation, Strategy) and *"I was moving around more, standing behind things, using cover a bit."* (S10; Strategy). Some unassisted participants believed they may have suffered a loss of performance as *"I could have been psyched out by knowing about the assistance. I was like "oh, oh well" so I went*

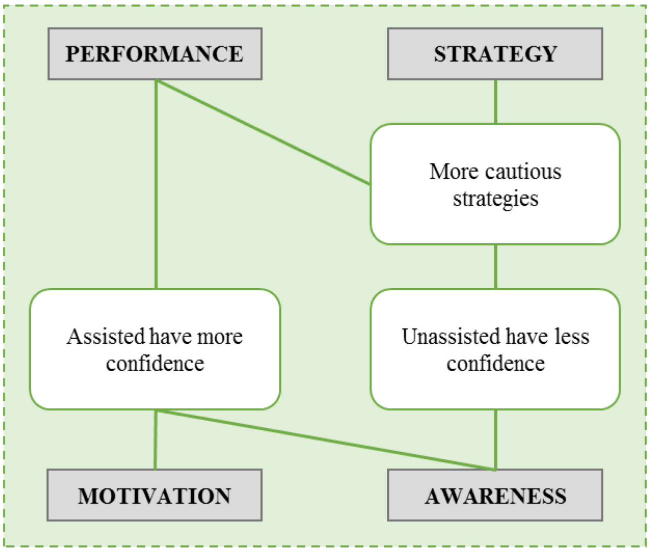


Figure 37. Stage 4 - Theme 2 chart

into it thinking I probably wasn't going to do as well so maybe that's why I didn't do as well? Just from that" (S12; Motivation, Awareness, Performance).

Conversely, knowledge of MDDA was seen as beneficial for assisted participants as *"I felt like I could give it a better go. It didn't turn me into Superman but, you know, I wasn't as worried about getting destroyed as much"* (S15; Motivation, Awareness) and *"it was nice having a bit of a safety net even if I didn't do anything different, I would live longer"* (S6; Motivation). While assisted participants expressed this confidence boost such as *"I think I was a bit better because I was braver. Or maybe when it went back to the normal matches it was that I was more scared then"* (S1; Performance, Motivation, Awareness), unassisted participants also saw benefits for assisted participants as *"it could have a confidence boost so they can try stuff out without being as, without worrying about dying as much"* (S9; Motivation, Awareness). However, assisted participants did not attribute this to a change in strategy as a result and noted that in the matches they were aware, *"I was doing it normally. I mean, if I have a shield then great but it doesn't change the way the game works"* (S4; Awareness, Strategy).

THEME 2 SUMMARY: The use of MDDA can improve confidence for assisted players without a conscious change in strategy. However, it may reduce confidence for unassisted players leading to more cautious gameplay strategies.

Theme 3: MDDA may be open to exploitation

A concern was expressed by participants that MDDA could be open to exploitation by high-performing players. For example, *"people would play bad at the beginning to get it and you'd have like who teams just committing mass suicide until they game thinks they're shit and gives*

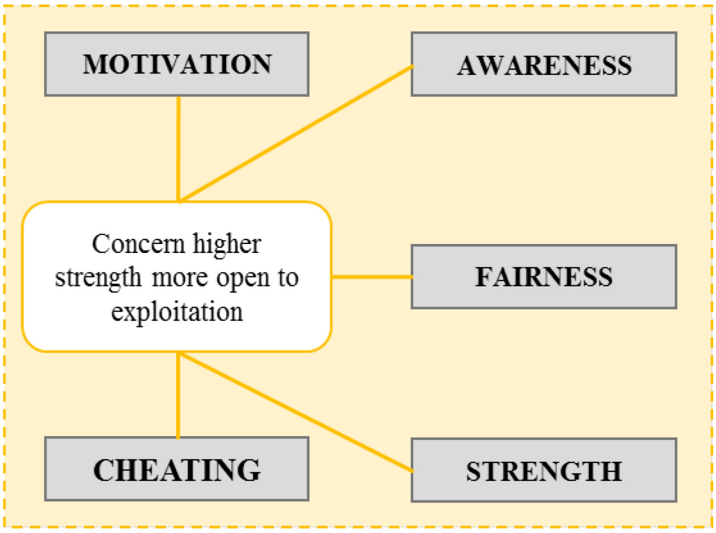


Figure 38. Stage 4 – Theme 3 chart

them a shield" (S8; Motivation, Strategy, Cheating). This was most often related to the strength of the assistance provided by MDDA, as *"if they know it's in the game, they could purposely kill themselves at the beginning until they get it and then dominate"* (S10; Strategy, Motivation, Strength, Cheating) and *"that's the thing – it'd be the really good players who would do it, not the ones who it's supposed to help"* (S17; Strength, Fairness). Participants also noted the potential for high-performing players to specifically hunt down assisted players if aware of exactly who was being helped by MDDA at a particular point in time, as *"that'd be like a beacon to run them down"* (S2; Motivation, Strategy, Fairness).

THEME 3 SUMMARY: MDDA features may enable exploitation through deliberate changes in performance in order to receive assistance; particularly if the assistance is seen as having a greater impact on performance.

Theme 4: Control and customisation of MDDA

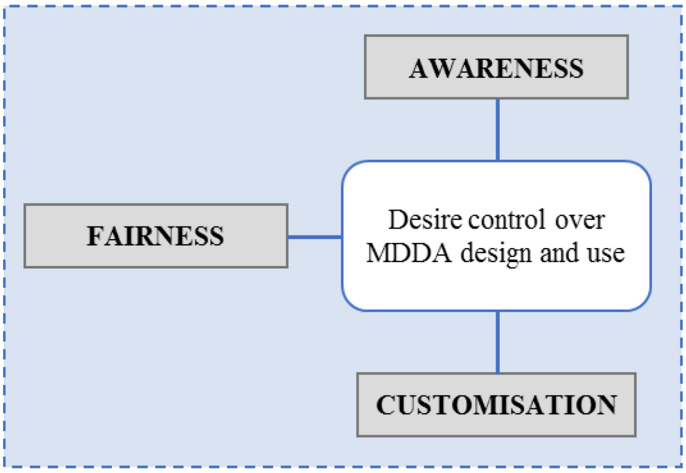


Figure 39. Stage 4 – Theme 4 chart

Player control over the use and customisation of MDDA was viewed positively by many participants. While MDDA was often viewed as a useful inclusion in games, participants expressed that they *"would want to control it though. Like, turn it on or off"* (S3; Customisation). The ability to choose whether a match included MDDA was seen as *"much more fair since then it's a proper feature just like a game rule. It's not sort of devious"* (S13; Fairness, Customisation). In addition to choosing whether to use MDDA or not, participants expressed the desire to customise the use or components of the MDDA. For example, *"maybe if you could choose the type of assistance? Like health, or weapons or something. Customise it"* (S2; Customisation). In order to players to customise the MDDA, knowledge of its presence and potential effects is required and subsequently raises the minimum possible awareness. Some participants paired this with the preference for customisation as *"you could choose whether it tells everyone who's assisted if you're wanting it more fair and in the open, or just hide it if it's not really a big deal"* (S16; Awareness, Customisation, Fairness).

THEME 4 SUMMARY: The ability to customise or control aspects of the use of MDDA may improve the perception of fairness.

Theme 5: Skill should affect outcome

The impact of skill of a match's outcome was highlighted as an important value for many participants. Concerns over whether the MDDA would be strong enough to affect gameplay were expressed, such as: *"For the first match we got the paper saying it would have the assistance I was worried it would interfere…I don't think that's the best word but it would change the game from what it's supposed to be"* (S4; Strength) and *"Like at the time when I was reading the instructions I was thinking getting the shields wasn't really good for playing competitively, because it took skill out of it"* (S10; Skill).

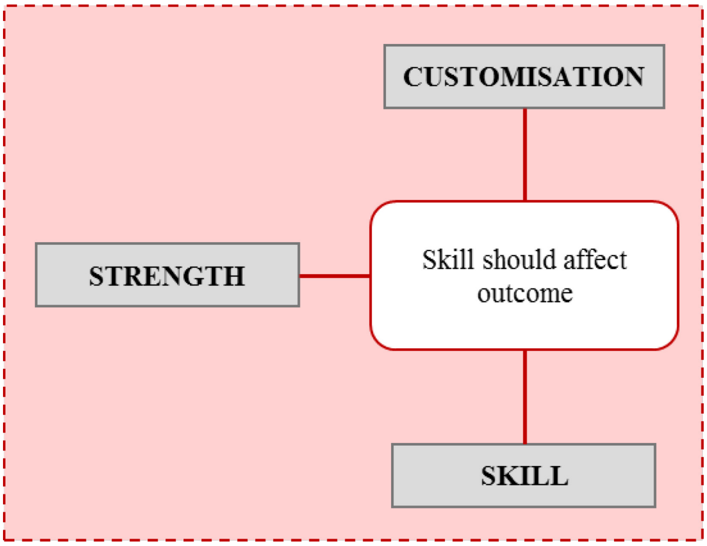


Figure 40. Stage 4 – Theme 5 chart

Regarding the strength of the assistance provided, it was stated that *"during play it didn't make as much of a difference as I thought since it didn't seem super strong. It didn't really feel like cheating so they still felt competitive"* (S10; Strength) and *"it didn't change the way the game works or anything. If it was just giving someone like god-mode or whatever that would make it different"* (S9; Strength). While the strength of the MDDA used in the study was not seen negatively, participants cautioned *"I get it for keeping it all competitive while you're playing but if you're the best you should win"* (S8; Skill, Strength) and *"so it's not just that 'anyone can win'. I still want to win on skill"* (S3; Skill, Strength). Using a reference to Mario Kart, one participant stated *"keep it balanced so it's not totally levelling the playing field and…you know, blue-shelling sort of stuff. Just a helping hand if you need it but not an instant-win card"* (S7; Strength). Some participants went further and suggested *"They should make it so you can adjust the sensitivity, like how much assistance it's giving out because it was fine today but I'd want to tweak it to make sure it's still the best player that wins"* (S6; Strength, Customisation).

THEME 5 SUMMARY: Players believe skill should still play the primary role in match outcomes, and the strength of the assistance from MDDA should not have so great of an effect as to change the final match 'winner'.

7.4 DISCUSSION

7.4.1 Performance

The game objective of "deathmatch" is to obtain the highest score from defeating opponents in 10 minutes. By looking strictly at score as a measure of success towards this goal, the addition of awareness did not result in a significant difference in score for unassisted participants. This is in spite of the adjustment in strategy frequently stated in the interviews by unassisted participants in the interviews as more cautious, defensive behaviour was adopted when aware that their opponents may be assisted by the MDDA.

On the other hand, assisted participants saw an increase in score in the Matches 2, 3 and 4. During Matches 2 and 4, assisted participants were aware of the presence and effects of MDDA, as well as the knowledge that they personally would be receiving assistance in comparison to Match 1 when no participants were aware and believed the match to contain no MDDA. This would suggest the knowledge of the shield assistance enabled better performance. Assisted participants often responded in the interview that they did not adjust strategy or behaviour when aware, however they frequently indicated an increase in confidence at the knowledge of an assistance "safety net" (Theme 2). The connection between confidence and improved performance is widely supported in similar competitive situations such as sports (Bandura, 1986; Feltz, 1988), and further indicated by the similarly increased feeling of competence and flow reported (see section 7.4.2. below).

Performance can also be examined using kill/death (K/D) ratios, which takes into account not just kills scored but also those scored against that participant (i.e., deaths). This is a good indicator of survivability, with a K/D ratio of 1 indicating a participant scored as frequently as others scored against them. By this metric, assisted participants did not show a significant difference indicating that even as their scores increased in Matches 2 (assisted aware), 3 (unassisted aware) and 4 (all aware), they were also dying more frequently. As unassisted participants did not see an increase in score in these matches, instead this suggests the assisted participants were scoring more frequently against each other, resulting in an increase in score but no effect on the K/D ratio. This would again support the interpretation that increased confidence improved the performance of assisted players when aware.

However, this does not account for the similarly improved performance in Match 3 when only unassisted participants had awareness of MDDA. The kill/death ratio of unassisted participants did not reach significance between match conditions and should therefore be interpreted with caution. However, descriptive results follow a trend of a reduction in both score and kill/death ratio; particularly in Match 3 when only they were aware. As previously mentioned unassisted participants frequently responded in the interviews that they adopted a more cautious and approach when informed that their opponents may be assisted due to a perceived increase in threat; attempting to surprise their opponents rather than engage in head-to-head combat. Due to the "twitch" nature (very fast-paced combat requiring rapid movement and reactions) of Unreal Tournament 3, this strategy did not appear to improve their score against their assisted opponents and in fact may have been more damaging to performance. This effect was noted in a study by Cox, Cairns, Shah and Carroll (2012) in which high-experience players incorrectly perceived and reacted to the challenge presented by an adaptive balancing system compared to low-expertise players who simply "got on with playing". This would account for Match 3 when assisted participants were not experiencing greater confidence, yet still maintained a score similar to when they were aware of the MDDA.

When asked to rate the matches they feel they performed best or worst, participants were generally able to correctly judge their performance without the benefit of visible rankings or scoreboards following each match (see section 7.3.4). Most assisted participants selected Match 1 as their lowest performing; matching their lowest scoring condition. Similarly, more unassisted participants selected Match 3 than any other round. While score did not significantly change, this match contained their lowest K/D ratio.

These results differ from those found in Stage 3, in which the introduction of awareness resulted in less balance as the difference in scores between assisted and unassisted participants widened. The same map, number of players and MDDA instance design were used in Stage 4, but a notable difference in the awareness conditions was present. While Stage 3 informed players of the presence and effects of the MDDA, it did not explicitly state which players were assisted and which were not. In contrast, Stage 4 provided instructions that directly informed participants whether they would be receiving assistance, or whether their opponents would be assisted (see section 7.2). This puts the conditions at different points along the Awareness component continuum (see section 5.5), with greater awareness in Stage 4. It is suspected that without direct knowledge that they received the assistance “safety net”, a similar boost in confidence for assisted participants may not have occurred in Stage 3. Consequently, the same improvement in score was not witnessed compared to Stage 4. However, this interpretation is presented with the limitation that direct testing of whether participants knew they were personally assisted or not was not performed in Stage 3,

Overall, the performance findings of this study indicate the addition of greater awareness can improve the performance of assisted participants through an increase in confidence (RQ4a), while unassisted participants may see little change or a potential decrease if overly-reactive in applying new strategies when aware (RQ4b).

7.4.2 Player Experience

A between-groups effect was present for competence, enjoyment and flow as unassisted participants recorded higher ratings on these scales, indicating a more positive experience overall. These echoed the findings of Stage 3 and were once again expected due to the link between task challenge and optimal experience (Csikszentmihalyi, 1990).

Within-groups effects demonstrated an improvement for feelings of competence in Matches 2, 3 and 4 compared to 1; conditions in which unassisted, assisted or both groups possessed awareness of MDDA. Looking specifically at assisted participants, these aligned with the matches they scored highest. This would suggest the difference in performance was able to affect feelings of competence without any visible ranking or scoreboard to validate the score improvement. Birk, Mandryk, Miller and Gerling (2015) found in their investigation into self-esteem in video games that improved competence can lower experienced tension and should ultimately lower negative affect. While they suggest effective matchmaking algorithms may assist in achieving this, the improved competence recorded by both assisted and unassisted participants in this study indicates MDDA with player awareness of the recipient and effects may also be an effective method. This may be beneficial for player retention, as improved competence has been previously found to encourage users to return to both competitive games (Tauer & Harackiewicz, 1999) and other activities (Harackiewicz et al., 1987).

The ability to self-judge performance was further supported by their higher agreement with the statement “I performed well in this match” during Matches 2 and 3. While Match 4 did not reach statistical significance, descriptively it followed a similar trend to 2 and 3. On the other hand, assisted participants did not report a similar increase in enjoyment to match competence and flow.

A clearer picture is visible in the match preferences, as the matches assisted participants most and least enjoyed closely resembled the matches they felt they performance best and worst in respectively. Collectively, the results suggest a trend towards a more positive experience when achieving higher scores for assisted participants. This is consistent with Depping, Mandryk, Li, Gutwin and Vicencio-Moreira’s (2016) findings that performance was a greater influence on the resulting experience of assisted players than awareness of the assistance itself.

As in Stage 3, no effects were found between matches or groups for relatedness. While communication between participants was restricted during the study in order to maintain the awareness conditions without the deception being revealed, the lack of a negative influence of the presence of MDDA on relatedness ratings provides some reassurance that the introduction of assistance did not reduce social connection to other players. It is suspected that this may have differed if the strength of the assistance were increased based on themes found in the discussion (Theme 3 and 5). Participants were concerned that very high-strength MDDA could result in cheating or reduce the effect of skill in a match’s outcomes, and while satisfied with the MDDA used in this study there is the potential for negative player experience effects if these concerns were realised (Gerling et al., 2014). Participants in a similar dynamic balancing study by Bateman, Mandryk, Stach and Gutwin (2011) also cautioned that the win “wouldn’t count” as assistance obscured actual ability; a potential consequence of excessive assistance .

Enjoyment as measured by IMI (Ryan, 1982) was not positively or negatively affected by the differing awareness conditions in spite of the effect on score performance, flow and competence. Similarly, assisted participants expressed higher agreement with the statement “I felt frustrated in this match” than unassisted participants. Awareness did not affect this response and was expected to inversely follow ratings for enjoyment which similarly saw no effect. This again echoes results from Depping et al. (2016) who found an improvement in enjoyment when MDDA was introduced, but no further effect for whether players were aware or not. They suggest providing awareness to be a safer choice for designers since it does not penalise enjoyment and avoids the potential for players to feel betrayed if hidden MDDA is later discovered. As participants in Stage 4 communicated a desire for control and customisation over the use of MDDA in games (Theme 4) and awareness is therefore a necessity for this feature, this is a safe recommendation.

However, while enjoyment and frustration were not affected, flow saw an increase for participants when all were aware compared to no awareness. This reflects the match preferences in which the most enjoyed was Match 4 (all aware), while the least enjoyed was Match 1 (no awareness). This further emphasises that across constructs which saw a change in player experience as well as match preferences, the "no awareness" condition was consistently reported as providing the lowest player experience.

When rating agreement with the statement "I performed well in this match", the response of assisted participants echoed their competence rating and score data. As previously mentioned, in spite of match results and rankings being hidden from them, participants demonstrated a good ability to estimate and judge their performance and experience in line with their sense of competence and flow. This bodes well for the use of MDDA with player awareness, as there is a danger that players may not internalise their success when assisted (Zuckerman, 1979) and instead attribute it to the MDDA. However, Depping et al.'s (2016) results similarly confirm assisted players to be crediting themselves with their achievements even when aware of MDDA.

The results of the challenge construct from the GEQ (IJsselsteijn et al., 2007) were unexpected with no interactions or effects recorded. It would initially appear assisted and unassisted participants experienced near identical levels of challenge which contradicts performance and competence findings. While unable to be confirmed post-hoc, it is suspected that the wording of the challenge sub-scale questions may have resulted in participants rating the challenge of controlling and interacting with the game rather than from competition from opposing players. More recent examination of the GEQ scale in literature has suggested there may be issues with the accuracy of the subscales in measuring the intended aspects of the player experience (Brühlmann & Schmid, 2015), and could potentially be a factor here.

Overall, the findings indicate that awareness of the presence, effects and recipients of MDDA can improve the player experience for assisted players. An improvement in feelings of competence and flow compared to when unaware, along with greater score performance (RQ4a) attributed to greater confidence has resulted in these matches being rated as most enjoyable. However, unassisted players may similarly experience improved competence and flow (RQ4b) when aware of MDDA and rate these matches as most enjoyable in spite of the increased perceived threat of their opponents and subsequent change in strategy.

7.4.3 Optimal Design of MDDA

The interviews provided additional information useful for the optimal design of MDDA (RQ3) and insights on the reasoning behind their player experience and performance results.

While not tested in this study, participants often qualified their opinion within the context of play (Theme 1); a factor that may affect the experience of using MDDA (Depping et al., 2016). User intention in social play contexts can affect player behaviour (Hsu & Lu, 2004), and participants frequently made a distinction between playing competitively and playing for "fun"; both of which were referring to player vs player gameplay. Mario Kart and party games were frequently cited as games "played for fun", in which play is situated in a very social environment with friends situated in the local area or same room. This reasoning is in line with Clarke and Duimering's (2006) research into first-person shooter games which found the most cited positive aspects of LAN (local area) multiplayer gameplay in the same room to be "more fun; more social". The outcome and influence of skill were portrayed as less important than the enjoyment in the moment, and the inability to utilise other balancing methods such as matchmaking within a group of friends was highlighted. Depping and colleagues (2016) describe this as "relationship enactment through games" as opposed to the direct skill comparison in purely competitive environments. In this context, MDDA was seen as beneficial to the purpose of providing a more level player field with less regard to how it may affect the game results. However, there is the potential that these opinions may be influenced by Mario Kart's position as a critically-acclaimed market leader with known MDDA use; providing familiarity with a "successful" implementation of MDDA. Kaye and Bryce (2012) found in their research that competitiveness can impact the player experience in particular social contexts as player expectations and objectives change.

Participants were more concerned about the potential use of MDDA in "competitive" games (i.e., games in which skill is highly valued) or games played in eSports. Examples such as League of Legends (Riot Games, 2009) were provided as games in which participants believed the outcome should have minimal interference from factors that may reduce the impact of skill (Theme 5). In these cases, participants were not as positive about the use of MDDA and would prefer the importance be placed on comparing player skill (Vorderer et al., 2003).

Additionally, in line with the results of Stage 2, concerns were voiced over the potential exploitation of MDDA by high-performing players as a method of "cheating". Clarke and Duimering (2006) found cheating to be the most negative aspect of online play of first-person shooters reported by players in a series of interviews, with "violate game objectives; spoil the game" another factor reported. This suggests cheating to be a common issue online, so the use of any feature such as MDDA with the potential for exploitation may naturally see some suspicion. Depending on the strength of assistance provided, participants believed some participants may intentionally perform poorly in order to receive assistance that may then be used to boost their performance further. The use of different strategies in response to awareness of MDDA was discussed by unassisted participants which displays the potential for high-performing players to alter tactics when playing with MDDA. However, as previously discussed this was seen as more problematic depending on the purpose of play and strength of the assistance. Kazakova and colleagues (2014) note excessively reducing the contribution of skill to match outcomes can reduce gratification and intrinsic motivation to continue playing for both low and high-performing player. This was not tested in this study and may be less likely to appear due to the relatively low strength of the performance assistance provided by the "static shield" MDDA, but may be an area in need of further research.

A desire for control and customisation of MDDA was frequently expressed (Theme 4) by participants and may alleviate some of the concerns raised above. The simple option to switch MDDA on or off was recommended by many participants, and often linked to the purpose of play previously discussed. For example, MDDA may be used when playing casually with friends but removed if wishing to compare skill instead. Additionally, desire to modify the type and strength of the assistance was requested and perceived as more “fair” when chosen by the players of a match much the same as other game rules. This naturally involves a degree of awareness of MDDA, but player experience findings above suggest this should not be a problem and may be a safe option.

7.5 CONCLUSIONS & LIMITATIONS

The study conducted in Stage 4 demonstrated performance and the player experience was affected by awareness of the presence, effects and recipients of MDDA (RQ4). In particular, awareness among assisted players may improve performance through providing additional confidence and a subsequent increase in feelings of competence and flow. This was stated to occur without a notable change in gameplay strategy. However, unassisted participants may adopt a more cautious and perhaps overly-reactive changes in strategy when made aware that their opponents may be assisted with MDDA. Match preferences were seen to be more closely tied to performance for assisted participants with the matches they performed best in favoured, while unassisted participants instead preferred the matches in which they retained awareness; even at the expense of relative performance.

Themes identified in the interviews served to both inform player experience and performance interpretations and well as provide further insights for the optimal design of MDDA and identify player values (RQ3). The desire to allow player control and customisation was expressed, along with the highlighting of other aspects of MDDA for further research such as the strength of assistance provided and potential for exploitations.

While this study provides comparative data between awareness conditions, interview responses indicate the context of play may be a large factor in the acceptance and player experience of MDDA. As the study took place in a laboratory setting, there is the potential for differing results to be found should different contexts be used or the purpose of play emphasised (e.g., “playing for fun” or “playing competitively”). The awareness conditions in this study were designed to contrast and compare between no awareness and high awareness of the presence, effects and recipients of MDDA. However, the effect of incorrect awareness on the awareness matrix was not tested (see section 5.5.1).

7.6 STAGE 4 SUMMARY

This stage followed the format of Stage 3's experimental method with a change in match conditions to examine the effect of varying states of awareness on performance and the player experience. Unlike Stage 3, participants were directly informed whether they would personally be the recipient of MDDA assistance or whether they would be competing against players assisted by MDDA. Data were examined using a range of player experience measures from the PENS, IMI, FSS and GEQ scales as well as thematic analysis of group interviews with participants following their session.

The performance of assisted participants was found to improve when they were aware of the shield-assistance MDDA and credited by participants in the interviews to a boost in confidence, although no conscious change in strategy was noted. It seems likely the associated increase in feelings of competence and flow were reflective of this increase in confidence as a result. However, unassisted participants reported using more caution when aware of the MDDA due to feeling more threatened by potentially assisted opposing players. In spite of this, a large majority of participants preferred the match in which all were aware of MDDA over the match in which none were aware; indicating personal performance was not as much of a factor in enjoyment for unassisted participants as it was for those assisted.

Themes identified in the interviews provided further insights into player preferences and optimal design and use of MDDA, including the notable findings that player experience may have differed based on the context of play and strength of the assistance effect.

8 Discussion & Conclusions

This chapter contains the overall findings, discussion and conclusions of the research contained in this thesis. This begins with a summary of the research covered in the four stages of the thesis (8.1) and a tabulated summary of the findings (8.2). Following this are the overall discussions and conclusions of the work (8.3) including a look at awareness, player values and the design implications of the findings as well as limitations. Following this are the contributions and applications of the research (8.4), suggestions for future research to be explored (8.5) and final words (8.6).

8.1 SUMMARY OF RESEARCH

The need for player balancing in competitive multiplayer video games has been previously established and supported by both intrinsic motivation theories and research into game design issues. This program of research was chosen to investigate a potential solution to this issue in the form of Multiplayer Dynamic Difficulty Adjustment (MDDA). In order to investigate these features, three initial research questions were proposed:

- RQ1: What are the different types and implementations of MDDA?
- RQ2: How does the presence of MDDA affect the performance and the player experience of:
    - RQ2a: low-performing players?
    - RQ2b: high-performing players?
- RQ3: How can the use of MDDA be better optimized for improved player balancing and experience?

In order to address RQ1, a formal review of MDDA features in existing commercial games was conducted. Using Metacritic (CBS Interactive Inc., 2013), 180 games with competitive multiplayer features were examined for evidence of MDDA use. From the MDDA instances found, each was broken down into the base elements of a game mechanic and then sorted iteratively to discover 7 core components shared by MDDA instances. Each component was assigned several possible attributes based on the range of states that component was found to possess across the games; providing the basis for the preliminary MDDA Framework. This framework provided a foundation for further research by allowing the classification and identification of differing designs of MDDA features. A notable finding of this review was the focus of existing MDDA on providing performance assistance for low-performing players rather than attempting to hinder high-performing players; thereby informing the design of practical MDDA for use in further stages.

Stage 2 followed on from the creation of the preliminary MDDA framework with a mixed methods combination of survey and interviews. The first purpose of this study was to search for missing elements of the framework from the collective knowledge of experienced players (RQ1). From the data collected, it became clear that the Visibility component of the framework did not account for the subjectivity of player awareness, as while an MDDA instance may be hidden from players it is likely to be discovered as experience and familiarity with a game is gained; as is the case for MDDA in some games such as Mario Kart 7 (Nintendo, 2011). Visibility was therefore replaced with the subjective component of Awareness to more accurately indicate the varying degrees of awareness of MDDA a player may possess, independent of visibility.

In addition to improving the validity of the MDDA Framework, the interviews and survey also began probing player preferences regarding MDDA by differentiating between MDDA designs using the framework (RQ2). By requiring participants to rate the effect on their experience from both the perspective of an assisted player and the perspective of an unassisted player competing against those assisted, components in which conflicts in preferences between these groups were identified. One of these components was the Visibility component, and combined with the identification of the subjective elements of Awareness lead to the addition of a new research question and focus for further stages of this program:

- RQ4: How does awareness of MDDA affect the performance and the player experience of:
  - RQ4a: low-performing players?
  - RQ4b: high-performing players?

While Stage 2's player preference findings provide a starting point for investigation into the effect of MDDA on the player experience, in order to accurately address RQ2 it was necessary to test this in actual multiplayer gameplay. In Stage 3, using Unreal Tournament 3 (Epic Games, 2007) as a representative successful multiplayer game, an MDDA instance providing shield-assistance to low-performing players was assessed with groups of up to 4 participants competing across multiple match conditions. The conditions allowed a comparison of the performance and experience of participants between a standard match and two with MDDA added; one in which no participants were aware (RQ2) and one in which all were aware of the feature but not who had received its assistance (RQ4). It was found that the performance of assisted participants increased when MDDA was added without awareness, but that performance did not improve for assisted participants when all participants were informed that MDDA would be used. Additionally, arousal as measured by EDA was higher when players were aware of the MDDA, but player experiences as recorded by PENS did not vary between conditions. This suggested further investigation of awareness was needed in order to fully address RQ4.

Stage 4 followed the experimental format established in Stage 3 to maintain consistency, but varied the conditions with respect to on awareness by changing whether none, assisted participants only, unassisted participants only or all participants would be informed of the presence and effects of the shield-assistance MDDA. Unlike Stage 3, this time participants were directly informed whether they would personally receive the assistance or whether they would be competing against opponents who were being assisted; providing greater awareness on the Awareness component continuum. Combining the performance and player experience results with group interviews examined using thematic analysis, it was found that awareness of the MDDA provided assisted participants improved feelings of competence and flow and improved performance they attributed to increased confidence. However, unassisted participants were found to be changing strategies in response to awareness of MDDA as they felt more threatened by the assisted participants. In spite of this, they too reported greater feelings of competence and flow and a preference for matches in which they were aware of MDDA compared to those in which they were not. The interviews also provided additional insights into how their preferences and experience may vary based on factors such as context and strength of assistances; further informing the optimal design and use of MDDA (RQ3).

8.2 SUMMARY OF FINDINGS

The following table presents a summary of the finding from each stage in response to each research question.

Stage	Research Question	Findings / Results
1 (Formal review)	**RQ1**: What are the different types and implementations of MDDA?	• Seven components common to all identified MDDA instances were found: Determination, Automation, Recipient, Skill Dependency, User Action, Duration and Visibility. • Two or more possible attributes were found for each component which signifies the state of the component for a specific MDDA instance. • MDDA Framework created to differentiate between types of MDDA. • All identified MDDA instances were found to be focused on assisting low-performing players rather than hindering high-performing players, or could be interpreted either way.
2 (Interviews and survey)	**RQ1**: What are the different types and implementations of MDDA?	• Visibility component found to not account for subjectivity of player awareness of MDDA, and was changed to the player-measured component of Awareness in the MDDA Framework. • No further components or attributes identified by interview or survey participants for MDDA Framework.
	RQ2: How does the presence of MDDA affect the performance and the player experience of low-performing and high-performing players?	• Both player groups valued component attributes that improved: o Player control over MDDA, with the exception of Automation. o Personal benefit (more assistance preferred by low-performing, less preferred by high-performing) o Awareness of MDDA
3 (Experiment with survey and EDA)	**RQ2a**: How does the presence of MDDA affect the performance and the player experience of low-performing players?	• Addition of MDDA improved score (performance) compared play without MDDA. • Generally lower recorded player experience (PENS) than unassisted (high-performing) participants, particularly for Competence. • Addition of MDDA did not affect player experience recorded by PENS.
	RQ2b: How does the presence of MDDA affect the performance and the player experience of low-performing players?	• Addition of MDDA did not affect score. • Generally higher recorded player experience than assisted participants (low-performing). • Addition of MDDA did not affect player experience.

	RQ4a: How does awareness of MDDA affect the performance and the player experience of low-performing players?	• Awareness of the presence and effects of MDDA (but not who was or wasn't assisted) did not facilitate the same performance improvement from non-MDDA match as when unaware. • Player experience (PENS) not affected. • Increased arousal (EDA) when aware compared to unaware.
	RQ4a: How does awareness of MDDA affect the performance and the player experience of low-performing players?	• Awareness did not significantly affect performance. • Player experience not affected. • Increased arousal when aware compared to unaware.
4 (Experiment with survey and group interviews)	**RQ4a**: How does awareness of MDDA affect the performance and the player experience of low-performing players?	• Awareness of the presence, effects and recipient of MDDA improved score performance compared to when no players aware, but not survivability (K/D ratio). • Feelings of competence and flow improved when all players aware compared to unaware. • Feel they performed better when aware compared to unaware. • Noted improved confidence when aware they would be assisted by MDDA. • Match preferences aligned with matches that contained improved performance.
	RQ4b: How does awareness of MDDA affect the performance and the player experience of high-performing players?	• Awareness of presence, effects and recipient of MDDA did not affect score performance, but a slightly reduced survivability (K/D ratio) indicated more deaths to assisted participants. • Higher feelings of competence and flow when all players aware of MDDA compared to no awareness. • Enjoyment, relatedness and challenge unaffected by awareness. • Noted feeling more threatened and subsequent use of more cautious strategies when aware opponents may be assisted by MDDA. • Match preferences aligned with when aware; not best performance.
	RQ3: How can the use of MDDA be better optimized for improved player balancing and experience?	• Preference for MDDA use in less competitive contexts (when playing "for fun", with friends and using less "competitive" games). • Awareness of MDDA may improve confidence of assisted players but reduce for unassisted players. • Higher strength of assistance may be more open to exploitation or encourage cheating. • Desire for player control and customisation of MDDA use and implementation. • Preference for skill to still dictate outcome.

Table 33. Summary of findings

8.3 OVERALL DISCUSSION AND CONCLUSIONS

The research contained in this thesis followed a progression from unpacking the variety and design of MDDA instances to investigating the effects of MDDA and awareness on performance and the player experience. This provided not just a foundation for further MDDA research, but also practical outcomes to better inform the design of MDDA in practical applications and game development.

An important early finding from the formal review conducted in Stage 1 was the focus in existing commercial games using MDDA to assist low-performing players rather than hindering high-performing players (see section 4.4). While the MDDA Framework is still applicable to MDDA in which the recipient of its effects are high-performing players, this directed the focus of subsequent research stages to investigating MDDA utilising assistance for low performing players, in order to be most broadly applicable to existing games.

At a broad level, it may first be concluded that the presence of MDDA has demonstrated potential as a viable method of performance balancing in competitive multiplayer games where other methods have limitations. By its ability to operate in local (offline) multiplayer contexts, MDDA does not hold the same dependencies of large player populations or online networking that restrict the use of other methods such as TrueSkill matchmaking (Herbrich et al., 2007). Additionally, a number of existing commercial games were found to already be utilising methods of MDDA in the formal review (Stage 1), but the variety of implementations and designs reinforces the perspective that MDDA is not a singular defined mechanic but rather a method of balancing that can exist in many forms.

With that in mind, the creation of the MDDA Framework was a necessity in order to confidently be able to differentiate the range of implementations of MDDA that may exist. By deconstructing MDDA instances from the perspective of their existence as game mechanics in the initial seven components, the framework was initially entirely built from a systems perspective. I.e., that each component's attributes could be explicitly set by a game designer or system and exist with certainty in that state.

The findings of Stage 2 revealed the subjective nature of awareness in response to the Visibility component as participants adopted the player's perspective of MDDA.

This resulted in the replacement of Visibility with the new player-measured Awareness component, which is discussed below (section 8.3.1). In addition, the contrasting attribute preferences of the Stage 2 surveys and interviews emphasised the importance of not just looking at the collective player experience of MDDA, but acknowledging and differentiating between the experience of assisted (section 8.3.2) and unassisted (section 8.3.3) players, which are also discussed below.

8.3.1 Awareness

The existence of player awareness of MDDA as a subjective measure on a two-axis matrix (see section 4.10.1) presented a challenge for examining its effects compared to the fixed states of other MDDA components. Stage 3's implementation used high awareness of the shield-assistance MDDA instance's presence and effects but did not explicitly inform participants of the recipients of MDDA; a scenario present in existing implementations of MDDA such as Call of Duty: Modern Warfare 2 (Infinity Ward, 2009). In contrast, Stage 4's awareness conditions aimed to ensure the matches contained awareness of presence, effects and recipient by clearly identifying whether the participant would or would not receive assistance in the form of a shield from the MDDA.

The effect of awareness on performance differed between these two studies. Awareness of the MDDA's presence and effects reduced the effectiveness of performance balancing in Stage 3 (compared to when unaware), while it was enhanced in Stage 4 with the addition of awareness *of recipient*. Stage 4's interview findings provide the key to understanding this with assisted participants reporting an increase in confidence in response to knowledge that they would be assisted; resulting in an improvement in score. An increase in feelings of competence and flow support this which was not present in Stage 3. This suggests that participants may have either had low or incorrect awareness of the recipients of MDDA during Stage 3; preventing the associated confidence boost from occurring and supporting the notion that awareness of that they are benefiting from MDDA is the optimal state for assisted players.

However, a similar study on the disclosure of dynamic balancing did not find this same effect on feelings of competence. Depping and colleagues (2016) instead recorded a slight reduction in feelings of competence when the presence, effects and recipient of their MDDA assistance was disclosed prior to a match. However, their study allowed players to view their score during gameplay in contrast to score being hidden in Stage 4; a key difference with Stage 3's method. Bowey and colleagues (2015) have recently found manipulation of player leaderboards was enough to induce differing feelings of competence, autonomy, relatedness, presence, enjoyment and positive affect without any change in actual gameplay. Like Depping and colleagues' (2016) study, player scores were visible prior to recording feelings of competence in a survey during Stage 3. While assisted participants may note a reduction in the difference between their scores and those of the unassisted high-performing players', their feelings of competence may still be affected by the knowledge that they have 'lost' the match. Research investigating perceived competence in sports has found that confidence and perceived competence are affected by relative comparison to peers (Feltz, 1988), and could be a factor in Depping and colleagues' study due to the visibility of real-time score relative to the participant's opponent. What this suggests is that real-time performance feedback during gameplay may reduce the effectiveness of MDDA awareness in enhancing the confidence of assisted players.

The effect of awareness of the shield-assistance MDDA on unassisted participants displayed some different effects on performance, although surprising similarities were present too. A reduction in kill/death ratio was found for these participants when only they were aware of the MDDA in Stage 4, and is likely due to the change in strategies discussed during the interviews. Unassisted participants expressed a more cautious approach to combat when aware that their opponents may be assisted; choosing more cautious or 'stealthy' strategies centred on surprising their opponents rather than engaging in face-to-face gunfights. Assisted participants did not report a similar conscious change in strategy, suggesting high-performing players may be more reactive to changes in rules but not necessarily in a way that benefits their performance. While outside the scope of this study, this effect may be reduced over time and the performance improved with experience as high-performing players learn the best strategies to engage assisted players. However, in spite of their higher-performing opponents, unassisted participants experienced higher feelings of competence and flow in these matches too. The perceived increase in opponent threat and more closely matches performance may have contributed to this effect, as higher competence entails not just high performance, but a suitably high task difficulty to overcome.

Vallerand (1983) found performance feedback improved feelings of competence in high-performing male hockey players in a competitive context. Study 4 deliberately limited performance feedback to all players through hiding score and leaderboards. However, by providing awareness to unassisted participants that their opponents may be assisted due to lower performance holds the implication that their own performance must be notably higher. It's possible this indirect performance feedback prior to commencing matches in which they were made aware may have contributed to feelings of competence. Vallerand (1983) notes the amount of positive feedback provided did not affect competence; simply its presence which provides support for the notion that awareness of MDDA for unassisted players may not be detrimental as suggested by previous studies.

The improved player experience from competence and flow in the match condition in which both groups were aware of MDDA is likely why participants selected this as the most enjoyable match in Stage 4. While feelings of competence, flow and self-judgement of performance for assisted participants aligned with their preferred matched, unassisted participants held a preference for the matches in which they had awareness of MDDA. Together, this provides support for providing awareness of MDDA to players in terms of both being beneficial to the player experience and preventing the situation of players discovering hidden MDDA.

The benefits to feelings of competence can be seen as one of the key contributions of MDDA awareness in addressing the primary issue of unbalanced challenge. As originally discussed, the core problem with unbalanced performance in competitive multiplayer games is the negative effect on feelings of competence; a key user need for achieving intrinsic motivation (E. L. Deci & Ryan, 1985; J. Reeve & Deci, 1996; Ryan et al., 2006). Ryan and colleagues (2006) state that "perceived competence is among the most important satisfactions provided by games, as they represent arenas in which a person can feel accomplishment and control". While Stage 3 and 4 findings indicate MDDA in a generic sense is not a guarantee of improved feelings of competence, providing player awareness of effects and recipient can see benefits to not just low-performing assisted players but also high-performing unassisted players. The increased experience of Flow in Stage 4 echoes this and suggests solid evidence that MDDA can provide the improvements to core aspects of the player experience harmed by unbalanced challenge. Overall, Stage 4's results demonstrate awareness of MDDA is not only capable of affecting performance but can also provide the subsequent improvements to player experience including competence and flow. With the evidence that competence and flow can predict improved motivation for continued task engagement, persistence and enjoyment (Csikszentmihalyi, 1990; E. L. Deci & Ryan, 1985; Harackiewicz et al., 1987; Ryan et al., 2006), providing awareness MDDA can be seen as a potentially valuable addition to competitive multiplayer video games; even if player perceptions may not always agree (Stage 2).

8.3.2 Player Values

Trends across Stage 2 and 4's interviews and surveys demonstrate values and preference held by players regarding what they perceive as optimal or problematic uses of MDDA. The three values of control, personal benefit, and awareness discussed in Stage 2 (see section 5.4.2) were reflected by interview results in Stage 4 (see section 7.3.5) and display a balance between player desire for their perception of optimal experience, and mediation of concerns of negative effect.

The consistent desire for control of the effects and use of MDDA followed a pattern of feeling generally positive about the use of MDDA, but also somewhat distrusting that it may be used in contexts seen as unsuited. The references to highly "competitive" games and desire for skill to still dictate match outcomes suggest a fear that MDDA may devalue individual skill. With the rise of eSports and other situations in which the purpose of play is direct comparison of skill, fairness may be dictated by the reduction of factors that affect performance beyond skilful play. As a generally high self-rated level of experience with competitive multiplayer games was expressed by participants in these studies, it is expected that they may have higher exposure or involvement with these contexts and a fear of interference. In these cases, the ability to modify or switch off MDDA can be seen as a logical expectation from players.

Even outside these contexts participants were still attracted to the ability to customise aspects of MDDA's use such as the strength of the assistance or type used. It is suspected that the capacity to tailor MDDA may be more prevalent with higher-experience players due to the common ability to modify game rules and options of popular competitive multiplayer games. This includes the frequently-used example throughout this research of Call of Duty: Modern Warfare 2 (Infinity Ward, 2009), which allows players to specify the type of assistance the MDDA will provide when low-performing from options such as increased movement speed or damage resistance. However, implementations in games more targeted towards more casual or local play with friends may not offer this option, such as Mario Kart 7 (Nintendo, 2011).

However, one aspect of control was seen as less preferential than allowing the game system to govern it. Stage 2's survey and interviews suggested the actual in-game awarding of MDDA was more trusted when automated by the same system than chosen by players. This links back to the fear of exploitation or cheating by other players. Clarke and Duimering's (2006) interviews with first-person shooter players note the most cited negative aspect of online play being cheating, and it may not be unusual for players to view any addition of change of rules presented by MDDA as offering the potential for exploitation by opposing players. Were control of the awarding of MDDA left to players, there may be concern of players wishing to artificially inflate their performance when assistance is not needed; subverting the purpose of MDDA to reduce the difference in performance.

8.3.3 Design Implications

MDDA may be effective where other balancing solutions are not possible

MDDA has been demonstrated to have a positive effective on performance balancing and components of the player experience. However, while other balancing methods such as matchmaking may be used in online gameplay or situations in which it is preferable that no in-game manipulation of skill occurs (e.g., eSports), MDDA has the ability to operate in local-area multiplayer and other situations where differently-skilled players choose to play together. The continued success of games traditionally focused around local play with MDDA such as Mario Kart (Nintendo, 2011) support this, and when online may also complement MDDA with matchmaking as commonly found in console-based games.

MDDA instance design matters

The findings throughout this thesis clearly demonstrate the design of an MDDA instance has an effect on both performance balancing and the resulting player experience; even when the balancing parameters or algorithm remain consistent. Stage 3 and 4 utilised identical MDDA instance design with the same parameters, yet the manipulation of the awareness component demonstrated the ability to alter the effectiveness of the balancing. Other research into MDDA features have similarly confirmed that factors such as disclosure of MDDA (Depping et al., 2016), control assistance type (S. Bateman et al., 2011), strength of balancing (Cechanowicz et al., 2014) and mechanical implementation (Vicencio-Moreira et al., 2014) can alter the player experience and dispels the notion of a "one size fits all" implementations of MDDA. This again emphasises the need for careful consideration of the component attributes used when designing MDDA in order to not only consider the performance effects but also the resulting player experience.

Player awareness of MDDA may be beneficial for both player experience and performance balancing

Previous consideration of informing players of the use of MDDA suggested that awareness of the balancing may result in negative player experience effects (Gerling et al., 2014); however the research conducted in Stage 4 suggests the inverse may be true. This is tied to the level of player awareness, as findings suggest the optimal solution to be awareness of the presence and effects of the MDDA for all players, combined with informing low-performing players of the assistance they are receiving. Utilising this configuration was demonstrated to have positive effects on the player experience of assisted players with an improvement in self-rated performance and confidence. This was found to translate into an increase in score for assisted players, leading to more balanced performance and an improvement in competence, flow and preference for this match condition by both assisted and unassisted players.

Low-performing (assisted) players' experience driven by better performance

Following the previous point, competence, flow and the belief of better performance were improved for the matches in which low-performing players achieved their highest scores. Match preferences were in line with these matches, and together demonstrate the experience of assisted, low-performing players to be driven by personal performance. This provides support for the direction of performance balancing to be focused on assisting low-performing players; the existing dominant direction of MDDA effects used in existing commercial games discovered in Stage 1's formal review. The improved experience of competence recorded in Stage 4 demonstrates potential benefits for improving motivation for replay intention (Przybylski et al., 2010); an important consideration for multiplayer and "games as a service" dependent on long-term engagement for revenue generation.

High-performing (unassisted) players' experience driven by higher awareness

In contrast to that of low-performing (assisted) players, the most positive experience and preferred matches expressed by high-performing (unassisted) players were the conditions with greatest awareness; not highest personal performance. Stage 2's interview and survey results reiterated that the unbalanced challenge issues affecting competitive multiplayer gameplay were not only when competing against higher-skilled opponents, but also lower-skilled. Together with the experimental study results, the greater threat presented by the now higher-performing assisted opponents demonstrated an improved experience for high-performing (unassisted) players too when aware; in spite of a potential reduction of their own performance. Depping and colleagues' (2016) suggest players are willing to accept changes to game rules such as MDDA in order to promote the setting's goals if they are informed of the change. Additionally, they believe unassisted players may attribute their reduced performance to the rule change of MDDA when aware which can reduce self-attribution of failure (Depping et al., 2016). Overall, these findings all indicate the player experience of unassisted players to be more positively influenced by awareness of MDDA than personal performance. From these results, a suggested optimal awareness configuration for unassisted players would consist of awareness of the presence and effects of MDDA, but not necessarily the recipient.

Player preferences may differ from the actual gameplay experience

Stage 2's interviews and survey provided a useful means of identifying player preferences of MDDA and the components and attributes that may have differing impacts on the experience of assisted and unassisted players. However, the experimental studies in Stages 3 and 4 demonstrate that the stated preferences of players may not directly align with the actual gameplay experience. The preferences of survey participants from the perspective of both assisted and unassisted players was to have MDDA 'visible' to them for an improved experience, and this was supported by Stage 4's findings. However, the more positive experience of unassisted players in Stage 4 was found to align with the conditions in assisted participants had awareness and subsequent improved performance. This contrasts with the more negative impression expressed by unassisted players in Stage 2 for MDDA in which assisted participants would be aware. This ties into the previously-discussed values for personal benefit, as outside of gameplay players a bias towards configurations that allow the greatest personal performance may influence preferences. Overall, these demonstrate that player opinions and preferences can be useful and informative but should be interpreted with caution until able to be confirmed in actual gameplay.

Control of MDDA

The ability to control and customise the use and design of MDDA was consistent across the interviews in Stage 4 and tied to several themes. Players expressed the desire to manipulate the context in which MDDA to used, to the strength of the effect and degree of awareness. This falls in line with the common option to modify and choose match rules in many popular competitive multiplayer games such as Halo 5 (343 Industries, 2015) which allow custom game modes to be created and may be featured by the developers. However, as previously discussed, there is a danger of players negatively impacting their own experience should their preferences misalign with the optimal configurations to support an improved player experience. This is a consideration to be weighed by developers when designing MDDA systems for the requirements of their target audience. The choice of attributes for Automation, Duration, Skill Dependency and User Action framework components hold the greatest potential for affecting player control over MDDA and would be recommended for careful consideration when designing for player control.

MDDA preferred in certain contexts

A recurring theme throughout interviews with differing importance placed on the role of skill on match outcomes dependent on context. Participants in Stages 2 and 4 expressed a more positive view of MDDA in contexts in which the competitive aspect is not the primary motivation and play is seen as “just for fun”. This links with the perception of MDDA fairness based on the purpose of play, and suggests consideration of the intended context of play should influence decisions regarding the use and design of MDDA. The Skill Dependency framework component affects the degree to which skill influences match outcomes, with participant values indicating the skill-dependent attribute may be perceived as more appropriate for MDDA use in highly competitive contexts.

8.3.4 Limitations

This research has provided insight on the effects of MDDA and awareness on performance and the player experience, as well as implications for optimal design. However, as revealed by the initial formal review and creation of the MDDA Framework, the variety of designs and implementations of MDDA leave many components unexplored. While player preferences were investigated in Stage 2’s survey and interviews, the effect of differing component attributes during gameplay is unconfirmed within the scope of this thesis and will require further research. Similarly, while experimental studies included the testing of conditions with different awareness of MDDA’s presence and effects (Stage 3) and recipients (Stage 4) it did not test for incorrect awareness. While not an intentional configuration noted in the design of any MDDA instances included in the initial formal review (Stage 1), it is nevertheless a potential condition players may experience in games with hidden or partial MDDA awareness.

Due to the requirement of controlling awareness between match conditions in Stages 3 and 4, the design of the MDDA instance employed had several constraints. In addition to replicating commonly-used MDDA in games examined during Stage 1, the static-shield MDDA provided a greater potential for avoiding participant awareness of its presence without participants being explicitly told that MDDA was not occurring. Consequently, while this method of MDDA is present in a number of popular commercial games and broadly representative of common MDDA use, the results of Stage 3 and 4 may vary if other forms of MDDA are used and the results should be interpreted with this limitation in mind.

The strength of assistance provided by the MDDA instance used in Stages 3 and 4 was consistent between studies to control for awareness testing. However, Stage 4's interviews suggest the degree of performance balancing used and its effect on match outcome may impact the player experience and results should therefore be interpreted with the understanding that they may not reflect the experience of very strong or weak MDDA assistance. Additionally, the context of play may also have an effect due to the differing social influences of playing locally with strangers compared to playing with friends or online with unconstrained communication.

The PC game Unreal Tournament 3 (Epic Games, 2007) was used in Stages 3 and 4 as a representative multiplayer game due to its reliance on common tropes of the first-person shooter genre; the most popular competitive multiplayer genre identified by participants in Stage 2's survey. It is a natural limitation of game research that experimental results cannot be tested in every unique game and genre, so results should be interpreted as broadly representative but not definitive for every scenario.

Participants in Stages 2, 3 and 4 were also predominantly male which may influence results. Findings must therefore be interpreted with this in mind. However, given the focus of this work exclusively on competitive multiplayer gameplay, the reduced attraction of competitive game elements amongst female players (Hartmann & Klimmt, 2006) may have influenced the response rate and participation of male and female game players. Similarly, the use of a first-person shooter game (Unreal Tournament 3) in Stages 3 and 4 maintains that the results are largely reflective of gender preferences of game genres as first-person shooter games enjoy higher popularity amongst male audiences ("Gender split of video game players in France in 2014, by game genre," 2014; Roseboom, 2015).

An additional limitation of the experimental studies conducted in Stages 3 and 4 was the maximum of four participants per session playing locally in the same room. With the exception of games utilising persistent online worlds to facilitate thousands of simultaneous players, online multiplayer gameplay typically occurs between 2-64 players in a match, such as Call of Duty: Modern Warfare 2 with up to 16 players in an online match. However, offline play on a single console is limited to 4 players.

While the results of this research are applicable for 4-player matches, there may be some variation in differing match sizes. It is expected that players may be more likely to identify the recipient of MDDA assistance with fewer competing players, while larger player populations could reduce this ability as less attention may be paid to individual opponents. Further research comparing the use of MDDA with populations of varying sizes and locations.

8.4 CONTRIBUTIONS AND APPLICATIONS

This thesis provides further validation of the effectiveness of MDDA; adding to the young field of research into dynamic player balancing in multiplayer games through several distinct contributions.

The MDDA Framework provides a means for the classification of MDDA instances (RQ1). Through the identification of components common to MDDA instances paired with attributes that represent the state of that component for a specific implementation, further research can easily investigate and differentiate between factors of MDDA. A more formalised and structured approach to MDDA research may be undertaken through the easy identification of components and attributes in need of further research or with unknown effects. Additionally, the MDDA Framework is also applicable to game development as both a means to design MDDA features and use in post-hoc analysis of existing MDDA. This allows game designers to approach the implementation of MDDA from a more informed perspective of both the range of options available as well as related research into the effect of differing components.

Investigation of player preferences of MDDA (RQ2, RQ3) provides developers with a resource to better understand player responses to differing forms of MDDA and therefore approach design from a more player-centric perspective. Interview and survey responses performed throughout this thesis give insight into not just the preferred methods of MDDA, but also how players may view the same MDDA differently from the perspective or low or high-performing players. Furthermore, aspects that may alter player approaches to MDDA such as context, purpose of play or the strength of the balancing effects are identified.

Testing of the effect of MDDA on performance and the player experience has provided an understanding of how the introduction of MDDA may affect a competitive multiplayer game. This adds to the body of work on MDDA from researchers such as

Mandryk, Gutwin and Bateman (S. Bateman et al., 2011; Cechanowicz et al., 2014; Depping et al., 2016; Gerling et al., 2014), while also building on adjacent research into DDA in singleplayer gameplay as a collective means of addressing unbalanced challenge through dynamic adjustment (Hunicke & Chapman, 2004; Liu et al., 2009; G.N. Yannakakis & Hallam, 2009). The particular delivery method of MDDA (for example, providing different weapons compared to adjusting score) has been noted in recent research as having an effect on the player experience (Gerling et al., 2014; Smeddinck et al., 2016). While the experiments performed in this thesis do not compare between methods, the recorded effects of the "static shield" delivery method of providing damage resistance to low-performing players contributes to this wider investigation while also positioning it within the MDDA Framework.

Furthermore, this research provides a detailed understanding of the effects of awareness on performance and the player experience as a core component of MDDA; introducing new findings that may solve previously associated negative player experience effects of awareness (Gerling et al., 2014).

8.5 FUTURE RESEARCH

The MDDA Framework provides a means of continuing research into MDDA through the easy differentiation of MDDA designs and implementations. While player preferences for each component and attribute were explored in Stage 2, future research into each component is required to obtain and more thorough understanding of the practical effects and optimisation of each. As investigation into the effect of the Awareness component revealed some differences between the preferences of players and actual effects on the player experience during tested gameplay, experimental methodologies are needed to either confirm or dispute the effects of each component attribute. This may also contribute to the refinement and development of the MDDA Framework in not just classifying MDDA instances but also providing information on the optimisation of each component.

The exploration of the Awareness component in this thesis covered both degrees of awareness of presence and effects as well as awareness of the recipient of the MDDA's effects. However, the Awareness component has been noted to exist in a two-axis matrix that includes not just the degree of awareness but also whether the awareness is correct or incorrect. Due to the scope of this research incorrect awareness has not been explored, but would be expected to hold consequences for player experience, behaviour and relatedness. As this has not been tested these expectations cannot be confirmed and may be an area to be explored in extended research of awareness.

The strength of balancing is another point of interest raised by participants; particularly the potential intersection with the perception of fairness of MDDA. It is suspected stronger MDDA may have a greater effect on player experience results; including potentially undermining the positive benefits of MDDA. Further research would be required to determine the effects of differing levels of MDDA including the differences between static performance adjustment (as tested in Stages 3 and 4) and dynamic performance adjustment.

A potential influence on the player experience of MDDA was found in interviews during the final study with the context of MDDA raised as a point of interest. It was suggested that players may view MDDA more or less favourably depending on the purpose of play, with MDDA use viewed as less fair in more competitive contexts. As Depping and colleagues (2016) similarly found this may have an effect on player experience, this area is suggested as an avenue requiring focused research and analysis.

8.6 FINAL WORDS

This thesis presents a starting point for further research into MDDA, as the creation of the MDDA Framework through the identification of components and attributes common to MDDA features allows for a structured exploration of large variety of designs and implementations in the effort to optimise their benefits. The MDDA Framework has also provided a means for more structured further research into MDDA through the classification of the differences and similarities between MDDA across games and genres.

The importance of distinguishing between the experience of low and high-performing players has been underscored as MDDA can impact each group differently. It has been identified that player awareness can have a profound influence on the benefits of MDDA. The configuration of providing low-performing (assisted) players with awareness of the presence, effects and recipient of MDDA and high-performing (unassisted) players with awareness of the presence and effects has been suggested to avoid the negative effects found in some previous research and instead improve the subsequent experience of both low and high-performing players. Additionally, the design of MDDA as classified by the MDDA Framework has been shown to impact both the ability to balance performance and the resulting player experience.

Overall, this program of research has demonstrated the potential for MDDA to address the issue of unbalanced challenge in competitive multiplayer games; not just in terms of balancing performance but also in providing an improved player experience for all players.

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Appendices

Appendix A – Stage 1 Formal Review

Formal review game listing and MDDA instance coding using MDDA Framework. Binary coding (1 = yes, 0 = no) is used to indicate both whether a game contains MDDA (2nd column), and the component attributes used by the MDDA instance(s) present in each game.

The following codes are used for each column heading to allow for formal review table space:

Component	Attribute	Table Code
Determination		**DET**
	Gameplay	DE1
	Pre-gameplay	DE2
Automation		**AUT**
	Applied by system	AU1
	Applied by player	AU2
Recipient		**REC**
	Individual	RE1
	Team	RE2
Skill Dependency		**SDE**
	Skill dependent	SD1
	Skill independent	SD2
User Action		**UAC**
	Action required	UA1
	Action not required	UA2
Duration		**DUR**
	Single-use	DU1
	Multi-use	DU2
	Time-based	DU3
Visibility		**VIS**
	Visible to recipient	VI1
	Visible to non-recipient	VI2
	Not visible	VI3

First-Person Shooter Games

		DET		AUT		REC		SDE		UAC		DUR			VIS		
GAME	**MDDA**	**DE1**	**DE2**	**AU1**	**AU2**	**RE1**	**RE2**	**SD1**	**SD2**	**UA1**	**UA2**	**DU1**	**DU2**	**DU3**	**VI1**	**VI2**	**VI3**
METACRITIC – 'POSITIVE'																	
Unreal Tournament 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Call of Duty: Modern Warfare 2	1	1	0	1	1	1	0	1	1	1	1	1	0	1	1	0	0
Call of Duty 4: Modern Warfare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Team Fortress 2	1	1	0	1	0	1	0	1	0	0	1	1	0	0	0	0	1
Halo 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Halo 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Halo: Reach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Battlefield 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Killzone 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ghost Recon: Advanced Warfighter	1	1	0	0	1	0	1	1	0	1	0	1	0	0	0	0	1
FEAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Call of Duty 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Battlefield 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Far Cry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bioshock 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Call of Duty: Modern Warfare 3	1	1	0	1	1	1	0	1	1	1	1	1	0	1	1	0	0
Rainbow Six: Vegas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Battlefield: Bad Company 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Call of Duty: Black Ops	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Doom 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Counter-Strike: Source	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resistance 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unreal Tournament 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resistance: Fall of Man	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crysis 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ghost Recon: Advanced Warfighter 2	1	1	0	0	1	0	1	1	0	1	0	1	0	0	0	0	1
Unreal Tournament 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metroid Prime: Hunters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unreal Championship 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		DET		AUT		REC		SDE		UAC		DUR			VIS		
GAME	MDDA	DE1	DE2	AU1	AU2	RE1	RE2	SD1	SD2	UA1	UA2	DU1	DU2	DU3	VI1	VI2	VI3
METACRITIC – 'MIXED'																	
Serious Sam 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red Faction 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medal of Honor (2011)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainbow Six: Lockdown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
XIII	1	1	0	1	0	1	0	1	1	1	1	1	0	1	1	1	0
Vietcong	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEAR 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wolfenstein (2009)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ARMA: Combat Operations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Darkwatch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Counter-Strike (Xbox)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Call of Duty: Finest Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medal of Honor: Heroes 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medal of Honor: Airborne	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ARMA 2: Operation Arrowhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urban Chaos: Riot Response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cold Winter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Men of Valor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frontlines: Fuel of War	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medal of Honor: European Assault	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Warfare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serious Sam 3: BFE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shattered Horizon	1	1	0	1	0	1	0	0	1	0	1	1	0	0	0	0	1
Dark Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area 51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Call of Juarez	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GoldenEye: Reloaded	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Section 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brink	1	1	0	1	0	0	1	1	0	0	1	0	0	1	1	0	0
Dark Messiah of Might and Magic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL (x/60)	**8**	**8**	**0**	**6**	**4**	**5**	**3**	**7**	**4**	**5**	**6**	**7**	**0**	**4**	**4**	**1**	**4**

Racing Games

		DET		AUT		REC		SDE		UAC		DUR			VIS		
GAME	**MDDA**	**DE1**	**DE2**	**AU1**	**AU2**	**RE1**	**RE2**	**SD1**	**SD2**	**UA1**	**UA2**	**DU1**	**DU2**	**DU3**	**VI1**	**VI2**	**VI3**
METACRITIC – 'POSITIVE'																	
Burnout 3	1	1	0	1	0	1	0	1	0	1	0	0	0	1	0	0	1
Forza Motorsport	1	1	1	0	1	1	0	1	1	0	1	0	0	1	1	0	0
Forza Motorsport 3	1	1	1	0	1	1	0	1	1	0	1	0	0	1	1	0	0
Forza Motorsport 4	1	1	1	0	1	1	0	1	1	0	1	0	0	1	1	0	0
Mario Kart DS	1	1	0	1	0	1	0	1	1	1	0	1	1	1	0	0	1
Project Gotham Racing 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burnout: Revenge	1	1	0	1	0	1	0	1	0	1	0	0	0	1	1	0	0
Forza Motorsport 2	1	1	1	0	1	1	0	1	1	0	1	0	0	1	0	0	1
Wipeout HD: Fury	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Need for Speed: Hot Pursuit (2010)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F-Zero GX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gran Turismo 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dirt 2	1	0	1	0	1	1	0	0	1	0	1	0	0	1	1	0	0
Burnout: Paradise	1	1	0	1	0	1	0	1	0	1	0	0	0	1	0	0	1
Wipeout: Pure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Project Gotham Racing 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NASCAR Thunder 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Race Driver: Grid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ridge Racer (PSP)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rallisport Challenge 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Midnight Club 3: DUB Edition Remix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dirt 3	1	0	1	0	1	1	0	0	1	0	1	0	0	1	1	0	0
Mario Kart: Double Dash	1	1	0	1	0	1	0	1	1	1	0	1	1	1	0	0	1
Colin McRae Rally 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NASCAR 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wipeout HD: Fury	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burnout: Legends	1	1	0	1	0	1	0	1	0	1	0	0	0	1	0	0	1
Midnight Club 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Colin McRae Rally 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mario Kart 7	1	1	0	1	0	1	0	1	1	1	0	1	1	1	0	0	1

		DET		AUT		REC		SDE		UAC		DUR			VIS		
GAME	MDDA	DE1	DE2	AU1	AU2	RE1	RE2	SD1	SD2	UA1	UA2	DU1	DU2	DU3	VI1	VI2	VI3
METACRITIC – 'MIXED'																	
FlatOut: Head On	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Need for Speed: ProStreet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Need for Speed: Underground Rivals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MX vs ATV: Reflex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Formula One: Championship Edition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sega Rally Revo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tourist Trophy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ridge Racer 6	1	1	0	1	0	1	0	0	1	0	1	0	0	1	0	0	1
TrackMania: Build to Race	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pro Race Driver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TrackMania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Race: Injection	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Need for Speed: Carbon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SBK X: Superbike World Championship	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moto Racer DS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Race: On	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juiced 2: Hot Import Nights	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drift Street: International	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drome Racers	1	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	1
FAST: Racing League	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ModNation Racers (PSP)	1	1	0	1	0	1	0	1	1	1	0	1	1	1	0	0	1
Need for Speed: Carbon - Own the City	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Excite Truck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Need for Speed: Underground 2 (GBA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Race: Pro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MotorStorm: Arctic Edge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sega GT: Online	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SkyDrift	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MotoGP 1 /11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IndyCar Series	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL0(x/60)	**16**	**14**	**6**	**10**	**6**	**16**	**0**	**13**	**11**	**9**	**7**	**5**	**4**	**15**	**6**	**0**	**10**

Fighting Games

		DET		AUT		REC		SDE		UAC		DUR			VIS		
GAME	**MDDA**	**DE 1**	**DE 2**	**AU 1**	**AU 2**	**RE 1**	**RE 2**	**SD 1**	**SD 2**	**UA 1**	**UA 2**	**DU 1**	**DU 2**	**DU 3**	**VI 1**	**VI 2**	**VI 3**
METACRITIC – 'POSITIVE'																	
Super Smash Bros. Brawl	1	0	1	0	1	1	0	0	1	1	0	1	0	0	1	1	0
Virtua Fighter 4: Evolution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Super Street Fighter IV	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Super Smash Bros. Melee	1	0	1	0	1	1	0	0	1	1	0	1	0	0	1	1	0
Marvel vs Capcom 2	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Virtua Fighter 5: Online	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tekken 5	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Super Street Fighter II Turbo HD Remix	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Tekken: Dark Resurrection	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
BlazBlue: Calamity Trigger	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
BlazBlue: Continuum Shift	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Guilty Gear X2: Reload	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Mortal Kombat (2011)	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Soul Calibur III	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Street Fighter III: Third Strike Online Edition	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
UFC Undisputed 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tatsunoko vs Capcom: Ultimate All-Stars	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Dead or Alive 4	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Soul Calibur IV	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
WWE Smackdown: Here Comes the Pain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ultimate Marvel vs Capcom 3	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Def Jam: Fight for NY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UFC Undisputed 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WWE: Smackdown vs Raw 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tekken 6	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Bleach: Dark Souls	1	1	0	1	0	1	0	0	1	1	0	1	0	0	1	1	0
Mortal Kombat: Deception	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
WWE: Smackdown vs Raw 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WWE: Smackdown vs Raw 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Def Jam: Vendetta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

		DET		AUT		REC		SDE		UAC		DUR			VIS		
GAME	**MDDA**	**DE1**	**DE2**	**AU1**	**AU2**	**RE1**	**RE2**	**SD1**	**SD2**	**UA1**	**UA2**	**DU1**	**DU2**	**DU3**	**VI1**	**VI2**	**VI3**
METACRITIC – 'MIXED'																	
Naruto: Clash of Ninja Revolution	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Darkstalkers Chronicle: The Chaos Tower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Naruto: Clash of Ninja 2	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
WWE: Smackdown vs Raw 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WWE: Smackdown vs Raw 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Naruto Shippuden: Clash of Ninja Revolution III	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Naruto Shippuden: Ultimate Ninja Storm 2	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Custom Robo Arena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WWE 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Naruto: Ultimate Ninja 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
The King of Fighter '98 Ultimate Match	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Pride FC: Fighting Championships	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Guilty Gear: Isuka	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Ultimate Mortal Kombat	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Arcana Heart 3	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Dragon Ball Z: Supersonic Warriors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dragon Ball Z: Budokai Tenkaichi 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small Arms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Virtual On: Oratorio Tangram Ver.5.66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dragon Ball Z: Budokai Tenkaichi 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WWE: Smackdown vs Raw 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Samurai Shodown II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Naruto: Clash of the Ninja Revolution 2	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Super Dragon Ball Z	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Mortal Kombat vs DC Universe	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
Dragon Ball Z: Burst Limit	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Naruto: Clash of the Ninja	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Fate/Unlimited Codes	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0
Dragon Ball Z: Budokai Tenkaichi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mortal Kombat: Armageddon	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0
TOTAL (x/60)	**36**	**19**	**35**	**19**	**35**	**36**	**0**	**18**	**36**	**21**	**33**	**36**	**0**	**0**	**36**	**36**	**0**

Appendix B - Stage 2 Online Survey

Note: at the time of issuing this survey, MDDA instances were referred to as "competence normalising techniques".

INTRODUCTION

This project is being undertaken as part of a PhD study for Alexander Baldwin.

The purpose of this project is to investigate certain multiplayer video game features intended to improve the player experience through seeking the opinion and input of multiplayer game players of all skill and experience levels.

You are invited to participate in this project because you have played at least one multiplayer video game.

PARTICIPATION
Your participation in this project is entirely voluntary. If you do agree to participate, you can withdraw from the project by closing the online survey before the survey responses are submitted upon completion of all questions without comment or penalty. Upon closing the survey prior to completion, all question responses and any identifiable information already obtained from you will be destroyed. Your decision to participate, or not participate, will in no way impact upon your current or future relationship with QUT (for example your grades).

As your responses will be anonymous, once the survey is submitted upon completion of all questions participation will not be able to be withdrawn.

If you agree to participate you do not have to complete any question(s) that you are uncomfortable answering. If you are uncomfortable answering a question marked as requiring an answer, please exit the survey and your responses will not be submitted.

EXPECTED BENEFITS
It is expected that this project will not directly benefit you. However, it may benefit you indirectly as the research will lead to the production of more enjoyable multiplayer video games.

To recognise your contribution, should you choose to participate, the research team is offering participants located in Australia the chance to win a $100 JB HiFi voucher. At the end of the survey you will have the option to enter this prize draw by supplying a contact email address.

RISKS
There are no risks beyond normal day-to-day living associated with your participation in this project.

PRIVACY AND CONFIDENTIALITY
All comments and responses are anonymous and will be treated confidentially. The names of individual persons are not required in any of the responses.

Any data collected as part of this project will be stored securely as per QUT's Management of research data policy.

CONSENT TO PARTICIPATE
Submitting the completed online questionnaire is accepted as an indication of your consent to participate in this project.

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT
QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Unit on 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner (Approval Number 1200000410).

Please click the NEXT button to begin the survey.

Part 1 - PLAYER BACKGROUND

NOTE: 'Competitive multiplayer' refers to any multiplayer gameplay that involves competing against other players.

1. Please select your age.

2. What is your gender?

- Male
- Female

3. How would you rate your experience level of playing competitive multiplayer video games?

	1 - Not at all experienced	2	3	4	5	6	7 - Extremely experienced
:	○	○	○	○	○	○	○

4. Approximately how many years ago did you first play a competitive multiplayer video game?

5. Approximately how many years ago was the last time you played a competitive multiplayer video game?

6. Approximately how many hours per week did you play competitive multiplayer video games during this time?

7. What is the estimated most number of hours you have played a competitive multiplayer video game in a single week?

8. Which platforms do you use to play competitive multiplayer video games online? (multiple platforms can be selected)

- [ ] Computer (PC, Mac, etc)
- [ ] Xbox
- [ ] Xbox 360
- [ ] PlayStation 2 (PS2)
- [ ] PlayStation 3 (PS3)
- [ ] PlayStation Portable (PSP)
- [ ] PlayStation Vita (PS Vita)
- [ ] Nintendo Gamecube
- [ ] Nintendo Wii
- [ ] Nintendo DS
- [ ] Nintendo 3DS
- [ ] Smartphone (e.g., iPhone, Android, Windows Phone 7)
- [ ] Tablet (e.g., iPad, Android)

9. What are some of your favourite competitive multiplayer video games? (Up to 5 may be listed in any order)

Game 1	
Game 2	
Game 3	
Game 4	
Game 5	

10. Which game genres from the list below do you enjoy playing in competitive multiplayer? (multiple genres may be selected)

- ☐ Action Adventure
- ☐ Action Role Playing Game
- ☐ Board or Card Game
- ☐ Casual
- ☐ Educational
- ☐ Fighting
- ☐ Flight
- ☐ MMORPG
- ☐ Music
- ☐ Party
- ☐ Platformer
- ☐ Puzzle
- ☐ Racing
- ☐ Real Time Strategy
- ☐ Role Playing Game (RPG)
- ☐ Shooter (first person)
- ☐ Shooter (third person)
- ☐ Simulation (non-flight)
- ☐ Sports
- ☐ Text Adventure
- ☐ Turn based strategy

Other (please specify)

11. Do you prefer to play competitive multiplayer games individually (competing against all other players) or in teams (competing as part of a team against other teams)?

- ○ Individual
- ○ Team
- ○ No preference

12. How much do you enjoy playing competitive multiplayer video games with others:

	1 - Not at all	2	3	4	5	6	7 - Very much
Above your skill level:	○	○	○	○	○	○	○
About the same skill level:	○	○	○	○	○	○	○
Below your skill level:	○	○	○	○	○	○	○

Part 2 - COMPETENCE NORMALISING OVERVIEW

The next set of questions relate to a feature in some multiplayer games known as **'competence normalising techniques'**. In order to answer the next set of questions, please read through the following information.

COMPETENCE NORMALISING TECHNIQUE DESCRIPTION
A 'competence normalising technique' is a **multiplayer gameplay feature designed to assist low-performing players** (such as new, inexperienced players) when competing against high-performing players.

This has two goals:

1) The technique aims to help the low-performing player compete with the high-performing player by reducing the difference in performance.

2) The technique aims to help the high-performing player experience challenge while competing with the low-performing player.

EXAMPLES OF COMPETENCE NORMALISING TECHNIQUES IN EXISTING GAMES

Mario Kart series:
Players drive through question-mark boxes in order to collect a 'random' weapon to use. However, players who are currently ranked higher in the match such as 1st, 2nd or 3rd are less likely to receive a powerful offensive weapons such as red shells, and more likely to receive weaker weapons such as bananas. Players ranked further back in the race are more likely to receive more powerful weapons such as red shells, 'bullet bill' and the blue shell.

Call of Duty: Modern Warfare 2, Black Ops, Modern Warfare 3
After being defeated repeatedly without scoring, a player may be given a 'Death Streak' which provides temporary assistance upon next respawning such as a boost to health or increased speed for several seconds.

Part 2 - COMPETENCE NORMALISING TECHNIQUE ATTRIBUTES

Competence normalising techniques are all made up of seven (7) different **'attributes'** that are used to describe and classify the differences between techniques. Each of these attributes has two (2) or more **'levels'** (options) to describe that technique.

For example, to describe a dog, one of its attributes may be Size. The 'levels' for this attribute may be Small, Medium and Large.

The following questions will relate to how you feel about different normalising technique attributes and levels.

ATTRIBUTE: Determination

Description: When the decision to utilise the competence normalising technique is made.

Levels:

Pre-Gameplay - The decision to use a normalising technique to assist a low-performing player is made before the match begins based on their previous performance, statistics or ranking. If a player has performed poorly in previous matches of the game, they will be assisted with a normalising technique in the upcoming match.

Gameplay - The decision to use a normalising technique to assist a low-performing player is made during a match based on their current performance, statistics or ranking in that match.

Please answer the below questions regarding how these types of normalising techniques would affect your experience of a multiplayer game match.

13. If you were a low-performing player, how would your experience be affected by being assisted with a normalising technique that was applied:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Pre-gameplay	○	○	○	○	○	○	○
During gameplay	○	○	○	○	○	○	○

14. If you were a high-performing player, how would your experience by affected by other players below your skill level being assisted with a normalising technique that is assigned:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Pre-gameplay	○	○	○	○	○	○	○
During gameplay	○	○	○	○	○	○	○

Part 2 - COMPETENCE NORMALISING TECHNIQUE ATTRIBUTES

ATTRIBUTE: Recipient

Description: The recipient of the normalising technique is the player or players who receive the benefits / assistance provided by the technique.

Levels:

Individual - An individual low-performing player will receive assistance.

Team - All members of a low-performing team will receive assistance.

Please answer the below questions regarding how these types of normalising techniques would affect your experience of a multiplayer game match.

15. If you were a low-performing player, how would your experience be affected by being assisted with a normalising technique that was applied:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
To individual low-performing players (including yourself)	○	○	○	○	○	○	○
To your entire team	○	○	○	○	○	○	○

16. If you were a high-performing player, how would your experience be affected by a normalising technique that was applied:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
To individual low-performing players	○	○	○	○	○	○	○
To the entire (opposing) team	○	○	○	○	○	○	○

Part 2 - COMPETENCE NORMALISING TECHNIQUE ATTRIBUTES

ATTRIBUTE: Automation

Description: Whether the decision to apply a normalising technique is made by the game system (automated) or by the player(s).

Levels:

Applied by System (automated) - The game itself will decide whether to assist a player with a normalising technique, and what type it will be.

Applied by Player(s) - Player(s) in the match will decide whether to assist a player with a normalising technique, and what type it will be.

Example of normalising technique APPLIED BY SYSTEM in Mario Kart

When the player is losing a race, the system increases the chance of picking up a highly-effective weapon such as Red Shells or Invincibility from weapon boxes.

Example of normalising technique APPLIED BY PLAYER in StreetFighter

Players can decide to use a 'handicap' in multiplayer, allowing one player to have more or less health than the other player. Generally the more skilled player will choose to have less health than the other player.

Please answer the below questions regarding how these types of normalising techniques would affect your experience of a multiplayer game match.

17. If you were a low-performing player, how would your experience be affected by being assisted with a normalising technique that was:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Applied by the system	○	○	○	○	○	○	○
Applied by yourself or other players	○	○	○	○	○	○	○

18. If you were a high-performing player, how would your experience be affected by other players being assisted with a normalising technique that was:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Applied by the system	○	○	○	○	○	○	○
Applied by yourself or other players	○	○	○	○	○	○	○

Part 2 - COMPETENCE NORMALISING TECHNIQUE ATTRIBUTES

ATTRIBUTE: Skill Dependency

Description: Whether the technique requires the player(s) to act with some degree of skill for the benefit to occur.

Levels:

Skill dependent - The player(s) must use utilise the assistance provided by the technique with skill in order for their performance to benefit.

Skill independent - The player(s) do not not need to act with any degree of skill for their performance to benefit from the assistance the technique provides.

Example of normalising technique that is SKILL DEPENDENT in Mario Kart

When the player receives the Green Shell weapon, they must successfully aim and fire at another player for the benefit of the opposing player being slowed down to occur.

Example of normalising technique that is SKILL INDEPENDENT in Mario Kart

When the player receives the Red Shell weapon, they can fire it at any time and it will automatically hit the next opposing player without any need to aim or use 'skillfully'.

Example of normalising technique that is SKILL DEPENDENT in Call of Duty: Modern Warfare 2+

After being defeated multiple times, the player may receive a 'Death Streak' that temporarily increases their movement speed. This assistance does not gaurantee improved performance (more kills, less deaths), but must be used with some degree of skill be the player in order to benefit their score.

Example of normalising technique that is SKILL INDEPENDENT in Call of Duty: Modern Warfare 2+

After being defeated multiple times, the player may receive a 'Death Streak' that temporarily increases their health, allowing the player to take more damage before dying. This makes the player more difficult to kill, even if they do not act with any skill.

Please answer the below questions regarding how these types of normalising techniques would affect your experience of a multiplayer game match.

19. If you were a low-performing player, how would your experience be affected by being assisted with a normalising technique that was:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Skill dependent	○	○	○	○	○	○	○
Skill independent	○	○	○	○	○	○	○

20. If you were a high-performing player, how would your experience be affected by other players being assisted with a normalising technique that was:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Skill dependent	○	○	○	○	○	○	○
Skill independent	○	○	○	○	○	○	○

Part 2 - COMPETENCE NORMALISING TECHNIQUE ATTRIBUTES

ATTRIBUTE: User Action

Description: Whether the player is required to interact with the interface to trigger the normalising technique's benefit to occur.

Levels:

Action required - The player must interact with the interface to trigger the normalising technique's benefit.

Action not required - The player does not need to interact with the interface to trigger the normalising technique's benefit.

Example of normalising technique in which ACTION IS REQUIRED in Mario Kart

While the game may provide a better weapon to the losing player, the player must still press the 'fire' button in order to activate its effects.

Example of normalising technique in which ACTION IS NOT REQUIRED in Call of Duty: Modern Warfare 2+

After dying repeatedly, the player will respawn with a 'Death Streak' such as receiving temporary increased health. This will trigger automatically without the player needing to 'activate' it.

Please answer the below questions regarding how these types of normalising techniques would affect your experience of a multiplayer game match.

21. If you were a low-performing player, how would your experience be affected by being assisted with a normalising technique in which:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Action is required	O	O	O	O	O	O	O
Action is not required	O	O	O	O	O	O	O

22. If you were a high-performing player, how would your experience be affected by other players being assisted with a normalising technique in which:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Action is required	O	O	O	O	O	O	O
Action is not required	O	O	O	O	O	O	O

Part 2 - COMPETENCE NORMALISING TECHNIQUE ATTRIBUTES

ATTRIBUTE: Duration

Description: How long or often the benefit of a normalising technique may be enacted.

Levels:

Single-use - The benefit occurs only once before the normalising technique is finished.

Multi-use - The benefit occurs a number of times before the normalising technique is finished.

Time-based - The benefit occurs continuously for a certain length of time before the normalising technique is finished.

Example of normalising technique which is SINGLE USE in Mario Kart

If receiving a Red Shell weapon, the player can fire it only once until receiving another.

Example of normalising technique which is MULTI-USE in Mario Kart

If receiving the 3 Red Shells weapon, the player can fire it 3 times until receiving another.

Example of normalising technique which is TIME-BASED in Mario Kart

If receiving the Invincibility Star item, once activated the increased speed and shield will last for several seconds before ending.

Please answer the below questions regarding how these types of normalising techniques would affect your experience of a multiplayer game match.

23. If you were a low-performing player, how would your experience be affected by being assisted with a normalising technique that is:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Single-use	○	○	○	○	○	○	○
Multi-use	○	○	○	○	○	○	○
Time-based	○	○	○	○	○	○	○

24. If you were a high-performing player, how would your experience be affected by other players being assisted with a normalising technique that is:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Single-use	○	○	○	○	○	○	○
Multi-use	○	○	○	○	○	○	○
Time-based	○	○	○	○	○	○	○

Part 2 - COMPETENCE NORMALISING TECHNIQUE ATTRIBUTES

ATTRIBUTE: Visibility

Description: If and to whom the presence of the normalising technique is made visible.

Levels:

Visible to beneficiary - Only the player(s) assisted by the normalising technique are made aware that they are being assisted.

Visible to non-beneficiary - Players that are NOT being assisted are made aware that others are currently receiving assistance from a normalising technique.

Not visible - No players, including those being assisted, are made aware of the presence of a normalising technique.

Please answer the below questions regarding how these types of normalising techniques would affect your experience of a multiplayer game match.

25. If you were a low-performing player, how would your experience be affected by being assisted with a normalising technique that is:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Visible to you (the beneficiary)	○	○	○	○	○	○	○
Visible to other players (non-beneficiaries)	○	○	○	○	○	○	○
Not visible to anyone	○	○	○	○	○	○	○

26. If you were a high-performing player, how would your experience be affected by other players being assisted with a normalising technique that is:

	1 - Very negatively	2	3	4	5	6	7 - Very positively
Visible to them (the beneficiary), but not you	○	○	○	○	○	○	○
Visible to you and other players (non-beneficiaries)	○	○	○	○	○	○	○
Not visible to anyone	○	○	○	○	○	○	○

Part 3 - MISSING TECHNIQUE ATTRIBUTES

Below is a a total list of all competence normalising technique attributes (written in CAPITALS) and their levels.

DETERMINATION – When the decision to utilize the competence ormalising technique is made.

Pre-gameplay
Gameplay

AUTOMATION – Whether the decision to apply a normalising technique is made by the game system (automated) or by the player(s).

Applied by system (automated)
Applied by player(s) (manual)

RECIPIENT – The recipient of the normalising technique is the player or players who receive the benefits / assistance provided by the technique.

Individual
Team

SKILL DEPENDENCY – Whether the technique requires the player(s) to act with some degree of skill for the benefit to occur.

Skill dependent
Skill independent

USER ACTION – Whether the player is required to interact with the interface to trigger the normalising technique's benefit to occur.

Action required
Action not required

DURATION – How long or often the benefit of a normalising technique may be enacted.

Single-use
Multi-use
Time-based

VISIBILITY – If and to whom the presence of the normalising technique is made visible.

Visible to beneficiary
Visible to non-beneficiaries
Not visible

27. Are there any LEVELS missing for any of the above attributes listed? If so, please describe below.

28. Are there any ATTRIBUTES missing from the above list that would allow better classification of different types of competence normalising techniques? If so, please describe.

Appendix C – Stage 3 Script

NOTE: Researcher instructions are in bold italics.

Thank you for agreeing to participate in this study. I'm Alex Baldwin, the lead researcher of this project investigating player experience of multiplayer video games. This study is expected to take approximately 1 hour and 15 minutes. At the end of the study, you will have the option to enter a prize draw for a $100 JB HiFi voucher.

Before we begin, would you please read through and sign the consent form in front of you. By signing, you are indicating your consent to participate in this study. However, at any point during this session you may withdraw consent, upon which any data collected will be deleted.

If you have heard any details of this study from a previous participant, please let us know now.

If participant indicates knowledge of study, leave hearing range of other participants and investigate extent of knowledge. Make judgement call of whether the participant is still viable for study.

Continue once forms have been collected.

As noted in the consent form, part of the data collection for this study involves the use of small sensors placed on the skin of the hand and side of the neck. These sensors should cause no discomfort, they only take a reading and you will not feel anything other than the sensation of the sensor sitting against your skin and the adhesive holding it in place. Basically, it will feel like a band-aid.

In order to attach these, it is required that you wash your hands for 30 seconds with soap and dry with paper towel, overseen by one of the researchers. An alcohol swab will also be used to clean a small area of skin on the side of your neck for one sensor to attach. The researcher will need to touch your left hand and neck in order to place the sensors on. Please inform us if there are any issues with this process or you experience any discomfort.

While each other participant is being prepped, you may click next on the survey now and complete the page titled Player Background. Once you have completed that, you may continue to the next page of the survey which will instruct you to stop at this point and wait for further instructions.

Take each participant to sink one at a time, ensure cleaning for 30 seconds and drying with paper towel. Ask each to sit down, and set up EDA.

I will now need to check the equipment briefly. Could you all please take a deep breath in now*….**check EDA…***and exhale. You may breathe normally again.

Once player background survey section completed.

This study will involve playing three matches of the game Unreal Tournament III on PC. Before each match you will be informed of the match rules.

During gameplay, it is important that you do not speak out loud or communicate with the other participants. Also, to avoid interfering with the sensor, please also refrain from foot-tapping or unnecessary movement in your chair. Otherwise, you may play as you usually would in a typical multiplayer game match.

Next to your computer you will see a printed control scheme for the game using keyboard and mouse. Please take a minute to learn the controls while I prepare your computers for play.

Set up UT3 dedicated server.

Explain appropriate rules (match order randomised for each session). Select the appropriate rules to read from below:

MATCH CONDITION 1 or 2:

In this standard match you will be competing against each other for the highest score in 10 minutes. The game mode is 'Deathmatch', in which your score is determined by the number of kills against other players.

MATCH CONDITION 3:

In this match you will be competing against each other for the highest score in 10 minutes. The game mode is 'Deathmatch', in which your score is determined by the number of kills against other players. Additionally, a gameplay feature will be used in this match only to assist low-performing players. When a player's score is more than a certain number below the leader's score, the player will respawn (reappear in the match after dying) with additional shield points. This allows the player to take more damage before being defeated.

Continue as normal.

Please place your headphones on now. A control wheel on the cord will adjust volume. Once the match begins, you may play. When the match automatically ends, please take your hands off the mouse and keyboard.

Please click 'Ready' when you are ready to begin.

Once match ends, kill server. Switch all PCs back to survey and click next.

Please complete the next 2 pages of the survey as honestly and accurately as possible, until it asks you not to continue.

Set up UT3 dedicated server.

Once participants finished, read appropriate match condition rules.

As before, please refrain from talking and unnecessary movement such as foot-tapping while playing.

Once the match begins, you may play. When the match automatically ends, please take your hands off the mouse and keyboard.

Please click 'Ready' when you are ready to begin.

Once match ends, kill server. Switch all PCs back to survey and click next.

Please complete the next 2 pages of the survey as honestly and accurately as possible, until it asks you not to continue.

Set up UT3 dedicated server.

Once all participants are ready, read appropriate match condition rules

As before please refrain from talking and unnecessary movement such as foot-tapping while playing.

Once the match begins, you may play. When the match automatically ends, please take your hands off the mouse and keyboard.

Please click 'Ready' when you are ready to begin.

Once match ends, kill server. Switch all PCs back to survey and click next.

Please complete the rest of the survey. You may continue through all the remaining pages of the survey, which includes optional entry into the prize draw for a $100 JB HiFi voucher.

Once you have finished the survey, I will remove the sensors. Once the wires are unclipped, you may wish to peel the disposable white sensor adhesive off yourself if you prefer or I can remove them for you. Some paper towel will also be provided to wipe off any remaining adhesive residue.

Remove EDA sensors and dispose.

Thank you for participating in this study. Please note it is important for this study that you do not share any details or contents of this study with anyone outside this room, as it may influence the results of any future participants. I will provide you with a link for updates on the results of the survey, and if you have provided your email address we will let you know when the data collection is finished. Until that time, please do not discuss the details of the study with people who might participate in it in the future.

END OF SESSION

Appendix D – Intrinsic Motivation Inventory (IMI) Scale

For each of the following statements, please indicate how true it is for you, using the following scale:

1 2 3 4 5 6 7

(1 - Not at all true); (4 – somewhat true); (7 – very true)

Interest/Enjoyment

I enjoyed doing this activity very much
This activity was fun to do.
I thought this was a boring activity. (R)
This activity did not hold my attention at all.(R)
I would describe this activity as very interesting.
I thought this activity was quite enjoyable.
While I was doing this activity, I was thinking about how much I enjoyed it.

Perceived Competence

I think I am pretty good at this activity.
I think I did pretty well at this activity, compared to other students.
After working at this activity for a while, I felt pretty competent.
I am satisfied with my performance at this task.
I was pretty skilled at this activity.
This was an activity that I couldn't do very well. (R)

Effort/Importance

I put a lot of effort into this.
I didn't try very hard to do well at this activity. (R)
I tried very hard on this activity.
It was important to me to do well at this task.
I didn't put much energy into this. (R)

Pressure/Tension

I did not feel nervous at all while doing this. (R)
I felt very tense while doing this activity.
I was very relaxed in doing these. (R)
I was anxious while working on this task.
I felt pressured while doing these.

Perceived Choice

I believe I had some choice about doing this activity.
I felt like it was not my own choice to do this task. (R)
I didn't really have a choice about doing this task. (R)

I felt like I had to do this. (R)
I did this activity because I had no choice. (R)
I did this activity because I wanted to.
I did this activity because I had to. (R)

Value/Usefulness

I believe this activity could be of some value to me.
I think that doing this activity is useful for ______________________
I think this is important to do because it can _____________________
I would be willing to do this again because it has some value to me.
I think doing this activity could help me to _____________________
I believe doing this activity could be beneficial to me.
I think this is an important activity.

Relatedness

I felt really distant to this person. (R)
I really doubt that this person and I would ever be friends. (R)
I felt like I could really trust this person.
I'd like a chance to interact with this person more often.
I'd really prefer not to interact with this person in the future. (R)
I don't feel like I could really trust this person. (R)
It is likely that this person and I could become friends if we interacted a lot.
I feel close to this person.

Appendix E – Flow State Scale (FSS) Sample Questions

Five sample questions from the Flow State Scale are provided below. Items are scored using a 5-point Likert scale from “strongly disagree” to “strongly agree”.

- I felt I was competent enough to meet the demands of the situation.
- I did things spontaneously and automatically without having to think.
- I had a strong sense of what I wanted to do.
- I had a good idea about how well I was doing while I was involved in the task/activity.
- I was completely focused on the task at hand.

Appendix F - Game Experience Questionnaire (GEQ) Scale

Please indicate how you felt while playing the game for each of the items,
on the following scale:

not at all	slightly	moderately	fairly	extremely
0	1	2	3	4
< >	< >	< >	< >	< >

1. I felt content
2. I felt skilful
3. I was interested in the game's story
4. I thought it was fun
5. I was fully occupied with the game
6. I felt happy
7. It gave me a bad mood
8. I thought about other things
9. I found it tiresome
10. I felt competent
11. I thought it was hard
12. It was aesthetically pleasing
13. I forgot everything around me
14. I felt good
15. I was good at it
16. I felt bored
17. I felt successful
18. I felt imaginative
19. I felt that I could explore things
20. I enjoyed it
21. I was fast at reaching the game's targets
22. I felt annoyed
23. I felt pressured
24. I felt irritable
25. I lost track of time
26. I felt challenged
27. I found it impressive
28. I was deeply concentrated in the game
29. I felt frustrated
30. It felt like a rich experience
31. I lost connection with the outside world
32. I felt time pressure
33. I had to put a lot of effort into it

Scoring guidelines GEQ Core Module

The Core GEQ Module consists of seven components; the items for each are listed below.

Component scores are computed as the average value of its items.
Competence: Items 2, 10, 15, 17, and 21.
Sensory and Imaginative Immersion: Items 3, 12, 18, 19, 27, and 30.
Flow: Items 5, 13, 25, 28, and 31.
Tension/Annoyance: Items 22, 24, and 29.
Challenge: Items 11, 23, 26, 32, and 33.
Negative affect: Items 7, 8, 9, and 16.
Positive affect: Items 1, 4, 6, 14, and 20.

Appendix G- Stage 4 Example Interview Questions

1) You have just played 4 matches of Unreal Tournament III; 2 of which were standard matches and 2 which contained a features called “assistance”. In general, did you prefer the standard matches or the assisted matches?
2) Did you change your strategy or tactics in the assisted matches compared to the standard matches?
3) Do you feel you performed differently in the assisted matches?
4) Which did you feel was the closest or most competitive match?
5) (after reveal of assistance conditions) Does this change your perception of your performance in any way?
6) How do you feel knowing the assistance was present in all 4 matches?
7) Assistance features like you saw today have been used in other multiplayer games too. Have you encountered any features like this in the game you play?
8) How do you think assistance features should be used best in multiplayer games?
9) Do you feel players should be made aware of assistance features in a match? And if so, which players?
10) Do you have any other thoughts or recommendations for how assistance could be used in games?

Appendix A – Stage 4 Script

NOTE: Researcher instructions are in bold italics.

Thank you for agreeing to participate in this study. I'm Alex Baldwin, the lead researcher of this project investigating player experience of multiplayer video games. This study is expected to take approximately 90 minutes. At the end of the study, you will be provided with a key code to redeem the Unreal game franchise on Steam for PC as compensation for your time.

Before we begin, would you please read through and sign the consent form in front of you. By signing, you are indicating your consent to participate in this study. However, at any point during this session you may withdraw consent, upon which any data collected will be deleted.

If you have heard any details of this study from a previous participant, please let us know now.

If participant indicates knowledge of study, leave hearing range of other participants and investigate extent of knowledge. Make judgement call of whether the participant is still viable for study.

Continue once forms have been collected.

You may now click next on the survey and complete the page titled Player Background. Once you have completed that, you may continue to the next page of the survey which will instruct you to stop at this point and wait for further instructions.

Once player background survey section completed.

This study will involve playing the game Unreal Tournament III on PC. In order for you to first familiarise yourself with the controls and gameplay, you will first have the opportunity for a quick warm-up match. Please take a moment to look at the printed control scheme for the game using keyboard and mouse while your computers are prepared

Set up UT3 dedicated server and prepare PCs.

The game mode for this warm-up match is 'Deathmatch', in which your score is determined by the number of kills against other players. Please take a few minutes to practise now before the study begins.

After 5 minutes record scores and note low and high-performing players. Exit game and load back to menu.

We will now begin the study. You will be playing 4 matches of the game Unreal Tournament III on PC, and following each match will answer some survey questions regarding your player experience. At the end of the study there will be an audio-recorded group interview and discussion of your experience.

Two of the matches you play today will be standard matches as you just experienced in the warm-up with no extra features, while two will have features explained before those matches. As each session of this study is randomised, you will be provided with paper instructions before each match that will inform you of whether you are playing a standard match, or whether there will be extra rules and what those rules will be. It will also instruct you to enter text in the survey indicating the match type about to be played to both confirm your understanding of the rules and indicate to use which order you played the matches in.

Unless otherwise specified by the paper, all matches will use the “deathmatch” game mode in which your score is determined by the number of kills against other players. Each match will be 10 minutes long. After 10 minutes the game will be ended, and at this point it is important you do not attempt to exit the game yourself but simply take your hands off the keyboard and mouse for a researcher to do this. Are there any questions so far?

From this point forward in the study, it is important that you do not speak out loud or communicate with the other participants to avoid influencing their experience. I will also be unable to answer any questions regarding the paper instructions or survey question interpretation.

I will now hand out the papers with the rules for the first match. Once you have read the paper and entered the text specified in the survey, please leave the paper on your desk and put your hand up for a researcher to collect it.

Hand out appropriate papers, wait and collect once ready. Switch PCs to Unreal.

Please place your headphones on now. A control wheel on the cord will adjust volume. Once the match begins, you may play. When the match automatically ends, please take your hands off the mouse and keyboard.

Please click 'Ready' when you are ready to begin.

Once match ends, kill server. Switch all PCs back to survey and click next.

Please complete the next pages of the survey as honestly and accurately as possible, until it asks you not to continue.

Repeat for next 3 matches….

You may now continue through all the remaining pages of the survey.

Once all participants finished, set up audio recording equipment.

We will now begin an audio-recorded group discussion about your experience.

Start recording and conduct interview. Reveal awareness condition deception at appropriate time.

Once interview finished, stop audio recording.

Thank you for participating in this study. Please note it is important for this study that you do not share any details or contents of this study with anyone outside this room, as it may influence the results of any future participants. I will provide you with a link for updates on the results of the survey, and if you have provided your email address we will let you know when the data collection is finished. Until that time, please do not discuss the details of the study with people who might participate in it in the future.

Provide Unreal Steam codes.

END OF SESSION