Towards the correlation of player preferences and behaviour for video game personalisation

A thesis submitted for the degree of

Master of Computer Science

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28th March, 2013

Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and, any editorial work, paid or unpaid, carried out by a third party is acknowledged.

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Acknowledgments

Firstly, I would like to offer a sincere thanks to my supervisors, Dr. Fabio Zambetta and Dr. Lawrence Cavedon, as well as to my wife and family for their consistent support, patience, wisdom, and encouragement over the years. The set of passionate and thoughtful reviewers of rejected papers and articles also have my thanks for showing me that not only do people want this work to be done, but they want it to be done exceptionally well. Your feedback also showed me how valuable it can be to challenge my own assumptions on a regular basis. I am also indebted to the School of Computer Science and Information Technology at RMIT University for giving me the opportunity to pursue this research. The financial support afforded by the scholarship, and the freedom to select a problem that I earnestly wanted to tackle are both humbly appreciated. Finally, to all who contributed to the development and testing of the experiment, as well as those who participated in the final run of the experiment: Your willingness to give up even a small amount of your time to assist with my research was exceptionally encouraging, thank you.

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Abstract

As an electronic medium, video games are capable of adapting its rules and content to individual players at *run-time* in ways defined by designers during *development.* This player-centric video game adaptation is what we mean by *video game personalisation.* However, to enable a personalisation system to adapt a video game without *explicitly* asking the player each time, the difficult task of *predicting* some relevant aspect of the player becomes necessary. This thesis describes a methodology for observing a player profile made up of 22 gameplay preferences and player behaviour data within a testbed role-playing video game. Our primary goal was to test whether specific preferences and behavioural trends correlate in order to permit the *prediction of gameplay preferences from in-game behaviour.* A successful finding would enable video game designers to define gameplay rules that are dependent on the preferences of their future players, thus providing one avenue for the future commercial adoption of video game personalisation. While our results were inconclusive, the rationale for the process we followed is carefully described and contains many important considerations for future research of a similar type. It is still our firm belief that other work can build upon our own to one day enable some form of video game personalisation.

Chapter 1

Introduction

Personalisation is the *automatic* customisation of content and services based on a *prediction* of what the user wants. Common examples of personalisation can be found in websites that automatically recommend news items or products based on the similar behaviour of other users. In the video game domain, personalisation involves constructing a system capable of tailoring video game rules and content to suit some aspect of the player (e.g., a player's gameplay preferences, playing style, skill level, etc). The result of personalisation is a video game that can *adapt* to suit individual players *while* they play in order to more effectively entertain, teach, or communicate.

While adaptive video games currently exist, those that *personalise* the playing experience to an attribute of the player is relatively unheard of in the commercial video game industry. For example, the *Left 4 Dead series* of video games adapt the intensity of the playing experience in a way that aims to constantly surprise the player, yet it does not do so in a way that is specific to whoever is playing. We believe this general lack of personalisation is, at least partially, a result of two assumptions: the difficulty of reliably predicting what a player wants or needs outweighs the potential gain, and a personalisation system takes authorial control away from video game designers. The primary goal of this thesis is to point towards a form of personalisation that takes these very practical concerns into account by **investigating whether a player's gameplay preferences (i.e., a player's general taste in video games) correlates with their in-game behaviour (i.e., a player's actions within a video game)**. A consistent finding of such a correlation would permit video game designers to assume access to additional information about potential players during development and thus be free to exploit it at their discretion. Such a finding would not only solve one of the difficult problems associated with video game personalisation, but it also affords designers with *more* control over how their video game reacts to the player than they would normally have.

The reasoning behind our hypothesis for a preference-behaviour correlation is relatively straightforward: if given the choice, players will tend to gravitate towards experiences that they enjoy most. This logic assumes two important points that we consider when designing our experiment: a player is permitted such choice between different experiences, and a player understands the likely outcome of any observed in-game choice. This hypothesised tendency for players to gravitate towards experiences they generally prefer of course includes the scenario where players may make a choice that only results in a preferred experience in the long-term and, in the short-term, actually results in a non-preferred experience that the player must tolerate for the time being.

To emphasise the necessity of video game personalisation we now briefly discuss the limits of allowing players to *manually* customise their video games. It could be said that customisation is a far simpler alternative to personalisation that still accounts for the varying wants and needs of players. Rather than having to *predict* what the player would choose in a given situation, surely it is simpler to just *ask them directly* via an on-screen prompt that appears either before or throughout the game. A common example of customisation is when a video game prompts the player for which *difficulty level* they would like to set the game to before it begins (e.g., *easy*, *normal*, or *hard*). However, just as with any survey design, it can be problematic to assume that a) players can correctly interpret the meaning of any such prompt, and that b) players are capable of objectively expressing which option best self-applies in a single response. Adding multiple prompts to elicit a response that is likely to be more meaningful would often be unsuitable within a video game context because it would quickly become onerous and disrupt the player's experience. This would be particularly the case if it occurred once the game had already begun. Furthermore, there are aspects of the video game that the player should simply not have any control of because it would cause the player's experience to deviate too far from that which the designer intended. For example, the player's ability to modify the difficulty level throughout the game is often disabled to prevent players from bypassing challenges, and having control over the behaviour of an enemy character is nonsensical. Customisation should be used wherever possible because of its simplicity, but unfortunately it is not appropriate for many situations and so a prediction of what the player *would* have wanted if asked has to be made (i.e., personalisation).

Finally, just as customisation has its limits, personalisation certainly does as well. Adams and Rollings [2007, p. 21] notes that "designing a video game that everyone finds enjoyable is impossible because not everyone enjoys the same kind of experiences". We do not view personalisation as a means to subvert this so-called impossibility. Even if it were technically possible to personalise a video game to such an extent that all players would find it enjoyable, surely the amount of effort required to achieve such a feat would be better spent creating multiple games that are *natively* suited to a variety of audiences. Instead, we view personalisation as a means of achieving two subtler forms of adaptations that do not have to necessarily conflict with a video game's original vision if the designer does not want it to. Firstly, personalisation could be used to *prioritise some generally enjoyable video game experience types over others*. For example, some video games are structured such that players are always given a selection of multiple in-game tasks or goals to choose from and complete (e.g., missions, levels, and quests). Not all players enjoy this freedom of choice and would instead prefer a more linear, guided experience. Personalisation would be able to select or suggest which task would suit a particular player at any given time for those who would prefer it. Secondly, personalisation can be used to *understate video game experience types that not all players enjoy*. For example, some video games heighten the sense of danger and tension experienced by the player through the use of auditory and visual effects (e.g., sound effects and on-screen cues that represent the enemy attacking the player, areas with dim lighting, in-game camera shaking and lurching in response to enemy action). Reducing these audio and visual elements to account for a player's tendency to dislike tense experiences would allow players to still enjoy other aspects of the video game while not being overwhelmed or overly scared whenever tension and danger dominates the experience.

1.1 Contributions and scope

Having established the primary goal of this thesis and our perspective of video game personalisation, in this section we establish exactly what we do and do not discuss or achieve. Firstly, this thesis places an exclusive focus on what aspect of the player a video game should be personalised to and how that might be observed without discussing *how* any particular adaptation would occur. Lopes and Bidarra [2011]; Togelius et al. [2011]; Yannakakis and Togelius [2011] all survey various methods for achieving video game adaptation, often describing them as either a procedural content generation process or an intelligent agent-based approach. The only thing we would add to this topic is that it need not be assumed that such complex systems are wholly mandatory for video game personalisation. The examples of player preference-driven personalisation described earlier in this chapter are relatively straightforward and could be implemented using even the most rudimentary of programming logic. Consider again the set of audiovisual effects used to enhance a video game's sense of tension and a player's preference for tense experiences (perhaps measured on a five-point scale). The degree to which these effects are present could be defined in terms of the player's preference using no more than a set of conditional statements. Of course, it should be left to the designer to determine whether or not a more complex algorithm is required to sufficiently achieve their personalisation goal.

Secondly, this thesis discusses at length how we define a player's preferences (i.e., a player's general taste in playing video games) and how we believe they can be observed (i.e., from a player's in-game behaviour without attempting to explain *how* a player's preferences might be formed. While an interesting topic and likely to be related in some way to a player's personality and early video game playing experiences, we have chosen to simply assume that, over time, players have somehow formed (or not formed) a preference for particular video game experience types.

Finally, the contribution of this thesis is *not* a conclusive answer to our primary hypothesis that a player's preferences will significantly correlate with some aspects of in-game player behaviour and as such remains an open question. To the best of our knowledge, other work exists that is *related* to this hypothesis but, at the time of writing, no other work exists that has sought to verify the *same* hypothesis. As our results are inconclusive (see Section 6.3), we state that the primary contribution of this thesis is instead the description of a process for observing a potential preference-behaviour correlation that may one day give rise to another that *can* produce conclusive evidence. It is for this reason that we take careful consideration throughout this thesis to explain *why* we made certain experimental design and data analysis decisions, and to give the reader a clear idea of the *method*. Additionally, we believe this thesis puts forward a novel and internally consistent perspective of two sub-areas of video game research: player preference modeling, and video game personalisation.

1.2 Structure

Having established the central focus of this thesis and its contributions, we now introduce how it is structured by briefly describing the purpose and content of each chapter.

In Chapter 2 we further describe our view of a player's gameplay preferences and our chosen observation method by contrasting them against other work within the video game domain. We do this by surveying how other work describes the differences between players while reiterating the appropriateness of describing players in terms of their gameplay preferences for video game personalisation.

Chapters 3 to 5 describe our methodology for observing a player's gameplay preferences and in-game behaviour, and our process for collecting preference and behaviour data. Specifically, Chapter 3 defines each of the 22 gameplay preferences that make up our preference profile, and Chapter 4 describes the design of our testbed role-playing video game which we use to observe player behaviour. Chapter 5 describes the design of our experiment and how we define each of our preference and behaviour variables, including the specific preference-behaviour variable pairs that we hypothesised would correlate. Chapter 5 also contains a listing of the survey items that we use to elicit a player's preferences within our experiment.

In Chapter 6 we describe the preference and behaviour data we collected by following our methodology before describing how we tested for their correlation. We also include some additional points of analysis that include the suggestion that most of our profile's preferences are independent of each other.

Finally, in Chapter 7 we summarise the description of our methodology and results before suggesting changes to our methodology that we believe are likely to result in more conclusive evidence for a correlation between a player's gameplay preferences and in-game behaviour. Such suggestions include modifications to the preference survey, testbed video game design, and experiment structure.

Chapter 2

Context and related work

As established in Chapter 1, personalisation is the *automatic* customisation of content and services based on a *prediction* of what the user wants. However, such a system that dynamically modifies or generates video game content and rules can theoretically also do so by basing its decisions on some kind of input *other* than the player. For example, a system that adapts the attitudes of non-playable characters in a role-playing game can do so in a randomised fashion, or in a way that is dependent on the time of day. In spite of this, much work describing an adaptive video game system still places an exclusive focus on a single input source: the player [Charles et al., 2005; Magerko, 2008; Lopes and Bidarra, 2011]. We believe this exclusive focus is hardly surprising given the sole purpose of a video game: to entertain, communicate with, and educate a population of human players that each have a varying assortment of tastes and attitudes.

However, while the potential of video game personalisation is significant and can enhance a video game's affectiveness and in some way account for variety within a population of players, achieving personalisation to any meaningful degree is no easy feat. Even a straightforward application such as "dynamic difficulty adjustment" [Hunicke and Chapman, 2004], defined as the adaptation of a video game's difficulty to match the player's skill level, is still far from becoming a staple feature of modern video games. Again, this is hardly surprising when you consider the profundity of what video game personalisation is really setting out to achieve: the construction of models that describe human characteristics and, in many cases, the reliable interpretation of in-game player behaviour.

This chapter introduces existing work relating to video game personalisation in subsections that correspond with five ways that players are often said to differ from each other:

1. By preferences (i.e., gameplay that players find appealing);

2. By personality (i.e., distinctive character of players);

3. By experience (i.e., how players emotionally and cognitively respond while playing);

4. By performance (i.e., the degree and rate of player achievement/progression);

5. By in-game behaviour (i.e., the player actions made within the game).

Each section introduces each player differentiation category before describing examples of their application to video game personalisation. Table 2.1 contains all references for each category's applications for quick reference. Our discussion of other work in this chapter aims to compare the advantages and disadvantages of other approaches to our own, and also to identify the key research avenues that clearly require further exploration.

Other surveys related to the topic of video game personalisation include Machado et al.

Input type	***Output***
Preferences	
Hartsook et al. [2011]	Role-playing game maps
Dias and Martinho [2011]	Difficulty, weapon control, and objectives
Nygren et al. [2011]	Platforming levels
Personality	None
Experience	
Yannakakis et al. [2010]; Martinez et al. [2010]	Camera position
Sharma et al. [2010]	Plot/story points
Pedersen et al. [2010]; Shaker et al. [2012]	Platforming levels
Performance	
Jennings-Teats et al. [2010]	Platforming levels
Yu and Trawick [2011]	Enemy type and count
Sorenson et al. [2011]	Platforming levels and dungeon structure
Zook et al. [2012]; Zook and Riedl [2012]	Battle missions
In-game behaviour	
Thue et al. [2007; 2008]	Quest structure
Hastings et al. [2009]	Weapon behaviour

Table 2.1: Examples of how video game personalisation has been applied, categorised by both the type of player data used (i.e., input), and the gameplay being personalised (i.e., output).

[2011]; Smith et al. [2011] which both survey the broad field of player modeling that primarily aims to better understand and capture how players behave in games.

2.1 Player preferences

In this section we review and compare work that focuses on differentiating players by how much they do or don't like particular types of video games (e.g., puzzle games, racing games), or elements of video game design (e.g., "competition", "discovery", and "strategy"). This is often described as a *player's preferences*. Our own work also fits into this category because we also view players as being different by way of their preference for different gameplay.

Though this section focuses on preferences and how they have been applied to personalisation, we also briefly discuss player motivation work and then lists of gameplay types that others have identified. We introduce motivations and gameplay types in this section on preferences because they can also provide insight into different preferences that a player might have. In fact, we draw upon work in all three categories (i.e., preferences, motivations, and gameplay types) to form our own list of 22 preferences that are properly introduced in Chapter 3.

We start our discussion of preferences by first establishing how our view of preferences is different from a lot other work. This is important because the term "player preference" has become ambiguous.

Firstly, we view a player's preferences as being equivalent to a player's "taste" in video games that is potentially *independent* of commonly held video game genres such as the real-time strategy (RTS) or role-playing game (RPG). For example, a player can have a preference for gameplay concepts such as “strategic planning” or “player cooperation” that can be fulfilled in different measures and forms by multiple genres. For example, strategic planning is often found in RTS’s where the future production and location of buildings and units require planning, and in RPG’s where the future development and specialisation of the player’s character requires forethought. By the same token, player cooperation is often found in both multi-player RTS’s and muti-player RPG’s. This view is in contrast to another that instead equates a player’s preferences to being an abstraction of a person’s “play style” *within* a particular video game genre. For example, a player can have a preference for gameplay activities such as “exploring/adventuring” or “collecting” within the role-playing game genre [Bartle, 1996; Hartsook et al., 2011]. While we posit that our view of a player’s preferences is potentially genre-independent, a formal investigation into this is considered to be beyond the scope of this thesis. Our work attempts to only correlate preferences with player behaviour data yielded by play within a single genre, the role-playing video game (RPG).

Secondly, we view a player’s preferences as having a similar stucture to psychological models of personality that are “trait-based” like the Five-Factor Model [McCrae and John, 1992] rather than“type-based” like the Myers-Briggs Type Indicator [Myers et al., 1985]. Our use of these terms throughout the thesis refer to their respective structures and separate that from the psychological reasoning behind them. To this end we view a trait-based model as one that defines a person as a set of values that each correspond with one trait from a set of independent traits, and a type-based model as one that typically defines a person as one type from a set of discrete types. An early example of a type-based player preference model is Bartle’s 4-type taxonomy that views online role-playing game players as either “achievers”, "explorers", "socialisers", or "killers" [Bartle, 1996] and has been since extended to 8 types [Bartle, 2004]. Other examples have also followed a similar approach since. Reynolds [2000] presents market research conducted by *Wizards of the Coast* that suggests a 4-type taxonomy similar to Bartle except that it operates on different axes, *strategic* and *tactical* in this case. This relevant aspect of the Wizards of the Coast's study were derived from the survey results of tabletop (i.e., non-digital) role-playing game players, although the specific survey questions have not been released. Laws [2001] uses informal observations of, again, tabletop role-playing game players to describe them as being either one of 7 types that all vary in their preference for specific game activities intrinsic to the genre. Bateman and Boon [2006] views players as being either one of 4 types based on self-admittedly "very sketchy and incomplete" analytical results despite "indicating certain trends" and some theoretical backing from the Myers-Briggs Type Indicator [Myers et al., 1985]. All these examples are not only what we consider to be the "play style" view of preferences but are also "type-based" without exception. Zammitto [2010] is an example that deviates from this trend and describes a set of preferences where each item corresponds to a common video game genre or subgenre from the set of 9 categories described at length by Rollings and Adams [2003]. This is an example of yet another player preference perspective that views each preference as being equivalent to a game genre. We constructed a preference profile that is similar to Zammitto [2010], at least in terms of having a non-hierarchical, trait-based structure (i.e., multiple dimensions/factors that are not organised into any higher-order category). Bateman et al. [2011] details at length the arguments for both type-based and trait-based models, but states that for the same reasons that psychological models have moved from being type-based to trait-based, future studies should focus on investigating a trait-based player model structure. [Bateman et al., 2011] also points out that without empirical evidence the 4 types in Bartle's model may or may not be mutually exclusive (i.e., it is possible a single player possesses attributes described by two or more types). We also argue that a weakness of type-based models are that they group together multiple attributes together, ruling out the possibility that players can be described by a set of attributes that occur in different types. Again, statistically significant evidence is required before any of the assumptions that type-based models hold can be properly tested.

In recent years other work has also applied genre-specific preference models to video game personalisation. Hartsook et al. [2011] personalises maps in a role-playing game to suit a player's preference for activities that are specific to that genre. Their project, named "GameForge", that also includes a plot point adaptation component Li and Riedl [2010] is still in its early stages and has not yet reached the stage of final implementation that has an actual player model and is evaluable. Dias and Martinho [2011] applies the 4-type preference model developed by Bateman and Boon [2006] to personalise the difficulty, level of weapon control, and player objectives of an action-shooting game. They also performed a preliminary evaluation of the method, however they acknowledge that more development and evaluation is required before they can claim that their methodology has a significantly positive effect on the player's experience. The final example, Nygren et al. [2011] is different to the two previous in that they incorporate both a pre-game preference survey and in-game behaviour of trial levels to personalise levels in a platform games. Unfortunately the details of the preference survey were sparse, there was no mention of whether the survey and trial behaviour data correlated at all, and evaluation at this stage was only performed on 4 players. In summary, these preference-drive personalisation examples require further evaluation before their preference models, predominantly type-based, are shown to be effective and sufficiently describe players. Much future application in the area is required before our hypothesis of a trait-based preference model being more descriptive and effective than type-based models can be confirmed and this is beyond the scope of our work.

2.1.1 Player motivations

In this subsection, we briefly list work that centres on player motivations rather than preferences. Unlike preferences, which generally equate to what players like or prefer, motivations relate to the explanations for why people play video games. There is some overlap as, for example, a player can have a preference for a gameplay element such as social interaction and also be motivated to play by the same thing, though their relationship to gameplay is clearly unique. Additionally, not all motivating factors do not make sense as a preference. For example, a player can be said to be motivated to play by the desire to "escape" from the stress and problems of the real world [Yee, 2006a] but it isn't logical to consider that a player can also have a preference for escapism.

Throughout our reading, we have identified 6 key pieces of work that describe lists of player motivations that, as we detail in later chapters, form an additional source of our own list of 22 general gameplay preferences. Also, some work below elicited the preferences of players via self-report, which helped to inform our own preference survey.

1. Malone [1981] describes 4 intrinsically motivating game playing factors in games that

he believes can be leveraged by instructional games;

2. Yee [2006b] identifies 10 motivational factors that drive the play of massively multiplay online role-playing games (MMORPG's) from the results of a survey;

3. Schultheiss [2007] developed a survey asking players why they play massively multi-player online games (MMO's) and forms a list of 13 *usage motivations* and 7 *gameplay experience factors*;

4. Tychsen et al. [2008] developed a motivation survey applicable to both single-player and multi-player role-playing games (RPG's) using the work of Yee [2006b] as its basis in forming 10 motivational factors [1];

5. Bostan [2009] adapts Murray's Psychogenic Needs [Murray, 1938] to the RPG domain, forming a list of 27 player motivations;

6. Kallio et al. [2011] conducts a cultural study and identifies a list of "player mentalities" that describe 9 reasons for playing video game.

Interestingly, player motivations have not been yet applied to video game personalisation in any context.

2.1.2 Gameplay types

We close this section with a brief listing of selected pieces of work that each describe either their own list of gameplay types, or their own list of explanations for why video games are

[1] Because Tychsen et al. [2008] describes a superset of the motivational factors presented by Yee [2006b] we only considered the survey items not already described by Yee [2006b].

fun. Work in this category is often used to inform the object of a player's preferences, and it is for that reason we list them in this "preference" section. We, too, use the following pieces of work in this way.

1. Caillois [1961] defines 4 types of play in non-digital games;
2. Lazzaro [2004] lists 4 keys to creating emotions in players without the use of a story and then describes 11 emotions that video games both common and uncommonly elicit;
3. Hunicke et al. [2004] lists 8 video game *aesthetics* which they define as "desirable emotions evoked in the player" during interaction with the game;
4. Sweetser and Wyeth [2005] defines a list of "criteria for player enjoyment" by adapting the concept of Flow [Csikszentmihalyi, 1990] to games;
5. Rollings and Adams [2003] describe 10 video game genres that each have key mechanics and common tropes;
6. Adams and Rollings [2007] describes a set of gameplay challenge types as well as a list of game genres that are highly similar to their previous iteration [Rollings and Adams, 2003] [2];
7. Schell [2008] defines an extensive list of appealing and important gameplay elements dubbed "lenses";
8. Bateman and Nacke [2010] neurobiologically explains other models of gameplay.

[2]Because the video game genres described by Adams and Rollings [2007] are similarly discussed in their previous book [Rollings and Adams, 2003] we only considered the list of gameplay challenge types listed in [Adams and Rollings, 2007].

We reintroduce the examples above, along with the preference-based and motivation-based examples, in later chapters in this thesis and describe how we form our list of preferences by analysing the recurring patterns found in all of them. We chose this "meta-analysis" approach rather than contribute yet another list to the already extensive body of work. This approach was inspired by other similar work conducted on a smaller scale Walz [2010]; Stewart [2011, pp. 62-74].

2.2 Player personality

Personality, a psychological construct said to partially explain human behaviour, is yet another way of describing differences between players. Examples of common personality models are the Myers-Briggs Type Indicator [Myers et al., 1985] and the Five-Factor Model [McCrae and John, 1992]. Bateman et al. [2011] discusses the potential disadvantage of applying constructs such as this to the video game domain and favours an approach that specifically applies to video game players. However, in spite of this, there have been successful applications of personality models to this domain. For example, Zammitto [2010] shows how a player's preference for 8 out of 12 game genres partially correlate to the Five-Factor Model. Additionally, there are other examples of the correlation between player behaviour and personality survey data: Lienhart et al. [2006], while inconclusive in its findings, used only descriptive statistics to show similarities in how participants answered both a Five-Factor Model survey and a player habits survey. Yee et al. [2011] compares responses to the Five-Factor Model with the chat logs players produced within the *Second Life* virtual world. The comparison was achieved using linguistics measures on the chat log data and a statistically significant correlation was found when performing an analysis of variance (ANOVA). van Lankveld et al. [2011] also found a statistically significant correlation, this time between in-game behaviour data from the computer role-playing game *Neverwinter Nights* and all traits described by the Five-Factor Model. While it is unclear what correlation mechanism they employed, they mention that they evaluated its statistical significance using Cohen's effect size interpretation method [Cohen, 1992]. Finally, Spronck et al. [2012] reports a significant correlation in a similar experiment also correlating in-game behaviour with the Five-Factor Model. In this case, they used another computer role-playing game, *Fallout 3*. Additionally, despite reporting statistically signficant results, Spronck et al. [2012] also do not list the correlation measure used and acknowledge that their strength of correlation "seldomly reached an effect size larger than 0.5" and that, in future, they should gather data from a larger number of participants than the current total of 36.

We close this section with a few observations that apply equally to all the above examples. Firstly, the benefits of observing personality through in-game behaviour have not yet been applied to video game personalisation, nor is there any inclusion of that as future work. The general intention behind their work is to instead better understand the relationship, if any exists, between gameplay and personality. Secondly, their methodology is similar to our own except we intend to investigate whether a video game-specific profile (in this case gameplay preferences) correlates with in-game behaviour, as opposed to personality, a construct that applies to human behaviour in general and was never intended to be applied to video game behaviour.

2.3 Player experience

The logic underlying experience-based video game personalisation is this: players who vary in their preference toward particular video game types or variants can be described by *how* they experience (i.e., respond) to them. Yannakakis and Togelius [2011] surveys the specific area of experience-driven procedural content generation (EDPCG) and provides a helpful summary of what is actually meant by "experience" in the context of video game personalisation: "the synthesis of affective patterns elicited and cognitive processes generated during gameplay". Personalising a video game based on how players are currently experiencing, or are predicted to experience, gameplay conveniently circumvents the need to understand characteristics about the player and how they relate to facets of gameplay by only concerning itself with a single goal: optimising the player's experience. For example, two-dimensional platforming game levels have been automatically designed and generated in order to optimise predictions of a player's experience of engagement, frustration, and challenge [Shaker et al., 2012].

Observing the experience of a user (in this case player) is often done using either one or a combination of two methods: objectively via physiological signals, or subjectively via self-report. Physiological signals (e.g., heart rate, skin conductance level, EEG) offer a continuous stream of data that is by and large unable to be manipulated by the subject (i.e., player) and is instead produced involuntarily. It is for this reason that they are considered to be free from the same contaminating factors known to reduce the reliability of self-reported data. Kivikangas et al. [2010] lists these factors as "participant answering style, social desirability, interpretation of questionnaire item wording, limits of participant memory, and observer bias". However, physiological data often requires complex equipment and is very time-consuming to co-ordinate with every participant required to attend an experiment in-person and tested either one at a time or in very small groups depending on equipment and co-ordinator availability. Secondly, and more importantly than the logistic complexities, physiological data alone provides no meaningful explanations for itself and thus requires correlation with other data sources and observation methods in order to interpret its meaning. This includes a more direct data source: self-reported data. Experimental designs incorporating self-reported experience data or applying it to personalisation include the use of open-ended questions [Sharma et al., 2010], post-game commentaries [Gow et al., 2010], and two or four-alternative forced choice method [Yannakakis et al., 2009; Pedersen et al., 2010; Shaker et al., 2010]. Given that neither physiological and self-reported data are ideal, a combined *psychophysiological* approach has also been taken to player experience research. This includes the successful correlation of both types of data [Mandryk et al., 2006; Tognetti et al., 2010] and the application to video game camera personalisation [Yannakakis et al., 2010].

Also, as with player preference and personality, the inferral of player experience with a personalisation variant from a player's in-game behaviour has also been attempted so that players do not need to self-report their experience after each game. A notable example of this being Pedersen et al. [2010] who show that using a two-dimensional platform game that limits the player to only running, jumping, and using an in-game item is enough to successfully predict six affective states observed via self-reported data at an accuracy that ranged varied 73% and 91%. We view this as added evidence that a player's in-game behaviour can be used to predict a characteristic of the player, even in simple games with a limited range of player expression. For the sake of completeness, we also introduce another example that incorporates both in-game behaviour and the player's self-reported preference of particular game variants to develop what they call a "player model-driven preference learning" approach tested in a personalising maze-arcade game [Martinez et al., 2010]. They report a small, yet statistically significant, improvement in the prediction of a player's experience using both types of data and serve as evidence for how multiple types of player data can be used to provide a more complete model of the player.

Lastly, we compare experience-driven personalisation to other types surveyed in this chapter (e.g., preference or personality profile-driven) in greater detail. We already said that defining players by how they experience a video game removes the need to understand anything else about the player or what they are playing, but experience-driven personalisation also has the added advantage of skipping another step: evaluating whether the personalisation is having the intended effect on the player. This can of course be skipped because knowing the personalisation's effect is required to even achieve experience-driven personalisation. However, with the added simplicity comes as many limitations. Experience-driven personalisation can only ever personalise according to facts of experience. The personalisation scope beyond this that includes personalising video game elements to other characteristics of a player that might include their demographic, preferences, or attitudes. Also, the experience-driven approach is not suited to cases where the designer would appreciate control over how the personalisation system should behave with respect to known differences between players. Experience-driven personalisation only permits designers to alter facets of experience, whether that be optimising for the player or according to their own intent.

Permitting designers to determine how a personalisation system should behave in accordance to some other facet of the player apart from experience is the main advantage, at least in theory, of profile-based approaches. The final limitation lies in the difficulty of gathering enough data to know how players experience every variant produced by a personalisation system (e.g., every kind of level or other game content type that is dynamically generated). In order to personalise according to experience, the system needs to know how any particular personalisation variant is likely to be experienced. It is not hard to imagine that a procedural content generation system containing several input variables that can each have several values requiring a data set containing thousands of player experience observations to function. This problem would only increase for personalisation systems that are managed by the behaviour of an AI agent, whose rules determine a potentially innumerable number of personalised game variants. This final limitation of experience-driven personalisation could be sidestepped if a player experience model could be constructed from player behaviour as was the case in the aforementioned example of Pedersen et al. [2010]. In other words, this concern would cease to apply if both a) the player experience model proved to be reliable for a sample of test cases deemed representative of the personalisation full set of variants and b) the personalisation system doesn't significantly modify the relationship between player experience and in-game behaviour assumed by the model.

2.4 Player performance

In this section we briefly review work that focuses on describing players by the degree of ease or difficulty of which they overcome obstacles found in different games (i.e., matching a particular game's difficulty to the player's current skill level). Applying this method of player differentiation to video game personalisation is often called dynamic difficulty adjustment (DDA) [Hunicke, 2005] and aims to keep the game's difficulty at a balanced middle-ground between boredom and frustration as dictated by the theory of Flow [Csikszentmihalyi, 1990] that has since been adapted to the video game domain [Sweetser and Wyeth, 2005]. Successfully achieving DDA is non-trivial however because players are said to develop their game playing skills at different rates. Jennings-Teats et al. [2010] acknowledges this and attempts to address it with a DDA system that dynamically generates levels in a two-dimensional plaform game according to a player's changing skill level, obtained by continuously monitoring the player's current level of in-game performance. Zook and Riedl [2012] agrees with this approach and observes that a player's performance from in-game behaviour is objective, whereas the player's perceived difficulty is subjective. It is for this reason that they view the adaptation of difficulty being based on observed performance as more reliable than that based on self-reports of difficulty.

However, Jennings-Teats et al. [2010] makes no mention of taking a player's preference for "difficult experience" or "challenge" into account when dynamically adapting their platform game's difficulty. However, while both Sorenson et al. [2011]; Zook et al. [2012] do not incorporate a challenge preference into their DDA systems, they both list this an avenue of further research. We agree with this hypothesis that players do posess such a preference for challenge, especially following a recent study on the effect of game difficulty on different players [Alexander et al., 2013] that confirms players have a varying desire to challenge themselves. This is particularly relevant to our own work because, even though "challenge" is one of 22 preferences that we define and investigate, it adds weight to the argument that players do posess a preference for different kinds of playing experiences.

Lastly, we introduce a final and unique example of personalisation within this category for the sake of completeness. Yu and Trawick [2011] combines player's in-game behaviour with data obtained from a brief pre-game preference survey to adapt the difficulty of enemies in a top-down shooting game according to the predicted frustration and boredom levels of players. The uniqueness of this example partially lies in the combination of preference data with in-game behaviour but unfortunately they do not correlate the two type of data, as we intend to. They note that their preference survey consists of two items: "what is the preferred level of difficulty" and "what is the preferred weapon type". [Yu and Trawick, 2011] is also unique when compared to the other personalisation examples in this category because it also incorporates elements of player experience (i.e., boredom and frustration) thus giving it the added benefit also afforded to other personalisation examples in Section 2.1. However, apart from this particular example, other DDA examples currently lack any evaluation of whether they achieve their intended effect on player experience. We conclude this section by noting that this lack of evaluation, one that also existed with the preference-based personalisation examples in Section 2.1, points to a general immaturity amongst current applications of video game personalisation.

2.5 In-game player behaviour

This section compares work that considers the player's in-game behaviour *alone* as suitable input for a video game personalisation system. Other work in previous sections views in-game behaviour as meaningful input for a personalisation system but the key distinction is that work in this category does not infer the behavioural data's meaning from other data (e.g., preferences, personality, etc). Work in this category instead assumes meaningful facts about the player (e.g., their general playing style) from the behaviour data itself. For example, players who were particularly adept at solving in-game puzzles in an action-adventure game were placed in the category of "solvers" without additional correlation with other psychometric or phsysiological data [Drachen et al., 2009]. Other examples are all similar in nature by way of also classifying players into various groups based on their playing style, except within different video game genres and using different analysis techniques. Matsumoto and Thawonmas [2004] classifies massively multiplayer online role-playing game (MMORPG) players using Hidden Markov Models (HMM), Tychsen and Canossa [2008] attributes "persona" types to players of an action-stealth game, Anagnostou and Maragoudakis [2009] clusters players of an action-arcade game using the Clustering Using REpresentatives (CURE) algorithm, Ramirez-Cano et al. [2010] clusters players of an action-hunting game using a three-level "meta-clustering" form of analysis, and Gow et al. [2011] describes players of two different action games using multi-class Linear Discriminant Analysis (LDA). Despite using a variety of different methods, the similarities between these examples are plain to see. All examples, that is, except Gow et al. [2011] which prefers to reduce the dimensionality of in-game behaviour data to produce a trait-like description of players rather than stating each player can be adequetly defined as being one of a set of distinct player types. For reasons argued in Section 2.1, we view a type-based description of players to be an oversimplication that, if evaluated, is likely to have only a limited effect on the player's experience when applied to personalisation. While trait-based models introduce complexity into personalisation systems that are already highly complex in nature, we expect the increased detail afforded by trait-based player descriptions to be a rewarding and worthwhile tradeoff.

Additionally, there are some examples of work in this category being applied to personalise both the quest structure in a role-playing game [Thue et al., 2007; 2008] and particle system behaviour of weapons in a space-action game [Hastings et al., 2009]. Unfortunately, the personalisation in both of these projects are yet to be formally evaluated by testing its effect, either quantitatively or qualitatively, on the experience of players.

Methodologies exemplified by this category of work, though having the benefit of being straightforward, are limited in their use because they rely upon in-game behaviour data alone. Bakkes et al. [2012] surveys work according to how they model player behaviour (e.g., modeling player actions, tactics, or strategies) and discusses how the inferral of a psychologically or sociologically verified profile from player behaviour can *extend the applicability* of player behavioural modelling, noting types of video game personalisation as examples. We believe this limited applicability also applies to the examples above that classify players according to their playing style. Without correlation with other types of data, in-game behaviour alone can only produce objective facts about what is happening in the game (e.g., how successful the player has been in the past, or the probability that a player will engage in specific game activities in the future). Personalisation based on these objective facts may, once properly evaluated, prove to be effective tools for limited types of video game personalisation but alone are not enough to confidently answer questions that are more subjective in nature (e.g., why is the player preferring to engage in a specific game activity, or how will the player experience an adapted piece of game content). If designers in charge of controlling the behaviour of a personalisation system were able to confidently answer these "deeper" questions, then they will be able to better understand the impact of their personalisation design choices prior to the evaluation of their effect as well as possibly learn more about the game they are creating. For example, consider two possible reasons for why some players actively skip fighting/combat sections in a hypothetical game more than others: they dislike having to repeat a sequence if they lose when they could have been progressing through the game's story, or they find that this game's particular combat design is overly chaotic and dependent on chance. If the designer of this game is presented with statistics derived from in-game behaviour data, they can only safely conclude that some players dislike the game's battle system. The designer could address this using personalisation so that the number of battles required to progress are reduced for these players. However, while the problem appears to be solved the underlying issue remains unbeknownst to the designer. The same reason that some players had for disliking the combat system could also apply to other game activities, and another less-than-optimal personalisation strategy may be enacted to identify that also. There is a chance that an experienced designer could have intuitively identified the underlying problem without supporting player data/observations, but then again maybe not.

In addition to being able to help explain the *cause* of in-game behaviour, reliably correlating it with other forms of data also greatly *simplifies* the observation process that ordinarily requires additional psychological or physiological instruments. While this would be of great benefit to the academic community, the most significant effect of this would likely be felt in the commercial industry. Currently, using existing video game hardware and services already available to consumers, a commercial video game has only the player's input (i.e., their in-game behaviour) to use as the basis for which a personalisation system would behave. This input currently varies from traditional keyboards, pointers, and controllers to the more recent motion-tracking devices that are available on all current-generation home consoles. If a video game developer wanted to enable personalisation based on an alternative source of input, they would have to develop and market alternative hardware themselves. The promise of alternative physiological input devices such as Nintendo's vitality sensor and Ubisoft's Innergy once existed but both projects have been long-delayed with no release date being confirmed despite being first announced in 2010. Regardless, in light of that and other more recent suggestions from other developers that they will develop controllers that observe players biometrically [3], traditional player input is likely to remain the only source of player data ready for use in the near future. On the psychological front, there is the rare example of personalisation in the commercial video game *Silent Hill: Shattered Memories*: a pyschological-horror game that personalised in-game models and elements based on a psychological test conducted by an non-playable psychologist character. While this explicit, self-reporting process makes sense in this case, the approach requires a suitable narrative context to avoid becoming disruptive, or at least burdensome. A context such as this can rarely exist naturally without feeling contrived, and the novelty of having to complete a mandatory survey at the beginning of a video game in order to obtain access to a personalised version would quickly wear off. It is for these reasons that we consider it of high importance to continue investigating the correlation

[3]For more information, read the full interview here: http://www.theverge.com/2013/1/8/3852144/gabe-newell-interview-steam-box-future-of-gaming

of player's in-game behaviour to other data ordinarily requiring the psychological and/or physiological instruments described above. This is also the primary motivator for our own particular hypothesis: to investigate whether a self-reported player preference profile can be inferred from a player's behaviour within a role-playing game.

2.6 Summary

Through this chapter we have specifically focused on four important requirements for the development of a commercially applicable means of video game personalisation:

1. Selection of a meaningful player characteristic to drive personalisation;
2. Observation of the player characteristic that is reliable and practical;
3. Integration of the observation method into a game adaptation system;
4. Evaluation that verifies the personalisation has the intended effect on player experience.

We have contrasted our view of a player's preferences to others, stating that ours is potentially video game genre-independent and more similar in structure to a trait-based psychological model of personality than the more common, yet possibly outdated, type-based variety. Secondly, we have observed a general lack of requirement number four in every sub-section with existing peronsalistion applications except for 3.1, where the evaluation is implicitly achieved by the method itself. Thirdly, we argued that correlating in-game behaviour data with other forms of data, as has shown promise in the case of both player personality and experience data, has a positive two-way effect on both types of data. Specifically, as more is known about why the in-game behaviour occurs, the more *widely applicable* it becomes to personalisation, and if psychological or physiological data can be inferred from in-game behaviour then the *practicality* of their application to personalisation greatly increases, theoretically to the point of commercial adoption. This third point is of particular importance with regard to our own work because it both motivates and supports our hypothesis that a player's general gameplay preferences can be reliably inferred from their in-game behaviour. To conclude this survey chapter, we describe the scope of our own work in this thesis with respect to the established four requirements. Our selected player characteristic is a profile of a player's general gameplay preferences (satisfying requirement one) and our hypothesis states that this profile can be observed from in-game behaviour (investigating requirement two). It is beyond the scope of this thesis to investigate requirements number three and four.

Chapter 3

Gameplay preference profile

The primary goal of our work is to investigate whether a player's gameplay preferences can be reliably inferred from a player's in-game behaviour for the sake of video game personalisation. One of the research steps required to test this hypothesis was the development of a suitable player preference profile. As introduced in Chapter 2, our profile is trait-based and non-hierarchical in structure, potentially video game genre-independent, and derived from recurring patterns in other work. Trait-based and non-hierarchical in structure because the profile consists of 22 factors which differ across individual players and are not grouped into higher-order factors that are statistically verified. Potentially video game genre-independent because its elements are found in a variety of video game genres and are exemplified rather than defined by genre-specific tropes. Derived from patterns in other work because each of the factors of our profile are based on recurring themes and concepts found in other work that either describes a player's preferences (i.e., what players do/don't find appealing), a player's motivations (i.e., why players play video games), or gameplay types (i.e., gameplay facets designed to interest players).

Constructing our profile from recurring patterns in other work was primarily inspired by both Walz [2010]; Stewart [2011] who, along with others, also observed some of this repetition. However, our analysis is unique for three reasons:

1. Our analysis was motivated by the construction of a profile of dissimilar preferences suitable for the personalisation of video games;
2. We dismantle player typologies and other list items that combine separable concepts;
3. We consider a body of work more diverse than that of other analyses.

The steps we followed during our informal deconstruction of other work are as follows:

1. Identify a body of work containing lists of relevant factors and types;
2. Divide the list items from each piece of work into *fragments* (i.e., sentences or parts thereof) that retain their original meaning when taken out of context;
3. Group fragments describing *similar* concepts to form a list of *dissimilar* preferences.

Following this method, we identified 572 fragments in other work and assigned 159 of them (approximately 28%) to individual preferences within our profile. This count of assigned fragments includes only those that refer explicitly to a single preference, the remaining fragments referred instead to either unrelated concepts or multiple preferences at a time even after the partitioning process.

Table 3.1 lists the count and percentage of fragments identified in each piece of work that we assigned to a preference as well as how many preferences were consequently associated with each piece of work. This table describes a critical point that motivated this analytical process: we could not find a piece of work without omission. Specifically, no single piece of work contained all of our selected preferences (the most was Lazzaro [2004] who mentions 14 of the 22 preferences). That is not to say that we believe our 22 preferences form a complete set, or that the pursuit of one is required to enable a preference-based form of video game personalisation. Section 3.4 at the end of this chapter shows that our analysis yielded several more possible preference candidates while still not completely exhausting our selected sources. It also stands to reason that there are a good many more that have been overlooked altogether by our selected body of work. In the end, the main takeaway from our analysis is that there are, at minimum, dozens of preferences that we believe can be used to enable a multitude of video game personalisation scenarios. Furthermore, we restrain ourselves from mandating that any particular collection of preferences be used, complete or otherwise, when personalising video games to a player's preferences. Instead, we recommend the determining factor in the selection of preferences be the video game designer's creative goals and their specific intent for the implementation of a personalisation system.

Throughout this chapter we describe the individual preferences described by our profile and list all sentence fragments and their source that we assigned to each preference. We also include examples that illustrate how each preference has historically been achieved in well-known video games and their respective genres. We introduce our list of 22 preferences by grouping them into three categories: types of *gameplay experiences* that are often elicited in players, *gameplay activities* that players often engage in, and types of *social interactions* that can only occur between multiple players and/or in-game characters that are non-playable

Source	***Assigned Fragments***	***Preferences***
Player preferences	**51 (36%)**	**15**
Bartle [1996]	16 (40%)	9
Bartle [2004]	5 (29%)	4
Reynolds [2000]	9 (41%)	4
Laws [2001]	6 (25%)	4
Bateman and Boon [2006]	15 (38%)	9
Player motivations	**40 (24%)**	**17**
Malone [1981]	6 (40%)	4
Yee [2006b]	10 (33%)	7
Schultheiss [2007]	11 (55%)	7
Tychsen et al. [2008]	5 (42%)	4
Bostan [2009]	6 (8%)	4
Kallio et al. [2011]	2 (22%)	2
Gameplay types	**68 (26%)**	**21**
Caillois [1961]	8 (57%)	5
Lazzaro [2004]	26 (43%)	14
Hunicke et al. [2004]	2 (25%)	2
Sweetser and Wyeth [2005]	9 (64%)	8
Rollings and Adams [2003]	12 (27%)	8
Adams and Rollings [2007]	9 (25%)	4
Schell [2008]	10 (10%)	9
Bateman and Nacke [2010]	5 (17%)	4

Table 3.1: For each selected piece of work, the count and percentage of sentence fragments we assigned to each preference and, the count of related preferences.

and AI-controlled. We do not divide the preferences in this way to advocate the use of each category as a *preference type* that is entirely consistent. Instead, the primary role of the division is to simply partition the long list in a non-arbitrary way, making them easier to navigate and digest throughout the thesis.

Section 3.4 concludes the chapter by listing a further 13 factors that were also found to commonly occur in other work. Of particular note in this subsection is our discussion of the factors we found relate to the formation of a set of suitable preferences.

3.1 Gameplay experiences

We placed preferences in this category that we believe are most naturally thought of as adjectives describing different experiences *elicited by games*, rather than in terms of experience types *triggered by player action* which we place in either Section 3.2 or 3.3. As a summary of which pieces of work contained sentence fragments that are associated with preferences in this category, we list each preference and their corresponding source(s) in Table 3.2. We do this by categorising each source in terms of whether they primarily discuss player preferences, player motivations, or different gameplay types.

3.1.1 Addicting

Compulsion to maintain play for prolonged periods of time, perhaps longer than was originally intended. We do not use this term to exclusively refer to the overtly negative situation where an addictive video game may "interfere with or damage more important things in life such as school, work, health, and personal relationships" [Schell, 2008]. While acknowledging these

Preference	***Source(s)***
Addicting	Bateman and Nacke [2010]
Challenging	Bartle [1996]; Bateman and Boon [2006]; Malone [1981]; Lazzaro [2004]; Sweetser and Wyeth [2005]
Exhilarating	Schultheiss [2007]; Caillois [1961]; Lazzaro [2004]; Sweetser and Wyeth [2005]; Bateman and Nacke [2010]
Immersive	Bateman and Boon [2006]; Malone [1981]; Yee [2006b]; Kallio et al. [2011]; Caillois [1961]; Lazzaro [2004]; Sweetser and Wyeth [2005]
Tense	Lazzaro [2004]; Rollings and Adams [2003]
Unpredictable	Caillois [1961]; Lazzaro [2004]; Schell [2008]

Table 3.2: A listing of source(s) that make mention of each item in the gameplay experience preference category.

extreme situations do occur, we interpret a preference for addictive video games to instead be the player's preference for a type of experience driven by compulsion or habit. Some players are seemingly all too eager to be put under a game's addictive spell whereas others, perhaps wisely, exercise considerable caution.

Example(s):

Many games from many genres are said to be addictive but we begin by highlighting one way in particular that *Civilization*, a turn-based strategy series of games, is said to be addictive. In this game, players are tasked with the management and expansion of a civilization comprised of cities and movable units and must do so either in cooperation with or competition against other civilizations. A hallmark of this series is how it successfully prompts players to regularly define and pursue goals that tend to reveal new goals worthy of pursuit once achieved. The following are a set of steps that form one of a potentially infinite number of scenarios that would lead to a prolonged playing session of Civilization:

1. Research of a new technology permits the player to travel by sea
2. A sea voyage reveals a valuable resource on a newfound continent
3. Discovery of the resource prompts the player to settle a new city on the new continent
4. The new city then comes under attack from a new enemy that is native to the new continent
5. Defense of the new city and resource requires the research of yet another technology

Role-playing video games (RPG's), and video games of other genres with *RPG elements*, contain examples of reward systems that permit the addictive properties inherent to particular game design patterns to be explained by their application of psychological theory. For example, Madigan [2011] explains that the anticipation of receiving a reward of significant in-game value within an RPG (e.g., a rare item) is said to excite the dopamine neurons in the human brain, the same neurons that play a significant role in regulating human decision making, particularly goal-oriented behaviour and the pursuit of pleasure.

Source(s):

1. Bateman and Nacke [2010] "Addiction"; "Habits and behavior"

3.1.2 Challenging

Sense of struggle experienced when attempting to better or develop oneself for the purpose of overcoming a challenge thought to be beyond one's capability. Players with a preference for challenge desire experiences that require players to become better than they are, often to the point of mastery, and often while showing fortitude in the face of defeat.

Example(s):

Adams and Rollings [2007] details many ways in which games can challenge players. These include physical coordination challenges noting *Tetris* as an example that rewards fast reflexes, and exploration challenges noting *Descent* as an example that complicates navigation of a zero-gravity environment by permitting the control of a flying vehicle with 6 degrees-of-freedom.

Role-playing video games (RPG's) are an example that highlight an important distinction between the development of a *player's skill* and the development of the *player's character's skill*. For example, RPG's often give the player a character to control and develop its fighting power and statistics. Throughout the game the *player's character* might be able to attack with an increasing level of power but this is not a reflection of the *player's* increase in capability. Instead, we regard the player's increasing ability to construct and implement combat strategies to be an illustration of the player's skill development within the RPG genre. We regard the development of a player's character's skill as being weakly associated to this preference and instead strongly related to the *achievement* preference.

Source(s):

1. Bartle [1996] "The point of playing is to master the game"
2. Bateman and Boon [2006] "Interested in mastery ... process-oriented challenge of learning how to play well"; "Will [seldom] give up if it gets too hard for them"; "[Requires] challenge"
3. Malone [1981] "Striving toward new skills"

4. Lazzaro [2004] "Test their skills"

5. Sweetser and Wyeth [2005] "Player skill development and mastery"

6. Schell [2008] "The lens of challenge"

3.1.3 Exhilarating

Adrenalin-fueled rush that results from fast-paced movement or action, often accompanied by a sense of momentary panic. We regard a player's preference for exhilarating gameplay to be the same force that drives some people to pursue the thrill of amusement rides or extreme sports while others refuse to make the same leap of faith.

Example(s):

Can be found in the chaotic nature of fast-paced action found in modern first-person shooters (FPS's) such as *Call of Duty* or the control of high-speed vehicles in arcade-style racing video games such as those in the *Need for Speed* or *Burnout* series. However, it should not be assumed that all video games in the racing genre routinely offer this sense of exhilaration. The *Gran Turismo* series resemble a more realistic sub-genre that places a far greater emphasis on the tactical nature of maintaining a perfect driving line than it does on the outrunning or running into of other cars.

Source(s):

1. Schultheiss [2007] "Thrill"

2. Caillois [1961] "The pursuit of vertigo and which consist of an attempt to momentarily destroy the stability of perception and inflict a kind of voluptuous panic upon an

otherwise lucid mind"; "Sudden panic"

3. Lazzaro [2004] "Excitement"; "Excitement and adventure"

4. Sweetser and Wyeth [2005] "The feeling of movement"; "Joy of flight"

5. Bateman and Nacke [2010] "Excitement ... adrenalin"

3.1.4 Immersive

Feeling of being completely absorbed to the point where the real world existing outside the game is temporarily forgotten. Adams and Rollings [2007] notes that "the feeling of immersion is a deeply and satisfyingly entertaining to some players" while also stating that "others prefer not to become immersed and to remember that it's only a game while they play".

Example(s):

Invoking an *immersive* player experience is a common goal amongst many game designers and can potentially result from the play of a wide variety of video game types. Adams and Rollings [2007] concurs by observing that there are multiple types of immersion using examples such as *strategic immersion* that is said to arise from the deep involvement of observation, calculation and planning. Amongst others, they also define a second immersion type that they label *narrative immersion* and define as "the feeling of being inside in a story, completely involved and accepting the world and the events of the story as real".

Source(s):

1. Bateman and Boon [2006] "Immersive storyline in single player"

2. Malone [1981] "An attempt to "assimilate" experience into existing structures in the ... mind with minimal needs to "accommodate" to the demands of external reality"

3. Yee [2006b] "Being immersed in a fantasy world"

4. Kallio et al. [2011] "Immersive play"

5. Caillois [1961] "All play presupposes the temporary acceptance, if not of an illusion ..., then at least a closed, conventional, and, in certain respects, imaginary universe"

6. Lazzaro [2004] "Immersed in the experience"

7. Sweetser and Wyeth [2005] "Become less aware of their surroundings"; "Become less self-aware and less worried about everyday life or self"

3.1.5 Tense

Experience of fear felt from the presence of danger from which may prove impossible to escape without penalty. Players who tend to revel in the tension of a sudden scare or from being at the brink of virtual death are considered to have this preference. Distinct from a player's preference for exhilaration in that tense gameplay instils fear into the player's mind whereas exhilarating gameplay aims to excite.

Example(s):

The survival horror video game genre with notable examples such as the *Dead Space* series serve as prime examples of games that instil fear by creating sudden, *jump scares* or creating a scarcity amongst in-game resources required to endure enemy attacks. Interestingly, notable video game series such as *Resident Evil* that were once identified as survival horror have either partially or completely forgone hallmarks of the genre in their most recent iterations to allow for a more exhilarating, action-based style of gameplay.

A second example of tension can be found in the pivotal, final racing lap found in many video game racing simulations. Often only a minor error is needed in such scenarios to derail the player's previous efforts, forcing an entire race to be replayed. Again to contradict one example with another from the same genre, the most recent iterations in the *Forza* series eliminate the tension component of the experience by allowing the player to rewind the game at will if they so err.

Finally, tension is also a factor in role-playing video games (RPG's), albeit a minor one. As in any video game where virtual death is possible, RPG's can create scenarios where the player finds themselves in a difficult battle where an enemy is proving to be a more worthy foe than anticipated and the player's options for counterattack are rapidly running dry.

Source(s):

1. Lazzaro [2004] "Fear ... threat of harm"; "Relief"

2. Rollings and Adams [2003] "Time pressure increases the stress on a player"

3.1.6 Unpredictable

Experience of being confronted by a situation that has an uncertain, or otherwise non-deterministic, outcome. This preference applies to players who are generally more willing to take a risk than those who will tend to play it safe. We believe unpredictability to be inversely related to control but we do not define it as that. At least partially, an unpredictable in-game situation is indeed beyond the control and influence of the player. However, as when any two such concepts are compared, their mutual exclusivity should not be assumed when interpreted as a preference without reliable data as evidence. Furthermore, Adams and Rollings [2007] notes that when a game contains too many unpredictable elements, what they define as *strategic immersion* breaks down. In other words, the more unpredictable the game, the less able the player is to strategise. Finally, we note that an example of unpredictable situations with reasonably high stakes adds a noticeable degree of tension to the mix.

Example(s):

Further to the point of a tension existing between player planning and game determinism, we illustrate a scenario that sees both existing in multiple ways. Many role-playing video games (RPG's), especially older-style ones, are structured in a way that sees the combat between players and non-controllable enemies occurring in a separate space governed by different rules than the rest of the game world. Addictionally, many combat systems in video games include mechanics that make it non-deterministic to a degree. For example, a critical hit can randomly deal double the usual damage at potentially any time during combat. While these elements can sometimes stifle a player's current strategy, it is often carefully balanced so that advanced players can still determine a small set of most likely scenarios and plan according to those. Outside combat and in the main game world, the player may not be able to plan according to exactly *how combat events transpire*. However, the player will still be able to accurately predict the *type of outcome* (e.g., a close win, a crushing defeat, etc) in most cases. This affords the player opportunity to form strategies for how to act within the main game world (e.g., plotting a path through a hostile area, or deciding how best to spend any accumulated in-game gold).

Source(s):

1. Caillois [1961] “Outcome over which [the player] has no control, result of fate rather than adversary”
2. Lazzaro [2004] “Luck”
3. Schell [2008] “The lens of chance”

3.2 Gameplay activities

We placed preferences placed in this category that we believe are most naturally thought of as gameplay experience types *triggered by player actions that are not inherently social.* Types of social interactions are instead left until we describe members of the third and final preference category in Section 3.3. As a summary of which pieces of work contained sentence fragments that are associated with preferences in this category, we list each preference and their corresponding source(s) in Table 3.4. We do this by categorising each source in terms of whether they primarily discuss player preferences, player motivations, or different gameplay types.

3.2.1 Achieving

Rewarding sense of accomplishment derived from the successful completion of a goal or objective, often reinforced by the attainment of a meaningful reward. This is related to multiple preferences in that a sense of achievement can be experienced by the success in a variety of scenarios. For example, by players who successfully solve a puzzle, derive a winning strategy, or defeat an opponent in competition.

Preference	***Source(s)***
Achieving	Bartle [1996; 2004]; Laws [2001]; Bateman and Boon [2006]; Lazzaro [2004]; Rollings and Adams [2003]; Bateman and Nacke [2010]
Choosing	Malone [1981]; Schell [2008]
Controlling	Bartle [1996]; Bateman and Boon [2006]; Tychsen et al. [2008]; Sweetser and Wyeth [2005]; Rollings and Adams [2003]; Schell [2008]
Creating	Schultheiss [2007]; Rollings and Adams [2003]; Adams and Rollings [2007]; Schell [2008]
Discovering	Bartle [1996]; Laws [2001]; Bateman and Boon [2006]; Malone [1981]; Lazzaro [2004]; Hunicke et al. [2004]; Rollings and Adams [2003]
Experimenting	Bartle [1996; 2004]; Laws [2001]; Yee [2006b]; Schultheiss [2007]
Roleplaying	Bartle [1996]; Reynolds [2000]; Caillois [1961]
Solving	Reynolds [2000]; Lazzaro [2004]; Rollings and Adams [2003]; Adams and Rollings [2007]; Schell [2008]
Strategizing	Reynolds [2000]; Bateman and Boon [2006]; Tychsen et al. [2008]; Lazzaro [2004]; Rollings and Adams [2003]
Tacticizing	Reynolds [2000]; Tychsen et al. [2008]; Lazzaro [2004]; Adams and Rollings [2007]

Table 3.3: A listing of source(s) that make mention of each item in the gameplay activity preference category.

Example(s):

To illustrate this preference we turn again to the reward systems that originated in the role-playing video game (RPG) genre. For example, an in-game character or avatar under control by or representing the player will often have a virtual level that corresponds with how powerful or otherwise noteworthy it is. Multiple actions, often repetitive in nature (e.g., *grinding* through a large sum of near-identical battles), are then required to earn the reward of an increase of that character's level (i.e., *level up*). This leveling up process is often repeated several dozens of times before a character finally reaches their in-game potential. The motivating power of techniques such as this are so significant they can lead players to invest dozens if not hundreds of hours into a single video game.

Another common example of achievement can be found in any genre by the attainment of a *high score* or virtual trophy (commonly referred to as *in-game achievements*). Also, to again reiterate the connection of achievement to other preferences, the pursuit of a high score or achievement can be motivated by self-development (challenge), the desire to beat another player's score (competition), the desire to impress a friend (performance), etc.

Source(s):

1. Bartle [1996] "Achieve [goals]"; "Points-gathering and rising in levels"
2. Bartle [2004] "Achievers"
3. Laws [2001] "However success is defined ... the player wants more of it"
4. Bateman and Boon [2006] "Actively interested in winning and beating the game"; "In single-player games, completing the game"; "They want to feel they are accomplishing

something"; "Accomplishing something"

5. Lazzaro [2004] "Structuring experience towards the pursuit of a goal"; "Rewards the player with feedback on progress and success"; "Feel accomplishment"; "Playing to beat the game"

6. Rollings and Adams [2003] "Player characters that improve with experience"

7. Bateman and Nacke [2010] "Achievement"

3.2.2 Choosing

Sense of freedom experienced by players when they are able to choose from an array of options that exist at a signficantly higher level of granularity than moment-to-moment gameplay choices. This is in contrast to video games that give the player constant direction through a linear sequence of stages, resulting in satisfaction more heavily grounded in other elements such as challenge. We consider choice a preference because we believe that although choice in a video game is generally desirable, not all players would like it in the same measure or form.

While acknowledging that it is not always possible, we attempt to make the distinction between our use of *choice* from another that is used to refer to much lower-level gameplay choices. For example, a player deciding which moment is optimal or advantageous to make their in-game character jump. We view this as hand-eye coordination and reflexive skill rather than player choice. This preference is also highly related to the act of exploration, which can also contain other elements such as discovery and, at times, experimentation.

Example(s):

Single-player role-playing video games (RPG's), such as those in the *Dragon Age* and *Mass Effect* series, permit player choice through the presentation of multiple dialog options. Players, while in conversation with other in-game characters, are given the chance to select one from a small set of choices. Interestingly, this scenario can also apply equally to the preference for role-playing if players make a dialog choice based on what they believe most befits the in-game character they have control over.

Another common example of high-level player choice is found in the structure of compulsory tasks and availability of optional tasks. Narrative-based video games are generally structured as a mostly linear set of compulsory stages in order to remain coherent from a story perspective. RPG's and video games in other genres often intersperse optional activities (e.g., missions, quests, mini-games) throughout the game's story so the player can still experience a strong, developing narrative without completely eliminating the opportunity for player choice with regards to the game's progression.

Video games with no story, or one less intertwined with the progression of the game, are more easily able to incorporate player choice at the highest level. As is routine with puzzle or platforming games, the player is often presented with a linear structure of stages that are each broken up into several smaller levels, often resulting in a game made up of 100+ levels. Players are often prevented from progressing to the next high-level stage until they have completed all or many of the levels in the current stage. This structure, amongst other things, prevents players from being overwhelmed with choice while still providing a sense of progression across the game's high-level stages, narrative or otherwise.

Source(s):

1. Malone [1981] "Giving people a choice, or even just the illusion of choice"; "Freedom of choice"
2. Schell [2008] "The lens of freedom"

3.2.3 Controlling

Sense of agency experienced by the player from the observation that their in-game action had a meaningful effect. Murray [1998] describes agency as one of the four essential properties of digital environments and defines it as "the satisfying power to take meaningful action and see the results of our decisions and choices". We believe players with a preference for control have an above average desire to become *actively involved* in a video game rather than those who are happier to aappear to be more like a *passenger*, only periodically acting to progress the game. That is not to say that the players we view as lacking a preference for control necessarily prefer uninvolvement, they could still be engaging with the video game on a different level (e.g., emotionally or strategically).

Example(s):

The Walking Dead is a genre-spanning hybrid of a video game that is of particular note because of the way it gives players a sense of high-level influence over the game, despite it being a narrative-driven experience. Throughout the game, players are often given the impression that selected, discrete choices they make are having a significant effect on the attitudes and behaviour of other in-game characters.

Source(s):

1. Bartle [1996] “Make [the game] do what you want it to do”
2. Bateman and Boon [2006] “Want to feel to be in control of how the story advances”
3. Tychsen et al. [2008] “Taking charge of things”; “Character that has a large impact on the fictional world of the game”
4. Sweetser and Wyeth [2005] “Sense of control over their actions in a game”
5. Rollings and Adams [2003] “Allow the player to experience a pivotal role in world-shattering events”
6. Schell [2008] “The lens of control”

3.2.4 Creating

Satisfaction gained from the act of self-expression, often with a set of creative goals in mind. Players with a preference for creation are particularly interested in seeing things that they imagine come to bear. While related to the sense of freedom and choice, it should be noted that not all choices are creative in nature and can be instead motivated by something else such as the gaining of an advantage.

Example(s):

Minecraft is described as being a *sandbox*-like video game, one where players navigate a procedurally created environment made up of a potentially infinite number of manipulable cubes. A significant part of this game's appeal is its creative mode that not only gives players an unlimited number of cubes which which to create objects, but also allows friends and other players to join in.

Source(s):

1. Schultheiss [2007] "Creativity
2. Rollings and Adams [2003] "Construction is the part of the game that lets the player exercise her imagination"
3. Adams and Rollings [2007] "Self-expression"; "Reflect his play style"
4. Schell [2008] "The lens of expression"

3.2.5 Discovering

Feeling elicited when something previously unknown is disclosed to the player. Includes the development of a story arc and the revelation of what exists within a previously unseen space. Highly related to the notion of exploration, except that exploration also implies a sense of freedom as captured by the preference for player choice.

Example(s):

Any narrative-based game such as those in the role-playing video game (RPG) genre or action-adventure genre consist of stories that aim to pique the player's interest at every turn. RPG's are often known for their ability to provide the player with a powerful sense that there is a whole world for the player to discover, sometimes at their own pace (i.e., freedom) and sometimes at the pace directly controlled by the game's design (i.e., lack of choice).

Source(s):

1. Bartle [1996] "Enjoyment from the logical progression of the narrative"

2. Laws [2001] “Quick to compromise if it moves the story forward”; “Please him by introducing and developing plot thread”
3. Bateman and Boon [2006] “Dont want to complete everything, they generally want to try new things”; “Interesting ... storyline in single player”
4. Malone [1981] “Novelty”
5. Lazzaro [2004] “Seeing what happens in the story, even if I have to use a walk through”
6. Hunicke et al. [2004] “Games as uncharted territory”
7. Rollings and Adams [2003] “Strong storylines”

3.2.6 Experimenting

Pleasure derived from the process of investigating how a game’s underlying systems operate, sometimes for the purposes of testing how a game can be exploited. Strongly related to the preference for discovery except that it is primarily motivated by the desire to see how the game itself works rather than the desire to see something new in-game content. While players who prefer to experiment with a game’s rules do certainly devise edge cases designed to understand the game’s rules in detail, we do not consider this to be done universally with the intention of exploitation or cheating.

Example(s):

The *Grand Theft Auto* series of video games take place in a simulated city in which the player can cause havoc and see how both its inhabitants and emergency services respond. This is a particularly destructive example of how players can experiment with a game’s systems to see what happens while also incorporating an element of control in that there is also an inherent joy experienced by the player because they know that they are responsible for the mayhem. On a more constructive note, simulation video games such as those in the *Sim City* series rely on the player to form their own mental model of the game's underlying rules in order to build a prospering city.

Experimentation within role-playing video games (RPG's) can also be sometimes found when rules governing combat are hidden for the player and left for them to understand. For example, players of the *Persona* RPG series are required to methodically test multiple attack types on new enemies in order to determine their weak point.

Source(s):

1. Bartle [1996] "Experimentation with [a game's] physics"; "Delight in having the game expose its internal machinations to them"; "Esoteric actions in wild, out-of-the-way places"; "Looking for bugs"; "Figuring out how things work"
2. Bartle [2004] "Experiment in a thorough, methodical fashion"
3. Laws [2001] "Pays close attention to the rules"; "A special eye to finding quirks and breakpoints"
4. Yee [2006b] "Analyzing the underlying rules and system"; "Knowing as much about the game mechanics and rules as possible"
5. Schultheiss [2007] "Game-mechanics"

3.2.7 Roleplaying

Feeling gained from either being another character or acting on their behalf, including the adoption of their mannerisms and attitudes. Players with this preference are particular enthusiastic when it comes to getting into the shoes of the character of which they are tasked with control. In its most acute form roleplaying is certainly related to the concept of immersion. However, roleplaying does not *necessitate* immersion as players can still enjoy acting on the behalf of their in-game character while also being aware that they are their own person.

Example(s):

While the role-playing video game (RPG) genre owes its name to the subject of this preference, the relationship is more historical than indicative that a typical RPG will contain actual role-playing. This is particularly the case for the Japanese RPG (JRPG) subgenre which traditionally has the player in a more observational role of the player character's development (narratively-speaking) as opposed to acting out through their character in any story-affecting way. In their Western counterparts, examples such as *The Witcher* series and the more action-oriented *Deus Ex* series are notable for their inclusion of role-playing mechanics that allow the player to choose between multiple sides of an ongoing conflict throughout the game which ultimately affect the game's conclusion.

Source(s):

1. Bartle [1996] "Role-playing"

2. Reynolds [2000] "Using props ... to express a character's actions and dialog"; "Ensure

that the character's actions are "correct" from [their] perspective"

3. Caillois [1961] "Becoming an illusory character oneself"; "Makes believe or others believe that he is someone other than himself"; "Temporarily sheds his personality to feign another"

3.2.8 Solving

Satisfaction gained from the process of meditating on a problem or puzzle presented by the game, possibly progressing through several steps of understanding in the process before a solution is found. As we do for other preferences, we take the emphasis away from the cathartic feeling of success or achievement and instead interpret players with this preference to enjoy the actual *process* of problem or puzzle solving.

Example(s):

A notable game that relies heavily on this kind of experience is *Braid*, a two-dimensional platform and puzzle game containing time-based mechanics and a time travel-themed narrative. Additionally, the "Portal" series of video games offer a similar experience type but differ in that they are played from the first-person perspective and the puzzles are achieved by creating and entering inter-spatial portals through a series of levels.

It would also be prudent to distinguish this from the *trial-and-error* style of puzzle solving that places a greater focus on experimentation, rather than the application of puzzle solving skills such as lateral thinking or conceptual reasoning. Examples commonly associated with this form of puzzle solving are classic-style adventure games such as the *Monkey Island* or *Deponia* series.

Source(s):

1. Reynolds [2000] "Wants to solve puzzles"
2. Lazzaro [2004] "Puzzles"
3. Rollings and Adams [2003] "Puzzle solving"; "Puzzle games"
4. Adams and Rollings [2007] "Formal logic puzzles"; "Conceptual reasoning puzzles require the player to use his reasoning power and knowledge of the puzzle's subject matter to arrive at a solution"; "Lateral thinking puzzles"; "The terms of the puzzle make it clear to the player that what seems to be the obvious or most probable solution is incorrect"
5. Schell [2008] "The lens of the puzzle"

3.2.9 Strategizing

Satisfaction gained from the mental process of predicting outcomes and devising plans for the sake of obtaining a long-term goal. To use a militaristic metaphor, players with this preference particularly enjoy the role of the general who command multiple soldier brigades. Players with a preference for strategic planning are not assumed to have a lack of preference for tactical action.

Example(s):

Strategy video games are often either real-time strategy video games (RTS's) where time flows continuously and all players act simultaneously, or turn-based strategy video games (TBS's) where time flows in discrete steps and players take turns to act. In both cases, players commonly have a birds-eye view of a battlefield and have to collect resources that can be used to create buildings and units in combination capable of defeating an opposing force. These often require players to predict and investigate what is happening under the *fog-of-war* that conceals the opposing force in order to determine a winning strategy.

Within role-playing video games (RPG's), strategy still occurs but in a different form. Examples of strategic behaviour include planning future offensive or defensive actions while engaged in combat with an enemy, and the preparation of controllable characters in anticipation of future battles.

Source(s):

1. Reynolds [2000] "Strategic/combat focus"; "A perspective larger than the immediate future and surroundings"
2. Bateman and Boon [2006] "[Especially enjoys] strategy ... games"
3. Tychsen et al. [2008] "Planning ... tactical strategies and plans"
4. Lazzaro [2004] "Development of strategies; Requiring strategy"
5. Rollings and Adams [2003] "Observation, contemplation, and planning"
6. Adams and Rollings [2007] "Strategy means planning"

3.2.10 Tacticizing

Satisfaction gained from the step-by-step execution of a plan that serves long-term, strategic goals. We use the term *tacticizing* as the verb form of tactic (i.e., employing a tactic). In spite of tactics officially having no verb form listed in many English dictionaries, we still use it for the lack of a better alternative. To extend the militaristic metaphor from Section 3.2, players with this preference particularly enjoy the role of the front-line soldier, skillfully following the orders dictated by the general. Players with a preference for tactical action are not assumed to have a lack of preference for strategic planning.

Example(s):

First-person shooter video games (FPS's) are often designed to represent the life of a front-line soldier who is directed from point to point. In these type of games, the player is given the sole responsibility of making sure the game's linear set of objectives are achieved, often requiring considerable hand-eye coordination and accuray to dispatch of enemy soliders with the use of virtual firearms.

Tactical behaviour is also found within battles of some role-playing video games (RPG's). While many RPG battle systems are turn-based in nature (i.e., participants take turns to fight) and consequently requiring minimal tactical action, others that occur in real-time and more are reliant on the player's skill and accuracy (as opposed to battles largely determined by the player character's skill level) are considered more tactical. Finally, by our definition we view games often categorised as being in the *tactical RPG* genre to actually be *strategic RPG's* by virtue of their strong emphasis on forward planning and positioning of multiple characters while engaged in battle.

Source(s):

1. Reynolds [2000] "Tactical/combat focus"; "A perspective limited to the immediate future"; "And the immediate surroundings"

2. Tychsen et al. [2008]"Executing tactical strategies and plans"

3. Lazzaro [2004] “Application of strategies”

4. Adams and Rollings [2007] “Tactics ... involves putting a plan into action”

3.3 Social interactions

We placed preferences placed in this category that we believe are inherently social and occur between multiple players and/or in-game characters. We distinguish between a player's preference for social interactions between players and that between a player and in-game characters rather than assume they are equivalent. As a summary of which pieces of work contained sentence fragments that are associated with preferences in this category, we list each preference and their corresponding source(s) in Table 3.4. We do this by categorising each source in terms of whether they primarily discuss player preferences, player motivations, or different gameplay types.

3.3.1 Assisting

Satisfaction gained from the aiding or supporting of another player or in-game character. A player with a preference for assistance is not necessarily more or less self-interested than other players, but they do have a greater desire for this type of satisfaction. When using this term, we create a distinction between situations where players are *intrinsically motivated* to assist another (e.g., by their empathetic feelings for someone in trouble) and those where players are *extrinsically motivated* (e.g., by a monetary reward or to gain favour). We only consider intrinsically motivated assistance as corresponding with this preference while also acknowledging that some situations can involve both types (e.g., a measure of both or a

Preference	***Source(s)***
Assisting	Bartle [1996]; Yee [2006b]; Bostan [2009]; Sweetser and Wyeth [2005]
Competing	Bateman and Boon [2006]; Yee [2006b]; Schultheiss [2007]; Caillois [1961]; Lazzaro [2004]; Sweetser and Wyeth [2005]; Schell [2008]
Cooperating	Bateman and Boon [2006]; Yee [2006b]; Bostan [2009]; Lazzaro [2004]; Sweetser and Wyeth [2005]; Schell [2008]; Bateman and Nacke [2010]
Performing	Schultheiss [2007]; Bostan [2009]; Lazzaro [2004]
Provoking	Bartle [1996; 2004]; Yee [2006b]; Schultheiss [2007]; Lazzaro [2004]; Schell [2008])
Relating	Bartle [1996; 2004]; Laws [2001]; Bateman and Boon [2006]; Yee [2006b]; Schultheiss [2007]; Tychsen et al. [2008]; Bostan [2009]; Kallio et al. [2011]; Lazzaro [2004]; Hunicke et al. [2004]; Sweetser and Wyeth [2005]; Rollings and Adams [2003]; Schell [2008]

Table 3.4: A listing of source(s) that make mention of each item in the social interaction preference category.

motivation shifting from extrinsic to intrinsic). Instead, extrinsically motivated assistance is viewed as more akin to other preferences such as *achievement*.

Example(s):

Single-player modes in video games that are narrative-driven routinely require assistance of players. For example, the *Mass Effect* role-playing video game (RPG) series illustrates a common trope found in multiple genres: fitting the player's actions into a broader context that sees them as the only hope for a universe, world, town, or individual in peril. While this style of narrative introduces other motivating elements such as power fantasy and revenge, it can also be used to encourage players to act who are more prone to feeling the pain or helplessness of others.

Another illustration that also brings the question of motivation into light can also be found in an example from *EVE Online*, a massively multiplayer online RPG (MMORPG) where tens of thousands of players all try to make their way in a persistent universe. In this video game, experienced players who have a management role in a player-driven corporation are all too happy to assist new players still grappling with the game's basics. Whether this assistance is driven by the inherent joy of helping another through trial or because the new player may one day become a money-making member of the corporation is difficult to ascertain.

Source(s):

1. Bartle [1996] "Empathising with people, sympathising"; "In rare cirumstances, help [others]"
2. Yee [2006b] "Helping other players"
3. Bostan [2009] "Nourish, aid, or protect a helpless person"
4. Sweetser and Wyeth [2005] "Rescue the kidnapped princess"

3.3.2 Competing

Satisfaction gained from participation in a contest against another player or in-game character, independent of outcome. Our definition takes the emphasis away from the pursuit of victory or achievement, stating instead that the preference is for the *process* of competing. We also view a preference for competition as distinct from the preference for *challenge* in that competition focuses on the comparison being made between competitors rather than the opportunity for the competitors to better themselves.

Example(s):

A vast majority of multi-player video games contain a mode that is balanced for fair competition. The possible types of competition are many but some notable examples include the *FIFA* series of football video game simulations that value a player's tactical skill and the *StarCraft* series of real-time strategy video games (RTS's) that place a greater focus on the player's multi-tasking and long-term planning skills.

Single-player games are less often thought of as being competitive but competition against in-game characters does occur, even when excluding the cases where AI-controlled *bots* are used as substitutes for human players. For example, one of the many repeating design patterns found in the "Pokemon" role-playing video game (RPG) series is that of a rival character who periodically appears to taunt and battle the player in order to establish whose skills are more improved.

Source(s):

1. Bateman and Boon [2006] "In multiplayer the goal is to beat the other players"; "Likely to be involved in direct competition"
2. Yee [2006b] "Challenge and compete with others"
3. Schultheiss [2007] "Competition"
4. Caillois [1961] "Competitive"; "Rivalry"
5. Lazzaro [2004] "Rivalries run hot as players compete"; "Playing for competition"; "Playing to see how good I really am"
6. Sweetser and Wyeth [2005] "Competition ... between players"

7. Schell [2008] "The lens of competition"

3.3.3 Cooperating

Satisfaction experienced while pursuing a goal alongside other players or in-game characters. Schell [2008] describes cooperation as the opposite of competition. However, for our purposes we need not make the two mutually exclusive when interpreted as a preference because it stands to reason that a player can potentially have a preference for one, the other, both, or neither.

Example(s):

Further to the point of avoiding mutual exclusivity between competition and cooperation, players are also said to be able to experience them in a combined sense through coalitional play [Bateman and Nacke, 2010]. The "capture-the-flag" (CTF) video game mode is a prime example of coalitional play where a team of players must work together to keep their own flag safe from an enemy team while also attempting to steal the opposition's flag.

Within single-player role-playing video games (RPG's), a sense of cooperation is sometimes achieved by providing the player with a party (i.e., multiple) in-game characters to interact with and join together in order to pursue in-game goals. However, the sense of cooperation is removed from many RPG's when the player has complete control over the actions of all party characters and success is consequently entirely dependent on the player. The player is effectively *managing* the other characters in these type of scenarios, rather than cooperating with them.

Source(s):

1. Bateman and Boon [2006] “Games where collaboration is primary ”
2. Yee [2006b] “Deriving satisfaction from being part of a group effort”
3. Bostan [2009] “Co-operate [with others]”
4. Lazzaro [2004] “Pursue shared goals”; “Playing for ... cooperation”
5. Sweetser and Wyeth [2005] “Cooperation between players”
6. Schell [2008] “The lens of cooperation”
7. Bateman and Nacke [2010] “Co-operation”

3.3.4 Performing

Pleasure derived from maintaining the attention of other players or in-game characters, often achieved by entertaining or piquing the interest of others. This preference serves to differentiate between players who prefer to remain in the background of a social setting to those who get a buzz from being, at least temporarily, the centre of attention. A player who enjoys demonstrating their game-playing prowess to others are not thought to be necessarily performing. This scenario is likely to also involve elements such as achievement or competition.

Example(s):

An example of games that permit performance are those that become popular in party, or party-like, settings. Music video games series such as “Rock Band” or “SingStar” require players to sing or play simplified versions of instruments in a way that matches the rhythm and pitch presented by the video game. As in video games from othe genres, players can play by themselves (i.e., *solo*), in cooperation with others, or in competition against others. The main advantage of games such as these are that even the non-playing audience enjoy observing the player(s), often participating with a cheer or taunt. More recently, this same kind of experience has become more popular with video game dancing simulations such as those in the "Dance Central" series. While these type of games often include a virtual audience that rudimentarily respond to the player's actions, the satisfaction gained from pleasing these in-game characters is typically far less than that experienced when playing for a real-life audience. Finally, and for whatever reason, examples of performing for in-game characters in single-player video games are considerably rare.

Source(s):

1. Schultheiss [2007] "Performance"

2. Bostan [2009] "Attract attention to one's person"

3. Lazzaro [2004] "Performance opportunities and plenty of spectacle for anyone watching"

3.3.5 Provoking

Satisfaction gained from eliciting or simply observing some measure of suffering in other players or in-game characters, often achieved by the intentional interference or aggravation of others. Related to the preference for control, but is distinct in that this preference refers specifically to the satisfaction gained from seeing another player or character express grief in reponse to an action take upon them. Instead and more generally, control refers to the satisfaction gained by a player who observes how the effect of their actions influence the course of events within a game. Terms such as *griefer* and *troll* are often reserved for people who particularly enjoy engaging in this kind of provocation.

Example(s):

Minor examples of *griefing* such as taunting occur in competitive video games just the same as they do in other forms of competition (e.g., physical sports). However, provoking others for effect is especially prevalent in online multi-player video games where anonymous communication between players is often supported. Additionally, this kind of behaviour also extends beyond communication, as players can also interfere with the in-game goals of other players without needing to communicate. For example, the intentional and repeated in-game slaying of players can be just as easily be interpreted as an act of provocation than an example of competitive behaviour.

It should also be noted that this kind of enjoyment need not be presented in an overly negative light as local (i.e., not online) multi-player video games such as the most recent iterations of the *Super Mario Bros.* series show. With the introduction of local multi-player, this two-dimensional platforming series allows players to choose between cooperative actions as well as those that frustrate others. For example, players are sometimes required to pick up the in-game character representing another player in order to progress through the game. That player is then left with the choice of throwing the other player's character in either the right or wrong direction.

The provocation of in-game characters within single-player games perhaps have a closer relationship with the preference for experimentation. However, as *The Elder Scrolls* series of role-playing video games show, antagonistic behaviour such as the attacking of city guards can still make for a satisfying, albeit often intense, experience.

Source(s):

1. Bartle [1996] "Interference in other's play"
2. Bartle [2004] "Interfering"
3. Yee [2006b] "Provoke or irritate other players"; "Annoy other players"
4. Schultheiss [2007] "Taunt"
5. Lazzaro [2004] "Wisecracks"
6. Schell [2008] "The lens of griefing"

3.3.6 Relating

Sense of warmth gained from friendship and community, whether it be with other players or in-game characters. Players who especially desire the feeling that they are both understood and loved by others are considered to have this preference. Other social interaction types such as cooperation and performing are related in that are likely to either produce or strengthen friendships between players and in-game characters.

Example(s):

Massively multiplayer online role-playing video games (MMORPG's) are a video game genre where players journey through the game in guilds (i.e., groups of close-knit players). While cooperation between guild members is often required, there is also an element of relationship where even guild members who did not originally know each other outside the game end up forming long-term friendships.

An analog for player guilds also exist within most single-player role-playing video games (RPG's) where players form a party of in-game characters with designed personalities and behaviour. While it's hard to imagine a player gaining the same level of satisfaction from relating with in-game characters as they do with other players, in-game characters designed to exhibit human-like characteristics such as realistic emotion can offer comparable appeal.

Source(s):

1. Bartle [1996] "Use the game's communicative facilities"; "Interested in people, and what they have to say"; "Getting to know [people]"
2. Bartle [2004] "Interact openly with other players ... on any and all subjects"
3. Laws [2001] "Present to hang out with the group"
4. Bateman and Boon [2006] "Generally only play games as a social experience"
5. Yee [2006b] "Getting to know other players"; "Chatting with other players"
6. Schultheiss [2007] "Friendship"; "Community"; "Experience in community"; "Friends"
7. Tychsen et al. [2008] "Socializing with other players"
8. Bostan [2009] "Form friendships and associations"; "Converse sociably with others"
9. Kallio et al. [2011] "Gaming for company"
10. Lazzaro [2004] "See games as mechanisms for social interaction"; "Playing with others"
11. Hunicke et al. [2004] "Games as social framework"

12. Sweetser and Wyeth [2005] “Connection; “Social interaction between players”; “Social communities inside and outside the game”

13. Rollings and Adams [2003] “Social interaction”

14. Schell [2008] “The lens of friendship; “The lens of community”

3.4 Other recurring themes

During our analysis of other work we also encountered other repeating themes in addition to the 22 preferences that we chose to form our profile. Table 3.5 lists these other recurring themes.

We conclude this chapter by observing three things about this list and our selected set of 22 preferences. Firstly, these additional factors have strong associations with our existing set of preferences in almost every case as shown by our column containing suggestions for related preferences. This does not mean that we believe our 22 selected preferences represent concepts that are more fundamental to the experience of video games than this list. However, we do anticipate that including items from Table 3.5 in our profile would introduce more overlap than novelty. This is undesirable given that our profile already consists of nearly two dozen preferences, a problem we revisit in Chapter 5 when we introduce the survey we designed to elicit our preference profile.

The original motivation for selecting our set of preferences was the pursuit of a *complete set* of factors that are all as *distinct in meaning* as possible and positioned at a *similar level of granularity.* Factors that when combined would give rise to *sufficient coverage* of the video game experiences that *transcend genre.* In hindsight, we believe this to be an overly

Theme	*Related concept(s)*	*Possibly related preference(s)*
Cheating	Subversion	Experimenting; Provoking
Collecting	Accumulation	Achievement; Addicting
Coordination	Reflex; Accuracy	Tense
Curiosity	Inquiring	Discovering; Experimenting
Customising	Individuality; Uniqueness	Choosing; Creating
Destroying	Ruin	Experimenting; Provoking; Controlling
Dominating	Power; Status	Controlling; Achieving
Escaping	Avoidance	Immersive
Fantasy	Imagination; Make-believe	Immersive
Managing	Leadership; Logistics	Controlling; Strategy
Obsessing	Fixation	Discovering; Addicting
Relaxing	Enjoyment; Casual	Tense (opposite); Challenging (opposite)
Self-efficacy	Self-esteem; Status	Achievement; Challenging
Self-relying	Independence; Autonomy	Relating (opposite); Cooperating (opposite)
Surprising	Astonishment	Unpredictable

Table 3.5: Other recurring themes found to occur within other work with suggestions for how they are related to our currently selected preference set.

ambitious goal with significant doubts about its possibility. As the discussion in this chapter brings to bear, the definition of each factor and their relationship to others are significantly complex. Simplifying a set of preferences for the sake of a practical application such as video game personalisation is one thing, but to create a profile or player model that conforms to all the above criteria is another entirely. Furthermore, as we describe further in Section 7.3.1, accomplishing this goal would not necessarily yield a preference profile more suited to video game personalisation than a subset of factors with a specific focus.

Secondly, perhaps not all items in Table 3.5 are intuitively interpretable as preferences and are possibly better left as being factors that motivate play. For example, does the nature of *escapism* exclude it from being a preference given that its source lies in something other than a game-centric desire originating from *within* the player? Relevantly, Yee [2006a] defines escapism as a measurable motivational factor within the context of massively multiplayer online role-playing video games (MMORPG's) as "how much a user is using the virtual to temporarily avoid, forget about and escape from real-life stress and problems."

Thirdly, the examples accompanying each preference description in this chapter show that at least 12 of the 22 preferences are found in prototypical single-player role-playing video game (RPG) design. This is important because we chose the single-player RPG genre as the domain in which to test our hypothesis that a player's preferences correlate with aspects of in-game player behaviour. However this also leads us to another conclusion revealed by hindsight: it would have been more useful to construct a smaller preference profile that consists exclusively of items which are strongly associated with the same tropes of the RPG genre that our testbed game aspires to. In this case *usefulness* is intended to be measured with respect to the testing of our aforementioned hypothesis. Finally, that is not to say that including preferences that are seemingly unassociated with the experience of playing our testbed game has no benefit. We can still test whether they are indeed unassociated with the game and also investigate whether any positive or negative correlation exists between them and other preferences.

Chapter 4

Testbed role-playing video game

The primary goal of our work is to investigate whether a player's gameplay preferences can be reliably inferred from a player's in-game behaviour for the sake of video game personalisation. One of the research steps required to test this hypothesis was to construct a video game framework within which we could monitor and record player behaviour within a testbed game. For this purpose, we chose to extend a prototype role-playing video game (RPG). Section 4.1 begins the chapter by motivating this choice alongside alternative options. We then proceed in Section 4.2 to describe the video game in detail with respect to hypothesised relationships between its design and the gameplay preferences introduced in Chapter 3. Finally, Section 4.3 then completes the chapter with a summary of our hypothesised relationships between specific preferences and in-game behaviour that results from the game's design.

4.1 Alternative genres and games

A significant factor in determining whether a video game elicits suitable player behaviour is its high-level type (i.e., genre). Each genre is identifiable by a collection of design tropes. We devised a list of suitability requirements that helped inform our choosing of the role-playing video game (RPG) genre. These requirements dictate whether a type of video game is suitable for our *experiment* (i.e., the observation of multiple preferences) but do not necessarily describe whether a video game is suitable for *application* (i.e., personalisation to a player's preferences). Potentially, a video game able to be personalised to a player's preferences requires that only one preference be inferrable from in-game behaviour.

Our list of design requirements are as follows:

1. Design permits a *variety of experiences* that relate to gameplay preferences
2. Design permits players to *express their preferred experience* through in-game choices
3. Design permits players to make their *choices in comparable circumstances*

The first design requirement implies that genres which target a specific experience or a limited set of experiences are less suitable for our experiment. For example, action-style racing video games largely target a sense of exhilaration or tension, and fighting video games target the satisfaction yielded by quick player actions or the anticipation of the other player. Typical examples within genres such as these do not offer as wide a variety of experience as others. For example, RPG's and other action-adventure video games contain detailed storylines, player character management and upgrading, combat systems, and a variety of other non-combat activities to choose from in an expansive world.

The second design requirement adds the notion that players must be free to choose from the variety of experience types that a game offers. Players, through their in-game choices, must be able to express their affinity for aspects of the game that relate to preferences. This implies that games with a non-linear structure are preferred for our experiment. For example, RPG's and other games often described as being *open-world* or *sandbox* regularly give the player a number of activities from which to choose and pursue. Additionally, this second requirement also implies that the availability of player choice must not be overly dependent on their ability to play the game. For example, a video game where optional areas are difficult to access and designed for particularly experienced players.

The third design requirement implies that video game genres known for *emergent* gameplay are less suitable for our experiment. In other words, video game genres where the designed rules tend to produce a large number of dissimilar situations even when players make relatively similar choices. This is considered undesirable because it becomes difficult to compare the reasons why players make in-game choices (e.g., to pursue a particular type of experience) when they are made under different circumstances. Video games with complex rulesets (i.e., a large number of game state variables, each with several possibilities) and interdependent systems (i.e., game state variables from one part of the game impacting others) fit into this undesirable category. A complex game from any genre could be potentially unsuitable, but RPG's are known to be particularly complex and have a large number of interpdendent game state variables. While not as simple as video games from other genres (e.g., platforming video games), our chosen testbed RPG is still far simpler than other modern RPG's. In addition to being easier to both develop and learn, our pursuit of a simple testbed RPG was motivated by this requirement.

In addition to the design requirements above, there are also a list of technical requirements that are independent of the choice of genre but still influenced our choice of testbed RPG. We chose to build a custom RPG that extends a sample game for the Microsoft XNA platform[1]. Given that no complete open-source RPG exists, the only other alternative left would have been to use an isolated segment of gameplay from within a commercially released RPG that allows custom scripting and modification (e.g., *Neverwinter Nights 2*, *The Elder Scrolls V: Skyrim*).

The list of technical requirements that informed our choice of the XNA sample over commercial video games are as follows:

1. Integrable with a preference survey
2. Loggable game state
3. Accessible to a wide demographic

The first technical requirement describes our need to be able to correspond playthroughs of our testbed video game with responses to a gameplay preference survey. The simplest way to adhere to this requirement within a commercial video game would have been to ask players to create a password and enter it when completing the preference survey on an external website. Modification tools for commercial RPG's are useful when creating custom scenarios (e.g., stories, characters, maps, etc) but are not suitable for the creation of a clear, Likert scale survey with randomised items. The solution we came to with our XNA RPG is

[1]For more information about the sample game, see: http://xbox.create.msdn.com/en-US/education/catalog/sample/roleplaying_game

optimal in terms of user experience in that it is presented in the same window as the testbed video game and seamlessly transitions between game and survey whenever necessary (e.g., pre-game and post-game).

The second technical requirement dictates that we be able to monitor what happens while our testbed game is played (i.e., logging the context and effect of each player action). Modification tools for modern RPG's would have permitted the logging of high-level variables but would not have easily allowed us to track *every* change to the game's internal state as has been achieved with our XNA RPG. Logging the complete state of the game is not necessary, but is useful in that we could take a more exploratory approach to the analysis of player behaviour. For example, instead of having to define a particular set of gameplay variables (e.g., number of times player performed action X) we were able to log everything that happened while the game was played and continue defining additional gameplay variables throughout the analysis process, after data collection had begun. Again, this advantage yielded by the use of a custom RPG was not strictly necessary but is certainly advantageous and allowed us to make full use of all the playthroughs we collected.

The third technical requirement stems from the demographic constraints inherent to supervised experiment sessions (i.e., organised sessions that participants have to physically attend). For example, sessions such as these were organised at RMIT University but prevented those who could not make it to the specified time and location from participation. This includes people who were not in the same city or country, and those who do not work or study at university. In order to permit the participation of a wider demographic, we found it advantageous to allow participants to download the testbed game/survey package for play at a time and location of their choosing. To achieve this, we needed the data collection to be automatic, and the package to be both freely distributable and quickly installable. Again this ideal solution would not have been possible with the restrictions that a commercial RPG introduces and we believe that this, when combined with the effect of the other requirements, overrides the one and only disadvantage of a custom RPG: the additional development time required.

4.2 Testbed game design

Our testbed video game was designed to expose a set of player's preferences, making them observable through in-game behaviour. As motivated in Section 4.1, we chose a custom RPG for our testbed game. This section describes the main aspects of our RPG's design, introducing its rules and how they enable in-game actions that we believe are associated with individual gameplay preferences from the profile we introduced in Chapter 3.

Finally, we also note that it is a complex task in and of itself to determine whether our game's design potentially offers the experiences that we intend (e.g., whether our combat system ever produces tense situations). However, while a formal investigation into this would be ideal, we believe that our game's design sufficiently imitates well-established tropes of RPG design that are known to appeal for specific reasons. We state this because participants volunteered generally positive ratings and feedback via optional survey questions in each phase of our experiment. A significant number of players suggested ways in which the game could be improved, but the general tone of the feedback was that our game was enjoyable enough and reminiscent of other examples in the RPG genre (e.g., *Zelda*).

4.2.1 Player characters

There are essentially two types of characters in the game: player characters (PC's) that form a party of controllable characters (i.e., group) , and non-player characters (NPC's) with whom the player can either engage in conversation or combat but not control. At the start of the game, the player is given the choice between 3 different characters: a warrior, thief, or wizard. The positioning and number of each class is randomised every time so as to remove any potential positioning bias. As Figure 4.1 shows, the warrior character is physically strong in battle and can use a greater variety of weapons/armor, the thief character is weaker but has an increased chance of items appearing after battle, and the wizard character posesses greater magic skill and is harder to hurt. We hypothesise that the choice of thief relates to a player's preference for unpredictable and/or challenging gameplay, and the choice of wizard relates to a player's preference for discovery due to the wizard's potential for more powerful spells. Some of the inverse hypotheses also apply. For example, a player who does not choose a thief might actively dislike challenging experiences.

At select points in the game the player is given the opportunity to, upon talking to special NPC's, add them to their party of controllable characters. The player's party can have a maximum of 3 characters. Each player character (PC) has the following set of statistics that affect their capability during combat:

1. *Health points* that determines how many enemy attacks can be tolerated before losing (i.e., each enemy attack reduces current health point level).

2. *Magic points* that determines how many spells can be cast (i.e., each spell consumes a

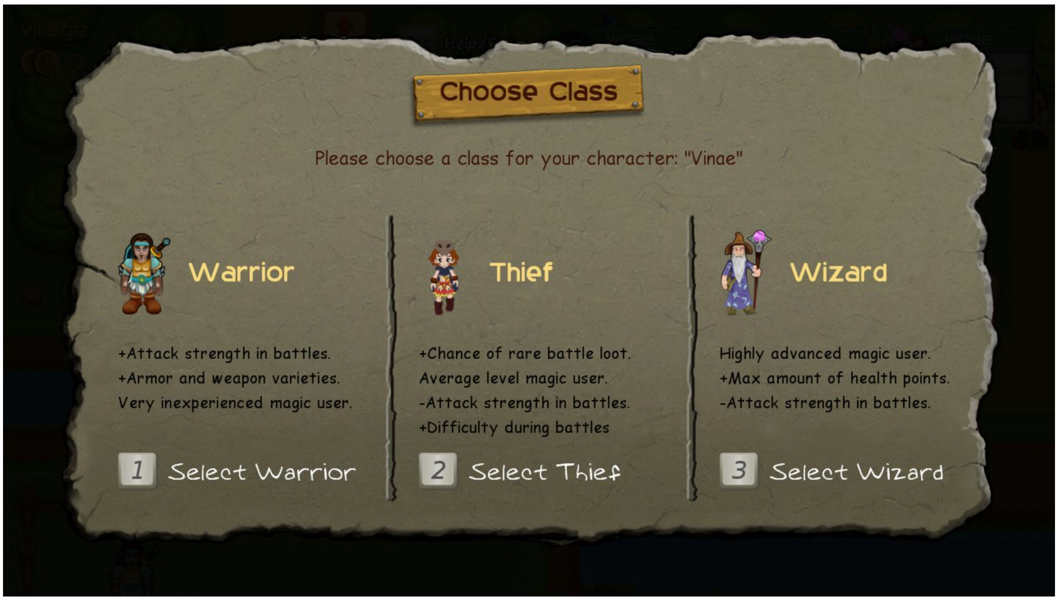

Figure 4.1: Testbed game screenshot depicting the character selection screen: warrior, thief, or wizard.

particular number of magic points when used).

3. *Attack* that determines a character's physical strength.

4. *Defense* that determines how resistant a character is to enemy physical attacks.

5. *Magic power* that determines the potency of magical spells.

6. *Magic defense* that determines how resistant a character is to enemy magical attacks.

If the player wins a battle, all PC's in the player's party earn *experience points* (XP) that increase a character's *level* once a threshold has been reached, increasing the value of one or more other statistics. Each level has an exponentially increasing threshold and effect. Increasing a character's level is commonly used in video games to inform the player that they have achieved something, specifically that the player's character is now more capable in

Figure 4.2: Testbed game screenshot depicting the party screen containing all currently acquired player characters and listing their combat statistics.

combat against in-game enemies. The effect of this being that if the player fights a particular enemy, increases their character's level, and then fights another instance of the same enemy, the second fight will be easier and less likely to cause in-game death for the player. Based on this logic, we hypothesise that players who increase the level of their characters to an above average level do so because of either a preference for achievement, and/or because they dislike challenging or tense experiences.

4.2.2 Inventory and gear

The player obtains gold and items throughout the game, carrying them around in their party's inventory (i.e., an in-game backpack where the player character's belongings are stored). Gold and items are obtained through success in combat, found in chests or hidden locations, or traded in stores.

Figure 4.3: Testbed game screenshot depicting the increase of a player character's level that in turn increases the value of the health point and attack statistics.

Figure 4.4: Testbed game screenshot depicting the player picking up 5 gold and a consumable scroll from within a chest they encountered.

There are two types of items: items that disappear once consumed and gear that can be equipped or unequipped by player characters to modify combat statistics. Items are either potions that restore player character's health and magic points, scrolls that act as once-off magic spells, or keys that unlock special doors. Gear modifies the offensive or defensive combat statistics when they are equipped to particular characters. For example, equipping a warrior character with a new sword will increase their physical attack strength during combat, unequipping the same sword will reverse the original attack increase.

Throughout the game, the player comes across stores which they can enter and buy or sell items and gear. For example, there is an item story, a weapon store, an armor store, etc. Additionally, there is special type of store called an *inn*. Players can enter inns and trade gold to restore the health points of characters within their party.

4.2.3 Combat

A player character's (PC's) statistics are a significant factor in determining who wins a battle. Enemies have the same set of statistics as PC's and their comparison can be used to determine how difficult a battle is going to be. For example, an enemy at level 5 is likely to be very challenging for a player character at level 3.

Combat takes place in turns: each player character selects and takes their move, each enemy selects and takes their move, and so on. A combat move can either be one of the following types:

1. *Attack* the enemy (i.e., cause physical damage to enemy);

2. *Cast spell* at enemy (i.e., offensive elemental spell) or ally (i.e., defensive healing spell);

Figure 4.5: Testbed game screenshot depicting the player in combat with 2 enemies and selecting the wild bear for attack.

3. *Use item* on enemy (i.e., offensive scroll) or ally (i.e., healing potion or defensive scroll);
4. *Defend* against next enemy attack (i.e., reduces damage caused by next enemy move);
5. *Flee* from current battle with a percentage of success (not all battles can be escaped).

If a player realises that they are in danger of losing a battle then they have the choice to either take the risky option and continue fighting, or take a safer option such and heal themself or escape. We believe player choices made in these type of battle moments will indicate whether a player prefers to play through tense and possibly challenging gameplay experiences, or will instead act in a way that makes the current experience less tense and challenging. Additionally, some players will place an above average priority on experiencing the feeling of satisfaction gained from winning a battle, and possibly increasing their character's level as a result of winning, by choosing safer battle options such as healing. Based on this logic, we hypothesise that the types of moves made by the player during combat moments when the player is losing, near death or at a significantly lower level than the enemy is related to a player's preferences for tension, challenge, and/or achievement.

Each amount of healing or damage resulting from attacks, spells, and scrolls are unpredictable to a degree and have a possible range of effect. For example, two physical attacks from one character to another is not guaranteed to deal the same amount of damage, instead being a random number that ranges between a set minimum and maximum value. While unpredictability is a minor element of the battle system, we hypothesise that players with a preference for unpredictable gameplay will engage in combat an above average number of times. A preference for achievement is also another hypothesised reason for a player engaging in battle an above average number of times because that is the primary method of gaining experience points and increasing a playable character's level.

Finally, strategy is a minor element of our custom RPG's combat system. For example, healing a character within a battle anticipates that at the current rate, their character's health points are likely to be depleted before the health points of the enemy. Therefore, though simplistic, we also hypothesise that a player who heals their characters an above average number of times within battle have a preference for strategic gameplay.

4.2.4 World and maps

As in other RPG's, everything in our testbed game is situated within a world map partitioned into 44 smaller maps, each map is divided into a grid of walkable and non-walkable tiles. The player navigates each map by moving, one tile at a time, around them and travelling to neighbouring maps by walking to the current map's edge. Each map is either a *town map* (i.e., contains stores and a large number of non-playable characters), a *hostile map* (i.e., walking inside it will trigger a combat after a random number of steps), or an *exporation map* (i.e., contains hidden objects or once-off combat encounters with special enemies).

The following is the game's list of world areas (i.e., a collection of maps):

1. *Village*, a small town where the player begins the game;

2. *Forest*, a hostile area north of the village;

3. *Ocean road*, a path that joins the starting village and the capital city to the east;

4. *Mountain pass*, an optional area north of the ocean road just west of the capital;

5. *Capital city*, a large town on the east side of the world;

6. *Dungeon*, an optional, hostile area south of the capital city on an island;

7. *Castle*, an area north of the capitcal where the game concludes.

The mountain pass and dungeon areas are optional (i.e., the game can be completed without entering them), as are maps within the forest and ocean road areas. We hypothesise that players who have a preference for discovery will at least partially investigate these optional areas. Within the forest and dungeon areas, there are optional hostile maps that were designed to be especially difficult. In both cases the player is warned that entering these maps will prove to be challenging and it is for this reason we hypothesise that players who spend an above average time within these maps have a preference for challenging gameplay. Additionally, while the player's choice for spending an above average time in hostile maps is

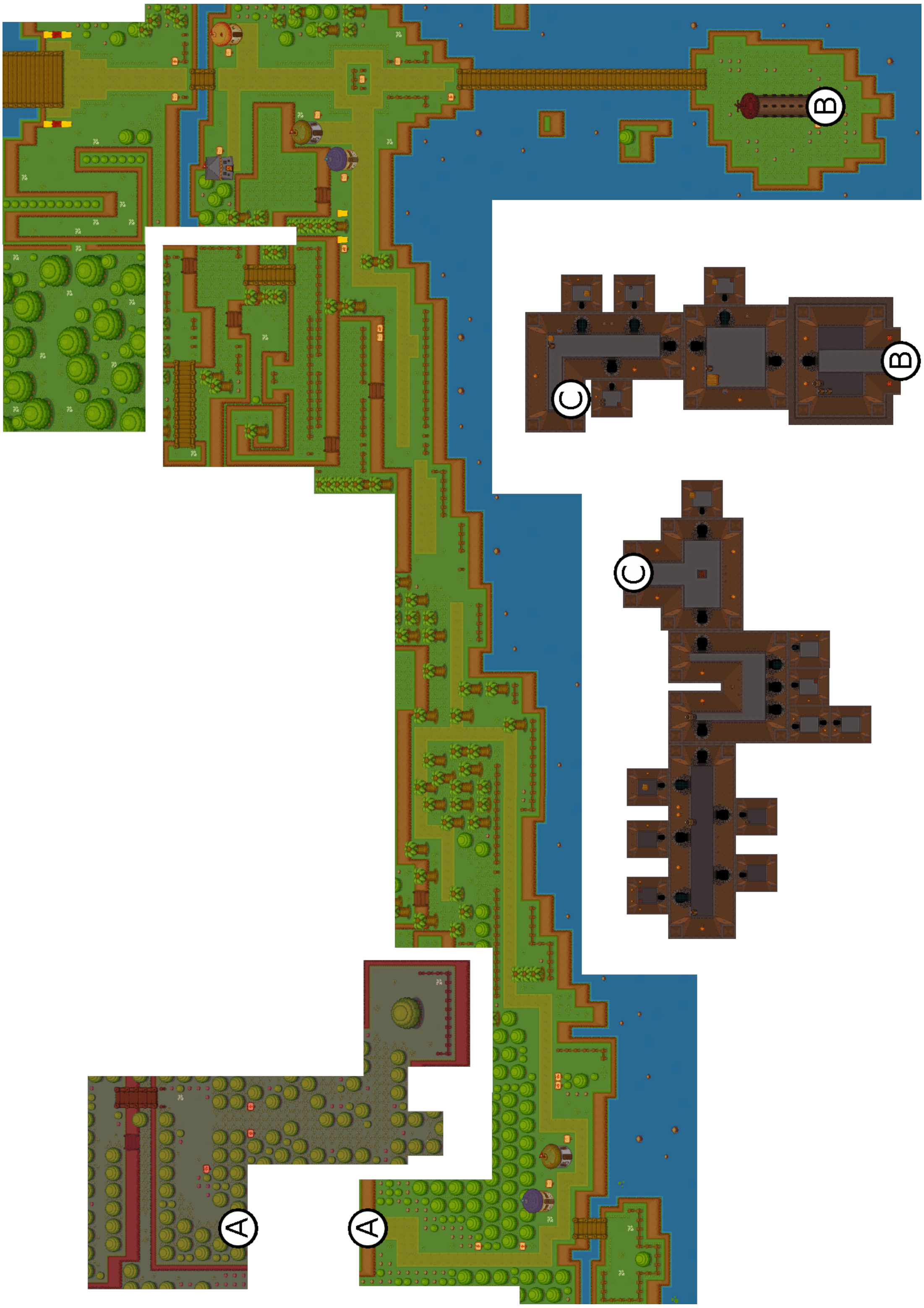

Figure 4.6: Overview describing how all game maps connect, using paired letter icons to indicate connections unable to be represented any simpler.

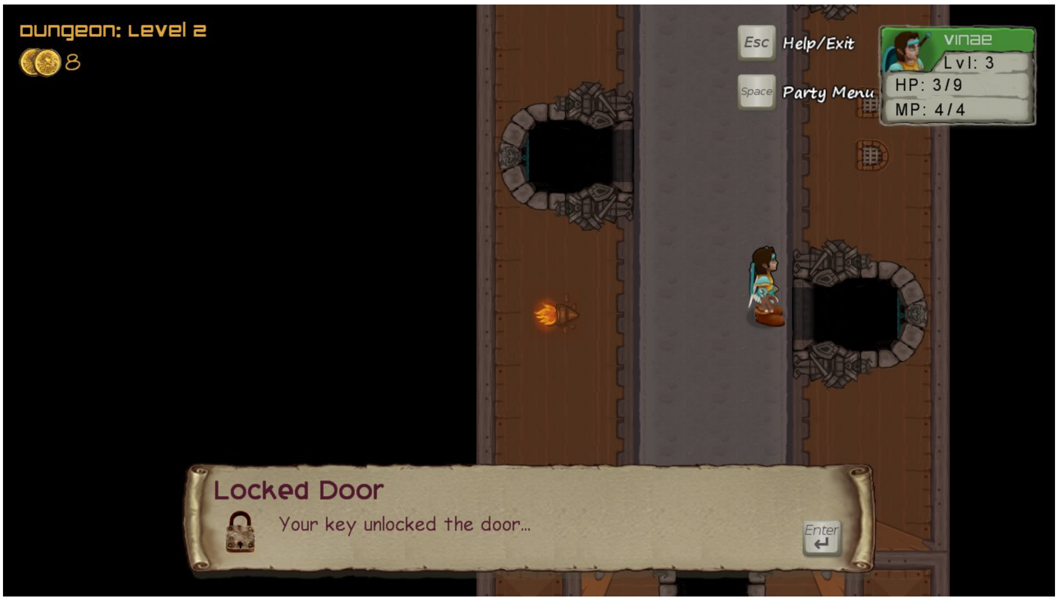

Figure 4.7: Testbed game screenshot depicting the player unlocking a dungeon door by using a special key.

expected to be complicated we still hypothesise a suspected relationship with one or more preferences. Specifically, a combination of a player's preference for unpredictability, challenge, and/or achievement. We make this hypothesis because hostile maps contain many more battles than town or exploration maps and we have already explained why we hypothesise battles are related to a player's preference for unpredictability, challenge, and/or achievement in Section 4.2.3.

Within the dungeon area, there are special doors that require special items called keys in order to be entered. Each locked door has a unique, corresponding key that can be found within other areas of the game's world. Figure 4.7 shows the player unlocking a dungeon door with a key. We hypothesise that the acquisition and use of keys in locked dungeon doors are related to a player's preference for discovery.

4.2.5 Quests and story

Our game is set within a world of simple side-characters, a flawed hero, and a clear villain that emerges over time. As in other RPG's, a narrative context such as this serves to provide players with another reason to remain invested (i.e., motivated to play). For example, players are given the following high-level narrative goal at the beginning of our game: investigate the disappearance of the player character's sister. To this goal's end, the game is structured as a linear sequence of 3 quests (i.e., tasks) that build up to a resolution. We hypothesise that players who complete each quest or somehow prioritise their completion will have a preference for discovery, achievement, and/or assistance of in-game characters. An additional hypothesis is that players who spend an amount of time engaging in conversation with non-player characters (NPC's) that is dramatically lower than the average amount lacks a preference for discovery. We also note that this player behaviour could also be explained by enviromental factors that are unrelated to the game. For example, the player is an extraordinarily fast reader or the player is in a rush brought upon by another impending responsibility.

As each quest is completed, the player is able to traverse new maps that open up as player completes them, concluding with a fight against a non-human monarch. Additionally, there are 5 *side-quests* (i.e., optional quests) the encourage the exploration of new areas or retreading of those already visited Table 4.1 contains an overview of the three stages in the game and the new maps and side-quests that become available at each one. Once each quest is given to the player, their description and whether they have been completed is noted within their journal (i.e., a game screen showing the state of all quests known to the player).

Side-quests are found in many RPG's and often included to give players a break from

Figure 4.8: Testbed game screenshot depicting a character (bottom) providing player (top) with directions.

Figure 4.9: Testbed game screenshot depicting the player's journal, a screen that lists which quests are available to or completed by the player.

the structure of the game's main quests/storyline. Like the main 3 quests in our game, side-quests are also often represented in the game's user interface by a series of checkboxes. For example, a player talks to an NPC and receives information relating to a side-quest which then appears in their journal as an uncompleted quest. One of the effects of this incorporation into the user interface is the sense of satisfaction that comes from completing a list of tasks. We believe this is an example of design catering to a player's preference for achievement, as implied by our definition of the achievement preference in Section 3.2. We made the intentional choice to exclude side-quests from our game's journal screen, hoping to diminish the effect of a player's preference for achievement on their completion. We therefore hypothesise that the completion of an above average number of sidequests relates primarily to a player's preference for discovery. The description of each side-quest is as follows:

1. **Forest Secret:** Find the secret item hidden within the forest area
2. **Stop Bullies:** Help a non-playable character in the mountain pass being harassed
3. **Dungeon Treasure:** Recover the treasure that someone left in the dungeon
4. **Recruit Village Friend:** Backtrack to the village, add another character to the party
5. **Recruit Brother-In-Law:** Search the dungeon, add another character to the party

The second side-quest explicitly involves the rescue of an NPC that also happens to be blocking the way to a bridge leading to a treasure chest. We hypothesise that the completion of this side-quest is related to the player's preference for assistance in addition to discovery. Given that maps contain many non-playable characters for the player to talk to, chests for the player to open, and stores to investigate, we hypothesise that the overall percentage of objects that players interact with are related to discovery. For example, a player who interacts with an above average number of objects is inherently interested in knowing more about the world and contents of maps and chests.

Quest name	***New areas***	***New side-quests***
Pay guards 10 gold	Village; Forest	Forest secret
Rendezvous in the capital	Ocean road; Mountain pass	Stop bullies
Confront the king	Capital city; Dungeon; Castle	Dungeon treasure; Recruit village friend; Recruit brother-in-law

Table 4.1: A listing of each which areas and side-quests become available during each of the game's 3 quests.

Finally, we note the difficulty of relating gameplay with a player's preference for choice. This is not as simple as hypothesising that players who make a certain type or number of choices have a particular affinity for choice. Instead, it would require the observation of how a player experiences sections of a game that involve choice and other comparable sections that do not include any high-level choice. It is for this reason, we consider the relating of a player's preference for choice with in-game behaviour as being beyond the scope of this work and instead outline how this could be achieved in future in Chapter 7.

4.3 Hypotheses

This section acts as a summary of our discussion in Section 4.2, listing the 15 in-game player choices we hypothesise are related in different ways to 7 preferences in Table 4.2.

Player behaviour	***Preferences***
Choosing the thief character	Challenging; Unpredictable
Choosing the wizard character	Discovery
Not fleeing while losing in battle	Achievement; Challenging; Tense
Entering into difficult battles	Achievement; Challenging; Tense
Number of character level increases	Achievement; Anti-Challenging; Anti-Tense
Number of battles started	Unpredictable; Strategy
Visiting optional maps	Discovery
Amount of time spent in difficult, hostile maps	Challenging
Amount of time spent in hostile maps	Achievement; Challenging; Tense; Unpredictable
Acquiring and using keys on locked doors	Discovery
Completing compulsory quests	Discovery; Achievement; Assistance
Amount of time spent conversing	Discovery
Completing optional quests	Discovery
Completing optional "stop bullies" quest	Discovery; Assistance
Interacting with newly found objects	Discovery

Table 4.2: A listing of specific in-game player choices we hypothesise are related to particular gameplay preferences.

The next chapter describes the structure of our experiment that was designed to collect quantitative preference variables from a preference survey and quantitative gameplay variables from our observations of the player's in-game behaviour.

Chapter 5

Experimental design and data

The primary goal of our work is to investigate whether a player's gameplay preferences can be reliably inferred from a player's in-game behaviour for the sake of video game personalisation. This chapter describes how we collected the quantitative data that was required for this investigation. We do this by first describing in Section 5.1 how we developed a survey with Likert scale items that all correspond with individual preferences from our profile introduced in Chapter 3. Section 5.2 of this chapter then introduces our set of in-game behaviour variables that we use to test the specific set of hypotheses from Chapter 4 (i.e., suspected correlations between specific preferences and aspects of our testbed game's design). The final section, 5.3, then describes how we designed our experiment with the aim of collecting preference and in-game behaviour data from participants.

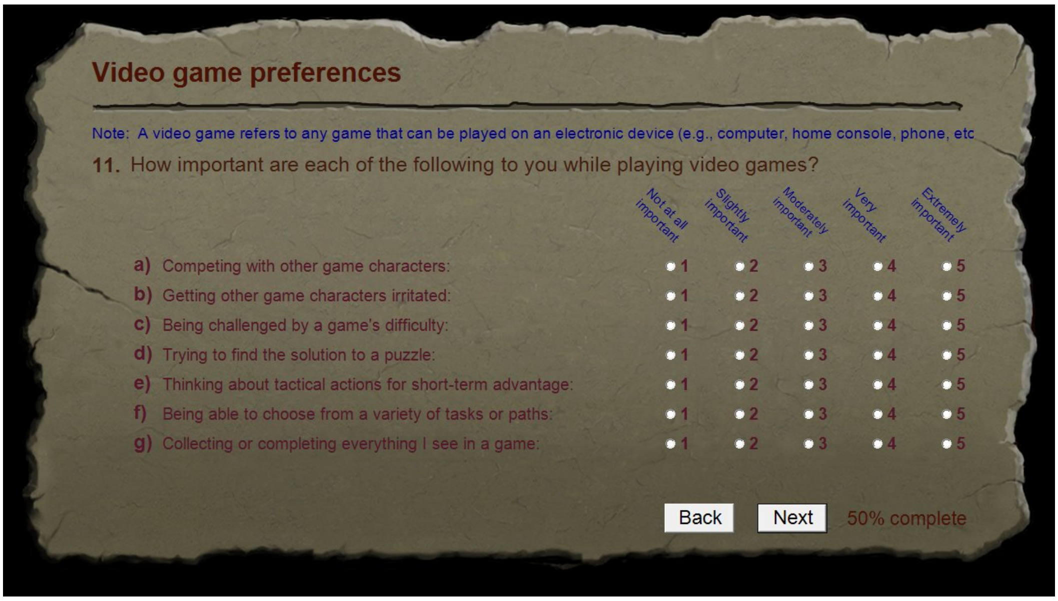

Figure 5.1: Testbed game screenshot depicting the gameplay preference survey with a random selection of survey items.

5.1 Preference survey

Chapter 3 introduced all preferences that form our gameplay preference profile. This section describes how we developed a survey that elicited the preferences of participants via self-report over many iterations before listing the final set of survey items. We do this by placing the survey items in the same 3 preference categories also introduced in Chapter 3. An example of how we presented this final version of the survey is shown in Figure 5.1. Survey respondents were presented with 4 of these survey pages that together contained all survey items in a random order to reduce ordering effects that are know to exist when using self-report/survey methods [Zaller and Feldman, 1992].

5.1.1 Survey development

Our survey takes the same form as existing player motivation surveys [Yee, 2006b; Tychsen et al., 2008] and personality surveys [Gosling et al., 2003] in that it consists of multiple items that respondents rank on a 5-point Likert scale. While some survey items resemble that found in existing player motivation surveys, we had to develop our own set because of the current lack of a comparable gameplay preference survey that is independent of any particular video game genre. Zammitto [2010] developed a preference survey but, as mentioned in Chapter 2, each of their player preferences equate to a different video game genre.

While developing our survey, these items were iterated upon many times, as were the framing question and label of each point on the Likert scale. Each iteration consisted of a trial run of our survey with at least 10-15 participants and was in every case run externally from any tests of our testbed role-playing video game. This subsection describes the reasoning behind the wording of the survey items, framing question, and scale point labels by describing the 4 metrics we used to determine whether the ordinal level data yielded by our survey would be meaningful. These 4 metrics were *response variance between respondents*, *consistent interpretation by respondents*, *response stability for each preference*, and *lack of correlation between preferences.*

Our survey underwent many minor iterations but was ultimately developed across two major iterations. In the first major iteration we prefaced each survey item with the following statement: *How much do you agree with each of the following? When playing video games, I enjoy. . .* . Each of the 5 points on our Likert scale were also labelled, in ascending order, with *strongly disagree* (1), *moderately disagree* (2), *neither agree nor disagree* (3), *moderately* *agree* (4), and *strongly agree* (5). Test runs of this survey showed that the median response value, averaged over all preferences, was approximately 4.02 and the standard deviation, averaged over all preferences, was approximately 1.06. While a nonparametric alternative to the standard deviation would have better suited the ordinal nature of our preference data, we use the standard deviation here only as a rough indication of how varied the survey responses were.

Ideally the survey data we obtain would have a larger standard deviation, implying that there was greater variety in the indicated preferences of respondents. This *wider* distribution would make the differences between different player's ratings more prominent and therefore any correlation measures more meaningful. The extreme negative case that we sought to avoid would be where nearly all responses to each preference were the same (e.g., likely to be either moderately or strongly agree). In this case, the self-reported differences of each respondent's preferences would not be particularly meaningful and would cause correlation measures to yield misleading results due to the lack of variety.

It does makes sense for the distribution of our survey results to be positively skewed because the survey items themselves describe generally positive gameplay experiences. However, we attempted to at least reduce increase the width of the distribution by modifying the survey's design. From the second major iteration onwards, we changed the statement that prefaces each item to the following: *How important are the following to you while playing video games?*. Additionally, the 5 Likert scale labels became, in ascending order, *not at all important* (1), *slightly important* (2), *moderately important* (3), *very important* (4), and *extremely important* (5). Test runs of the revised survey showed that the median response value, averaged over all preferences, was approximately 3.58 (i.e., a decrease of approximately 0.45) and the standard deviation, averaged over all preferences, was approx. 0.99 (i.e., a decrease of 0.07). While not an ideal outcome, we considered it to be highly similarly with respect to variation and consequently settled upon this revised version of our survey for the final run of our experiment.

By far, the most time consuming part of the survey development process was in the wording of each survey item. Throughout the many iterations, we learnt that even subtle changes to the wording would significantly alter the shape of the data (e.g., means, standard deviations, and strength of correlation between survey items). We estimate that each survey item was, on average, rewritten 6-10 times.

One of the reasons we iterated upon the survey items so many times was because we found that participants were not consistently interpreting each survey item during the trial runs of the survey (i.e., different respondents were attributing a different meaning to the same survey items). While this effect is likely to never be completely eliminated, we did aim for each question to be as clear as possible to as many respondents as possible by removing technical or abstract language. To test the clarity of our questions, we modified the survey so that instead of rating each survey item, respondents gave a concise description of what they thought the question was asking along with what an example of each might look like in an actual video game. This modified survey was used periodically throughout both major iterations of testing as much as was feasible. It very quickly became time-consuming to test the clarity of each survey item and then test how they fared according to the next two metrics. This process would often require going back to the clarity test for any survey items that proved to be lacking according to the latter metrics. One of the largest issues we faced when wording the survey items was the need to use language that was neither too abstract nor specific. If a survey item was too abstract, respondents would give multiple and conflicting interpretations of the survey item because it was too vague or confusing. If a survey item was too specific, respondents would combine multiple preferences in their interpretation. For example, respondents could be given the following survey item: *How important is... getting a high score*. Intepretations of this survey item would likely relate not only to the *achievement* preference but also the *competition* or even *performing* preference. Additionally, overly specific survey items would also in some cases lead respondents to expressly *exclude* other examples that in fact also related to the preference that the current survey item was intended to correspond with. Finally, if survey items described overly specific in-game situations that had not been experienced before by a respondent then they might not know how to rate its importance to them. For example, the following survey item illustrates a specific in-game situation: *How important is... successfully countering an opponent's army in a strategy game*. It is difficult for a respondent to know whether they identify with this example if they had not encountered it before and understand either the terminology used or how it would make them feel if they had this experience.

As described in Chapter 3, each of our preferences represent distinct concepts. Therefore we considered it important that the responses to individual preferences did not significantly correlate with each other. This was another motivation for the many iterations of our survey items. To test the correlation, we used Spearman's rank correlation coefficient [Spearman, 1904], known as Spearman's *rho*, to test the correlation because it is a measure that suits ordinal variables such as those yielded by our Likert scale survey. A significant correlation between any two preferences would have indicated that some of our survey items did not accurately describe what makes each preference unique, and instead combined similar facets of multiple preferences. For example, the survey items that correspond with the *strategy* and *tactics* preference often significantly correlated (e.g., rho=0.76, p¡0.001, n=22). Ideally we would have been able to keep the rho value below a particular threshold that indicates either a very weak or no correlation when correlating all our preferences with each other (e.g., rho=0.3). However, we were not able to consistently achieve this in the case of 3 preference pairs. *Strategy* consistently and significantly correlated with *tactics*, *choosing* consistently and significantly correlated with *controlling*, and *discovery* consistently and significantly correlated with *immersive* gameplay. This suggests that either our survey items that correspond with these 6 preferences need even further iteration, the inherent differences between these 6 preferences are simply too subtle for the average video game player to recognise, or that these 6 preferences are in fact distinct but generally occur together.

Another reason why we iterated upon each survey item so many times was because we found that responses to them were sometimes unstable (i.e., when asked a highly similar question multiple times, the response was significantly dissimilar). When this happened, it is possible that respondents were not actually expressing their gameplay preferences when ranking our survey items. It is possible that even if the question is understood, the average video game player (let alone the average person) might not be capable of understanding what gameplay they do or don't prefer. This would lead to responses that are, at best, an imprecise guess and, at worst, random. To test the stability of responses, we introduced a second survey item for each of the 22 preferences. This choice effectively doubled the amount of time required to develop the survey but enabled us to correlate the 2 responses for each preference to assess whether the data was actually meaningful and represented a respondent's gameplay preferences. However, we only used the first survey item for each preference in the final run of our experiment. Once we had established that both of the survey items that correspond with a preference produce a relatively stable response, including them both in future surveys would be largely redundant. To test whether questions correlated we used the same Spearman's rho method described in the previous paragraph. While we were able to achieve a moderate correlation (i.e., rho value of close to 0.5 or greater) with most of the survey item pairs that correpond to the same preference, there were 6 preferences that didn't appear to be significantly correlated even after many iterations when using this measure. In the most extreme cases of the *controlling* (rho=0.10) and *tactics* (rho=0.11) preference, this could be explained by a lack of variance in those responses. The standard deviation of the *controlling* preference responses was approx. 0.73 on average, and approx. 0.70 for *tactics*. We say this because when viewing the same survey item pair data in a scatter plot it is difficult to determine whether a correlation actually exists given the limited range of responses for those particular preferences. Other, less extreme, cases can also be partially explained by the drawbacks of using correlation measures on data that lacks variety. When viewing the scatter plots of the other survey item pairs, a correlation does seem apparent but the correlation measure was possibly misled by too many responses that are *similar* but not *the same*. For example, the *very important* and *extremely important* survey responses are relatively similar but treated as relatively dissimilar by the correlation measure. Additionally, in most cases a humanly observed correlation did not seem to occur when plotting survey item pairs that corresponded to different preferences. Other possible explanations for the unstable response to a preference's survey items either lie in the unclear wording of the relevant survey items or an inherent difficulty that respondents had in expressing a particular preference. Perhaps because the preference is difficult to self-assess, the preference is not generally well understood by players, or both.

5.1.2 Gameplay experience survey items

This section lists all gameplay preference survey items that correspond with a preference in the gameplay experience category. When presenting the survey items, respondents were asked *how important they were to them while playing video games.* Each of these preferences and their category were introduced in Section 3.1.

Addicting

Being obsessed or addicted to a game

Collecting or completing everything I see in a game

Challenging

Being challenged by a game's difficulty

Testing my skill or playing ability

Exhilarating

Getting an adrenaline rush or thrill from a game

Feeling exhilarated from fast-paced action

Immersive

Suspending my disbelief and pretending a game is real

Temporarily believing a game world really exists

Tense

Being in a tense situation and then feeling relieved

Coming close to losing but still succeeding

Unpredictable

Being surprised by something unpredictable

Having something unlikely or rare happen

5.1.3 Gameplay activity survey items

This section lists all gameplay preference survey items that correspond with a preference in the gameplay activity category. When presenting the survey items, respondents were asked *how important they were to them while playing video games.* Each of these preferences and their category were introduced in Section 3.2.

Achieving

Achieving or accomplishing something

Completing an objective or achieving a high score

Choosing

Being able to choose from a variety of tasks or paths

Selecting from a number of alternatives in a game

Controlling

Having my actions influence or change a game

Seeing my actions have a real effect on a game

Creating

Expressing my creativity in a game

Creating or making things in a game

Discovering

Finding out new things in a game or its story

Discovering or exploring places in a game

Experimenting

Experimenting with a game's rules and mechanics

Pushing the boundaries of a game's rules

Roleplaying

Playing like how my character would think or act in a game

Adopting my character's personality while playing

Solving

Trying to find the solution to a puzzle

Solving puzzles or problems

Strategizing

Executing strategies and plans

Strategic or long-term planning

Tacticizing

Thinking about tactical actions for short-term advantage

Tactical planning in a game

5.1.4 Social interaction survey items

This section lists all gameplay preference survey items that correspond with a preference in the social interaction category. When presenting the survey items, respondents were asked *how important they were to them while playing video games.* Each of these preferences and their category were introduced in Section 3.3. We differentiate between a player's preference for a social interaction with other human players and a player's preference for other in-game characters that are controlled by the game. For example, a player's preference for competing with other players is not the same thing as a player's preference for competing with other in-game characters. We did this because we found that survey items such as this did not significantly correlated when using the same correlation process described in Section 5.1.1. Additionally, given that our testbed role-playing video game is single-player, the only player-related form of a social preference that might be relevant is *performing.* Even single-player video games can be associated with this preference.

Assisting

Assisting other game characters

Helping other game characters

Competing

Competing with other game characters

Playing against other game characters

Cooperating

Co-operating with other game characters

Working in a team with other game characters

Performing

Showing other game characters how I play a game

Having other game characters watch me play

Having other people watch me play a game

Showing other people how I play a game

Provoking

Getting other game characters irritated

Provoking or aggravating other game characters

Relating

Having game characters as companions or friends

Maintaining friendships with game characters

5.2 Gameplay variables

Chapter 4 concluded in Section 4.3 with a table that *qualitatitively* described a set of hypothesised correlations gameplay preferences and player behaviour within our testbed role-playing video game (RPG). For example, our first hypothesis was that choosing the thief character at the beginning of the game would correlate with a player's preference for challenging and/or unpredictable gameplay on account of the textual description of the thief character presented to the player while this choice is made. This section describes the set of 17 *quantitative* variables we defined to describe the identified in-game player behaviour. We do this by first categorising each of the hypotheses and behaviour variables into 5 broad categories, describing each in detail within a corresponding subsection:

1. Player character variables (Subsection 5.2.1);
2. Combat choice variables (Subsection 5.2.2);
3. World map variables (Subsection 5.2.3);
4. Quest completion variables (Subsection 5.2.4);
5. Object interaction variables (Subsection 5.2.5).

Following this, we then describe the *temporal nature* of these behaviour variables (i.e., how their values are expected to change over time), and how this can cause some behaviour variables or periods of time in which they are calculated to be unsuitable for our purpose of video game personalisation. We do this in Subsection 5.2.6 by separating our behaviour variables into two different sets: those that are temporally *stable* and those that are temporally *unstable*. In this subsection we also explain how the values of *some* temporally unstable behaviour variables produced by multiple players cannot be meaningfully compared with each other. Following this, Subsection 5.2.7 then introduces the notion that observing a player's behaviour within the *entire* playing session (i.e., from game start to completion or exit) would be either misleading or unsuitable for video game personalisation. For example, in-game actions made before players properly understand the game's rules are not likely to express the actual intention behind each action because the player is not yet fully aware of the effect that their in-game actions will have. Additionally, because a personalisation system would ideally begin personalising a video game as early in the playing session as possible, the end of the playing session is not very a useful point at which to calculate the behaviour variables. We conclude Subsection 5.2.7 by creating a list of of points within a session of our testbed RPG at which to start and stop observing the player's in-game behaviour. We later put the suitability of this set of observation points to the test in Section 6.2.

We also note that the temporal stability of behaviour variables does not need to be considered in cases where a video game is separated into short, completely disjointed sections (e.g., a series of short levels). Behaviour variables in this case do not persist beyond the length of each section and the end of each section is a suitable point at which to compare the values produced by multiple players. However this does not apply to many video games, such as our own testbed RPG, where the behaviour variable of interest persist across the entire length of the game.

However, before introducing the set of behaviour variables and their temporal nature we also note that we in fact derived dozens more variables than that described in this thesis. These additional variables either became stepping stones that we used to arrive at our current list or were used in the early, more exploratory (i.e., less hypothesis-driven) stage of our work. Also, we note that all of the variables chosen to be described throughout this thesis are not equally suitable. In fact, some behaviour variables that we chose for this thesis are particularly unsuitable for one reason or another (e.g., their values do not regularly vary over time, the difference in values between values is inconsistent over time, some variables make others redundant). We included this particular mixture of variables to allow us to describe in detail why we can conclude that a behaviour variable is unsuitable and contrast that with behaviour variables that we consider to be more suitable in Section 6.2.

5.2.1 Player character variables

This first category relates to the selection and development of the player's main character which also includes, at times, extra characters that the players add to their *party* of characters. Table 5.1 describes the set of in-game behaviour variables in this category.

Hypothesis	***Variable name(s)***
Choosing the thief character correlates with player's preference for **challenging** and/or **unpredictable** gameplay	ThiefCharacterSelection
Choosing the wizard character correlates with player's preference for **discovery**	WizardCharacterSelection
Number of character level increases correlates with player's preference for **achievement**	CharacterLevel
Number of character level increases inversely correlates with player's preference for **challenging** and/or **tense** gameplay	CharacterLevel

Table 5.1: The in-game behaviour variables that were defined to test our player character-related hypotheses.

The *ThiefCharacterSelection* and *WizardCharacterSelection* variables are mutually exclusive boolean variables. The player is given the choice to select only one type of character at the beginning of the game.

The *CharacterLevel* variable is a floating-point number calculated by taking the average character level value of all characters in the player's party. For example, consider the situation where the player has their main character and another party member (i.e., 2 player characters in total) and they are at level 3 and 5 respectively. The value of *CharacterLevel* will be 4 in this case. The range of this variable is 1-20, the minimum and maximum player character levels.

5.2.2 Combat choice variables

This second category relates to the player's choice to enage in battle and also flee (i.e., escape) from a battle once it has started. Table 5.2 describes the set of in-game behaviour variables in this category.

Hypothesis	***Variable name(s)***
Not fleeing while losing in battle correlates with player's preference for **achievement** and/or **challenging** and/or **tense** gameplay	NotFleeingWhileLosing
Entering into difficult battles correlates with player's preference for **achievement** and/or **challenging** and/or **tense** gameplay	PartyHealthComparison
Number of battles started correlates with player's preference for **unpredictable** and/or **strategic** gameplay	FleeingFromBattle; BattleCount

Table 5.2: The in-game behaviour variables that were defined to test our combat choice-related hypotheses.

The *NotFleeingWhileLosing* variable is a floating-point number with a range of 0-1 and is calculated by determining the percentage of times that the player chooses not to flee (i.e., either attack, cast a magic spell, use an item, or defend) while losing in battle. We define the player as being in a *losing* state when the average value of their party character's health points is less than the average current health point value of the enemy characters they are fighting against. For example, consider the situation where the player's party of 2 characters have an accumulated total of 18 health points and the enemy's party of 2 characters have an accumulated total of 24 health points. The player is considered to be losing because it will take a greater number of health points to defeat the enemy party than it will to be defeated by them. This variable, while indicating the player's position in battle, does simplifies the situation by ignoring additional variables such as the gear that each character has equipped (e.g., swords, armour, etc) and how much damage each party is capable of dealing with each attack or spell. We assume that these additional factors are not nearly as important as the party's health point values because of the way the game has been balanced. In other words, it is unlikely that the player's equipped gear and attack strength will not be able to be consistently compared to that of the enemy party's throughout the game.

The *PartyHealthComparison* variable is a floating-point number that will always be a positive value and is calculated by dividing the total health point value of all enemy characters that the player has battled so far in the game by the total health point value of the player's characters at the time of each encounter. This variable is only calculated and aggregated at the beginning of each battle. For example, if the variable value is 1 then on average the player has begun a battle with the same number of health points as the enemy party posesses. If the variable value is 1.5, the player's party has on average begun battles with a health point total that is 50% less than the enemy's party (i.e., tended to engage in relatively difficult battles). This variable assumes that battles are largely optional and that the player has control over whether this variable will have a relatively low (i.e., less than 1) or high value (i.e., greater than 1). In nearly all cases this is true as there are only 2 compulsory battles in the game and entering areas that contains relatively difficult enemies are optional in every case.

The *FleeingFromBattle* variable is a floating-point number with a range of 0-1 and is calculated by determing the percentage of battles from which the player has chosen to flee (i.e., escape). While the player has considerable control over how many battles they fight in throughout the game, this variable potentially adds more insight as to whether the player enjoys the game's combat system and is assumed, in many cases, to correlate with the *BattleCount* variable (i.e., players who generally avoid entering battles will also generally avoid fighting in battles that they find themselves in). The *BattleCount* variable is a positive integer value that simply equates with how many battles the player has currently encountered in the game so far.

5.2.3 World map variables

This third category relates to the player's exploration of the game's world, including the player's choice to not explore every nook and cranny. Table 5.3 describes the set of in-game behaviour variables in this category.

The *OptionalMapsVisited* variable is an integer with a range of 0-7 and is calculated by determining how many of the 7 optional maps in the game the player has visited. These optional maps are spread throughout many of the game's areas (i.e., group of maps) so that this variable's value can become meaningful (i.e., greater than 0) early in the game and be repeatedly assessed throughout the game. For example, the player might accidentally come across an optional map early in the game but do not continue to visit optional maps later in

Hypothesis	***Variable name(s)***
Visiting optional maps correlates with player's preference for **discovery**	OptionalMapsVisited
Amount of time spent in hostile maps correlates with player's preference for **achievement** and/or **challenging** and/or **tense** and/or **unpredictable** gameplay	TimeNearRandomEnemies
Amount of time spent in difficult hostile maps correlates with player's preference for **challenging** gameplay	TimeNearDifficultEnemies

Table 5.3: The in-game behaviour variables that were defined to test our world map-related hypotheses.

the game.

The *TimeNearRandomEnemies* variable is a floating-point number with a range of 0-1 and is calculated by determining the percentage of game time that the player spends in a map that contains enemies who will randomly attack the player. Only a small amount of time is required to be spent in such an area in order to complete the game's compulsory quests so if the player spends an above average time in this type of area it is assumed that they at least do not mind the fact they are being attacked at random. It should also be noted that every calculation of time for each variable, whether it be a count of time or percent of the total time, only the time in which the player was *actively playing* (i.e., not *idling*) has been considered. We define a player to be idling when they they have not performed any actions for ten seconds. We deem this to be necessary because the data showed that three players had idled for over half an hour (i.e., they left the game running in the background whilst doing something else) and this would have generated misleading outliers on any time-dependent behaviour variables.

The *TimeNearDifficultEnemies* variable is similar to the *TimeNearRandomEnemies* variables except that it only includes maps where the enemies that randomly attack the player are considered to be particularly difficult to defeat. Our metric for defining whether this is the case compares the player character's level with the general difficulty of random enemies in each map on a map-by-map basis. Specifically, there are two maps in the game that contain enemies that are potentially difficult: the furthest depths of the forest and the top level of the dungeon. If a player is exploring either of these maps and has a character level that is not especially high, then they are considered to be spending time in a map with difficult enemies. This metric was chosen because a simpler comparison of character level is not particularly meaningful (i.e., an enemy of a particular level is not necessarily a good match for a player character of the same level).

5.2.4 Quest completion variables

This fourth category relates to whether the player completes both optional and compulsory quests (i.e., in-game tasks given to the player by in-game characters). Table 5.4 describes the set of in-game behaviour variables in this category.

Hypothesis	***Variable name(s)***
Completing compulsory quests correlates with player's preference for **discovery** and/or **achievement** and/or **assistance**	QuestsCompleted
Completing optional quests correlates with player's preference for **discovery**	OptionalQuestsCompleted
Completing optional "stop bullies" quest correlates with player's preference for **discovery** and/or **assistance**	BullyQuestCompleted

Table 5.4: The in-game behaviour variables that were defined to test our quest completion-related hypotheses.

The *QuestsCompleted* variable is an integer with a range of 0-3 and is calculated by determining how many of the 3 compulsory quests the player has currently completed. The *OptionalQuestsCompleted* variable is the same, except has a range of 0-5 and is calculated by determining how many of the 5 optional quests the player has currently completed. The *BullyQuestCompleted* variable is a boolean value that describes whether the player has currently completed the "stop bullies" optional quest.

5.2.5 Object interaction variables

This fifth and final category relates to the player's interaction with objects, including engaging in conversation with non-player characters, opening treasure chests, visiting stores and inns, and opening locked doors with keys. Table 5.5 describes the set of in-game behaviour variables in this category.

Hypothesis	***Variable name(s)***
Amount of time spent conversing correlates with player's preference for **discovery**	TimeConversing
Interacting with newly found objects correlates with player's preference for **discovery**	ObjectsInteracted
Acquiring and using keys on locked doors correlates with player's preference for **discovery**	KeysFound; LocksOpened

Table 5.5: The in-game behaviour variables that were defined to test our object interaction-related hypotheses.

The *TimeConversing* variable is a positive integer that is calculated by determining the number of minutes that the player has spent speaking with non-playable characters in conversation. This variable assumes that the differences in player's reading speed has a less significant effect on the time spent conversing than the amount of conversation dialog that is actually being read. An alternative variable could be calculated by counting how many words or conversation lines the player reads but that won't take into account the case where players begin many conversations but end up skipping over most of the dialog within them.

The *ObjectsInteracted* variable is a floating-point number that is calculated by determining the percentage of objects the player has interacted with at a particular point in time. The objects that we consider for this variable are non-player characters, treasure chests, stores, inns, and locked doors. The total number of objects that is used for this variable includes only the objects that exist within maps that have been already visited by the player. We did this so the value of this variable could be compared between players that are at different points in the game.

Both the *KeysFound* and *LocksOpened* variables are integer values with a range of 0-5. The *KeysFound* variable is calculated by determining how many of the 5 keys, that have been spread around the first 4 world areas, have been found by the player. The *LocksOpened* variable is calculated by determining how many of the 5 locked doors in the dungeon (one of the later world areas) that have been opened by the player using the found keys.

5.2.6 Temporal stability

In this subsection we explain why we consider our list of behaviour variables detailed in Subsections 5.2.1 to 5.2.5 to be examples of variables that are either relatively *stable* or *unstable* when observed throught a playing session (i.e., the period of time between a player starting and stopping their play of a video game). The purpose of this subsection is to establish a difference between temporally stable and unstable variables, as well as to explain why *some* temporally unstable behaviour variables have the problem that the behavioural differences they describe between multiple players are *inconsistent* over time, which makes them unsuitable for correlation with a player's gameplay preferences (or any other inherent difference between players either expected or known to be temporally *stable*). We do this by introducing *why* variables can be expected to be either stable or unstable over time, presenting a table that separates all our 17 behaviour variables into either category, and then discussing in detail why *some* temporally unstable variables are unsuitable for our purposes.

Firstly, we now describe how some in-game behaviour variables can be defined in a way that produces a relatively *stable* value over time, at least within video game sections that are comparable in ways that affect the variable's value. Consider the *FleeingFromBattle* behaviour variable that is defined by the percentage of times a player fled from combat with enemies. This percentage divides the number of times the player fled from combat by the total number of battles that the player entered into. The variable's value will not change in video game sections where the player does not enter into any battles and the variable's value will not significantly change as long as the player's desire to flee remains relatively constant. However, we do not anticipate that stable variables such as these would produce a similar value across an entire playing session, particularly as the game itself progresses and varies. For example, if the battles in one section of a game is either unexpectedly difficult or does not appeal to the player in the same way that battles in a previous section did then that would likely cause a significant change in the variable's value. In this case there would be two relatively stable values, one during the current section and another for the previous section. This type of occurance shouldn't be seen as a problem but it does dictate that such changes in the game's design need to be identified and considered when comparing the value of behaviour variables. For example, this would only make comparisons between the variable's value in two different playing sessions meaningful when they are observed within the same type of section.

Secondly, we now describe why some in-game behaviour variables are expected to be *unstable* over time and why a stable form is either difficult or impossible to define. Consider the *CharacterLevel* behaviour variable that is defined as the number of times the player incremented the level of their controllable characters (taken as an average across each controllable character). This variable could not be expressed as a percentage because we could not be sure what would constitute a maximum possible character level at various points within the game. As long as players of our testbed video game are willing to invest the appropriate amount of time, they are free to increment their character's level at will by repeatedly triggering battles in certain areas (a trope generally found in role-playing video game design at the time of writing). At best, by observing the behaviour of a group of players within our testbed video game, a generally occuring maximum variable value could be defined at key points throughout the game. Tabe 5.6 describes our full list of behaviour variables, categorising each as either being temporally stable or temporally unstable.

Finally, we now close this subsection by explaining when a temporally *unstable* behaviour variable should be *excluded* in our final correlation with gameplay preference variables (or in any correlation with other player attributes such as personality or age that are considered to be temporally stable, at least throughout the play of a video game). Consider a behaviour variable that changes dramatically over time within highly similar sections of a video game,

Temporally stable	***Temporally unstable***
ObjectsInteracted	OptionalMapsVisited
PartyHealthComparison	TimeConversing
WizardCharacterSelection	KeysFound
ThiefCharacterSelection	LocksOpened
FleeingFromBattle	BattleCount
NotFleeingWhileLosing	CharacterLevel
TimeNearRandomEnemies	QuestsCompleted
TimeNearDifficultRandomEnemies	OptionalQuestsCompleted
	OptionalBullyQuestCompleted

Table 5.6: Listing of in-game behaviour variables expected to either be temporally stable or temporally unstable.

increasing and/or descreasing as time progresses. Now imagine that the variable fluctuates in a similar way over time when the values produced by multiple players are compared (i.e., the *difference* between the values produced by different players remain relatively similar over time). While somewhat complicating the interpretation of the variable's value, such a temporally unstable behaviour variable still describes a difference between players that remains *consistent* over time and can still be possibly associated with a temporally stable player characteristic.

Now consider another temporally unstable behaviour variable where the difference in values produced by different players are *not* relatively similar over time (i.e., the variables fluctuate over time in non-similar ways for different players). The effect of this would be that the measure of correlation between any such behaviour variable and another variable expected to be temporally stable will itself vary depending on the point in time selected to observe the behaviour variable's value. In the case of such variables, it would seem that anything associated with the behaviour variable is itself *also* changing over time and should *also* be considered as temporally unstable to some degree. Assuming the state of each player's video game remains relatively comparable over time and any change in the context surrounding the relevant player choices is not itself an *external* cause of any inconsistent behavioural shifts between players, we could make only one of two possible conclusions. The first being that a player's gameplay preferences, expected to be temporally stable, are *not* associated with such behaviour variables and some other facet of the player, known to be temporally unstable, is instead (e.g., the player's mood). The second being that a player's gameplay preferences *are* still associated with such behaviour variables but gameplay preferences themselves are, unexpectedly, temporally *unstable*. Given that we are not sure how to assess which conclusion should be made without additional data (e.g., psychophysiological data observed during play describing shifts in a player's mood), we should exclude such behaviour variables that inconsistently vary between different players. In Section 6.2 we use our collected data set to confirm the temporal stability of each of our behaviour variables, and whether any temporally unstable behaviour variables inconsistently vary between different players (i.e., and should then be later excluded from our final correlation with gameplay preferences in Section 6.3).

5.2.7 Observation period

When we logged the in-game behaviour of players, we did so by logging the *complete* game state and *all* player action information from each participant's playing session. Doing so enabled us to calculate the value of all in-game behaviour variables at each point in time that something occurred within the playing session (i.e., any time that the player acted or the game triggered an event). Furthermore, any time after data collection was already complete, we were able to to decide whether any period of time within the playing session of each player should be *excluded*. For example, any behaviour variable could be calculated while ignoring the first five minutes of play, or while ignoring the period of time that followed the completion of the second (out of three) compulsory in-game quests. In this subsection we introduce three major points: why the *start* of a playing session *may* be a less than ideal point at which to *begin* observing a player's behaviour, why the *end* of a playing session is *surely* an unsuitable point at which to *complete* the observation of a player's behaviour, and which start/end points of behaviour observation we will consider in Section 6.2 when we introduce our collected in-game behaviour data set.

The primary goal of this subsection is to introduce a heuristic that can be used to determine what behaviour observation period is ideal when a player's behaviour is being used to infer some other player characteristic (e.g., their gameplay preferences). This heuristic can be summarised as follows: the observation period should begin as early as possible, have as short a duration as possible, and capture as much information about the player as is possible. However, it should be noted that in practice it is unlikely that only a single observation period will be used and that the behaviour observation will never actually cease unless it was affecting the video game's performance (i.e., the game's framerate and general responsiveness). In practice, attempts to infer something about the player from their behaviour will be repeated throughout a playing session and will become more accurate as time goes on, resulting in an understanding of the player that becomes both more complete and reliable over time. The tension surrounding time only exists because, ideally, a personalisation system would have a complete understanding of the player as early as possible in a playing session and thus be able to personalise a video game throughout as much of the playing session as possible. This of course rules out why we believe the end of a playing session is an unsuitable point at which to complete the first behaviour observation period when the goal is to personalise a video game (or act in any other way based upon the information inferred from a player's behaviour).

We now introduce why the start of a playing session, while considered to be ideal from the perspective of our time-information tradeoff, will in some cases make an *unsuitable* start point for a period of behaviour observation. It is often expected that participants will vary in their level of video game playing experience (i.e., different participants will understand a particular video game's rules to varying degrees). Consequently, a player with limited or no experience must go through a period of *experimentation and learning* in order to build some kind of mental model of the game's rules and systems that allows them to predict the outcome of their in-game actions. Including this learning phase of play in the calculation of behaviour variables would be problematic in our case. Because we hypothesise that a player generally acts within a video game in order to produce gameplay situations that they would prefer to experience, we should discard any players actions made while a player does not understand the effect of their actions. This is why we believe the beginning of the playing session may prove to be an unsuitable point to begin observing an inexperienced player's behaviour, at least when their behaviour is being used to infer their gameplay preferences.

We conclude this subsection with Table 5.7, which describes the set of behaviour observation points that we have chosen to consider when describing our collected behaviour data in Chapter 6. We identified two different points at which to begin observation, and four points at which to finish observation. Together, because one of the start points is the same as one of the end points, this results in seven different observation periods that we consider to be a representative sample of the full set of possible observation periods that are signficantly dissimilar when compared to each other. In Section 6.2 we describe the suitability of particular observation periods for different behaviour variables when considering the aforementioned tradeoff between time passed and information gained.

Start point
The beginning of the play session (*Start Game*)
The beginning of the second quest (*Start Quest 2*)
End point
The beginning of the second quest (*Quest 2*)
The first time exiting the optional dungeon area (*Exit Dungeon*)
The completion of the final quest (*Complete Game*)
The end of the play session, triggered by player exiting or completing the game (*End Session*)

Table 5.7: Listing of the observation start and end points that we considered, making seven combinations in total.

5.3 Experiment structure

Throughout this chapter and Chapters 3 to 4 we have established how we a) derived a survey that explicitly elicits each of our gameplay preferences, b) created a testbed video game that monitors in-game player behaviour, and c) established a set of quantitative preference and in-game behaviour variables that we hypothesise are correlated. In this section we describe the experiment we designed in order to collect a data set containing both preference and behaviour variables for correlation analysis.

Participants of our experiment were invited to download our single testbed game/preference survey package from our website, install it, and run it at a time of their choosing. The preference survey is automatically administered post-game, immediately after the player their completes or quits the testbed game. Each of the preference survey items are presented in a random order across four separate pages. All of the in-game behaviour and survey responses are automatically logged for each participant and packed into a single XML file which is then compressed and uploaded to our secure server. We had no specific demographic in mind when designing our experiment, however we expected the majority of participants to at least have an interest in role-playing video games because the experiment requires the play of one.

Before we began our final experiment phase and collected our final data set, we ran a trial phase. During the trial, we collected data from people who participated from home in addition to those who participated in a computer lab session that we supervised. We found that while supervised players played the game for more time on average, the *play-from-home* approach is still a viable means of collecting in-game behaviour from playing sessions of approx. 24 minutes on average. To reduce the effect that external, disrupting factors could have potentially had on participants who played from home, we added a further set of questions to the post-game survey. For example, we asked participants whether they were watched or influenced by other people and excluded their game record from our final data set if so. Additionally, those participants who had a self-admittedly poor understanding of the English language, were below the age of 18 years, had already played the testbed video game for more than 5 minutes on a previous occasion, or improperly answered the preference survey were excluded from our final data set. Participants who improperly completed the preference survey included those who either did not answer all of the survey items, or were considered to have answered them all suspiciously when viewed in the original, random order presented to the participant. A survey response was deemed to be suspicious when either all (or nearly all) survey items were ranked with the same value, or all survey items were consistently alternating between multiple values to form an obvious pattern.

In Chapter 6 we describe the data set that we collected while running this experiment, and it is in Section 6.1.4 there that we assess the effect of placing our preference survey after the testbed video game in our experiment. The potential effect that this could have had on our preference survey data is difficult to assess a priori but we hypothesised that the effect would not be significant. We assess this effect by performing a Wilcoxon rank sum test [Siegel, 1956] on our two groups: those that completed the survey by itself in the final trial run of our survey, and those that completed it post-game in the final run of our experiment.

Chapter 6

Results and analysis

The primary goal of our work is to investigate whether a player's gameplay preferences can be reliably inferred from a player's in-game behaviour for the sake of video game personalisation. Throughout Chapters 3 to 5 we developed a set of hypotheses regarding particular gameplay preferences and in-game behaviour variables. It is in this chapter that we present the gameplay preference and in-game behaviour data that we collected, and the results of our correlation of these variables. We do this by introducing the collected preference survey data in Section 6.1, describing the demographic of survey respondents (Subsection 6.1.1), the degree of response variation for each survey item (Subsection 6.1.2), and whether any preference responses correlated in the process (Subsection 6.1.3). In this section we also compare the reponses of those who completed the survey while participating in our experiment with those who did so during a trial of our survey to test the effect that playing a video game prior to the survey might have had (Subsection 6.1.4). In Section 6.2 we introduce our collected in-game behaviour data by first discussing the suitability of each behaviour variable expected to be either temporally stable (Subsection 6.2.1) or temporally unstable (Subsection 6.2.2). We then test whether any behaviour variables lacked a significant level of variation (i.e., were sufficiently *dispersed*) or whether any variables were significantly correlated with each other and therefore redundant (Subsection 6.2.3). Finally, in Section 6.3, we describe the results of testing whether hypothesised preference and behaviour variable pairs would signficantly correlate in Section 6.3.

6.1 Preference survey data

In Section 5.1 we introduced our preference survey which includes two items for each of the 22 preferences we introduced in Chapter 3. As explained in Section 5.1, we developed two survey items for each preference, using both when trialling the survey but only the first when running the final experiment (i.e., the data set primarily described in this chapter).

In this section we describe the demographic of the 47 participants who completed our survey (Subsection 6.1.1), how varied the preference reponses were (Subsection 6.1.2), and whether any preferences were correlated with each other (Subsection 6.1.3). The final subsection (6.1.4) then compares the survey results from this participant group that completed the survey during the experiment described in Section 5.3, to those who completed the survey in the final trial run of our survey. The motivation for the comparison of these groups was motivated in Section 5.1 where we discussed the potentially significant effect that playing our testbed video game prior to completing the preference survey could have on participants and, consequently, the data.

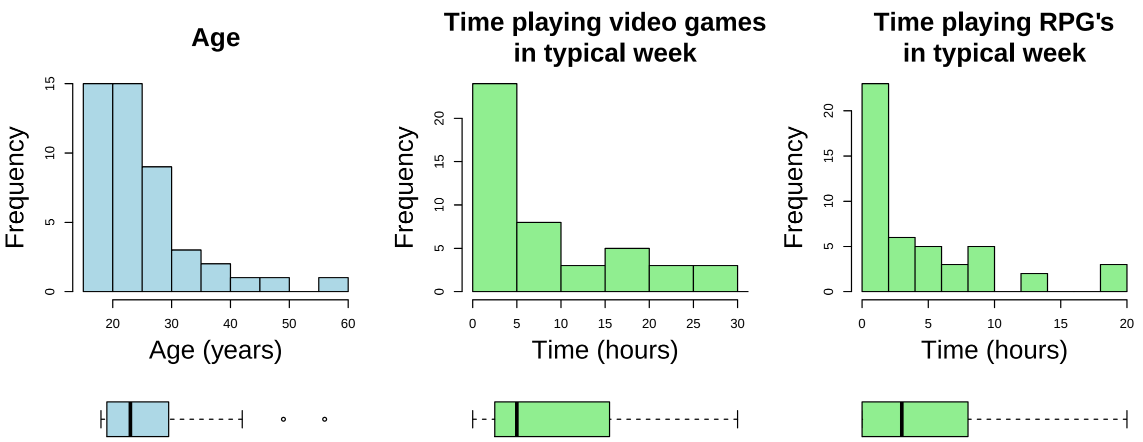

Figure 6.1: Histogram and corresponding boxplots describing the demographic of the 47 participants who completed our gameplay preference survey.

6.1.1 Respondent demographic

During the data collection phase of our work, 47 participants completed our gameplay preference survey. The survey was administered when participants had either completed or exited our testbed role-playing video game (RPG). To capture the demographic of these participants, we asked additional survey questions to obtain the relevant demographic information. The results of these additional demographic questions are described in both Figure 6.1 and Table 6.1.

We do not present any cross tabulations of our survey demographic and preference data, to be introduced in Subsection 6.1.2, for two reasons: our collected data set is relatively small (n=*47*), and the key demographic variables are unbalanced (e.g., gender, country, playing experience). Because of this, results produced by our cross tabulation were never both interesting and, when applying the chi square test, statistically significant. Additionally, there were no significant correlations between any numeric demographic variables (i.e., those

Gender	**Count**
Male	37 (79%)
Female	10 (21%)
Country in which participants grew up	**Count**
Australia	32 (68%)
Other (8 countries)	15 (32%)
Main field of study	**Count**
Computer science	15 (32%)
Engineering	6 (13%)
Social science	5 (11%)
Other	13 (27%)
None	8 (17%)
Experience playing video games	**Count**
Played them frequently or regularly at some point	39 (83%)
Played them occasionally or casually at some point	7 (15%)
Only ever played them a few times	1 (2%)
Never played them	0 (0%)
Experience playing role-playing video games (RPG's)	**Count**
Played them frequently or regularly at some point	34 (72%)
Played them occasionally or casually at some point	8 (17%)
Never played them but would probably know how to	5 (11%)
Never played them and would not know how to	0 (0%)
Not sure what a role-playing video game is	0 (0%)

Table 6.1: Demographic of the 47 participants who completed our gameplay preference survey.

in Figure 6.1) and ordinal preference variables when tested using either the Pearson's r or Spearman's *rho* correlation measures.

6.1.2 Preference responses

In this subsection we describe how our preference survey was completed and how varied our preference survey data is by making use of diverging stacked bar charts, a common technique for visualising Likert-type items. Figure 6.2 shows the use of each of the five response alternatives varied significantly between respondents. We include this graph to explore one of the issues that has been associated with the rating of Likert-type items: personal bias may occur when respondents consistently use only some of the responses [Yannakakis and Hallam, 2011]. While comparing the leftmost and rightmost bars in Figure 6.2 shows that some personal bias of this nature has occured, the majority of the middlemost bars show that there is also a smooth gradient between these extremes. If some respondents more clearly used a different set of response options (e.g., there were more obvious discrepencies in the number of times different respondents used each response), then it might have been possible to group our participants. Having done that we could have compared the responses of each group in order to determine a statistical difference and attempt to explain it using in-game behaviour variables. In lieu of that, throughout this chapter we simply assume that different respondents varied considerably in how generally important they find our set of 22 gameplay preferences to be.

Figure 6.3 shows that response options assigned to most of our 22 gameplay preferences had a significant level of variety. Interestingly, all of the *social interaction* preferences were

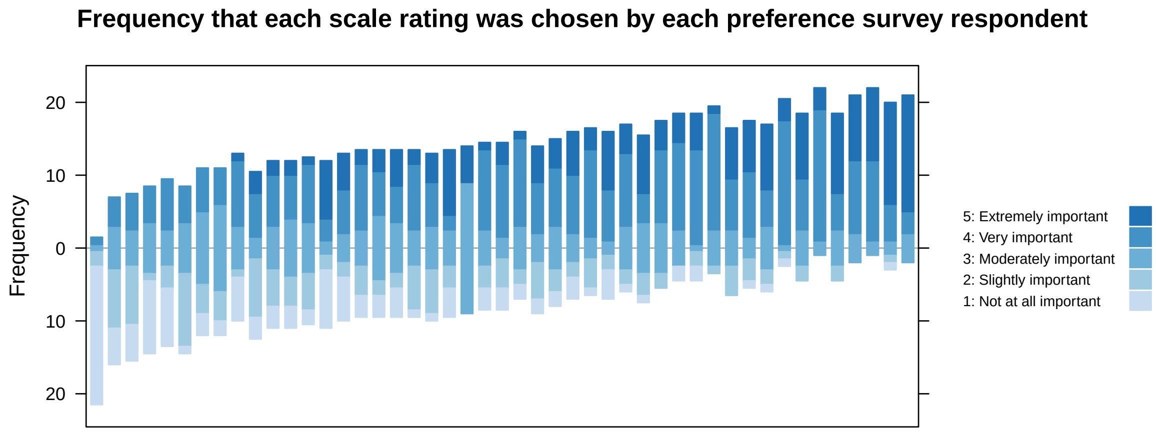

Figure 6.2: Stacked bar chart describing response option frequency for the 47 gameplay preference survey participants.

on the left-hand side (i.e., was on average given relatively low ratings) whereas the *gameplay experience* and *gameplay activity* preferences were spread more evenly throughout.

6.1.3 Correlation analysis

In this subsection we investigate whether any preference responses were significantly correlated with each other. To do this, we used rank correlation measures (i.e., non-parametric) because we cannot confidently describe the distance between each of the response options and what interval they represent, even approximately. While it can vary from situation to situation, we assume can we can only reliably know the *order* of the response options of our Likert-type items [Jamieson et al., 2004]. While not guaranteed, the use of parametric methods might be more appropriate if we combined multiple Likert-type items to form a Likert scale [Clason and Dormody, 1994; Boone and Boone, 2012].

Figure 6.4 describes the strength and statistical significance of the correlation between each gameplay preference using Kendall's *tau* [Kendall, 1938], a correlation measure suited

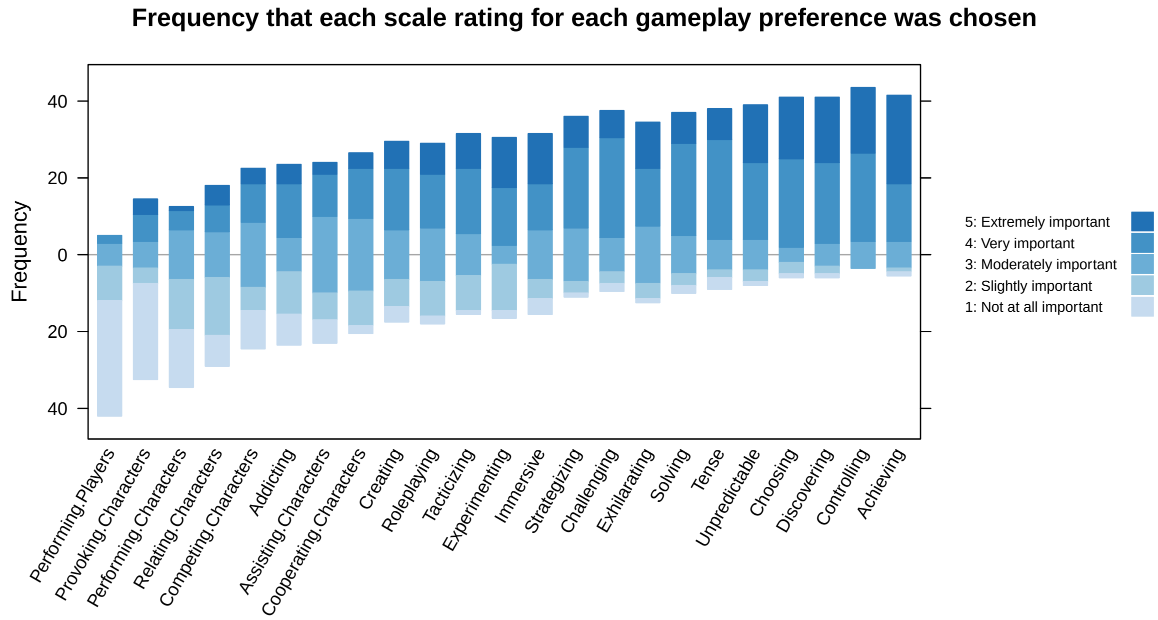

Figure 6.3: Stacked bar chart describing response option frequency for all gameplay preferences.

to ordinal/non-parametric data. The preference column order was calculated using *principal component analysis* (PCA). The effect of this ordering is that the most correlated preferences will tend to appear close to each other in the matrix. We also followed this same procedure but replaced Kendall's *tau* with Spearman's *rho* [Spearman, 1904], another correlation measure that differs in its formula but was also designed for correlating ordinal/non-parametric variables. We do not report this second correlation matrix because the results were nearly identical in the both of them, only differing in the general magnitude of the correlation values (*tau* being generally weaker than *rho*).

Assessing whether a particular value produced by a correlation measure can be considered as *strong*, *moderate*, or *weak* is complex and varies depending on the nature of the data. Because our survey data is comprised of only five different values that correspond with each

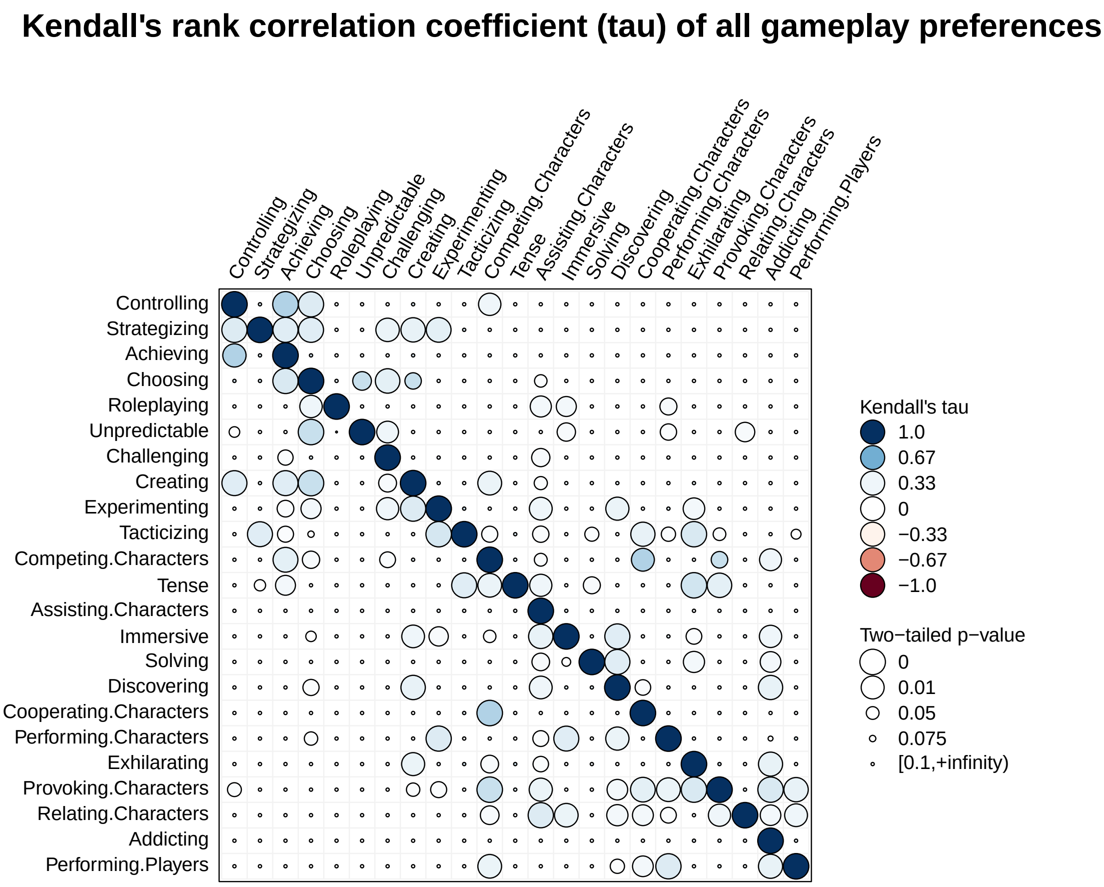

Figure 6.4: Correlation matrix describing the strength of correlation for all gameplay preferences and their statistical significance.

response option, it would make sense that, statistically, correlations are more likely to occur in that which has double or more possible values. Figure 6.5 describes the frequency of each correlation value and suggests that no pair preference pair has a particularly strong correlation. This histogram was created by taking one of the correlation matrix halves from Figure 6.4 and also removing the diagonal where each preference is tested against itself.

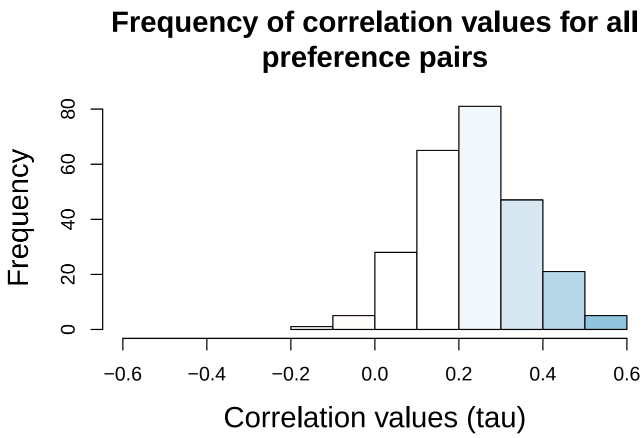

Figure 6.5: Histogram describing the frequency at which different values occurred when correlating all gameplay preferences with each other.

However, we now further analyse whether the correlation values on the rightmost side of Figure 6.5 (i.e., those with the highest correlation value) represent corelations that we can consider as *strong*. Table 6.2 describes the five preference pairs that all had a correlation value between 0.5 and 0.55, and an additional final pair that represents the average case. Figure 6.6 plots these six preference pairs against each other, adding a line of best fit calculated using linear regression and a small amount of jitter to each data point for clearer visualisation. Note that we removed the line of best fit from the final scatterplot in the bottom-right (i.e., the average case) to further differentiate it from the other, more strongly correlated preference pairs.

Preference 1	***Preference 2***	***tau***	***p-value***
Achieving	Controlling	0.548	<0.001
Competing with characters	Cooperating with characters	0.544	<0.001
Choosing	Unpredictable	0.519	<0.001
Choosing	Creating	0.512	<0.001
Competing with characters	Provoking characters	0.512	<0.001
Unpredictable	Creating	0.224	<0.130

Table 6.2: The most strongly correlated preference pairs (tau values between 5 and 5.5) and a sample preference pair that is averagely correlated.

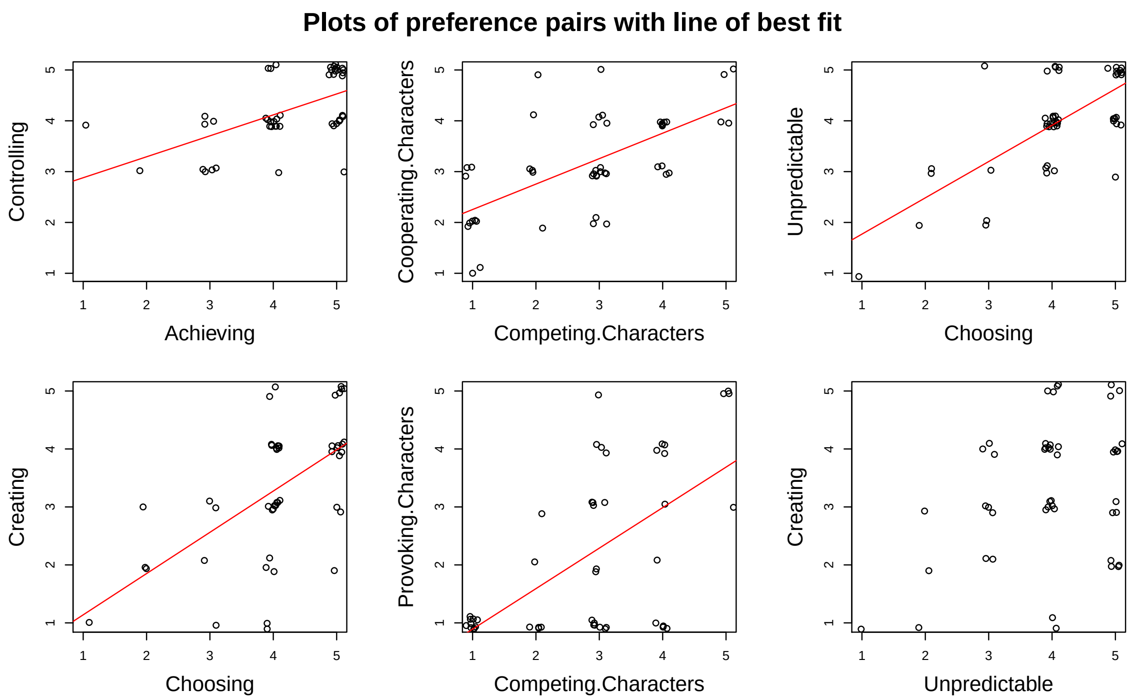

Figure 6.6: Scatterplots visualising the preference pairs selected for Table 6.2 (i.e., the 5 most strongly correlated pairs and a sample pair representing the average case).

6.1.4 Comparing experiment data with final survey trial

In this subsection we compare the preference survey data completed by respondents during the *experiment* (i.e., post-game), and those who completed it during the earlier trial phase (i.e., independent of playing any video game). Survey items were randomised in both cases. The motivation for this comparison was to get an indication of the effect of administering our survey directly after our testbed video game. It is possible that this experimental design choice had a significant effect on participants, and thus our survey data.

The final trial survey was performed in two parts with eighteen respondents answering questions corresponding to half of our preferences in each. Although we can't be sure, we assume the demographic of the trial participants are at least similar to that described in Subsection 6.1.1 because they were sourced the same way.

Comparing these two data sets was not our original intention when collecting the data, and there were some additional processing steps required to make them compatible. Firstly, the trial survey participants were answering two questions that correspond with each preference whereas the respondents of our experiment data set answered only one. When comparing the data sets we ignore the second question for each preference from within the trial data set. Also, no questions corresponding with the *choosing* preference was included in the trial survey and so we also exclude the correponding survey item from the experiment data set.

To make the comparison we have chosen the Wilcoxon rank sum test, also known as the Mann-Whitney U test amongst others [Siegel, 1956]. We make this choice because the test is suited to comparing, between two groups, ordinal/non-parametric variables that do not necessarily need to be normally distributed. The point of distribution type is relevant because many of our preference responses were not normally distributed, at least with our sample size. However, it should also be noted that our data contains a significant number of ties, something that Likert-type item data will always contain when the sample size is greater than the number of response options. Ties are an issue worth noting because they can affect the reliability of the p-value produced by non-parametric tests, the statistic that indicates the significance of the test's outcome. It is for this reason we note that while the test is of the standard form that corrects for ties, the *two-tailed p-value* therefore cannot be considered as exact. Furthermore, given that a significant number of ties exist, we are hesitant to draw strong conclusions from the test's result and treat them as instead a source of a *possible indication.* Table 6.3 and 6.4 describes the W values (i.e., sum of the ranks) and approximate *two-tailed p-values* (i.e., statistical significance of no difference occuring between groups) that resulted from comparing each preference between the experiment and trial groups. The test's results are presented in two separate tables because while in both cases the experiment survey respondents *were* the same, the trial survey respondent groups were *not* the same.

The results from the Wilcoxon rank sum tests suggests that three or four preference responses significantly varied between groups. The *achieving*, *competing (characters)*, and *relating (characters)* preferences all had a *two-tailed p-value* below 0.05, indicating that the null hypothesis can safely be rejected if these results are to be relied upon. In this case, the null hypothesis is that there was *no* significant difference between groups. All other preference responses with the exception of *strategizing* had a *two-tailed p-value* above 0.1, indicating that the null hypothesis *cannot* safely be rejected. The result for the *strategizing* preference

Preference	***W***	***p-value***
Performing.Characters	402.5	0.962
Roleplaying	390.5	0.887
Experimenting	383.5	0.800
Exhilarating	375.5	0.702
Immersive	430.5	0.627
Addicting	440.5	0.521
Provoking.Characters	353.5	0.455
Cooperating.Characters	340.0	0.342
Performing.Players	308.0	0.115
Tense	496.0	0.109
Achieving	545.5	0.018

Table 6.3: Results from a Wilcoxon rank sum test comparing the first half of preference responses between the experiment and trial groups.

Preference	***W***	***p-value***
Solving	394	0.934
Controlling	384.5	0.811
Challenging	352.5	0.436
Unpredictable	336	0.305
Discovering	327.5	0.240
Tacticizing	309.5	0.147
Creating	297	0.106
Assisting.Characters	296.5	0.103
Strategizing	288.5	0.073
Competing.Characters	261.5	0.030
Relating.Characters	168	<0.001

Table 6.4: Results from a Wilcoxon rank sum test comparing the second half of preference responses between the experiment and trial groups.

lies directly between these two levels of significance and could be reasonably interpreted either way. To show that the results of this test can be confirmed upon further inspection, Figure 6.7 describes scatterplots and boxplots for these four preferences, as well as an average case, and the two cases with the highest *p-value*.

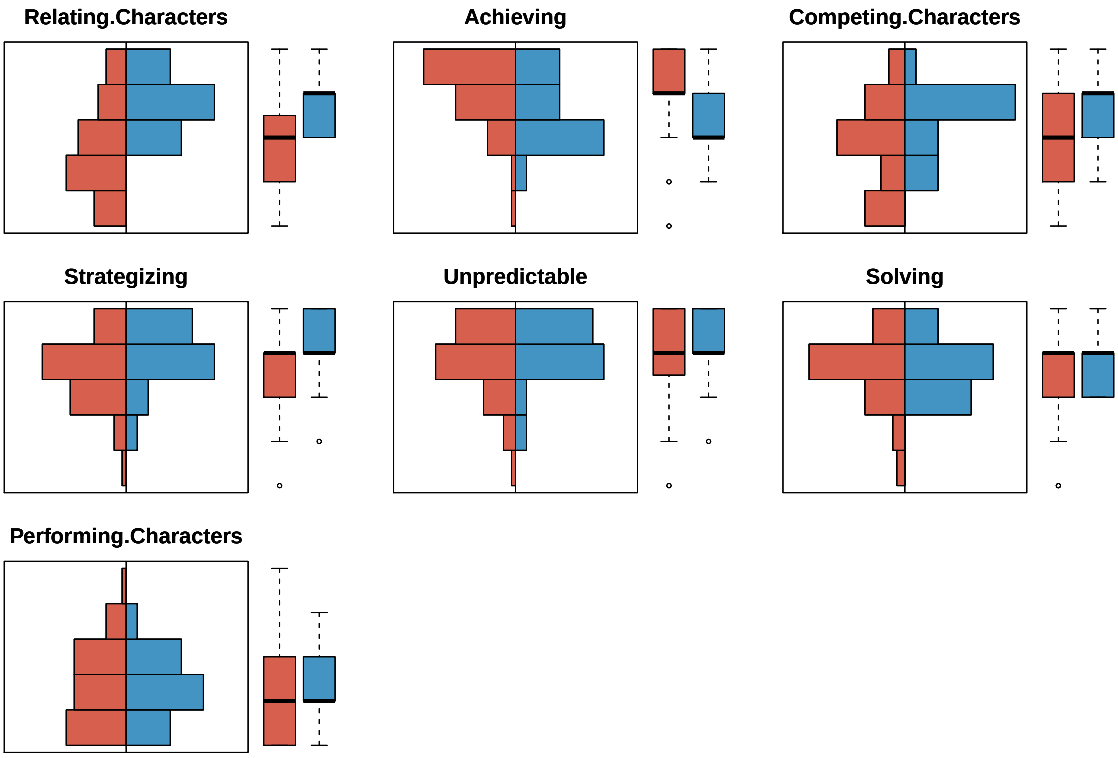

Figure 6.7: Comparing a sample of the experiment group's (left / red, n=47) and trial group's (right / blue, n=18) preference responses in order from most different to most similar when viewed from left to right and then top to bottom.

6.2 In-game behaviour data

In Section 5.2 we introduced our 17 in-game behaviour variables and explained how we calculated them by observing participants of our experiment as they played our testbed role-playing video game (RPG). In this section, we describe the in-game behaviour data we

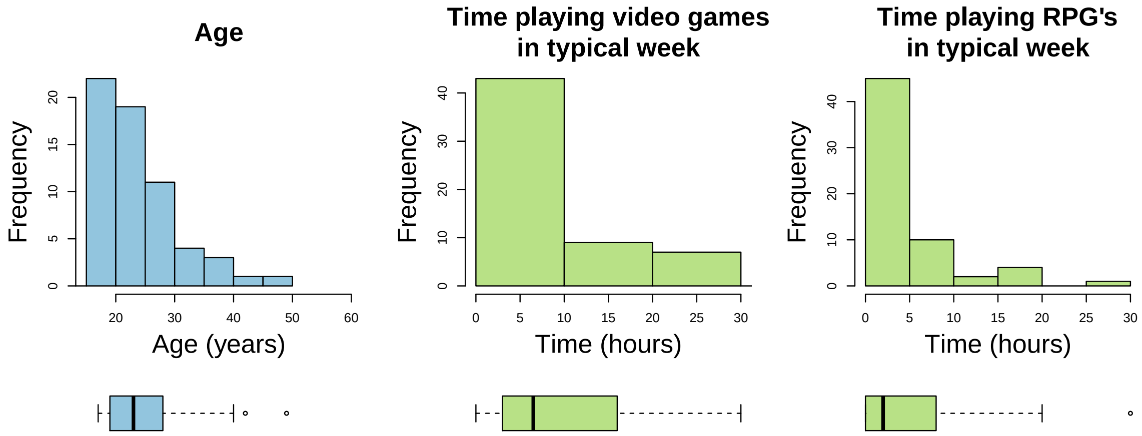

Figure 6.8: Histogram and corresponding boxplots describing the demographic of the 62 participants who played our testbed role-playing video game for at least five minutes each.

collected from 62 participants of our experiment who all played our testbed video for at least five minutes each and, on average, either quit or complete our game after approximately 18 minutes. Nearly without exception, this group of 62 participants is a superset of the group that completed our preference survey (Section 6.1.1). For the sake of completeness, Figure 6.8 and Table 6.5 describe the demographic of this larger group. The reason our behaviour data sample is larger than the preference data sample is because not all participants correctly completed our preference survey while nearly all participants played our testbed video game for a duration of at least five minutes.

The goals of this section are to describe the nature of our chosen behaviour variables and determine whether each is actually suitable to be correlated with the gameplay preference variables already described in Section 6.1. As noted in the beginning of Section 5.2, we intentionally chose behaviour variables that were both suitable and unsuitable for our purposes so that we can demonstrate what exactly makes a behaviour variable suitable in

Gender	**Count**
Male	50 (81%)
Female	12 (19%)
Country in which participants grew up	**Count**
Australia	36 (58%)
Other (12 countries)	26 (42%)
Main field of study	**Count**
Computer science	27 (43%)
Engineering	6 (10%)
Design	5 (8%)
Social science	5 (8%)
Other	5 (8%)
None	14 (23%)
Experience playing video games	**Count**
Played them frequently or regularly at some point	49 (79%)
Played them occasionally or casually at some point	11 (18%)
Only ever played them a few times	1 (1.5%)
Never played them	1 (1.5%)
Experience playing role-playing video games (RPG's)	**Count**
Played them frequently or regularly at some point	42 (68%)
Played them occasionally or casually at some point	13 (21%)
Never played them but would probably know how to	5 (8%)
Never played them and would not know how to	1 (1.5%)
Not sure what a role-playing video game is	1 (1.5%)

Table 6.5: Demographic of the 62 participants who played our testbed role-playing video game for at least five minutes each.

this section. In Subsection 6.2.1 we describe our set of six temporally stable, non-binary behaviour variables, and in Subsection 6.2.2 we describe our set of eight temporally unstable, non-binary behaviour variables. Finally, in Subsection 6.2.3 we confirm whether each variable is sufficiently dispersed (i.e., different players produced different variable values) and not redundant.

6.2.1 Temporally stable behaviour variables

Figures 6.9 and 6.10 provide a concise summary of the degree to which some of our behaviour variables (that we expected to be temporally unstable) varied over time. Figure 6.9 compares the values produced by the in-game behaviour of one group of three participants and Figure 6.9 does the same for a *different* group of three participants in order to provide a more general picture of how the variables varied. While the *x-axis* of these figures represent time, all values are actually scaled so that seven key events that can occur while playing our testbed video game all line up at the same point on the figure for each participant. Additionally, these figures describe behaviour variable values calculated fom two different observation periods: from the beginning of each playing session to the beginning of quest two, and from the beginning of quest two to the completion of the final quest. Of course, not every player reached each of the seven key points in the time described by these figures. Most players either skipped some of the optional key points (e.g., entering and then exiting the dungeon) or quit playing before completing the final quest. The six participants highlighted in these figures were a random selection from a subgroup of 17 participants who fit the critera by reaching each of the seven key points.

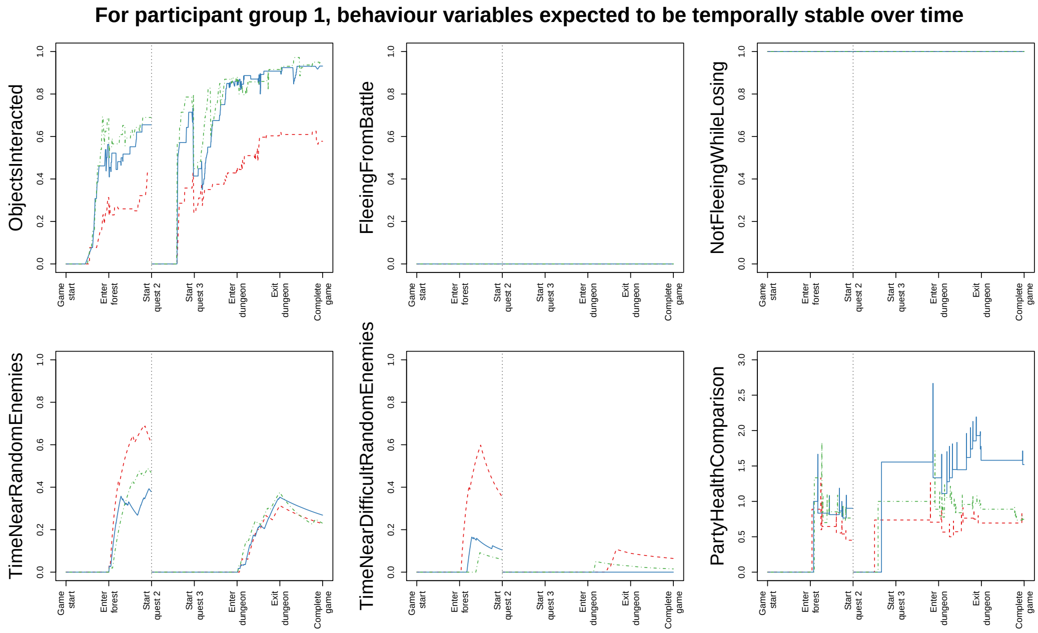

Figure 6.9: Line plot describing how three participant's in-game behaviour affected a selection of behaviour variables that we expected to be relatively stable over time.

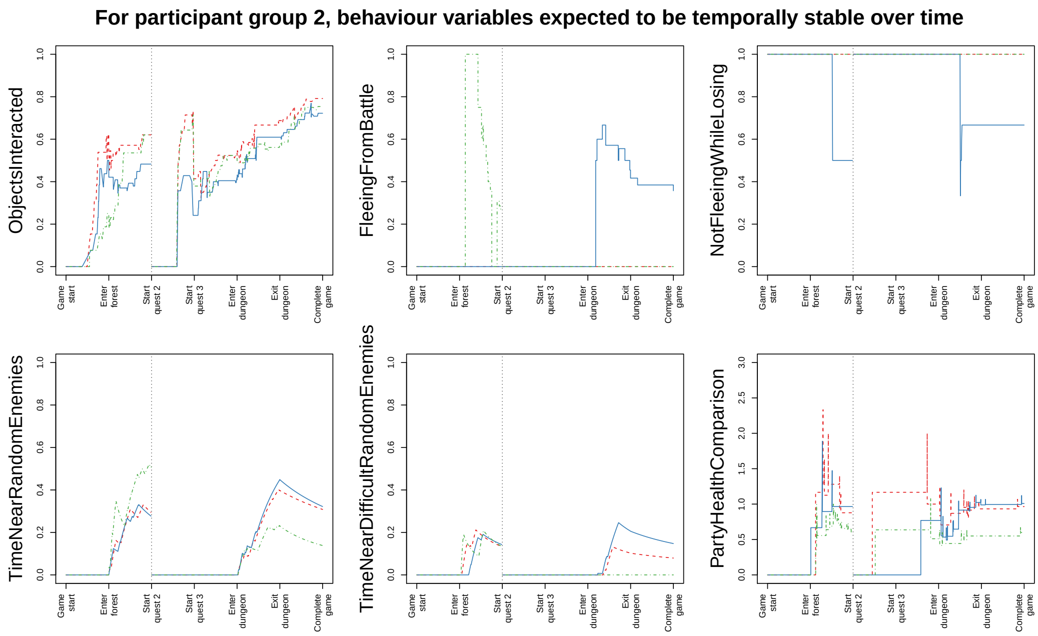

Figure 6.10: Line plot describing how another three participant's in-game behaviour affected a selection of behaviour variables that we expected to be relatively stable over time.

Using Figures 6.9 and 6.10 we can make a few helpful observations that follow up our discussion of the temporal nature of our behaviour variables in Section 5.2.6. Firstly, the *FleeingFromBattle* and *NotFleeingWhileLosing* behaviour variables rarely varied. Secondly, the variance found in the *TimeNearRandomEnemies* and *TimeNearRandomDifficultEnemies* behaviour variables are a result of only a few points in time. In the case of all these four variables, this points to the fact that the variation in these variables are based on only a small number of data points (i.e., only a few player actions contributed to the values of the variables). Figure 6.11 also confirms that the *FleeingFromBattle* and *NotFleeingWhileLosing* variables relatively lacked in variation by plotting the distribution of each of these variable's values when calculated from two different observation periods. As a consequence of this lack of information and variation, we cannot conclude with much confidence whether these four variables describe a meaningful trend of player behaviour that remains consistent over most or all of a participant's playing session.

Thirdly, this leaves the *ObjectsInteracted* and *PartyHealthComparison* behaviour variables as the most interesting and potentially useful. While inconsistent at times for particular participants, these last two variables starkly contrast the four previously discussed behaviour variables in that the differences they describe in the set of six participants is generally consistent over time. As noted in Section 5.2.6 this consistent difference between players over time points to some *temporally stable* difference as the cause. Additionally, before discussing the difference between different observation periods, we make the general observation that these temporally stable variables do not look particularly temporally stable. However, as we will show in Subsection 6.2.2, they are somewhat more temporally stable when compared to

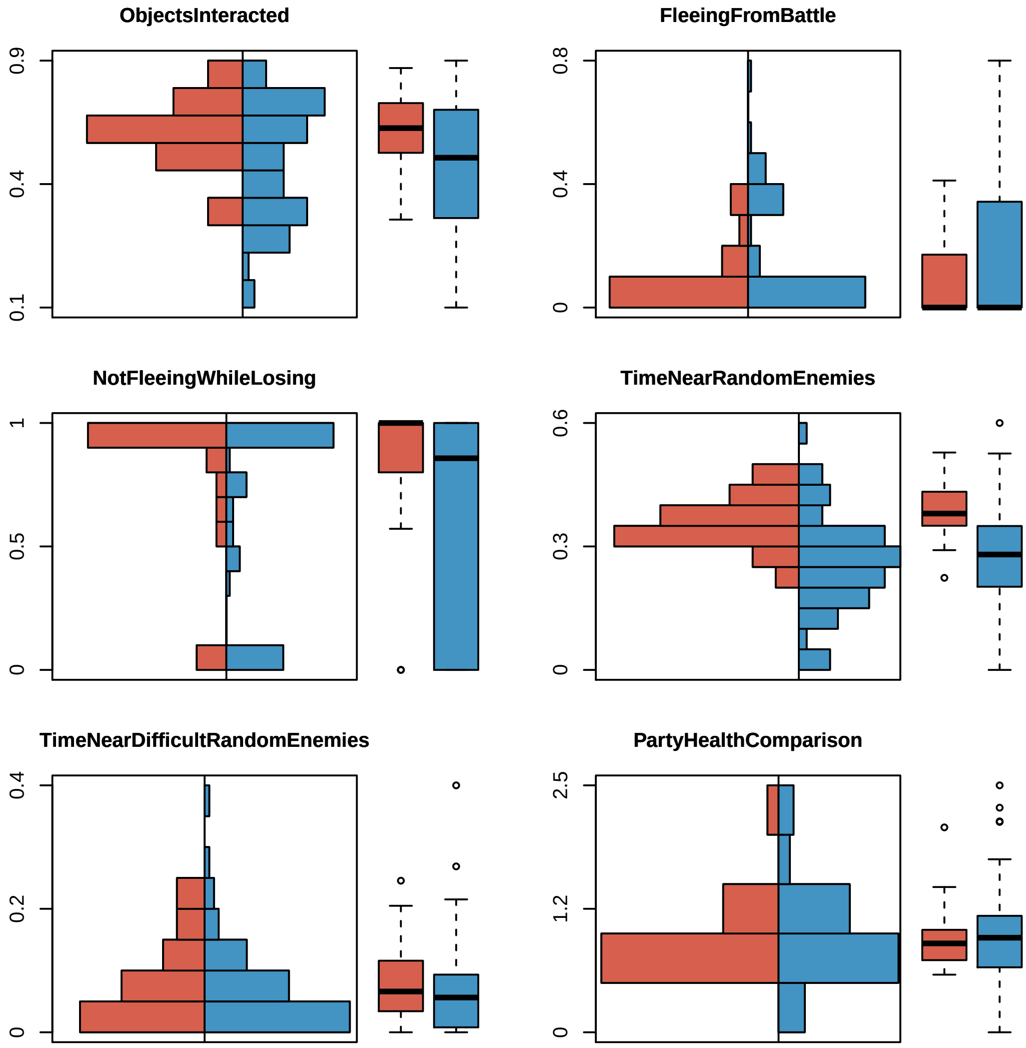

Figure 6.11: Comparing distributions of behaviour variables expected to be temporally stable. Observed from game start to exiting the dungeon (left / red, n=23), and from game start to either game quit or completion (right / blue, n=62).

a set of behaviour variables that we expected to be temporally unstable.

Finally, Figures 6.9 and 6.10 show that, at least in the case of the *ObjectsInteracted* and *PartyHealthComparison* behaviour variables, the first observation period (i.e., from the beginning of the playing session to the beginning of the second quest) can be used to produce values of similar meaning to that of the later, second observation period (i.e., from the beginning of the second quest to the completion of the game). We say this because the difference in the behaviour variable values between each player was relatively similar both between and throughout each observation period. Figure 6.12 also contributes to the point by describing distributions that are relatively similar in shape in most cases when the values of the same set of behaviour variables are calculated during the following observation periods: from the beginning of the second quest to the end of the playing session, and from the beginning to the end of the playing session. The is an important point because, as we discussed in Section 5.2.7, an ideal observation period begins and ends as early in a playing session as possible while still containing much or all of the player behaviour information from the entire playing session.

Additionally, while not intended to be conclusive evidence, we take this to at least suggest that players did not take very long to learn how the game worked and began selecting in-game actions in a well-informed manner. The alternative conclusion to this is of course that players never really ended up understanding their own choices or how the game worked, and that the figures shown are a result of players fumbling their way through the game. That players did this before beginning the second quest is not terribly surprising given that our demographic is made up of predominantly people with *some* experience in playing games

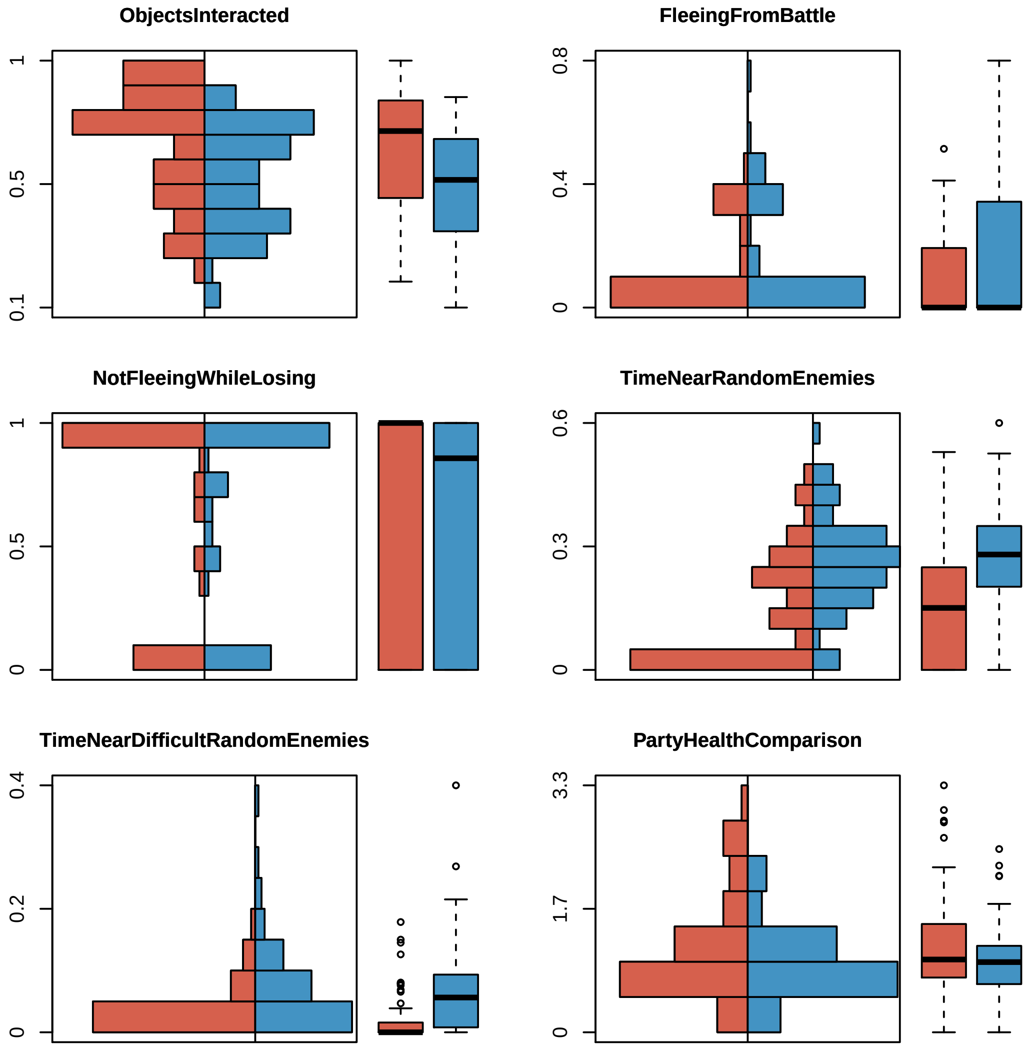

Figure 6.12: Comparing distributions of behaviour variables expected to be temporally stable. Observed from start of quest 2 to either game quit or completion (left / red, n=52), and from game start to either game quit or completion (right / blue, n=62).

in the same genre as our testbed video game (see Table 6.1). Furthermore, in many cases, players used the open-ended post-game survey question as a chance to offer advice on how to make our testbed video game, in their opinion, better.

6.2.2 Temporally unstable behaviour variables

Figures 6.13 and 6.14 serve the same purpose as Figures 6.9 and 6.10 in Subsection 6.2.1 except provide a summary of eight behaviour variables that we expected to be temporally *unstable* rather than temporally *stable*. The observation periods and the two groups of three participants randomly sampled for these figures are the same as that used in Figures 6.9 and 6.10.

By describing how the values of these eight behaviour variables vary over time, we now make a further set of observations. Firstly, these participants who completed the game were all similarly eager in the amount of optional maps and quests they visited and completed (see variables *OptionalMapsVisited* and *OptionalQuestsCompleted*). Secondly, with the exception of one of the participants in Figure 6.13, all participants even found a highly similar number of hidden keys and then used them to open the corresponding dungeon doors (see variables *KeysFound* and *LocksOpened*). Consequently, we can conclude that players who both visited the dungeon and then completed the game are similarly interested in exploring all the optional aspects of the game and consequently these variables do not vary significantly. Figure 6.15 confirms that, when including the participants who did not go on to complete the video game, these variables do not paticularly lack in variation and still may be useful when correlating them with gameplay preference variables with a broader sample. While an attempt was made

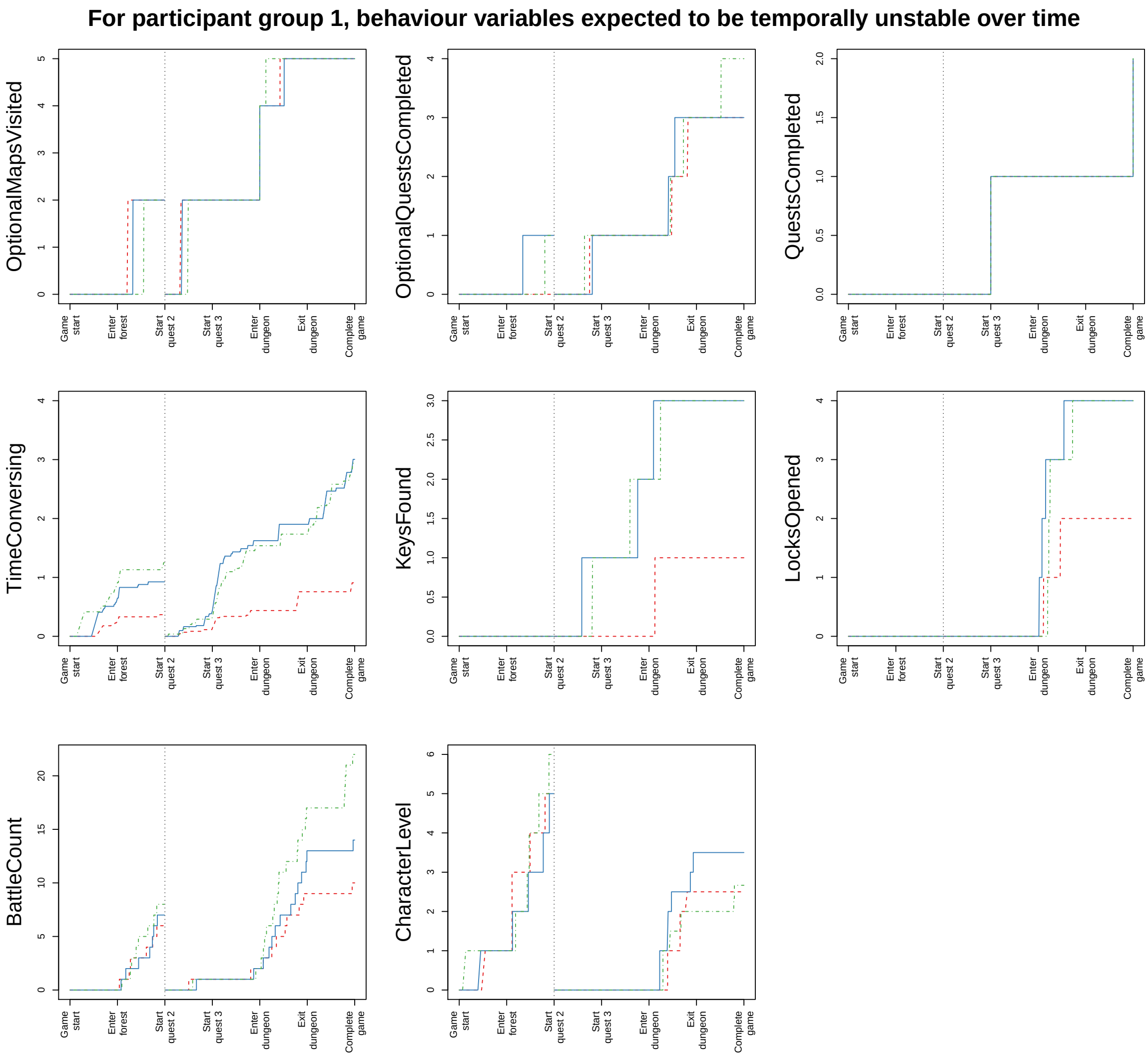

Figure 6.13: Line plot describing how three participant's in-game behaviour affected a selection of behaviour variables that we expected to be relatively unstable over time.

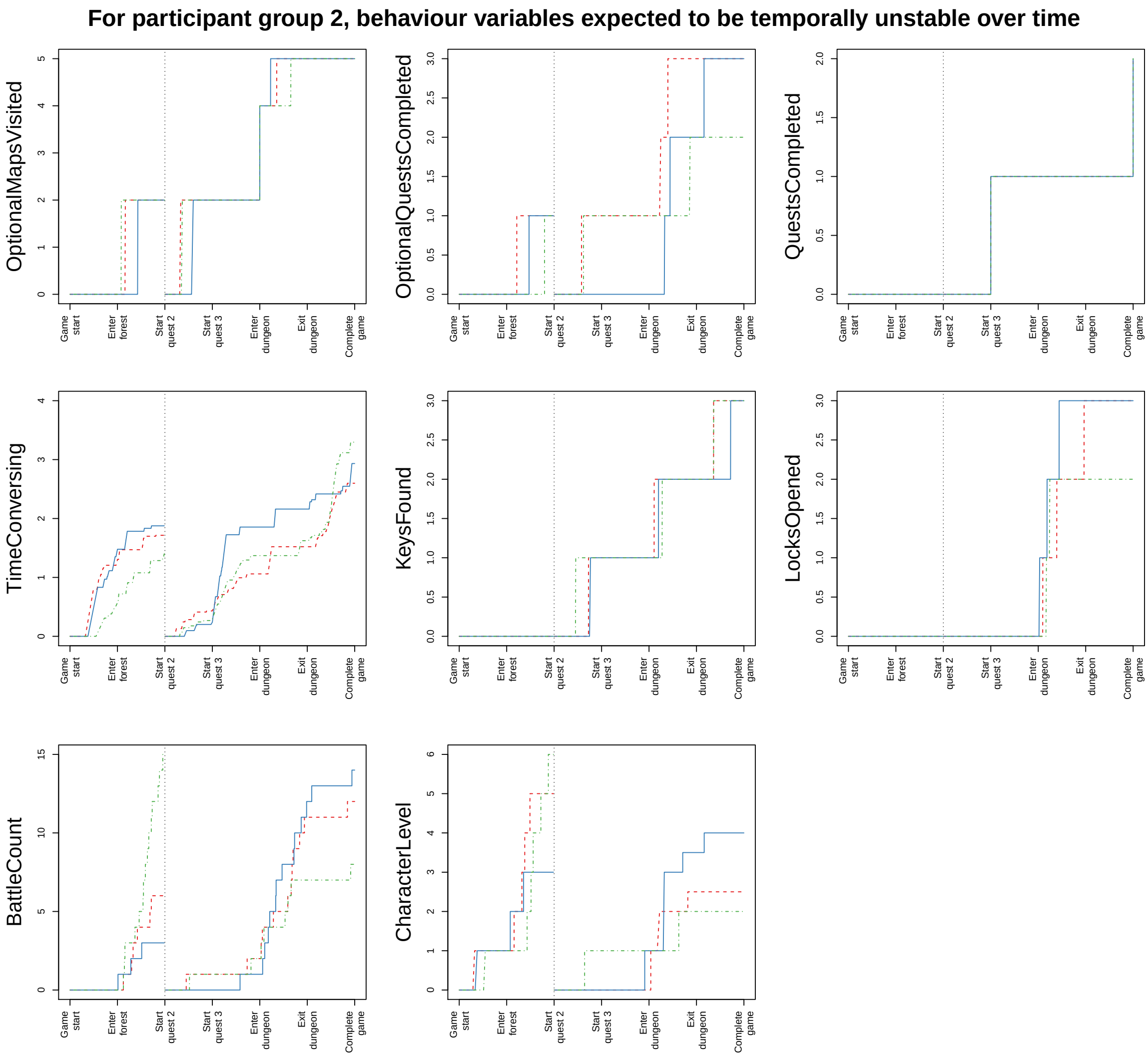

Figure 6.14: Line plot describing how another three participant's in-game behaviour affected a selection of behaviour variables that we expected to be relatively unstable over time.

to compare the difference in the behaviour variable values between players who completed the game and those who did not, there was unfortunately no visibly obvious difference in the values of our chosen behaviour variables. If an obvious difference was observable, we would have been able to say that those who went on to complete the game behaved differently to those who did not go on to complete the game, even early in the playing session.

Thirdly, the difference in value of the *TimeConversing* variable did not considerably vary except in the case of one participant in Figure 6.13. Finally, the *BattleCount* and *CharacterLevel* variables both have an interesting effect that relatively consistently *reverses* the difference between each participant. Effectively this means players who entered an *above average* number of battles *before* completing the second quest (i.e., in the forest area) then went on to enter a *below average* number of battles in the later, dungeon area. Because this combat activity does not significantly change between the forest and dungeon area, we suggest that this effect is due to the fact that players either did not feel the need to continue entering battles in the dungeon, or that players had by that point become bored with combat and had experienced it enough.

We now close this subsection with a more general observation of a special case in Figures 6.13 and 6.9 described by the red, dashed line. These figures show us that this participant is a special case representing someone who rushed through our testbed video game, choosing to skip quickly through the compulsory aspects of the game and also avoid some optional aspects. Given the responses given to our survey questions, it is unclear whether this participant was being rushed by something external to the playing experience, or instead simply played our testbed video game in this manner. We also cannot conclude whether or not

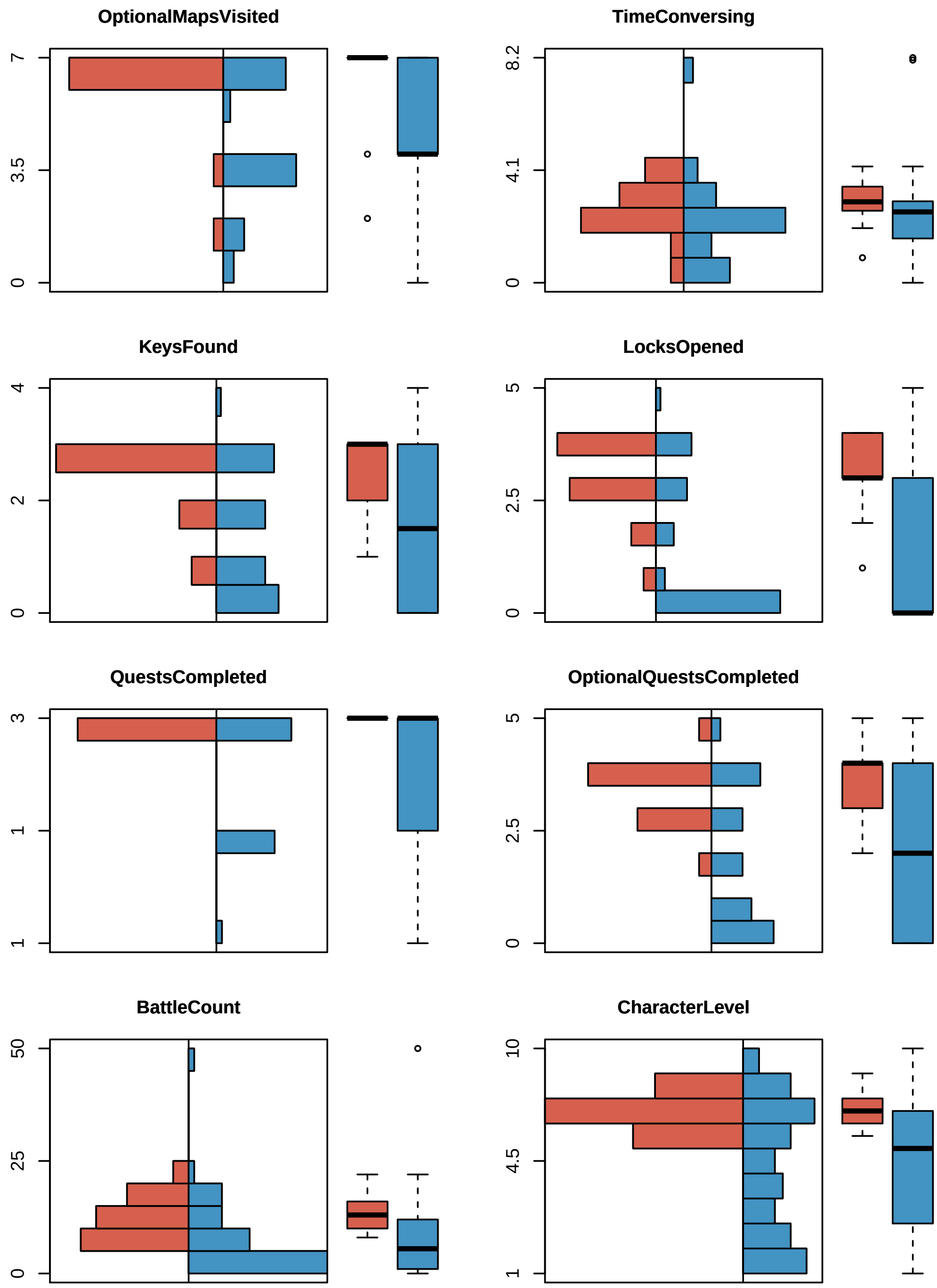

Figure 6.15: Comparing distributions of behaviour variables expected to be temporally unstable. Observed from start of quest 2 to game completion (left / red, n=18), and from start of quest 2 to either game quit or completion (right / blue, n=52).

this effect applies more generally to the manner in which this participant plays other video games.

6.2.3 Dispersion and redundancy

In this subsection we now formally introduce two further metrics for assessing whether a behaviour variable is suitable for correlation with a player's gameplay preferences: dispersion and redundancy. By dispersion we mean the degree to which the variable values varied between each participant, and by redundant we mean whether any two behaviour variables highly correlate with another and thus make the observation of one of the two unnecessary. Doing so is our method of further assessing whether these variables will be useful for the final step of our analysis that correlates them with particular gameplay preference variables.

Firstly, to test for dispersion we attempted to select a measure that was both *dimensionless* and *scale invariant* to account for the fact that our behaviour variables differ in both these properties when compared with each other. However, commonly used measures that possess these properties (e.g., variation coefficient, disepersion coefficient, and relative standard deviation) did not produce values for each variable that could be meaningfully compared because the mean of some variables were so close to zero. So instead we rely on manual observation of the behaviour variable's distributions. Most of these distributions were already shown in Subsections 6.2.1 and 6.2.2 except for the three binary behaviour variables that we now present in Table 6.6.

Secondly, we then tested for any possible redundancy in our set of behaviour variables by assessing the degree of correlation between each behaviour variable and then performing

Behaviour variable	***True***	***False***
WizardCharacterSelection	24 (34%)	46 (66%)
ThiefCharacterSelection	18 (26%)	52 (74%)
OptionalBullyQuestCompleted	34 (49%)	36 (51%)

Table 6.6: Frequency of each each binary behaviour variable values as logged from the start to the end of the participant's playing session (n=62).

an additional test that describes each correlation value's statistical significance. We did this by using Pearson's *r* [Cohen], a parametric correlation measure suitable for interval or ratio level variables. We also used Kendall's *tau*, by first ranking our ratio level variables, and then compare the results from our use of Pearson's *r*. We used both correlation measures and compare the results to counter any possible effect that may have arisen from our violation of Pearson's *r* assumption of normality. In this section we only report the *tau* values because they were highly similar to those produced when using Pearson's *r*. Only some of our behaviour variables appeared to have a relatively normal distribution (skewed or otherwise) when calculated from different observation periods.

Figure 6.16 shows the *tau* correlation values for each of our behaviour variables that were calculated from the beginning of the playing session to the completion of the game (n=27). Figure 6.17 describes the distribution of *tau* values that occurred in Figure 6.16. Using this particular observation period, this suggests that the following groups of behaviour variables are significantly correlated with each other, either positively or negatively:

1. Positively: *OptionalMapsVisited*, *LocksOpened*, *OptionalQuestsCompleted*, *KeysFound*;

2. Positively: *BattleCount*, *CharacterLevel*;

3. Positively: *NotFleeingWhileLosing*, *FleeingFromBattle*.

Other variables also correlated to a certain degree but not as significantly as those in the above list. Also, we do not include slighly negatively correlated cases of *WizardCharacterSelection* and *ThiefCharacterSelection* as we already know these are mutually exclusive (i.e., players could only choose one playable character at the beginning of the game). Furthermore, the only other possibly significant effect that the choice of character had was on the *PartyHealthComparison* variable which makes sense because the wizard character has the highest health point value of all the three possible characters. This is significant because the choice of character has a noticeable effect on the *PartyHealthComparison* variable, not only player behaviour following their choice of character. Ideally, each behaviour variable would not be affected significantly by this early, once-off choice and instead reflected how the game was being played throughout the session.

Figure 6.18 inspects the strongest correlations more closely by plotting all of the relevant variables against each other with a line of best fit as was done in Section 6.1.3. This analysis of behaviour variables shows a higher degree of dependency between some of our behaviour variables than we had anticipated. For example, we assume that some of the optional maps that players did not visit are two of the dungeon maps in which keys were used to open locked doors. More generally however, there are also indications that players either did many non-battle activities (i.e., picking up keys, opening locked doors, completing optional quests, visiting optional maps) or they did few. Another way of looking at it is to say that players appeared to generally either interact with everything that they came across or did not bother to go out of their way to find these optional things.

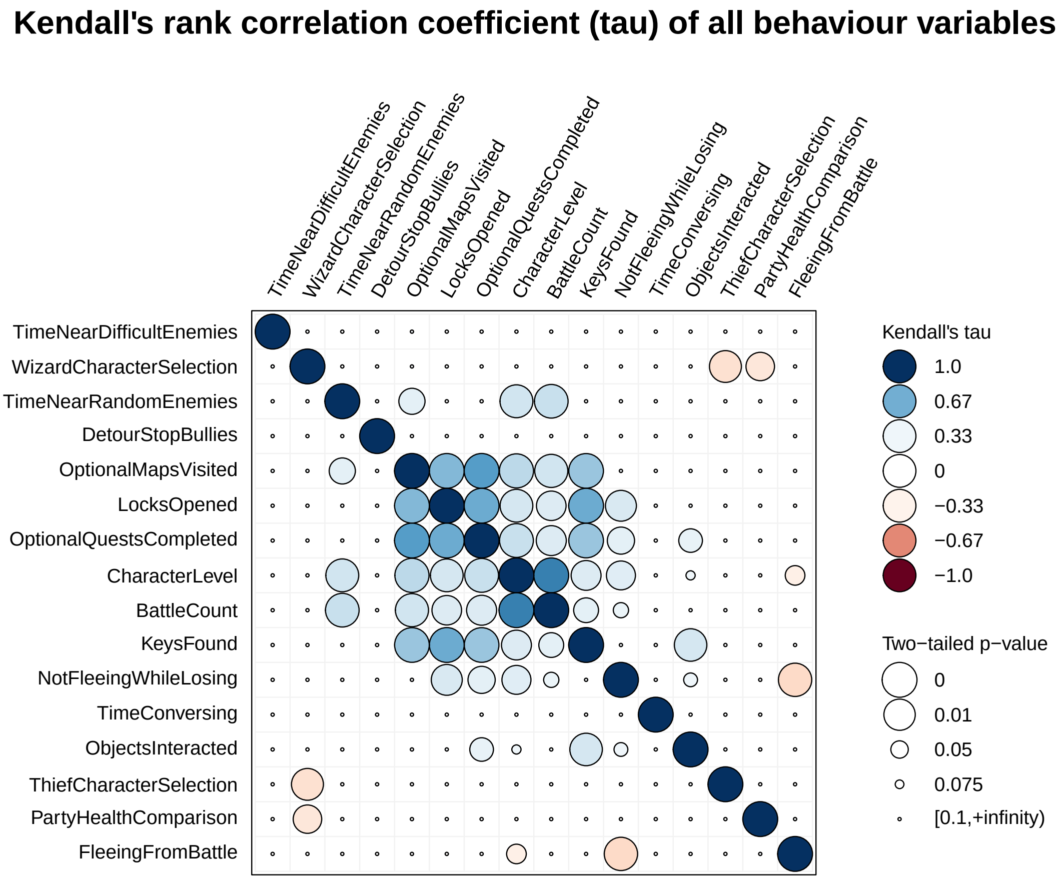

Figure 6.16: Correlation matrix describing the strength of correlation between behaviour variables, as well as their statistical significance. Variables were logged from the start of the playing session to completion of the game.

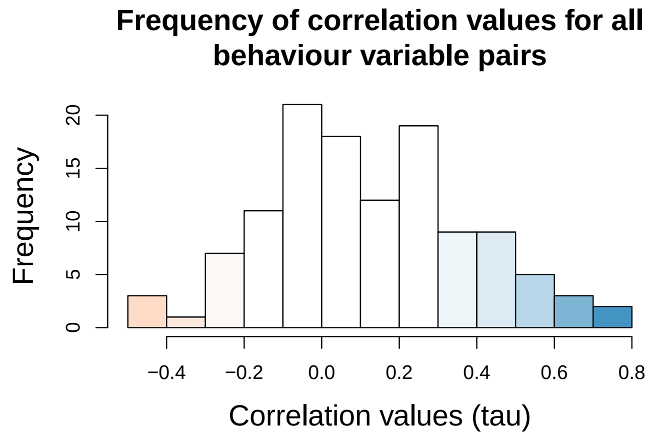

Figure 6.17: Histogram describing the frequency at which different values occurred when correlating all behaviour variables with each other. Variables were logged from the start of the playing session to completion of the game.

Also, the correlation between the *BattleCount* and *CharacterLevel* variables shows us that players generally won the battles that they entered because a direct consequence of winning multiple battles is the increase of the player character's level. This is also another indication that our game did not offer a particularly high level of challenge during combat. Because of the lack of variation in both the *FleeingFromBattle* and *NotFleeingWhileLosing* we are hesitant to conclude that these variables were particularly correlated. Finally, we note that with the exception of *FleeingFromBattle* and *NotFleeingWhileLosing*, the most significant correlations have occurred between unstable variables. This is a possible indication that some of the unstable variables are redundant because they are significantly dependent on each other, both because of the game's rules and also how players generally behave within them.

All other previously discussed observation periods produced similar values to those shown in Figure 6.16. That is, except when the behaviour variables were calculated from the

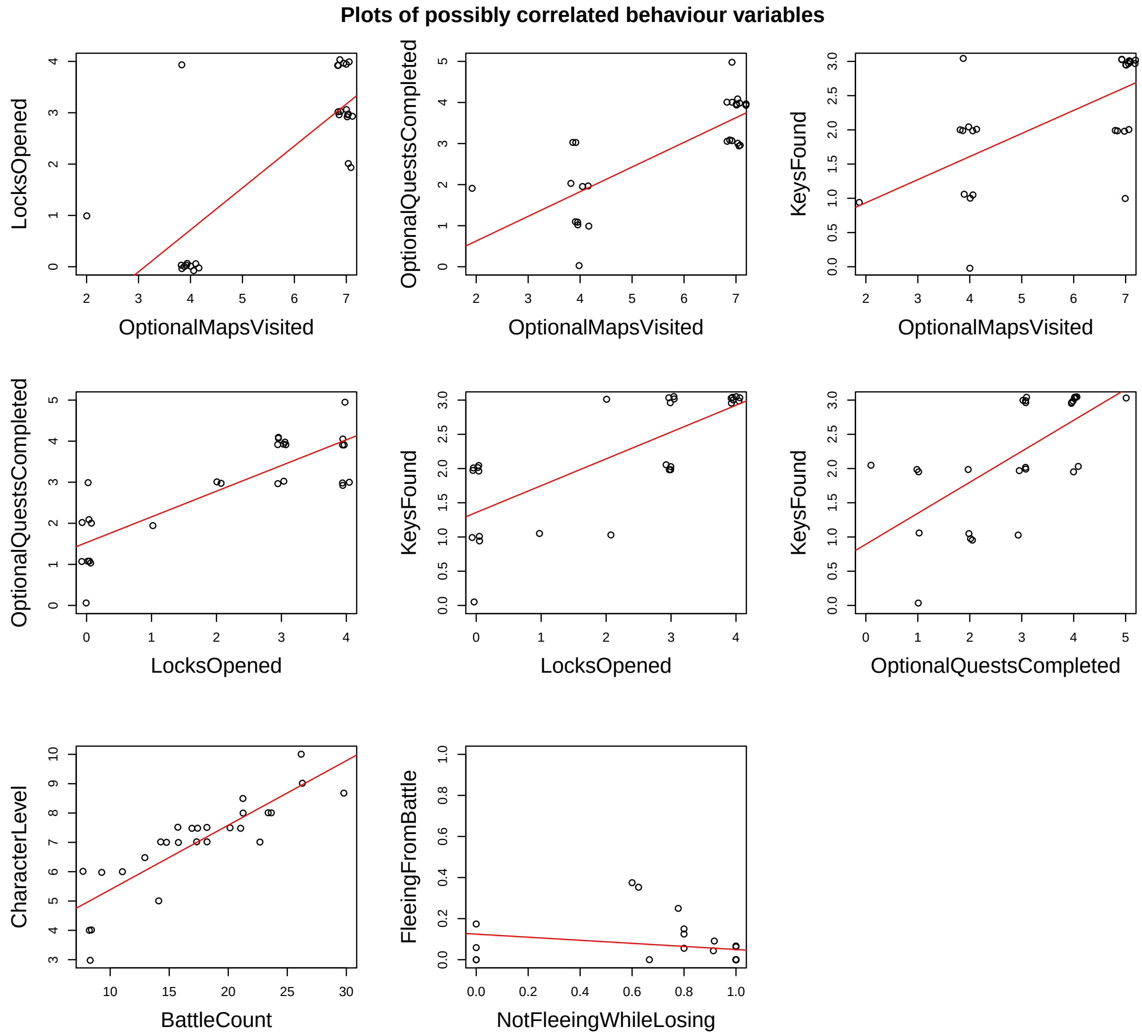

Figure 6.18: Scatterplots visualising the most strongly correlated pairs of behaviour variables as calculated from the beginning of the playing session to when players completed the game.

beginning of the playing session to the end, whether players completed the game or simply quit. Figure 6.19 shows the correlation of all behaviour variables for this end point (n=62). Interestingly, the effect observed with the other observation periods is amplified to the point where all unstable variables correlate with each other to some degree. Additionally, two stable variables (*TimeConversing* and *ObjectsInteracted*) also correlate with the group of unstable variables, albeit to a noticeably lesser degree. Based on these observations we suggest that the end point of the playing session is possibly not as useful as other observation period end points if independence between behaviour variables is the goal. Finally, we conclude this section by stating that we observed some redundancy in our set of behaviour variables, particulary between our unstable variables. However, we refrain from discarding any of these redundant variables, and any other behaviour variables shown to be unsuitable, when measuring their correlation with our preference variables in the next section. We do this so that we can more definitively conclude whether hypothesised associations between specific behaviour and preference variables actually exist.

6.3 Correlation of survey and behaviour data

In this section we test the primary hypothesis of this thesis: whether any of our gameplay preferences correlate with variables derived from player behaviour within our testbed role-playing video game. We do this by testing whether specific gameplay preference and in-game behaviour variables correlate. The specific variable pairs that we hypothesised would correlate were listed in Section 5.2.

As already established earlier in the chapter we consider our preference responses to be

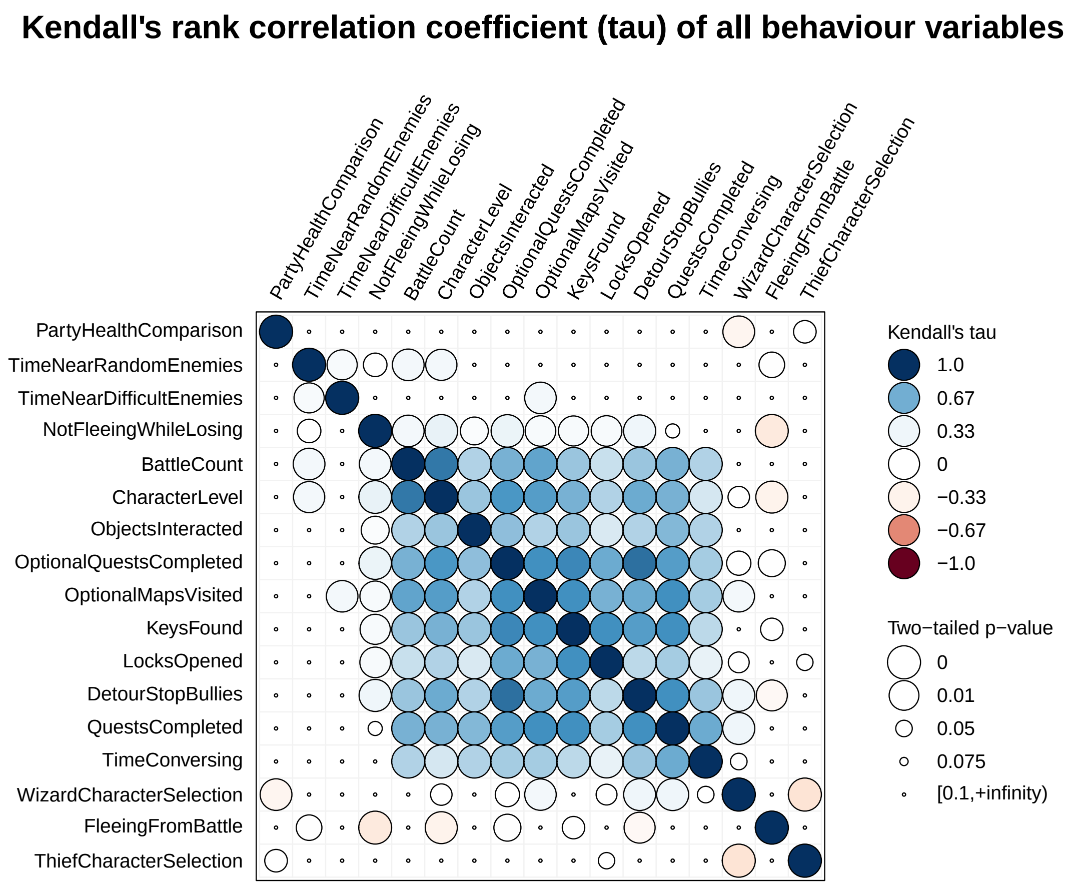

Figure 6.19: Correlation matrix describing the strength of correlation between behaviour variables, as well as their statistical significance. Variables were logged from the start of the playing session to the end.

measured at an ordinal level (i.e., only the order of values are considered meaningful and the distance between them is not assumed to be known), and our in-game behaviour variables are either binary (i.e., categorical variable that can only have two possible values) or measured at a ratio level (i.e., the distance between values are known and the zero point is fixed/absolute). This is important because in order to correlate them we have to convert them to the same level of mearsurement. In the case of comparing our ordinal preference variables with our ratio behaviour variables, we have chosen to convert the behaviour variables to an ordinal level of measurement. We consider the information loss inherent to this process to be favorable when compared to the likely undeserved information gain yielded by the reverse (i.e., converting our ordinal preference variables to a ratio level of measurement).

We start our analysis by plotting each category of preference-behaviour hypotheses in Figures 6.20 to 6.24. The behaviour variables used in this case were calculated from the start of the playing session to the end. While other figures were created using other, previously discussed, behaviour observation periods, they did not meaningfully differ to the results presented here and so we did not include them. As manual observation of these figures suggest, these variables do not appear to obviously correlate.

We now statistically test the manually observed suggestion that our selected preference and behaviour variables actually do not correlate. Figure 6.25 shows the correlation statistics of not only these specific variables but the testing of all gameplay preference variables with all behaviour variables in an attempt to find significant correlations in any case, not only those that we hypothesised. We used both Spearman's *rho* and Kendall's *tau* but include only Kendall's *tau* as we did in Section 6.1.3. Figure 6.26 describes the distribution of *tau*

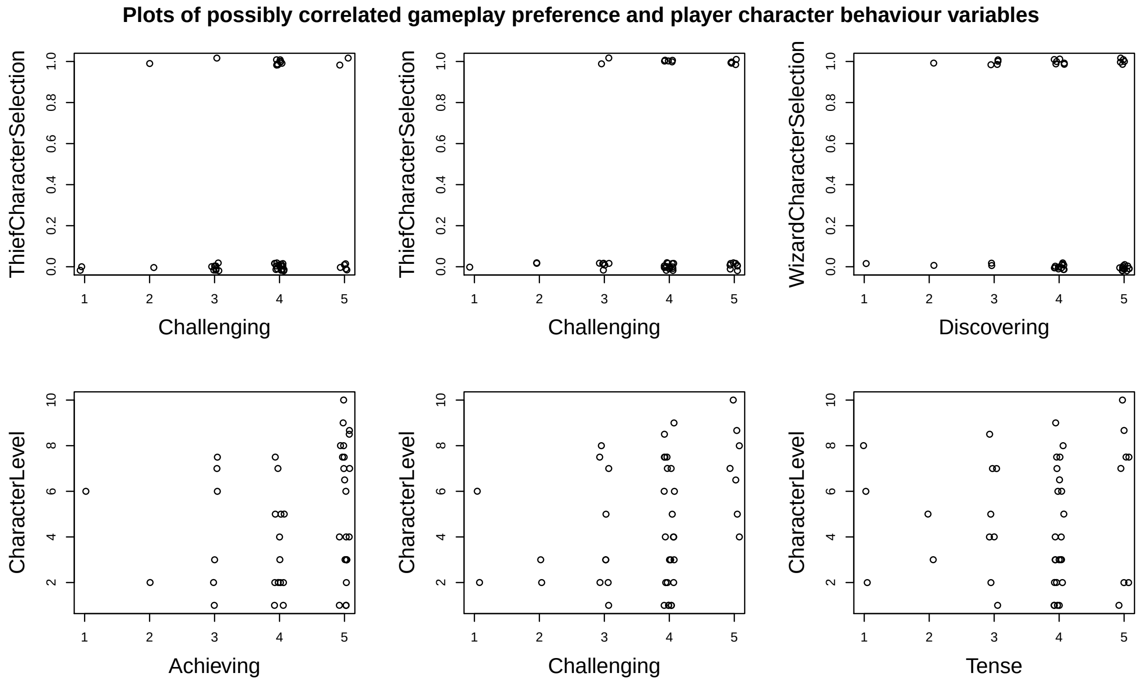

Figure 6.20: Scatterplots of gameplay preference and player character behaviour variables that are hypothesised to be correlated in some way.

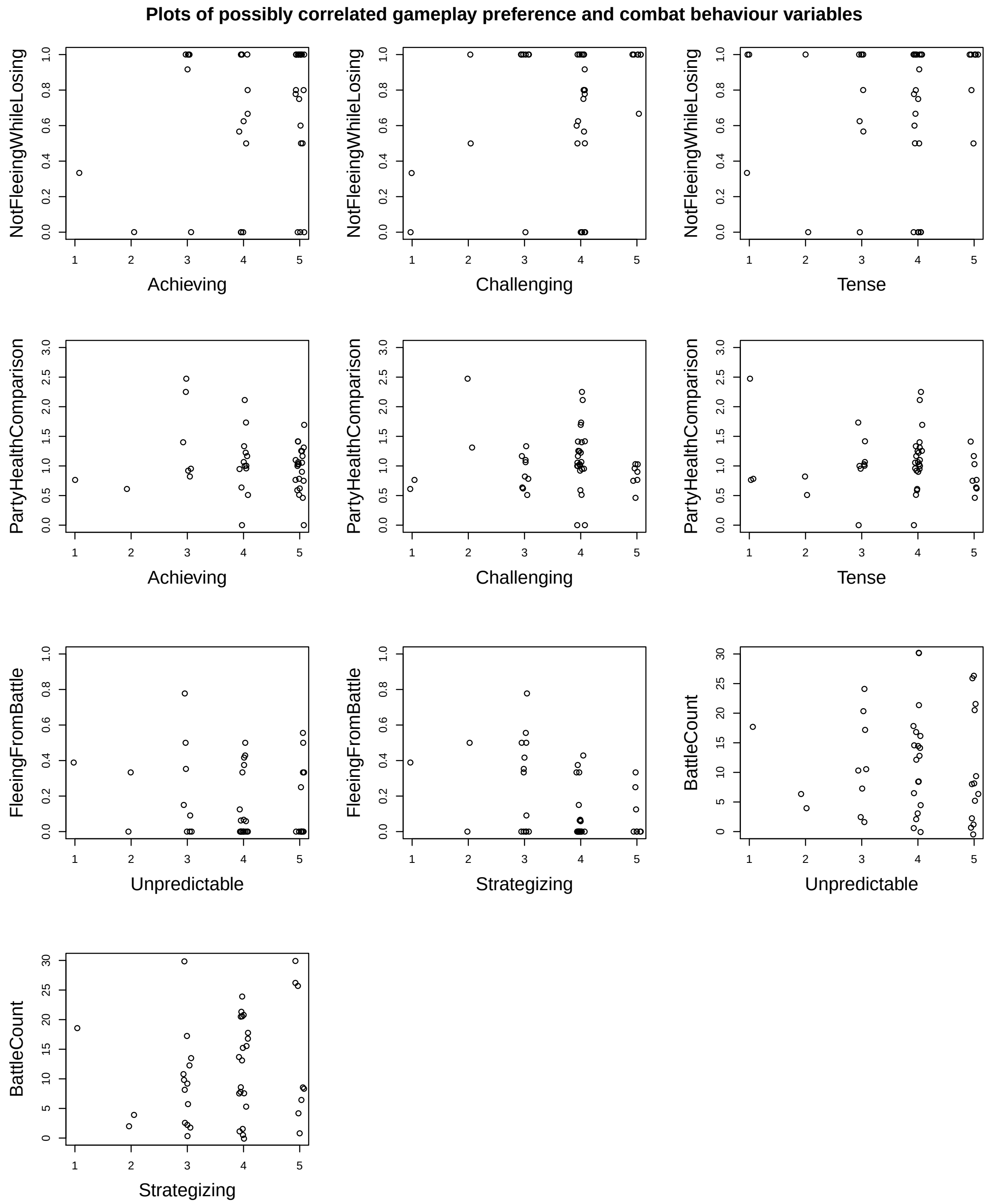

Figure 6.21: Scatterplots of gameplay preference and combat behaviour variables that are hypothesised to be correlated in some way.

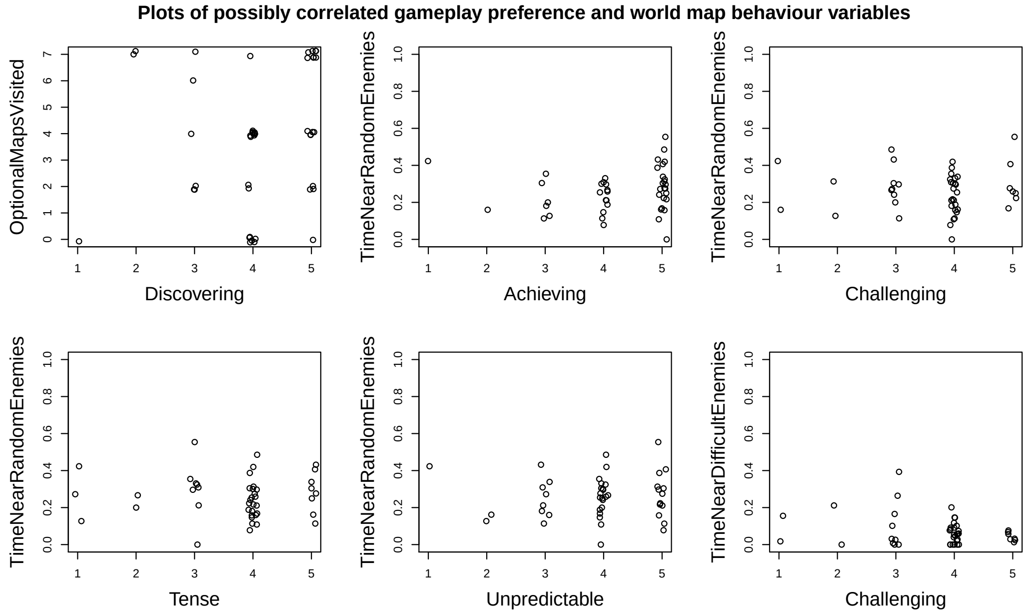

Figure 6.22: Scatterplots of gameplay preference and world map behaviour variables that are hypothesised to be correlated in some way.

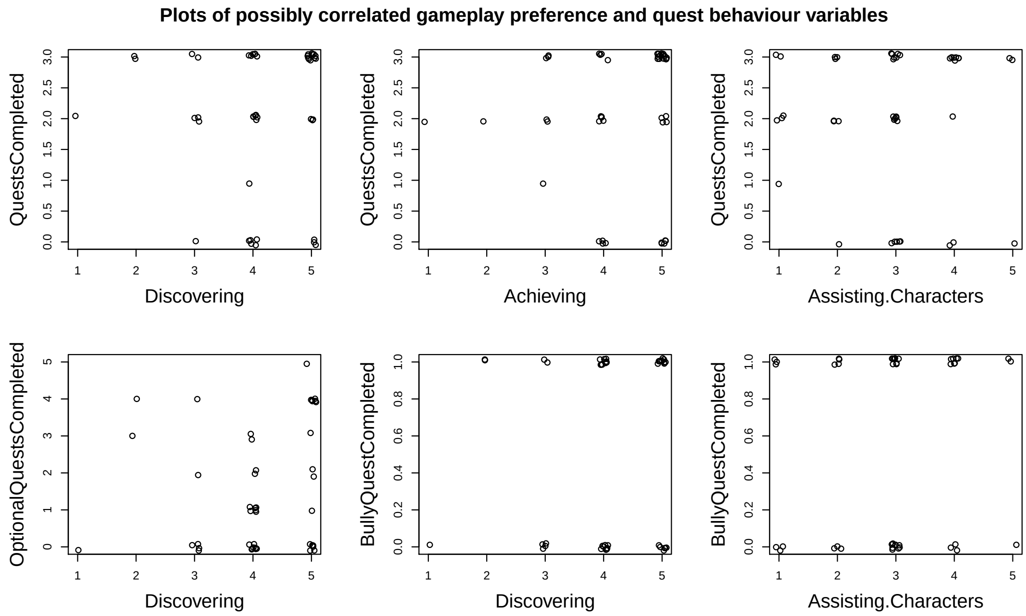

Figure 6.23: Scatterplots of gameplay preference and quest completion behaviour variables that are hypothesised to be correlated in some way.

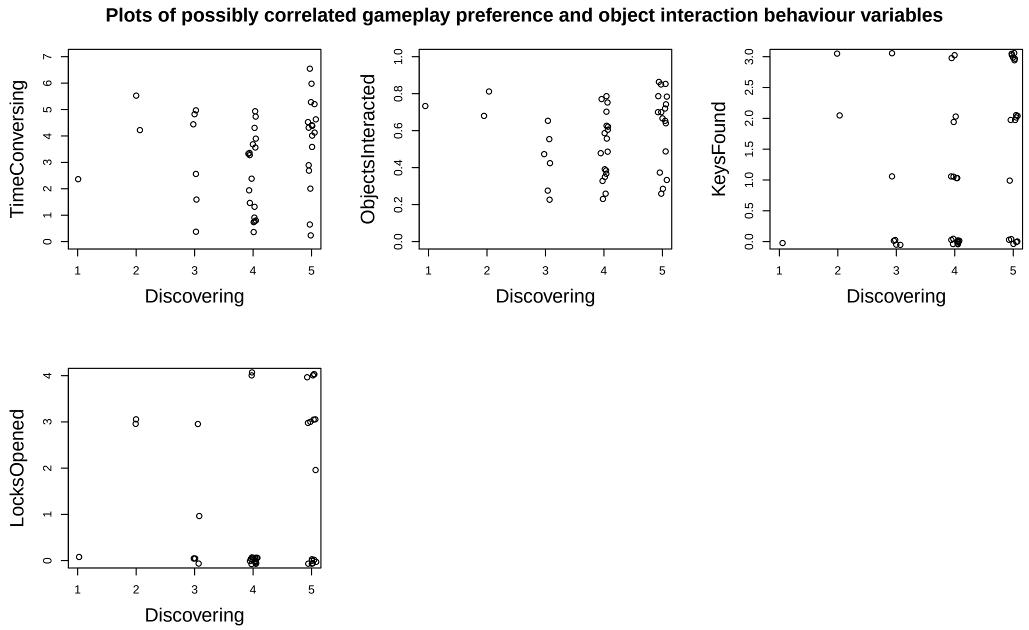

Figure 6.24: Scatterplots of gameplay preference and object interaction behaviour variables that are hypothesised to be correlated in some way.

values that occurred in Figure 6.25. In addition to what we describe in this section, we also correlated each of our preference variables with all of the additional 90 behaviour variables that we have not included in this thesis. In every case we did not find a pair of preference and behaviour variables that were significantly correlated.

Furthermore, we made extensive use of a *naive Bayes classifier* and *decision tree* within a supervised learning setting to further test the predictive power of groups of our behaviour variables. We did this by transforming each of the preference variables to a categorical level of measurement with either two or three values that each represented a *low*, *medium* or *high* preference. We applied machine learning in this way to test whether the correlation measures we previously used simply were not able to uncover a more complex relationship, or account for a likely high level of noise within our preference data. Again, no consistently positive result occurred that led us to believe any of our preference and behaviour variables were associated in some way.

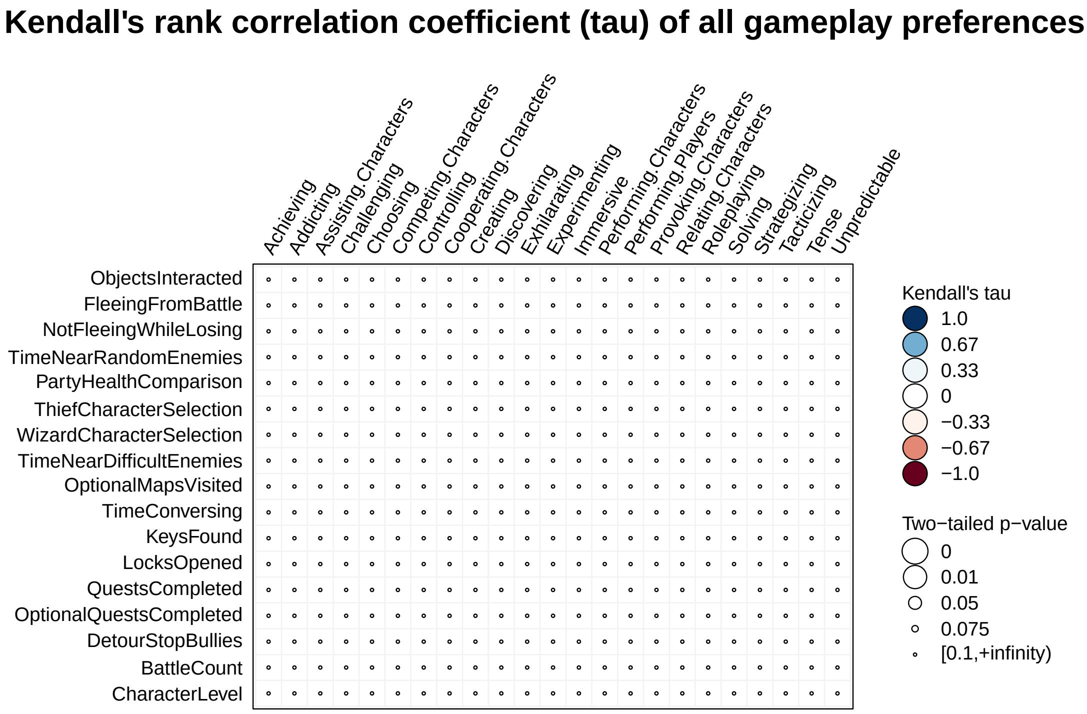

Figure 6.25: Correlation matrix describing the strength of correlation between all preference and behaviour variables, as well as their statistical significance.

Throughout this chapter we have introduced our collected data set of player preference and behaviour variables while taking care to describe the nature of the collected data and its usefulness for our purpose of correlation. The final figures (6.25 and 6.26) adequately summarise the fact that our hypothesis of a correlation between specific preference and behaviour variables could not be conclusively proved. It is for this reason that at in the next chapter (specifically, Section 7.3) where improvements to our methodology could be made so that future studies can generate the conclusive answers we have sought.

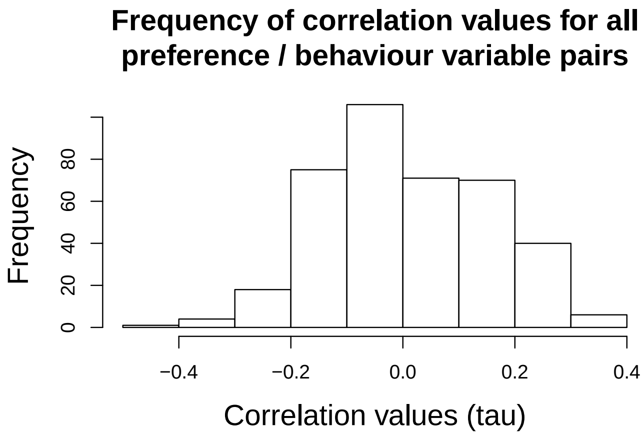

Figure 6.26: Histogram describing the frequency at which different values occurred when correlating all preference and behaviour variables with each other.

Chapter 7

Conclusions and future work

We begin this chapter by summarising the work described in previous chapters (Section 7.1) before briefly discussing the conclusions we have made from our results, including whether gameplay preferences were found to correlate with the in-game behaviour of players (Section 7.2). To complete the thesis we then present various suggestions for possible improvements to our methodology and future work (Section 7.3). This includes related research directions that would serve to inform future work of the nature of a player's gameplay preferences.

7.1 Summary

In Chapter 2 we introduced our novel definition of a player's preferences by comparing it with that held by others. We also discussed the appropriateness of using either a player's preferences, personality, skill level, experience/response, and in-game behaviour as input for a video game personalisation system, including other work that has applied them to personalisation wherever possible. In Chapter 3 we introduced our profile of 22 gameplay preferences, taking care to note the nuances of each that we believe would make them largely independent from each other. This preference set was selected after examining commonly occuring patterns and concepts from with a collection of work that describes a list of preferencs, motivations, or gameplay types. In Chapter 4 we introduced our testbed role-playing video game (RPG), describing details of its design that we hypothesised would either positively or negatively corelate with particular gameplay preferences from Chapter 3. In Chapter 5 we derived a quantitative set of player preference and in-game behaviour variables from the qualitative description of our preference profile (Chapter 3) and testbed video game (Chapter 4). To define quantitative variables from our player preference profile we had to develop a list of Likert-type survey items that were used to elicit the profile via self-report. Additionally, in Section 5.3 we described the structure of the experiment we conducted to collect preference and behaviour data from 62 participants in total. Finally, in Chapter 6 we introduce our collected data and performed a correlation analysis between particular preference variables that we hypothesised would significantly correlate with other variables representing in-game behavioural trends.

7.2 Conclusions

In Section 6.1.3 we performed a correlation analysis on our gameplay preference data. The correlation measure for the five most strongly correlated preference pairs being relatively similar. Additionally, when these five pairs were plotted, visual inspection showed the controlling/achieving and choosing/unpredictable preference pairs seemed more obviously correlated than the others. However, the four preferences that make up those two pairs were of the five most highly rated preferences as shown in Figure 6.3 where a vast majority of ratings were either 4 (very important) or 5 (extremely important). It is for this reason we are hesitant to conclude that any of the the gameplay preferences were significantly correlated and instead simply state that the majority of preferences clearly did not correlate and are likely to be independent of each other.

In Section 6.1.4 we compared the preference responses of two groups: those who completed the preference survey during the final survey trial (*n=18*), and those who completed it following play of our testbed video game during participation of our experiment (*n=47*). The results of a series of Wilcoxon rank sum tests results showed that 18 of 22 preference responses did not significantly vary between two groups. This is considering that in addition to our chosen independent variable (i.e., the context in which participants completed the survey), other variables also changed. Namely, some questions were present in the trial group's survey that were not in the experiment group's, and possibly the demographic of participants differed between groups. Why exactly the response to these three, possibly four, Likert-type items varied between groups whereas the others are suggested to have not is unclear. Perhaps those survey items lacked clarity in the minds of respondents.

In Section 6.2 we performed a series of tests that determined a behaviour variable's suitability for correlation with other temporally stable variables (e.g., a player's gameplay preferences). Using observations made from the test we were able to show how a correlation between our collected gameplay preference variables and following behaviour variables would produce potentially meaningful results: *ObjectsInteracted*, *PartyHealthComparison*, and *BattleCount*. We conclude this largely because these variables described in-game behavioural trends that remained consistently different between multiple participants throughout each playing session, and therefore must have some temporally stable cause.

In Section 6.3, we found that our preference variables did not significantly correlate with any of our behaviour variables. We view this outcome as a conclusive rejection of our hypothesis that any of them *would* in fact correlate and no see no reason to suggest this outcome would change if our data set had consisted of a different (including more balanced) demographic. However, we only assume that this result applies to our *particular* data set that resulted from our *particular* approach described throughout this thesis. Whether gameplay preferences would be found to correlate with specific patterns of player behaviour by using an improved version of our approach still very much remains an open question. To this end, the remaining sections in this chapter describe our suggestions for how further research of this type could be improved and how a positive result might one day be achieved.

7.3 Future work

In this final section of the thesis we describe numerous suggestions for future work. We attempted to view our own work as objectively as possible in order to form a list of improvements that others would benefit from. In doing so, we also identified some related research avenues that would aim to discover the temporal nature of a player's gameplay preferences and what other factors may, at least partially, explain the in-game behaviour of players.

7.3.1 Preference profile

The gameplay preference profile that we introduced in Chapter 3 consists of 22 preferences. As initially discussed in Section 3.4, in hindsight we now consider the initial goal of an all-encompassing profile (i.e., one that factors in a majority of the common gameplay experience types) to be unnecessary. While such a profile may be useful as a theoretical framework, it is unlikely to be of much use to a single example of video game personalisation. The designers who have a specific use for personalisation should be free to define what aspect(s) of the player they want their produce to be personalised to. We imagine that a relatively small set of preferences, similar to the many we first introduced in Chapter 3, would be sufficient. Of course, designers should be free to determine whether a different aspect of the player better suits their creative purposes (e.g., player personality, demographic, etc).

Furthermore, throughout this thesis we have suggested that a player's preferences can be defined as being *temporally stable*. While beyond the scope of our current work, investigating whether a player's preferences can be meaningfully separated from their emotional state (i.e., mood) and thus remains relatively stable over time would be relatively simple to achieve. Correlating a participant's preferences that have been repeatedly self-reported over a significant period of time (i.e., a longitudinal study) would be enough to shed some light as to whether a player does indeed possess a set of gameplay preferences that are relatively stable over time. A finding that shows a person's mood or some other factor does have a significant effect on their preferences (i.e., *temporally volatile*) would be undesirable. We say this because it would significantly complicate the process of eliciting preferences for personalisation. Not only would a player's preferences have to be learnt early in every playing session but, in the case of extended playing sessions, a player's preferences would also be expected to change either as a result of playing the video game or some other external factor (e.g., a change in playing environment).

Finally, we note that for a preference to be a suitable candidate for personalisation it must have a significant number of people who do not see it as an integral party of playing video games (i.e., are either ambivalent towards it or actively avoid it). In the case of our *achieving* preference within Figure 6.3, our group of experiment participants generally self-reported a very high affinity for this type of experience with relatively few exceptions. If it was found that this or any other particular preference occurs to a high degree within a vast majority of the general population (or within a game's particular audience) then personalising a video game to that preference would be of limited benefit. Investigating whether this ever occurs would be of significant benefit to designers.

7.3.2 Preference survey

Looking at the collected preference data described in Section 6.1.2, a commonality amongst 17 of the 22 gameplay preference variables is that the distribution of responses are heavily skewed towards the 3 to 5 range (mid to high preference) with a markedly lower number of responses being either 1 or 2 (null to low preference). Given the generally enjoyable nature of most preferences and how most players tended to find nearly all preferences at least moderately important, it is possible that this limited variation in the survey responses played a role in our data's inconclusiveness. We believe a survey that yields such a limited range of responses (i.e., less than 5 different responses) is problematic and makes it difficult to assess whether a correlation is present.

To counter this, our first suggested change is the development of *multiple* Likert-type items for each preference and then summating each response form a Likert scale for each preference [Likert, 1932]. Doing so would potentially permit each gameplay preference to be measured at a ratio level with a considerably large range (e.g., a range of ten for two Likert-type items with five responses each, a range of fifteen for three five-point items, etc). Additionally, assigning multiple survey items to each preference would permit the detail and nuance of each preference to be more effectively communicated to respondents.

However, it is also possible that a Likert scale (originally derived as a method to measure *attitudes*) is unsuitable for observing gameplay preferences. It is possible that even experienced respondents, unless provided with further information and a greater amount of time to answer, are not able to reliably self-report a rating for each gameplay preference. While further investigation into this is surely necessary, we would suggest a more substantial change to the preference survey's design if this was confirmed. For example, consider a survey that asks respondents to assign one of four labels to each preference: *like*, *avoid*, *no strong feelings*, and *don't know what it is or how I feel about it.* With this alternative survey design, respondents are being asked to self-report their gameplay preferences to a lower level of detail than when using Likert scales. Of course, the data this survey would yield is nominal or dichotomous (i.e., the lowest level of measurement) but that would be a price worth paying if the data is found to be more meaningful and reliable.

7.3.3 Testbed game design

The collected in-game behaviour data described in Section 6.2 shows that, at the very least, our game's design facilitated a significant degree of player choice that led to a variety of different values for our chosen behaviour variables first introduced in Section 5.2. This shows that players of our testbed video game were, to some extent, able to express how they wanted to play through their in-game actions. This is an important point because that is exactly what a successful correlation of player behaviour with gameplay preferences would have required.

However, after having analysed the in-game behaviour obtained from all our experiment participants, we believe explaining the variation in our set of chosen behaviour variables to be significantly more complex than we first hypothesised. Consider that two hypothetical players are confronted with an in-game choice between option A and option B. The collected data shows that the first player chose option A and the second chose option B. It would be reasonable to assume that the explanation behind this variation of choice can be largely determined by the value of two complex variables: an inherent difference between each player (e.g., their gameplay preferences), and a difference in the context of which players are making the choice. It would be reasonable to assume that if the context in which a set of players made a particular choice was kept completely constant, the inherent differences between each player must be the *cause* for any observed differences in player behaviour, not only associated (i.e., statistically dependent).

While the *real-world context* in which players are making the choice is likely to have some effect on in-game choices (e.g., the room the video game is being played in, other real-world stresses weighing on the player's mind, etc), we are only here referring to the *virtual context* (e.g., whether the player's in-game character is in need of healing, which in-game tasks are still pending, etc). Having said that, *future studies of this type should be far more careful than we were to ensure that the real-world context of observed player choices should be kept as constant as possible.* This is not an easy task when considering that even something weighing heavily on the mind of one player but not on another's may constitute a relevant variation of real-world context. In any case, a significant problem that we encountered during our behaviour data analysis was that our chosen behaviour variables did in fact describe *comparable types of choices*, but players were making them within *significantly different virtual contexts.* Different virtual contexts that were themselves generated by previous player choices, not necessarily by the rules of our testbed video game.

A typical scenario would be that a player makes an error while in combat, flees from the battle in a near-death state, and then later chooses to avoid assisting an in-game character because they are ill-equipped to do so. Even in a video game like ours with relatively simple rules, this *butterfly-type effect* [Lorenz, 1995] makes comparing in-game choices of different players a complicated affair. Even if we perfectly understood the impact of every possible virtual context on every relevant in-game choice and took this into account when defining our behaviour variables, it is likely that we would not be able to collect enough data so that we have *significant coverage* of every possible virtual context. To reuse the earlier example, if we considered the player character's health level when observing the choice of assisting a character then we would need a significantly-sized group of players that made this choice at every health level we define in order to observe the effect that the inherent difference between players had on this choice. Of course, this variety of virtual contexts can be largely produced wholly as a result of interaction between the game's set of rules (i.e., *emergent* gameplay) and it need not only be caused by a variation in player action.

Before discussing possible solutions to this problem we first note that this issue is largely dependent on the *lifetime* of the variables that make up a video game's state. In video games that are structured as set of short levels or mission between which the values of no relevant game state variables persist, the virtual context is effectively resetting on a regular basis (e.g., a typical two-dimensional platformer). However, as is the case in any video game structured as a continuous path along which the progression of relevant game state variables are critical to the playing experience, the virtual context becomes incredibly varied over time (e.g., a typical role-playing video game). While it is often possible to ensure that potentially choice-affecting aspects of the game's state regularly resets, this is incompatible with the design of many video game genres, not only role-playing video games. For example, we would expect the variety of video game types often categorised as *action-adventure* to be equally problematic in this regard.

While there are no easy solutions, we would first suggest a thorough investigation into *whether* game state variables affect the particular player choices that are being used for prediction, and *how* they do if so. For example, Gow et al. [2010] describes a method of capturing the experience of players using a post-game commentary. Instead of capturing experience, we would imagine a similar approach could be taken to explore why individual players behaved they way they did in a particular playing session in order to determine the factors involved. We would not expect players to be able to outright indicate that particular choices were dictated in some way by their gameplay preferences but we would hope that players are able to naturally describe their in-game choices in terms of what was currently happening in the game.

Secondly, we would suggest ensuring that long-lasting game state variables remain *separated* from the player choices being observed. By this we mean presenting players with in-game choices that do not affect (and are not affected by) game state variables that are likely to significantly vary between multiple players at the same point of a video game. In our testbed video game, this could have been achieved by including dialogue options (i.e., options that the player can select while in conversation with in-game characters) that do not affect the game world or other characters in any way. This solution introduces the interesting notion of designing narratively justified player choices throughout a game that exist only to elicit information from and about the player. While *Silent Hill: Shattered Memories* does this in the form of a personality survey administered to the player via an in-game psychiatrist character, creative methods other than the use of an in-game test could also be used.

7.3.4 Experiment structure

Outside of how the survey and game elements of the experiment are designed, there are also decisions to be made that determine how the experiment is structured. The goal of the experiment's structure is to introduce as little bias and have as little influence on the collected data as possible. We designed our experiment such that players always played the game *before* answering the survey. While our testing of this in Section 6.1.4 produced inconclusive results, future experiments should be designed to account for the effect this decision has on any collected survey data in the event that it is found to be significant.

Implementing the reverse (i.e., administering the survey directly before the game is played) would be unlikely to solve the problem but in hindsight this would have been a better choice given that survey results are likely to be more affected by the playing of a game than the reverse. However, when administering the survey before the game, participants who are not in a supervised experiment session should be made well aware of the fact that a video game can be played following the completion of an extensive survey or else they will simply quit before completing the survey. While recruiting participants for our own experiment, we got the distinct impression that participants would be more willing to commit if the opportunity to play a video game preceeded the completion of a survey.

Future studies should really test the effect that the ordering of the game and survey would have and in the event neither orderings produce data unbiased by the experimental process, they should be separated by a significant length of time (e.g., multiple days). Studies with multiple stages (e.g., longitudinal studies) routinely use password and account systems to link the data from the same participants across multiple stages.

The future research directions and improvements suggested throughout this section have come from a multi-year exploration of one simple question: *how can players benefit from a video game that understands something meaningful about them?* We now close this thesis by stating that, while our results are inconclusive, we still firmly believe that a player's preferences can indeed be predicted from their in-game behaviour to enable video game experiences only made possible through some form of personalisation. Video games will continue to innovate in many ways, but there are few less profound than that which allows them to be designed in a way that accounts for the differences that make us all unique. It is our hope that the work presented in this thesis may one day contribute to a future where video game personalisation, in one form or another, is assumed.

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