



**FACULTY OF COMPUTING,
ENGINEERING & TECHNOLOGY**

**USER PROFILING ON THE BASIS OF INTERACTIONS
WITH A COMPUTER GAME**

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Adapting computer software to the individual user during run-time could offer substantial advantages over the current practice of tailoring software to groups of users during the development process (Stewart 2007; Charles et al. 2005; Charles & Black 2004; Houlette 2004). In order to achieve this, the computer requires information about the user, yet its ability to perceive them is severely limited (Suchman 2006 p.167; Fisher 2001). In an effort to address this shortcoming, this dissertation examines the potential for determining an individual's personality through analysis of their interactions with commercial computer games – which, in common with cinema and literature, work on an underlying model of reality – as well as their performance in game elements using an underlying general intelligence factor, and their emotional state from visual and physiological cues. Through a program of original primary research, it demonstrates that data pertaining to several of the big five personality factors can be captured from interactions with a commercial computer game, and explores methods for predicting these personality traits using regression analysis and clustering techniques. It also employs a series of factor analyses to investigate the latent variables present in interactions with a computer role-playing game, as a foundation for further work.

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CHAPTER 1
INTRODUCTION

1. INTRODUCTION

In the traditional paradigm of software development, a group of professionals attempt to anticipate the requirements of end-users during the design process and develop software which will meet their needs. In order to achieve this they must envisage not only the tasks the software will be expected to perform, but the context in which it will be used; a feat which can be all but impossible for complex systems that serve the needs of large and diverse groups of users, due to the wide range of ability, experience, and knowledge involved, and degree of variation in individual preferences and habits (Fisher 2001). Unlike traditional media, which are fixed after development, “computational media have interpretive power: they can analyze the artefacts created by users and the interaction patterns between users and system” (Fisher 2001), allowing decisions which would ordinarily be made during the development process to be delayed until run-time, when specific information about the task and user might be obtained (Stewart 2007; Charles et al. 2005; Charles & Black 2004; Houlette 2004). In many modern computer applications this real-time tailoring is limited to the provision of contextual help, or information, such as the Microsoft Office Assistant – which debuted in Office 97 (2006), but was disabled and subsequently removed in later versions of the software, replaced by a context sensitive multipurpose panel (Redmond 2001; Horvitz et al. 1998). Computer games, as an interactive medium, have been more inclined to adopt this concept: allowing players to select their preferred difficulty, or inferring their expertise from performance metrics, as a precursor to adjusting the availability of resources, such as health and ammunition, or tailoring the behaviour and attributes of computer controlled opponents; it is also relatively common, in some genres, for the player’s actions and decisions to shape scripted events and the overarching story, which often has several possible resolutions (Charles et al. 2005; Charles & Black 2004; Houlette 2004).

Suchman (2006 p.167) has argued that, “one way to characterize machines is by the severe constraints on their access to the evidential resources on which human communication of intent routinely relies,” and we might therefore seek to improve our ability to tailor computer software to the user through the development of techniques which allow the computer to gather information about them (Fisher 2001). With this in mind there are a number of recent approaches worthy of investigation, including:

Skyles and Brown's (2003) efforts to determine a player's arousal from the pressure they exert on the analogue buttons of a PlayStation 2 controller; D'Mello et al.'s (2005) "endeavours to classify emotions on the bases of facial expressions, gross body movements, and conversational cues"; Hazlett's (2006) determination of positive or negative emotional valence through facial electromyography; and Bailenson et al.'s (2008) use of physiological responses and facial feature analysis and to distinguish happiness and sadness.

Computer science is a relatively new discipline, with Babbage's 'Analytical Engine' – a mechanical automatic computing machine – having been conceived of scarcely two centuries ago (Bromley 1982), and we might therefore look to older disciplines for inspiration. Although as Dickens (1859 p.9) eloquently surmises "every human creature is constituted to be that profound secret and mystery to every other," this has not dissuaded humanity's efforts to do so, for while we cannot know another's mind, we can observe their actions and wonder about the unseen processes from which they result. Psychometrics, the branch of psychology dealing with measurable factors, can trace its origins to China during the Sui Dynasty (589–618 AD) where the introduction of imperial examinations allowed an adult male, regardless of wealth or social status, to become a high ranking government official through the study of a syllabus and assessment of its attainment (Miyazaki & Schirokauer 1981). In its modern incarnation, psychometrics has been heavily influenced by the intelligence testing movement of the 19th and 20th centuries (Rust & Golombok 1989), and the American Armed Force's efforts to identify appropriate roles and training for large numbers of conscripts during World War I & II (Edenborough 1994). Today, in addition to the clinical applications, psychometric tests are popular in industry, where they are used for personnel selection, assessment and, more recently, development, particularly in professional, managerial and technical professions (Jackson & Yeates 1993; Woodruffe 1993).

Computerisation has been substantial in the field of psychometrics (Anastasi & Urbina 1997, p.74; Susan & Rust 1989, p.131), with traditional pen and paper inventories, such as the Minnesota Multiphasic Personality Inventory, being adapted for computerised administration, scoring, and interpretation – using expert systems

and more recently artificial neural networks (Vlachonikolis et al. 2000). The nature of these instruments has remained largely unchanged however, with computational power being leveraged primarily to conduct more complex analyses than were practical by hand (Anastasi & Urbina 1997, p.74; Susan & Rust 1989, p.131), and as a result many instruments are onerous, requiring responses to hundreds of closed questions. While this means that many psychometric instruments are ill-suited for capturing data to tailor computer software, their occasional presence in commercial computer games – such as *Fallout 3*, which parodies traditional inventories with its G.O.A.T. (Generalized Occupational Aptitude Test) determining the player’s starting statistics, and more prominently in *Silent Hill: Shattered Memories* (Konami Digital Entertainment 2009), which uses pseudo-projective techniques as props to support the narrative and adapt the game’s aesthetics and plot – highlights the potential for some of the more engaging instruments and underlying techniques.

1.1. INTELLECTUAL CHALLENGE

The potential for adapting computer software during run-time has been highlighted by a number of researchers (Charles et al. 2005; Charles & Black 2004; Houlette 2004; Fisher 2001), and could offer substantial advantages over the current practice of tailoring software during the development process, but its implementation is inhibited by the computer’s limited capacity to perceive the user (Suchman 2006 p.167; Fisher 2001). Postulating that in interacting with a computer game – which, in common with cinema and literature, works on an underlying model of reality – players reveal information about themselves, this dissertation endeavours to address this shortcoming through a program of original research which will capture and analyse computer game interaction data, in order to assess the potential for constructing a psychological profile of the player suitable for tailoring a computer game. Adapting techniques from the domain of psychology for this purpose poses a considerable challenge, as players’ interactions with a computer game are distinctly different to those involved in conventional self-reported personality inventories, and while there is a greater degree of commonality with projective techniques – which involve the interpretation of subjects responses to vague or ambiguous stimuli – the subjective

nature of these instruments may prove problematic for a computer. It may therefore be necessary to explore ancillary data, such as the player's emotional state, which, while intuitive to humans, remains challenging for a computer system to reliably determine. If successful, however, this work should lay the foundation for the construction of software specific psychological player profiles in computer games, with the potential for developing more broadly applicable user profiles through the aggregation of high quality data captured from a wide variety of commercial software.

1.2. RESEARCH METHODOLOGY

Utilizing methods guided by the principles of sociological positivism – which directs scientific inquiry to focus on the explanation and prediction of observable events through empirical means, independent of bias – this research will form hypotheses based on accepted scientific knowledge which will be tested through experimentation and the application of statistical mathematics. In order to develop techniques to capture data from players' interactions with a computer game, a rigorous investigation of secondary sources will be undertaken. Initially this will focus on methods for gathering and interpreting real-time physiological data from computer game players – which will necessitate determining what inferences can be made about the player using this data – as well as a thorough examination of psychometric instruments, and the techniques through which they are created and adapted to electronic formats. Once suitable techniques have been identified, they will be refined and tested, using a series of laboratory based experiments, in order to construct a profile of players for a specific computer game.

1.2.1 KEY TERMS

In the interest of clarity, it is useful to define some of the principal terms employed in this dissertation, particularly those instrumental in the definition of the hypotheses or of significant importance to the subsequent discussion; while vocabulary specific to the domain, but of lesser significance, is defined in the glossary.

Computer Games, or **Video Games**, “at a very simple level ... comprise any game played on an electronic device” (Griffiths cited in Newman & Simons 2004, p.33). It is difficult to precisely define what constitutes a computer game (Newman & Simons 2004, p.29–84), but for the purposes of this dissertation we may consider them to be computer software that manages a model of reality – though typically not our reality – with which humans interact for entertainment.

Users, in the context of this dissertation, are individuals who interact with computer software or hardware, while **Players** are a subset of users who interact specifically with a computer game.

Psychology, is used as per a standard dictionary definition: “the science that deals with mental processes and behaviour” or “the emotional and behavioural characteristics of an individual, a group, or an activity” (The American Heritage Medical Dictionary 2008, p. 446).

Profile is also used per a standard dictionary definition: “a set of characteristics or qualities that identify a type or category of person or thing” (Dictionary.com 2012), and in context often refers to a **Psychological Profile**, which is a description of the “distinctive and characteristic patterns of thought, emotion and behaviour that define an individual’s personal style of interacting with physical and social environments” (Atkinson et al. 2000, p.435).

1.2.2. AIMS

Through the observation of players’ interactions with a commercial computer game, this research aims to identify methods for the computerized capture and processing of psychological data, in an effort to construct individual player profiles suitable for tailoring that computer game. In order to structure the investigation, this principal objective has been deconstructed, and expressed formally as a series of sequentially linked hypotheses – where each hypothesis depends on the validity of the preceding hypotheses – all of which will require validation.

H1 *In interacting with the underlying model of reality presented in a computer game, players reveal information about their psychology.*



H2 *If, during the course of their interactions with a computer game, players reveal aspects of their psychology, it is possible for the computer to capture and process that information.*



H3 *If, during the course of their interactions with a computer game, it is possible for the computer to capture and process information pertaining to the psychology of a player, that information will be of sufficient quantity and quality as to allow the construction of a psychological profile of that player.*

1.2.3. OBJECTIVES

In order to realise these aims, it will be necessary to achieve the following objectives.

1. Secondary Research

- a. Identify existing psychometric instruments in either electronic or traditional formats that are suitable, or can be adapted, for use in a computer game.
- b. Identify the methods used to develop current psychometric instruments and evaluate their potential for constructing novel instruments for use in a computer game.
- c. Identify techniques originating in fields other than psychometrics which may be incorporated in the development of a profiling system for computer game players.
- d. Discuss any relevant ethical or legal implications involved in the use of the aforementioned techniques.

2. Preliminary Primary Research

- a. Adapt or develop psychometric instruments for use in computer games, testing their effectiveness and revising them as necessary.

3. Preliminary Discussion

- a. Discuss the effectiveness of the psychometric instruments adapted or developed for use in computer games, identifying their potential applications.
- b. Identify a promising computer game and select suitable psychometric instruments, from those adapted or developed, to create player profiles.

4. Primary Research

- a. Tailor the psychometric instruments selected to create player profiles for the chosen computer game, and collate data suitable for assessing the validity and reliability of these instruments.

5. Discussion

- a. Discuss the accuracy and utility of the profiling system, considering its potential for generalisation and relevant ethical or legal implications.

6. Conclusion

- a. Review critically the project, summarizing the major findings and identifying the limitations, successes and failings.

1.2.4. DELIVERABLES

The preceding objectives will result in the following deliverables.

1. Secondary Research

- a. A literature review detailing existing psychometric instruments in electronic and traditional formats and their suitability for use in a computer game.
- b. A literature review detailing the methods used to develop current psychometric instruments and their possible role in constructing novel instruments which could be used in a computer game.

- c. A literature review detailing relevant techniques originating in fields other than psychometrics and their suitability for use in constructing a profile of players for a computer game.
 - d. A discussion of relevant ethical or legal implications, included with the aforementioned literature reviews.
2. Preliminary Primary Research
- a. A range of psychometric instruments, which could be used in a computer game, and a collection of data indicating their effectiveness.
3. Preliminary Discussion
- a. A document discussing the effectiveness of a range of psychometric instruments, which could be used in a computer game, and details of their potential applications.
 - b. A document determining which computer game and psychometric instruments would be suitable for the creation of player profiles.
4. Primary Research
- a. A system that utilises a range of psychometric instruments to build a profile of players, on the basis of their interactions with a specific computer game, and a collection of data which will allow the validity and reliability of that system to be assessed.
5. Discussion
- a. A document discussing the profiling systems' validity and reliability, the potential for generalisation, and pertinent ethical or legal issues.
6. Conclusion
- a. A document critically reviewing the project, summarizing the major findings and discussing the limitations, successes and failings.

1.2.5. SCHEDULE

This research will require approximately forty-eight months for completion, with an allowance of an additional twelve months to account for illness and unexpected delays or developments. A tentative schedule illustrating the tasks to be completed, the related objectives and deliverables, and their estimated time for completion, is outlined below:

Research Schedule

| 2007 | | 2008 | | | | | 2009 | | | | | 2010 | | | | | 2011 | | | | | 2012 | | | Task |
|------|----|------|----|----|----|----|------|----|----|----|----|------|----|----|----|----|------|----|----|----|----|------|----|--|---------------------------------|
| 07 | 10 | 01 | 04 | 07 | 10 | 01 | 04 | 07 | 10 | 01 | 04 | 07 | 10 | 01 | 04 | 07 | 10 | 01 | 04 | 07 | 01 | 04 | 07 | | |
| | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | 1. Secondary Research |
| | | | | | | x | x | | | | | | | | | | | | | | | | | | 2. Preliminary Primary Research |
| | | | | | | | x | | | | | | | | | | | | | | | | | | 3. Preliminary Discussion |
| | | | | | | | | x | x | x | x | x | | | | | | | | | | | | | 4. Primary Research |
| | | | | | | | | | | | | | x | x | x | x | | | | | | | | | 5. Discussion |
| | | | | | | | | | | | | | | | | | | | | | x | x | | | 1. Update Secondary Research |
| | | | | | | | | | | | | | | | | | | | | | | x | | | 6. Conclusion |
| | | | | | | | | | | | | | | | | | | | | | x | x | x | | Revision & Editing |

Figure 1.2.4a – Research Schedule

CHAPTER 2
LITERATURE REVIEW

2. LITERATURE REVIEW

A number of academics have observed that tailoring computer software to individual users at run-time offers substantial advantages, over the current practice of tailoring software to groups of users during the development process (Stewart 2007; Charles et al. 2005; Charles & Black 2004; Houlette 2004). To achieve this, information about the user is required, but computers are limited in their ability to perceive and interpret the visual and auditory cues on which human expression and communication routinely relies (Suchman 2006 p.167; Hayes 1994, p.517&525; Fisher 2001; Ekman & Friesen 1971; Osgood, 1966 cited in Hayes 1994, p.516; Apple, Streeter & Krauss 1979; Tompkins 1962 p.204; Davitz & Davitz 1959a, 1959b). In an effort to improve this situation, the subsequent literature review – which opens with an introduction to the medium of computer games – focuses on several approaches which might be employed by a computer system to learn about the user: the determination of emotional states through observation of physiological and visual cues; the analysis of the user’s interactions with the computer system; and the adaptation of established psychometric instruments and techniques for automated profiling. In recognition that the principle discussion relates to psychological concepts with which the computer scientist may not be familiar, a concise summary of the pertinent theories have been incorporated in to the body of the literature review for the reader’s convenience.

Literature Review Domains and Sub-Domains

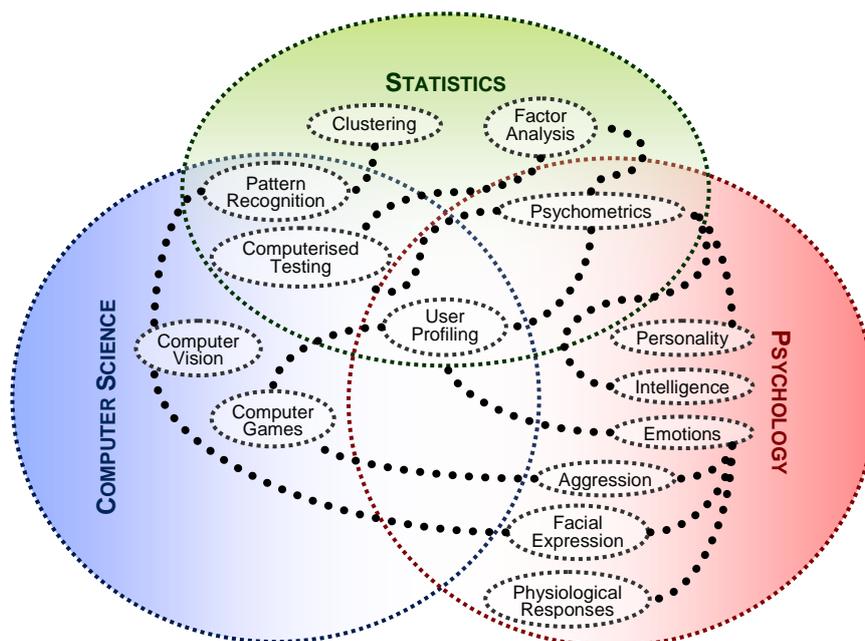


Figure 2a – Literature Review Domains and Sub-Domains

2.1 COMPUTER GAMES AS A MEDIUM

In his book entitled ‘Homo Ludens’ – Man the Player – Huizinga (1980) observes that “play is older than culture, for culture, however inadequately defined, always presupposes human society, and animals have not waited for man to teach them their playing.” “Some of the earliest evidence of human play can be found in the board games uncovered in ancient burial grounds or depicted in ancient drawings and carvings. Initially these games were simple folk objects made as needed out of earth, wood, or stone ... but as play became a larger part of culture, the ruling classes joined in games as well, and extraordinary game sets for kings and pharaohs evolved” (Flanagan 2009, p.63). Given the importance of games as an integral part of human culture (Juul 2001), it should come as no surprise that “there have been computer games for almost as long as there have been computers” (Aarseth 2001) and that “video games are meaningful – not just as sociological or economic or cultural evidence, but in their own right, as cultural expressions worthy of scholarly attention” (Jones 2008 p.1).

While “[computer] games are arguably the most influential form of popular expression and entertainment in today’s broader culture” (Jones 2008 p.1), it is difficult to define what constitutes one (Newman & Simons 2004, p.29–84) – “at a very simple level, video games comprise any game played on an electronic device ... [but] whether the player will define what they are doing as a video game will differ from person to person” (Griffiths cited in Newman & Simons 2004, p.33). “Games are not a kind of cinema, or literature ... extensive media differences within the field of computer games makes a traditional medium perspective almost useless” (Aarseth 2001), and “ludologists were right to point out the unique qualities of video games as a form of expression, and ... [the danger] that cultural studies would merely fit video games into earlier models based on studies of TV and other broadcast media” (Jones 2008 p.5). It is not, however, the mandate of this dissertation to determine the nature video games, or the qualities that separate them from traditional media. Our interest lies in the high degree of interaction between the player and computer system during the course of game play, as this affords an opportunity to capture a large quantity of data unobtrusively which might be useful for constructing a profile of the player.

2.2 THE DETERMINATION OF EMOTIONS

In the 19th century James and Lange, both psychologists working independently of each other, proposed that while

“our natural way of thinking about these standard emotions is that the mental perception of some fact excites the mental affection called the emotion, and that this latter state of mind gives rise to the bodily expression ... the bodily changes follow directly the PERCEPTION of the exciting fact, and that our feeling of the same changes as they occur IS the emotion. Common sense says, we lose our fortune, are sorry and weep; we meet a bear, are frightened and run; we are insulted by a rival, are angry and strike ... this order of sequence is incorrect, that the one mental state is not immediately induced by the other, that the bodily manifestations must first be interposed between, and that the more rational statement is that we feel sorry because we cry, angry because we strike, afraid because we tremble, and not that we cry, strike, or tremble, because we are sorry, angry, or fearful, as the case may be” (James 1884).

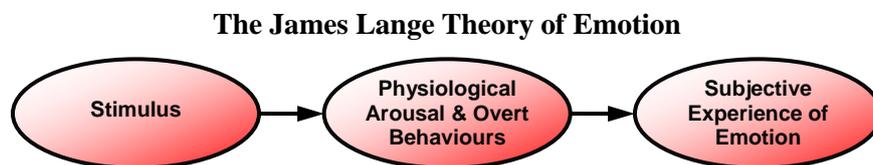


Figure 2.2a – The James Lange Theory of Emotion (Atkinson et al. 2000, p.397)

If this proposition holds, and the emotional experience is a direct result of physical changes in the body, then it would follow that the identification of an emotion should be possible from those physiological changes which induce it. It is not as simple as this however, and “a formidable number of studies were undertaken in search of the physiological differentiators of the emotions ... but [at the time] there appeared to be no clear-cut physiological discriminators” (Schachter & Singer 1962), prompting suggestions that cognitive elements might be the major determinants of emotion, and ultimately leading Schachter and Singer to propose that, “emotional states may be considered a function of a state of physiological arousal and of a cognition appropriate to this state of arousal” (Schachter & Singer 1962).

While the introduction of a cognitive component complicates the determination of emotion considerably, and dominates contemporary research in the field (Levenson 2003), the focus of Schachter and Singer's (1962) experiment pertained to the influence of arousal of the autonomic nervous system unrelated to an emotional response, such as that induced chemically or through physical activity, on the subjective experience of emotion. It was determined that this 'neutral arousal' could be misinterpreted as emotional arousal, in instances where the individual could not otherwise explain it, and generally intensified other emotional experiences – an effect which, it is important to note, is supported by Zillmann and Bryant's (1974) experiments with neutral arousal and aggression, as while Schachter & Singer's (1962) experiment was influential in the development of more complex models of emotion, it has not been successfully replicated and has been criticised for its methodology (Atkinson et al. 2000 p.396; Hayes 1994, p.459).

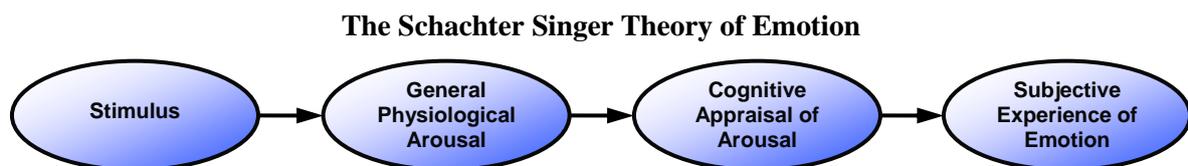


Figure 2.2b – The Schachter & Singer Theory of Emotion (Atkinson et al. 2000, p.397)

2.2.1. A CONTEMPORARY PERSPECTIVE OF EMOTION

Today, emotion is considered to be a complex condition consisting of at least six components: the subjective experience, or feelings associated with the emotion; the physiological responses, which may include effects on the autonomic nervous system; changes in facial expression; related cognitions and thoughts; tendencies toward specific behaviours; and global reactions, such as changes in information processing (Lazarus 1991). While it is generally accepted that these components are interrelated, there are a number of competing theories and the exact nature of the relationships is still not clearly defined (Atkinson et al. 2000, Chapter 11).

2.2.1.1. ANGER AND AGGRESSION

The emotional state of anger and its relationship with aggression – “behaviour that is intended to injure another person (physically or verbally) or destroy property” (Atkinson et al. 2000, p.406) – has been the focus of much research during the past century (Berkowitz 1993), which, in conjunction with the dissimilarity between the major theories, make it an ideal candidate to illustrate the complexity of emotional experiences and their influence on behaviour.

Freud’s (1940) Psychoanalytic Theory takes the perspective that aggression is a basic biological drive – like hunger – which results from frustration due to an inability to express our instincts. Inspired by this, Dollard et al. (1939. p.IX) formulated the Frustration Aggression Hypothesis, postulating that “aggression is always a consequence of frustration” (Dollard et al. 1939. p.27) resulting from obstacles that inhibit an individual’s ability to reach a goal; a controversial proposal due to the assertion that frustration is the cause of aggression, and that aggression is a biological drive which persists until it is satisfied (Atkinson et al. 2000 p.406; Berkowitz 1989) – although there is evidence to support a biological component to aggression (Atkinson et al. 2000 p.407; Dabbs & Morris 1990).



Figure 2.2.1.1a – Aggression as a Biological Drive (Atkinson et al. 2000, p.409)

Bandura’s (1977) Social Learning Theory offers an alternative perspective, positing that behaviour is “a continuous reciprocal interaction between cognitive, behavioural and environmental determinants” (Bandura 1977), and suggesting that aggression is just one of several possible learned responses to emotional arousal, deployed based on the situation and their anticipated results. It is proposed that these responses are learned through observation, with the effectiveness of a demonstration depending on the degree to which the observer identifies with, or is attracted to, the demonstrator, and the perceived benefits and consequences of the behaviour. If the result is appealing, then the behaviour may be practiced in a situation where it is expected to be advantageous, and assessed in order to determine its effectiveness; if the

anticipated outcome is achieved then the behaviour should be retained for use in the future, but if it proves ineffective, or there are unforeseen consequences, it may either be abandoned, or, if the failure is attributed to ineffective execution, reassessed after further observation or practice.

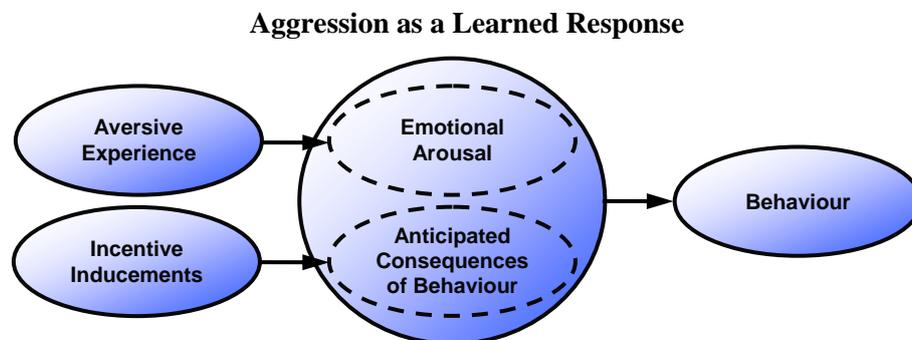


Figure 2.2.1.1b – Aggression as a Learned Response (Bandura 1977; Atkinson et al. 2000, p.409)

Irrespective of the nature of aggression, it has a demonstrable effect on our interpretation of events and perception of the world around us; places, people, and objects associated with aggression, or the gratification of aggression, “prime an aggressive inclination plus aggression related feelings, ideas, and memories” (Berkowitz 1993, p.71), making “aggressive schemas more easily available for use in processing other incoming information, creating a temporary interpretational filter that biases subsequent perceptions. If these aggressive schemas are primed while certain events – such as ambiguous provocation – occur, the new events are more likely to be interpreted as involving aggression, thereby increasing the likelihood of an aggressive response” (Anderson et al. 2003, p.95). It should not be assumed, however, that anger and aggression related feelings will necessarily lead to aggressive behaviour. It is the premise of Social Learning Theory (Bandura 1977) that an individual’s behaviour is dependent on the anticipated effectiveness of those in their repertoire, but even the Frustration Aggression Hypothesis recognises that “anticipation of punishment inhibits overt aggression” (Dollard et al. 1939 p.35), and Berkowitz (1989) contends that, “even when the interference with goal attainment meets the specifications spelled out by Dollard ... it is clear that a variety of psychological processes can intervene to determine whether a given thwarting will be followed by aggressive acts.”

Factors Which Influence the Strength of Impulsive Aggression

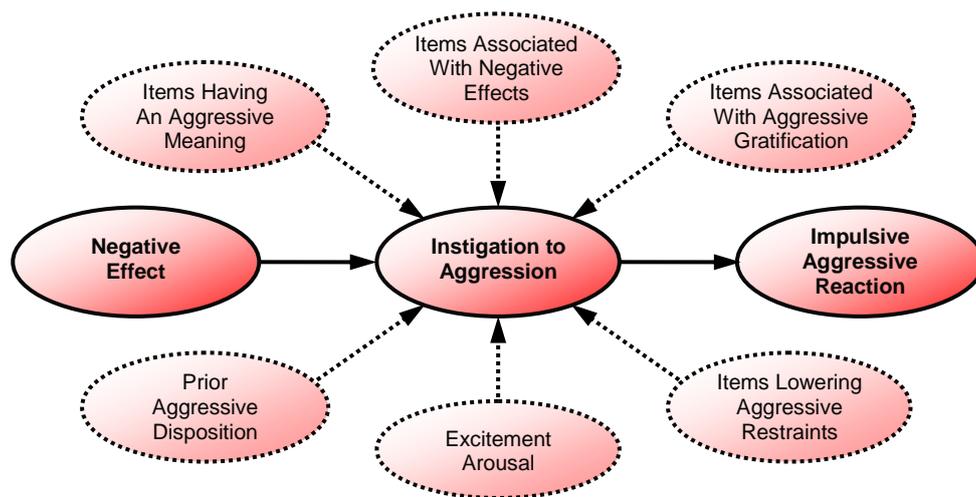


Figure 2.2.1.1.c –Factors Which Influence Impulsive Aggression (Berkowitz 1993, p.71)

2.2.1.2. MOODS

The concept that our emotional state influences the way in which we perceive the world is not limited to anger and aggression; it may be easier to relate this to our personal experiences of the more mild, enduring emotional states termed ‘moods’, which – as with anger and aggression – influence our judgement through the creation of interpretational filters that skew our perception of ambiguous events, ensuring details congruent with our mood more likely to be noticed and recalled (Atkinson et al. 2000, p.405; Forgas & Bower 1987; Bower 1981). Thus, when an individual is in a good mood risks are underestimated and altruistic motives are more likely to be ascribed to ambiguous events – perpetuating that mood – while being in a bad mood reverses these effects.

2.2.2. THE AUTONOMIC NERVOUS SYSTEM AND EMOTION

The previous discussion highlights the complexity of emotion and its related behaviours, indicating that it consists of no less than six interrelated components (Lazarus 1991), which may make the determination of an individual’s emotional state from physiological factors alone problematic. This has not dissuaded efforts to do so, however, and “a number of emotion and cognition theorists have studied the physiological correlates of emotions, arguing that each emotion probably has its own

unique somatic response pattern” (Picard 1997 p.25) – such as “anger’s close association with a motor program or action tendency of ‘fight’, which makes significant demands on the heart” (Levenson 1992). If this is the case, it may still be possible to determine an individual’s emotional state from physiological elements, such as the activity of the autonomic nervous system, using sensors connected to a computer system (Levenson 2003, 1992; Picard 1997; Ekman, Levenson & Friesen 1983). The following discussion provides a comprehensive outline of the challenges involved in this endeavour, and efforts to address them.

In order to measure changes in emotional activity, it is necessary to establish a baseline which can be used for comparison. “An obvious choice is a rest period where the subject can be assumed to have no particular emotion,” (Prendinger & Ishizuka 2005) however “emotion in its natural occurrence is rarely superimposed upon a prior state of rest. Instead, emotion occurs most typically when the organism is in some state of prior activation” (Levenson 1988 p.24), which necessitates determining, and capturing, a suitable baseline of autonomic nervous system activity, which cannot be assumed to remain static between sessions. This process is likely to be further complicated by the increase in mobile computing (European Travel Commission 2012) and the trend toward motion sensing controller technology in computer consoles (Ogg 2011; Portnow, Floyd & Theus 2010) – evidenced in the success of the Wii (Gaudiosi 2007; Nintendo 2006), and the recent launch of the PlayStation Move (Sony 2010), and Kinect (Microsoft 2010b) – which are likely to introduce substantial variation in neutral, or non-emotional, arousal of the autonomic nervous system (Hayes 1994, p.440; Zillmann and Bryant 1974; Schachter and Singer 1962) as a result of physical activity during game play.

The temporal dimension of emotion is also problematic, necessitating the continuous examination of both current and recent autonomic nervous system activity for signs of specific emotions, which may occur suddenly, or build up gradually over time (Levenson 1988 p.30). In many practical applications, this means not only identifying the patterns associated with specific emotions amongst a continuous stream of autonomic nervous system activity, but accounting for the temporal disconnect

between the physiological changes that are being monitored and the feelings, which may precede them, associated with those emotions (Cannon, 1927 cited in Atkinson et al. 2000, p.394).

Finally, perhaps the most challenging issue lies in identifying specific emotions from the activity of the autonomic nervous system, as the physiological responses which accompany an emotion differ little between emotions, and occur too slowly to be the source of feelings associated with that emotion (Cannon, 1927 cited in Atkinson et al. 2000, p.394). Although Levenson (1992) identifies distinct differences in the patterns of autonomic nervous system activity for different emotions, which generalize well with respect to age and cultural background, his concern that in the case of intense or sustained emotions “the configuration of autonomic nervous system activation normally associated with the emotion will be distorted by natural biological ceilings and floors that are reached, by neuro-hormonal factors that alter autonomic nervous system responses, and by compensatory mechanisms that will act to protect the organism from permanent damage,” (Levenson’s 1988 p.27) seems well founded. In particular Picard’s (1997 p.161) findings that even in a controlled environment the “variation in signals for the same emotion over different days can be greater than the difference between two different emotions on the same day,” indicates that it would be “very hard to build a system to recognise just the differences between emotions” (Picard 1997 p.161). Assessing emotions in an uncontrolled environment, even without the aforementioned complications associated with motion sensitive controllers or mobile computing, is likely to prove even more difficult (Conati, Chabbal & Maclaren 2003), as “physiological responses similar to those in an emotional state can arise without corresponding to an emotion” (Picard 1997 p.31), and it would be necessary to account for the influence of neutral arousal – which can intensify the subjective experience of an emotion (Zillmann and Bryant 1974; Schachter and Singer 1962), aggression – which can bias an individuals’ perceptions and influence judgement (Berkowitz 1993, p.71; Bandura 1977), and moods – which are perpetuated by perceptual and interpretational filters (Forgas & Bower 1987; Bower 1981).

2.2.3. SENSOR BASED DETERMINATION EMOTION

One of the challenges in determining emotion outside of the laboratory lies in the practical limitations it imposes on the sensory equipment available; in addition to being inexpensive and readily obtainable, preferably already ubiquitous in the home computing environment, it is vital that the equipment is uncomplicated and quickly setup, in order to minimise the inconvenience for the user.

One solution to this problem might lie in leveraging sensors present in the current generation of console input devices for the determination of emotions, such as the pressure sensitive buttons on the recent iterations of Sony's PlayStation controller – which have been successfully used to infer emotional arousal during game play in controlled environments (Sykes & Brown 2003). In combination with the “simple modification of existing [computer] input devices [to include] temperature or pulse sensors,” proposed by Charles & Black (2004), this could provide a basis for determining players emotional arousal in uncontrolled environments – although their assertion that “[these additional sensory capabilities] could potentially revolutionize game design with respect to a games' responsiveness to an individual player” (Charles & Black 2004), seems premature, as “the level of noise in the [sensors] signals increases in uncontrolled environments, where subjects have high mobility” (Conati, Chabbal & Maclaren 2003).

2.2.4. RECOGNISING EMOTIONS

Given the complexity of emotions, human beings are surprisingly adept at identifying the full range of emotional states in others using just visual and auditory cues. In the visual channel, facial expression is one of the most important indicators of emotion (Tompkins 1962 p.204), with many expressions – such as happiness, surprise, fear, anger, disgust, contempt, and sadness – transcending cultural barriers (Ekman & Friesen 1971; Osgood, 1966 cited in Hayes 1994, p.516); but other visual information like posture, which can reflect more general attitudes, as well as proximity and physical contact, which vary with culture but can be deeply meaningful, are also important (Hayes 1994, p.517). Even verbal communication is laden with non-verbal

cues, such as pace, tone, and emphasis, which – in addition to the mundane task of clarifying the verbal content – can provide information about the speakers emotional state, authority, and competence (Apple, Streeter & Krauss 1979; Davitz & Davitz 1959a, 1959b). In fact “we place a great reliance on non-verbal communication, and if the non-verbal content of a message isn’t congruent with its verbal content, as a rule we tend to ignore the verbal content and believe the non-verbal message” (Hayes 1994, p.525).

Exploiting this, Hazlett (2006) provides an alternative to the determination of emotion using the autonomic nervous system, employing facial electromyography to identify positive and negative emotional valence from changes in facial expression during computer game play; an approach which lacks specificity, but addresses Levenson’s (1988 p.27) concern that there may be levels of emotional intensity so low that no discernable autonomic nervous system activation will occur, as “facial electromyography has been shown to be capable of measuring facial muscle activity to weakly evocative emotional stimuli, even when no changes in facial displays have been observed” (Cacioppo, Bush & Tassinary 1992). Beyond the laboratory, this technology is likely to be too inconvenient for consumers to adopt unless it can be shown to significantly improve game play or can be cheaply integrated with other equipment, such as the stereoscopic glasses which might become popular if the aggressive marketing of 3D display technology proves successful (Hartsock 2011; Savage 2011).

Sensor Positions During Facial Electromyography



Figure 2.2.4a – Sensor Positions During Facial Electromyography (Gibert et al. 2009)

The integration of video cameras with computer games consoles – first seen in the Dreameye (IGN 2000; Sega 2000a; Sega 2000b), an accessory for the Japanese Dreamcast (Sega 1998), and then more successfully in the international release of the EyeToy (Robischon 2003; Sony 2003) for the PlayStation 2 (Sony 2000) – has recently become more common as part of a trend toward motion control (Ogg 2011; Portnow, Floyd & Theus 2010; Gaudiosi 2007), with both the PlayStation Move (Sony 2010) and Kinect (Microsoft 2010b) integrating cameras and microphones. This provides a technological foundation for the visual identification of the player’s emotional state through analysis of the facial expressions integral to the expression and recognition of human emotion (Lazarus 1991; Osgood, 1966 cited in Hayes 1994, p.516). D’Mello et al. (2005) have demonstrated the promise of this approach in their “endeavours to classify emotions on the bases of facial expressions, gross body movements, and conversational cues,” using a camera to track pupils of the eye and fit templates to the upper facial features in real-time, recognising facial action units with an accuracy of 68% without calibration – close to the 75% minimum required for a human to be considered an expert – and identifying associations with frustration, confusion, and boredom.

Computer Vision: Kinect & PrimeSense

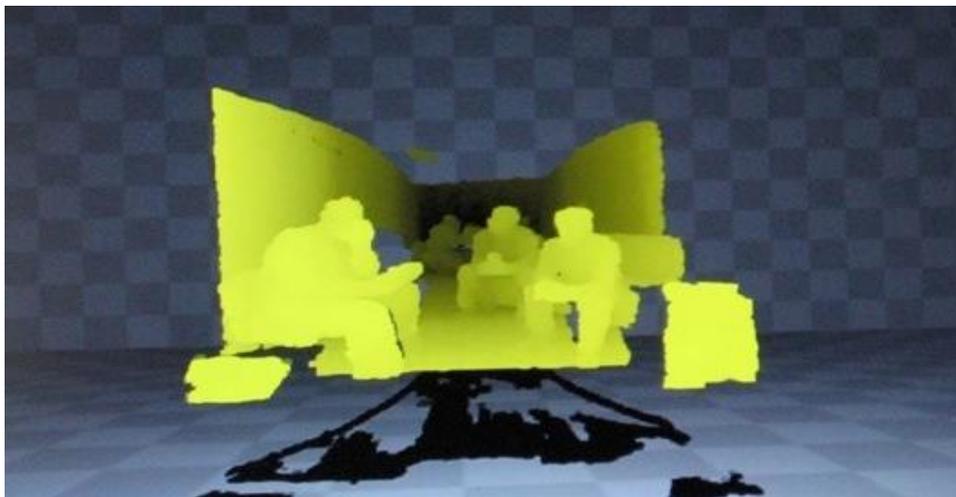


Figure 2.2.4b – Computer Vision: Kinect & PrimeSense (Schramm 2010)

Facial feature recognition continues to be an active research topic, with Ong & Bowden’s (2011) “learnt data-driven approach for accurate, real-time tracking of facial features using only intensity information”, and Tsalakanidou & Malassiotis’

(2010) extension to the Active Shape Model to incorporate 3D data, endeavouring to overcome some of the challenges associated with tracking such a highly deformable object, capable of both rapid and subtle deformation, in real-world situations where occlusion and variation in lighting and posture are common. It has been possible to successfully determine facial expressions and mirror them on a computer generated avatar in real-time using both facial electromyography (Gibert et al. 2009) and computer vision (Takahashi 2012), however D’Mello et al. (2008) contend that “the problem of automating affect recognition is extremely challenging, on par with automating speech recognition”, and their subsequent work has focused on the detection of emotion from conversational dialogue with a computer system to “complement bodily measures for emotion detection” (D’Mello et al. 2008). A combined approach which has also been seen in Bailenson et al.’s (2008) efforts to identify happiness and sadness in subject’s natural reactions to emotional videos using a multilayer perceptron, where incorporating physiological responses into their model yielded more accurate predictions than facial expression in isolation.

Properties of an Ideal Facial Expression Analysis System

| Robustness | Automatic Process |
|---|--|
| 1. Handle lighting changes 2. Handle large head motion 3. Handle occlusions 4. Handle different image resolution | 1. Automatic face acquisition 2. Automatic facial feature extraction 3. Automatic expression recognition |
| Expressions | Real-Time Process |
| 1. Recognise all possible expressions 2. Recognise all spontaneous expressions | 1. Real-time face acquisition 2. Real-time facial feature extraction 3. Real-time expression recognition |

Figure 2.2.4c – Properties of an Ideal Facial Expression Analysis System (Markin & Prakash 2006)

It is difficult to assess the commercial potential of this technology at present, as while we are still far from Markin & Prakash’s (2006) ‘ideal facial expression analysis system’, Keio University’s real-time facial tracking using a standard webcam “could be used by CG animation hobbyists” (Takahashi 2012), and commercial interests may be preventing the publication of other research, especially since Microsoft’s (2010b) Kinect became the “fastest-selling consumer electronics device” (Guinness World Records 2011) with it’s premise of ‘you are the controller’.

2.2.5. COGNITION AND EMOTION

The prevailing theories of emotion suggest that the individual's cognitive appraisal of the situation and their physiological responses are influential in determining their subjective experience of an emotion (Berkowitz 1993; Lazarus 1991; Smith & Ellsworth, 1987 & 1985 cited in Atkinson et al. 2000, p.398; Bandura 1977; Shachter, 1964 cited in Hayes 1994, p.459), and "in recent years, the spotlight in affective science has moved away from the autonomic nervous system and toward the brain" (Levenson 2003 p.222).

Although, "after decades of neglect, neuroscience has again embraced emotion as a research topic" (LeDoux 2000 p.155), the "highly focused approach centred on the study of fear" (LeDoux 2000 p.177) means that there is not yet a foundation for determining the broad range of emotions desirable for tailoring a computer game (Lane & Nadel 2002; LeDoux 1995). While there might be instances in which even this limited spectrum of emotion could prove useful, such as the survival horror genre, it would be impractical outside of the laboratory due to the bulk, expense, and inconvenience of the equipment involved. That the player's cognitive appraisal of the situation is involved in the emotional experience might still prove useful however, as that situation depends largely on their interaction with the computer system; information about the recent, and current state of computer generated world, and the player's interaction with it, may therefore assist in the determination of their emotional state using the visual and physiological methods discussed in this chapter.

2.2.6. SUMMARY

Although the identification of emotions based on the capture of autonomic nervous system activity has been successfully achieved in a controlled laboratory setting (Hazlett 2006; Sykes & Brown 2003; Levenson 1992), Picard's (1997) discovery that the "variation in signals for the same emotion over different days can be greater than the difference between two different emotions on the same day," and Levenson's (1988) concerns regarding distortions due to intense or sustained emotion, and a potential inability to detect weak emotions, must be addressed if it is to become an

effective method for the determination of emotion. Practical applications, in uncontrolled environments, introduce further complications in the form of a substantial increase in sensor noise (Prendinger & Ishizuka 2005; Conati, Chabbal & Maclaren 2003), difficulties associated with establishing a baseline immediately prior to measurement – although integrating sensors into computer input devices, as suggested by Charles & Black (2004), may address this by allowing the unobtrusive capture of baseline data while the application loads – and variation in neutral arousal, where by “physiological responses similar to those in an emotional state can arise without corresponding to an emotion” (Conati, Chabbal & Maclaren 2003); all of which are likely to be further exacerbated by the current trend toward motion sensing controllers (Ogg 2011; Portnow, Floyd & Theus 2010; Gaudiosi 2007) and mobile computing (European Travel Commission 2012).

“In recent years, the spotlight in affective science has moved away from the autonomic nervous system and toward the brain” (Levenson 2003 p.222), but the “highly focused approach centred on the study of fear” (LeDoux 2000 p.177) and the practical limitations on sensory equipment in the home – which must be accessible, inexpensive, and convenient – mean it is ill-suited for this project. A promising alternative, or augmentation, can be found in the identification of facial expressions – which are integral to the expression of emotion, and its recognition by other human beings (Lazarus 1991; Osgood, 1966 cited in Hayes 1994, p.516) – whether by facial electromyography (Gibert et al. 2009; Hazlett 2006), or the identification of facial action units using computer vision (Bailenson et al. 2008; D’Mello et al. 2005). Given aforementioned limitations on sensors in the home, the recent inclusion of video cameras and microphones in computer games consoles (Microsoft 2010b; Sony 2010), and advances in facial feature recognition technology (Ong & Bowden 2011; Tsalakanidou & Malassiotis 2010; Markin & Prakash 2006), D’Mello et al.’s (2005) “endeavours to classify emotions on the bases of facial expressions, gross body movements, and conversational cues,” seems likely to be the more practical approach, especially considering some of the early results (Bailenson et al. 2008; D’Mello et al. 2005) and modest technological requirements (Takahashi 2012).

In summation, while it is certainly possible to determine emotions from physical cues in a controlled laboratory environment (Hazlett 2006; Prendinger & Ishizuka 2005; Conati, Chabbal & Maclaren 2003; Sykes & Brown 2003; Levenson 1992), the limitations and complications introduced in adapting this process for use in the home are colossal, and remain largely unresolved. While this approach might be sufficient to tailor a computer game, “most [emotional influences] are caused by a mixture of interacting physical and cognitive systems, with a potentially very complex set of interactions” (Picard 1997), such as temporary interpretational filters which bias perception and judgement with relation to aggression – which is of particular importance with respect to computer games due to their often violent content (Anderson et al. 2003) – and enduring emotional states such as moods (Berkowitz 1993; Forgas & Bower 1987; Bower 1981). Even given the provision of real-time contextual information, such as the player’s actions and the state of the computer generated world, modelling this “continuous reciprocal interaction between cognitive, behavioural and environmental determinants” (Bandura 1977) in order to predict behaviour is an enormous task, and “a true physically based model [of emotions] is likely to be a tangle of parameters with non-linear relationships, which may make it intractable for practical use” (Picard 1997).

The analysis of facial features to identify emotions from the visual cues integral to the expression and recognition of emotions by human beings (Lazarus 1991; Osgood, 1966 cited in Hayes 1994, p.516) has matured considerably during the course of this project, with substantial improvements in techniques for recognising facial features (Ong & Bowden 2011; Tsalakanidou & Malassiotis 2010; Markin & Prakash 2006). It is now a promising alternative, or augmentation, to physiologically based approaches to the determination of emotion (Bailenson et al. 2008; D’Mello et al. 2005), and with the inclusion of computer vision capabilities in commercial computer games consoles as part of a trend toward motion control (Schramm 2010; Microsoft 2010b; Sony 2010), may soon have commercial applications (Takahashi 2012).

2.3. PSYCHOMETRICS

Because “[computational media] can analyze the artefacts created by users and the interaction patterns between users and system,” (Fisher 2001) they have access to a wealth of information which might be leveraged to make predictions about a specific user and their likely behaviour – a possibility which was briefly mentioned in the preceding discussion on the role of cognition in emotion. The prospect of determining broad attributes, such as knowledge, skill, or aptitude, on the basis of an individual’s interactions with a computer system may meet with initial scepticism, but in practice it is little different to the pen and paper tests – which purport to determine these same qualities on the basis of an individual’s responses to a series of questions intended to be representative of a syllabus, which is in turn intended to represent a broader domain of knowledge, such as mathematical ability – that are the foundation of our education system, and are relied on in industry for personnel selection. Excepting the computer game element, this is primarily the domain of psychometrics – the branch of psychology dealing with measurable factors – and a multitude of techniques have been developed in this field that might provide insight into the construction of profiles for players based on their interaction with a computer game.

2.3.1. LEGAL CONSIDERATIONS

On one hand, if it is to be effective, a test, psychometric or otherwise, must discriminate between individuals, for that is its purpose; on the other hand, there are groups in society facing unfair disadvantages and prejudices, which the law seeks to protect. The result is a convoluted system of laws, with significant variation between states, intended to prohibit unfair direct and indirect discrimination on the grounds of age, disability, ethnicity, gender, linguistic ability, marital status, political affiliation, race, religion and sexual orientation, amongst others (Roberts 1997; The Parliament of the United Kingdom's Sex Discrimination Act 1986, 1975).

While the aforementioned legislation should have no impact on the secondary or primary research involved in this project, nor should politics or the potential practical applications inhibit scientific investigation, the current legal situation is likely to become relevant as the domain matures, and influence future developments and

practical applications. In practice, unfair direct discrimination – which could consist of prohibiting a protected group from using a psychometric instrument, or denying them access to adaptive software, unless the necessity of that refusal can be established – is unlikely to impact the development and practical applications of this research. Unfair indirect discrimination is of greater concern, however, as it might occur in the provision of goods and services, or education, where adapting software on the basis of psychometric or physiological data results in a superior product, or learning experience, for some, but not all, protected groups. In addition, if the profiles developed are used in any form of selection process, it may not only be necessary to ensure that no irrelevant data is used to reach a decision, in order to avoid a claim of indirect discrimination, but could require a substantial amount of normative data for each protected group, to provide an appropriate baseline for the relevant data.

2.3.2. VALIDITY

Given the controversy surrounding the intelligence testing movement of the 19th and 20th centuries (Rust & Golombok 1989), it is important to recognise that the determination of an individual's intelligence or personality, if such concepts even exist in a concrete form, is not an objective of this research. The traits described are merely convenient identifiers, and could be any combination of known or unknown factors, which relate or correlate to specific behaviours, and therefore have predictive value in determining a player's actions. In the context of psychometrics this is an issue pertaining to validity – the degree to which an instrument measures what it claims to – a simple premise which belies significant complexity, and which will be broken into five aspects: face, content, predictive, concurrent, and construct validity, for more detailed discussion.

“[Face validity] is not validity in a technical sense; it refers, not to what the test actually measures, but to what it appears superficially to measure ... to the examinees who take it, the administrative personnel who decide on its use, and other technically untrained observers” (Anastasi & Urbina 1997, p.117). Typically determined on the basis of a cursory examination of the instruments presentation and content, it is vital to maintain face validity in order to ensure that respondents take the testing procedure

seriously (Edenborough 1994, p.31). If it is an issue, “face validity can often be improved by merely reformulating test items in terms that appear relevant and plausible in the particular setting for which they will be used” (Anastasi & Urbina 1997, p.118); although in some instances, such as when questions are intentionally disguised to inhibit the ability of respondents to project a socially desirable image, it may be preferable to focus on the professionalism of the presentation and administration to bolster an instrument’s credibility (Edenborough 1994, p.31). In either instance, “it cannot be assumed that improving the face validity of a test will approve its objective validity. Nor can it be assumed that when a test is modified so as to increase its face validity, its objective validity remains unaltered” (Anastasi & Urbina 1997, p.118).

Low Face Validity: G.O.A.T.

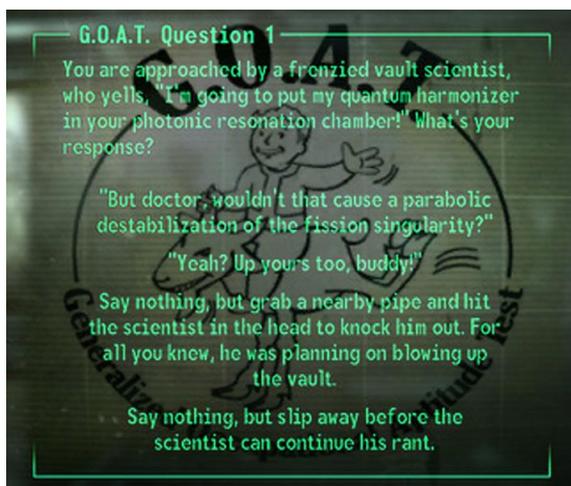


Figure 2.3.2a – G.O.A.T. (Bethesda Softworks 2008)

High Face Validity: MMPI-2

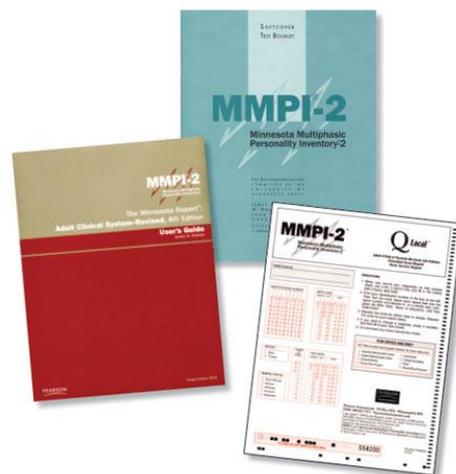


Figure 2.3.2b – MMPI-2 (PsychCorp 2011)

In contrast, determining content validity is a more complex process based on establishing that an instrument’s composition reflects a representative sample of the domain that it purports to examine. Conventionally this is achieved through a “systematic examination of the test content to determine whether it covers a representative sample of the domain to be measured” (Anastasi & Urbina 1997, p.114). In instances where this approach is impractical, such as with personality inventories where questions are routinely obfuscated, content validity can be built into an instrument deductively using a development process which first defines the domain of prospective instrument, and then selects items based on systematic sampling (Cronbach & Meehl 1955).

Both concurrent and predictive validity pertain to an instrument's ability to determine a specific criterion. Concurrent validity is concerned with the assessment of criteria that could be determined at the time of an instrument's administration, such as whether an A-Level exam is an accurate reflection of a student's current understanding of a subject, or the degree to which the Minnesota Multiphasic Personality Inventory (MMPI) correlates with contemporary diagnoses (Anastasi & Urbina 1997, p.119; Cronbach & Meehl 1955). While predictive validity is concerned with the ability of an instrument to determine criteria which cannot be known until some point in the future, such as the use of an A-Level grade to forecast a prospective candidate's university or job performance, or the value of the MMPI as a predictor of subsequent behaviour (Anastasi & Urbina 1997, p.119; Cronbach & Meehl 1955). In either instance, the criterion's validity is typically determined inductively through a correlation analysis of a statistically significant sample; a process which is relatively straightforward for concurrent validity, provided the criterion can be assessed directly, but which can prove difficult with predictive validity, due to confounding factors and an increased contamination risk (Anastasi & Urbina 1997, p.120; Edenborough 1994, p.31).

“In a number of instances, concurrent validation is employed merely as a substitute for predictive validation. It is frequently impracticable to extend validation procedures over the time required for predictive validation or to obtain a suitable preselection sample for testing purposes ... therefore, tests are administered to a group on whom criterion data are already available.” (Anastasi & Urbina 1997, p.119).

In the event of a perfect correlation it would be relatively easy to select the highest scoring respondent, or to establish a minimum acceptable score (illustrated in figure 2.3.2c), and be confident that it accurately reflects the criterion. In practice however, it is necessary to contend with a degree of error, positioning the minimum acceptable score either to eliminate the majority of false positives (illustrated in figure 2.3.2d), which would be advantageous if recruiting a small number of candidates from a pool of job applications, or to reduce false negatives, which may be more appropriate as part of a medical screening process. (Edenborough 1994 p.84).

Perfect Criterion Oriented Validity

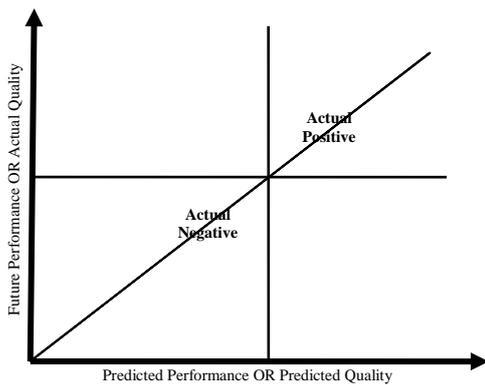


Figure 2.3.2c – Criterion Oriented Validity (Edenborough 1994 p.79)

Typical Criterion Oriented Validity

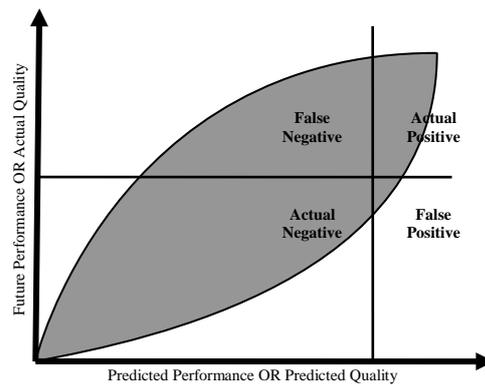


Figure 2.3.2d – Criterion Oriented Validity (Edenborough 1994 p.84)

In some cases the aforementioned measures of validity are impracticable as “no criterion or universe of content is accepted as entirely adequate to define the quality to be measured” (Cronbach & Meehl 1955). Often, this occurs when non-physiological qualities, such as intelligence, are the subject of study, and it is the validity of this construct, a “postulated attribute of people assumed to be reflected in test performance,” which must be established (Cronbach & Meehl 1955). In order to make this determination it is necessary to find evidence which corroborates the existence of the proposed construct – such as a correlation between respondents’ scores on the instrument and a subjective determination of intelligence made by a panel of observers – while eliminating alternative explanations – such as the proposition that the observers judgements reflect variation in facial features, rather than intelligence – in order to build a body of evidence sufficient to establish the construct’s validity.

2.3.3. ABILITY ASSESSMENT

Although they measure a multitude of criteria and constructs, the majority of psychometric instruments are concerned with aspects of ability, personality, and psychiatric diagnosis (Cook 2004; Edenborough 1994) – a facet which holds little relevance to this research, and will therefore be excluded. In order to facilitate discussion of the specific qualities of these instruments, and their implications for the development of profiles using data captured from players’ interactions with a computer game, these two broad categories will be decomposed based on their distinguishing features and methodologies, and accompanied by related theory. There

are three main types of ability test (Edenborough 1994 p.39): achievement tests, which assess the respondent's command of a specific body of knowledge or skill; aptitude tests, which predict an individual's potential to acquire a specific skill if given training; and general intelligence tests, which attempt to determine an the subject's general intelligence factor (Anastasi & Urbina 1997, p.310; Hayes 1994, p.178; Spearman 1904).

Provided there is no physical or social component, "in principle any test can be represented on computer" (Kline 1986 p.193), and doing so may yield a number of benefits over a traditional pen and paper implementation (Rust & Golombok 1989 p.131; Kline 1986 p.193). Computerisation makes it practical for questions to be tailored to a subject during the testing procedure, assessing their prior responses in real-time in order to select a suitable question from a large pool of pre-prepared questions, offering "the same reliability and validity as conventional tests with a much smaller number of items and less testing time ... [and] with greater precision of measurement for individuals at the upper and lower extremes of the ability range covered by the test" (Anastasi & Urbina 1997, p.277). Nearly instantaneous automated marking is also a possibility (Kline 1986 p.193), although the raw test scores typically have little inherent meaning and must be assessed relative to the performance of an appropriate population (Cook 2004, p.96) – a process which could employ normative data provided with the instrument, but which might benefit from access to a central repository, accessed via the internet, as it would always be up-to-date. Finally, because computer games are an interactive media with interpretive power (Fisher 2001), there are some novel possibilities. Ability tests could be constructed to measure specific aspects of a player's performance – such as their reaction time and accuracy during quick-time events, the time it takes them to move their crosshairs over a target in a first person shooter, or their ability to enter a complex sequence of inputs in *Guitar Hero* (Harmonix 2005) – utilizing elements which are common in many games, and may therefore prove useful in predicting a player's performance in games which rely on those elements. It may also be possible to obfuscate the measurement of more traditional traits, such as the general intelligence factor (g), by adapting elements, like puzzles, already present in commercial computer games, or through the development of small games specifically for that purpose.

2.3.3.1. GENERAL INTELLIGENCE

In 1904 Spearman observed, “a correspondence – continually varying in size according to the experimental conditions – between all the forms of Sensory Discrimination and the more complicated Intellectual Activities of practical life”, which lead him to conclude that “all branches of intellectual activity have in common one fundamental function (or group of functions)” (Spearman 1904, p.284). Although the nature of intelligence is a controversial subject in psychology, due to the significance of its implications (Hayes 1994, p.178), this General Intelligence Factor has remained highly influential in intelligence testing and formed the foundation for many subsequent theories of intelligence (Carroll 1993) – including Cattell’s (1971) Fluid Crystallized Model and subsequent hierarchical theories, such as Vernon’s (1961) Hierarchical Organisation of Abilities, Carroll’s three-strata model, and the Cattell-Horn-Carroll Theory (McGrew 2004).

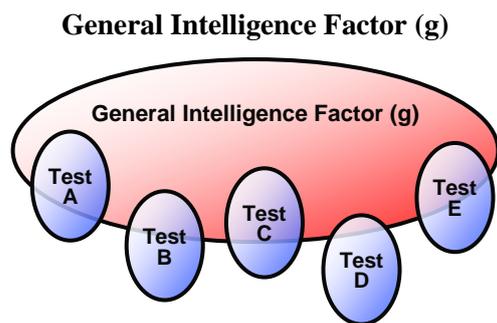


Figure 2.3.4a – General Intelligence (g)

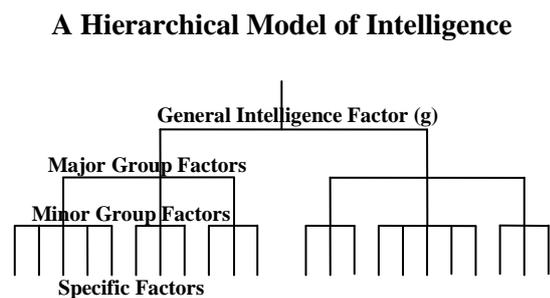


Figure 2.3.4b – A Hierarchical Intelligence Model

Irrespective of its structure, the presence of a general intelligence factor (g), or major groups of factors which contribute substantially toward performance in all aspects of intelligence (Johnson & Bouchard 2005), provides a solid foundation for predicting an individual’s performance in a wide variety of tasks on the basis of their prior performance in g loaded tasks – tasks where the general intelligence factor (g) is highly influential – which involve similar high level groups of factors. In practice however, asking users to complete sixty of Raven’s Progressive Matrices – one of the highest g loaded tests (Jensen 1992) – prior to playing a computer game would be onerous; although might be justifiable where a persistent profile allows the results to be retained and reused by other games and applications.

Raven's Progressive Matrices Example Question

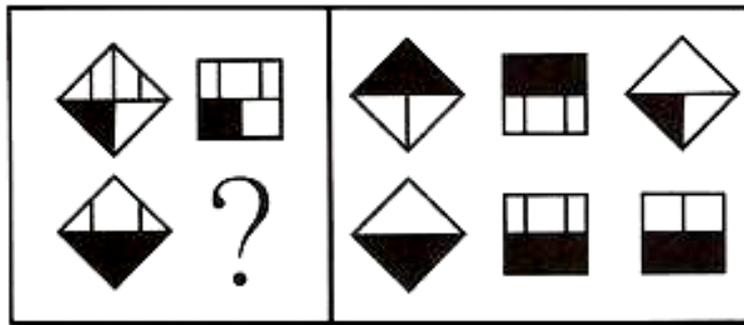


Figure 2.3.4c – Raven's Progressive Matrices Example Question

2.3.3.2. ASSESSMENT CENTRES

In industry, selecting the best candidate for a position from amongst a group of prospective candidates can be of considerable importance, and the use of a good selection method can offer tangible benefits which can be expressed in monetary terms through Utility Analysis – a technique developed by Hunter and Schmidt that utilizes information regarding the statistical accuracy of selection methods in conjunction with data on the ratio of positions to prospective candidates and variance in job performance (Hunter & Schmidt 1986; Schmidt et al. 1983; 1979). It is therefore no surprise, given that historically the validity of the traditional job interview was believed to be very low (Hunter & Hunter 1984; Reilly & Chao 1982) – although more recent estimates are substantially higher, comparable with that of ability tests, and suggest the validity depends on the interview's structure, content, and rating scales (Schmidt & Hunter 1998; McDaniel et al. 1994; Huffcut & Arthur 1994) – that there was interest in developing superior methods.

One of the most popular alternatives to emerge has been the assessment centre, which has achieved an estimated predictive validity of 0.43 (Schmitt et al. 1984) through a combination of conventional psychometric instruments, such as personality inventories, with written assignments – often involving report writing and organizational tasks, such as an in-tray exercise – with a mixture of solo and group activities – typically consisting of discussions, presentations, negotiations, and role-playing – intended to form a simulation of the job. In addition to the aforementioned high predictive validity, a cursory examination of the methodology of the assessment

centre approach – which involves distilling a list of competencies, or qualities, that are important in performing the job to be filled, and then selecting a range of exercises which will thoroughly assess them – offers excellent content validity as well as a high degree of face validity – stemming from the rationale that a method of assessment which simulates a job should be an effective means of identifying the best candidate (Woodruff 1993 p.93). On closer examination however, although “given the predictive validities consistently reported in reviews, we would have to conclude that indeed assessment centres do work,” “research consistently demonstrates a lack of evidence for the construct validity of assessment centre dimension ratings,” (Klimoski & Brickner 1987) with inter-exercises correlates being higher than inter-competency correlates. This poses a significant problem in employing the assessment centre approach in this project, as although the method utilizes a representative sample of the domain to be measured in a way that appears reasonable and correlates with performance, without knowing why the technique works, and what is actually being measured, adapting it could compromise its predictive validity, and interpreting the results would be exceptionally difficult.

2.3.4. THEORIES OF PERSONALITY

As with intelligence, the nature of personality is still not clearly defined and there are a number of competing theories which aim to account for the “distinctive and characteristic patterns of thought, emotion and behaviour that define an individual’s personal style of interacting with physical and social environments” (Atkinson et al. 2000, p.435). This section is limited in scope and provides only a broad outline of the major approaches to understanding personality (Ewen 1980; Mischel 1971), in order to provide context as a prelude to the discussion of personality testing.

2.3.4.1. THE PSYCHOANALYTICAL APPROACH

Founded by Sigmund Freud (1940), psychoanalytic theory proposes that personality is the result of interaction between a tripartite formed from the id – which seeks the immediate gratification of impulses, the ego – which determines when and how the demands of the id can be realistically satisfied, and super ego – which judges these

impulses and behaviours against the values and morals of society. The perspective of psychoanalytical theory is therefore “human nature as basically evil ... emphasising that human nature is determined by forces beyond our control ... our personalities are basically determined by inborn drives and events in our environment during the first five years of life ... depriving us of free will and psychological freedom” (Atkinson et al. 2000, p.462).

2.3.4.2. THE BEHAVIOURIST APPROACH

In contrast the behaviourist approach emphasizes the importance of the environment, considering behaviour to be “a continuous reciprocal interaction between cognitive, behavioural and environmental determinants” (Bandura 1977) and focusing on processes through which behaviour may be learned in an effort to discern the influence of an individual's experiences on their behaviour and personality. From this perspective “people are not inherently good or evil but are readily modified by events and situations in their environment ... shaped primarily by forces beyond our control ... social learning approaches increasingly emphasise the individual's active role in selecting and modifying the environment, thereby permitting the person to become a causal force in his or her own life” (Atkinson et al. 2000, p.468).

2.3.4.3. THE HUMANISTIC APPROACH

Humanistic psychology – the third, and final approach to understanding personality based on a philosophy of human nature – emphasises the role of the individual, reflecting the view of Rogers (1967), whose observation of clients, as a psychotherapist, lead him to conclude that the basic force motivating the human organism is “man's tendency to actualize himself, to become his potentialities ... to express and activate all the capacities of the organism, or the self.” (Rogers 1967, p.351), and Maslow (1957; 1943) who proposed ‘a theory of human motivation’ based on a hierarchy of needs, where basic physiological needs must typically be fulfilled before an individual becomes concerned with safety, love, esteem, cognitive, aesthetic, and self-actualisation needs in sequence. According to the humanistic

approach, “biological and environmental variables can influence behaviour, but they emphasises the individual’s own role in creating his or her destiny, and they downplay the determinism that is characteristic of the other approaches. In their view, individuals are basically good, striving for growth and self actualisation”, and “psychological health is a process, not an end state ... only an individual that is growing toward self-actualisation can be said to psychologically healthy.” (Atkinson et al. 2000, p.472)

2.3.4.4. THE COGNITIVE APPROACH

While the preceding approaches to understanding personality are founded on a philosophy of human nature, the cognitive approach is grounded in empiricism. Kelly (1963 p.5) asks, “Might not the individual man, each in his own personal way, assume more of a stature of a scientist, ever seeking to predict and control the course of events with which he is involved? Would he not have his theories, test his hypothesis, and weigh his experimental evidence? And, if so, might not the differences between the personal viewpoints of different men correspond to the differences between the theoretical viewpoints of different scientists?” This is the core of the cognitive approach, the idea that differences in personality stem from differences in individuals’ cognitive models – or schemata – of themselves and the world, and the mechanisms by which they perceive, process, organise and utilise information (Markus 1977; Kelly 1963).

2.3.5. PERSONALITY ASSESSMENT

There are several hundred instruments available for the assessment of personality (Anastasi & Urbina 1997, p.348), often referred to as personality inventories or questionnaires – differentiating these self reported instruments, which have no definitive responses, from their counterparts with neat model answers. As might be anticipated given the diversity of personality theory (Ewen 1980; Mischel 1971), there are a variety of approaches to personality assessment, but only two major applications: the diagnosis of psychiatric conditions; and the appraisal of personality

in order to predict subsequent behaviour. While clinical instruments remain largely beyond the scope of this research – relegated to the discussion of instrument construction methodologies – the capacity of non-clinical personality tests to predict aspects of performance and behaviour which are not covered by mental ability tests in isolation (Cook 2004 p.152), highlights the potential utility of personality assessment for constructing profiles of players on the basis of their interaction of a computer game.

The computerisation of personality inventories is relatively straightforward and instruments are often available in both computerised and traditional pen and paper formats (Roberts 1997, p.179), with results reported as “a set of raw scores, or a set of sten responses (a standard ten-point scale derived from the range of responses in the population norm) and often [accompanied] with a narrative report” (Roberts 1997, p.179). The calculation of respondents’ scores is purely mathematical task, ideally suited for computerisation due to the machines capacity for processing information and performing arithmetical and logical operations at high speed, and as with intelligence testing it might be preferable to use an internet based repository to store any requisite normative data, allowing it to be easily updated, rather than include it in a static form with the instrument. In comparison, the production of the narrative report is more challenging for a computer, and is typically based on interpretation of the sten responses using an expert system approach similar to that demonstrated by Krug (1981, cited in Edenborough 1994, p.55) – who reduced the 1×10^{16} possible score combinations present in the Sixteen Personality Factor Questionnaire (16PF) to 81 combinations, for which he was able to write descriptions.

2.3.5.1. PERSONALITY TRAITS

Inspired by the Lexical Hypothesis (Krug, 1932 cited in Waller 1999 p.157) – which posits that “those individual differences that are most salient and socially relevant in people’s lives will eventually become encoded into their language; the more important such a difference, the more likely is it to become expressed as a single word” (Goldberg, 1982 cited in Waller 1999 p.157) – trait theories are predominantly

concerned with the categorisation and measurement of personality using adjectives derived from natural language, rather than the explanation of its underlying mechanisms (Atkinson et al. 2000, p.435). An approach which is exemplified by the work of Cattell (1946), who combined and condensed the personality related terms from psychiatric and psychological literature with those compiled in 1936 from Webster's International Dictionary by Allport and Odbert (Waller 1999 p.159), producing a list of fewer than 200 traits which he subsequently analysed with factor analysis, yielding 16 factors which would form the foundation for his Sixteen Personality Factor Questionnaire.

2.3.5.2. FIVE ROBUST FACTORS

Echoing the words of Thurstone's (1936) presidential address to the American Psychological Association almost 30 years before, Norman's (1963) observation that "a series of studies ... using peer nomination rating methods ... yielded clear and consistent evidence for the existence of 5 relatively orthogonal, easily interpreted personality factors," sparked brief interest amongst personality researchers before "an era of scepticism ... to traditional personality research" (Digman 1996, p.11). Since its resurgence in the 1980's (Digman 1996) this five factor approach – although in practice the number can vary by ± 2 depending on the sample, the purpose of the assessment, and the instruments employed (Anastasi & Urbina 1997, p.364) – "represents an unusual level of consensus among personality researchers from the various factor analytic traditions" (Anastasi & Urbina 1997, p.364). Although there is still some contention (Block 2010), particularly with respect to how the factors should be named and interpreted (Hayes 1994, p.244), a common designation is:

agreeableness, which reflects an optimistic view of human nature and a tendency toward social harmony, agreeable individuals are typically compassionate, trusting, and generous, and get on well with others;

conscientiousness, which reflects self-discipline and attention to detail, conscientious individuals are typically reliable, organised, and dutiful, and strive for achievement;

extraversion, which reflects a propensity for activity and a desire to interact with others, extroverts are typically positive, friendly, and gregarious, and enjoy being the centre of attention;

neuroticism, which reflects a predisposition toward depression and emotional instability, neurotic individuals are typically anxious, impulsive, and hostile, and are often self-conscious;

and **openness to experience**, which reflects an appreciation of aesthetics and art, individuals who are open to experience are typically imaginative, creative, and curious, and intrinsically understand their feelings and emotions.

The Five Factor Model: A Hierarchical Personality Trait Theory

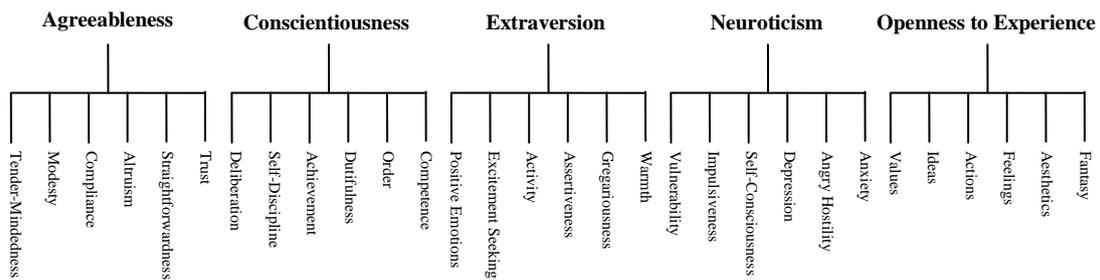


Figure 2.3.5.2a – The Five Factor Model as used in the NEO PI-R

There are a number of personality inventories that can be used to measure these factors, ranging from the Revised NEO Personality Inventory (NEO PI-R), which consists of 240 items (Anastasi & Urbina 1997, p.366), to simplistic adjective tests, which can take as little as 15 minutes (Roberts 1997, p.179). Requiring players to complete even a short personality inventory for each game they play is clearly unacceptable; but even where a persistent profile allows the results to be retained and migrated between applications their periodic administration might prove onerous unless the instrument is inherently interesting and gracefully integrated with the game experience – such as in *Silent Hill: Shattered Memories* (Konami Digital Entertainment 2009) where pseudo-psychometric instruments are employed as part of the narrative in interjected scenes with a psychologist.

2.3.5.3. PROJECTIVE TECHNIQUES

Not all instruments for personality assessment follow the closed question structure which is characteristic of personality inventories; projective techniques present subjects with an unstructured task, typically involving the interpretation of vague or ambiguous stimuli (illustrated in figures 2.3.5.3a/b), intending that the respondent will project fundamental aspects of their psychology in their interpretation of the task and exposition of their responses.

A Rorschach Ink Blot

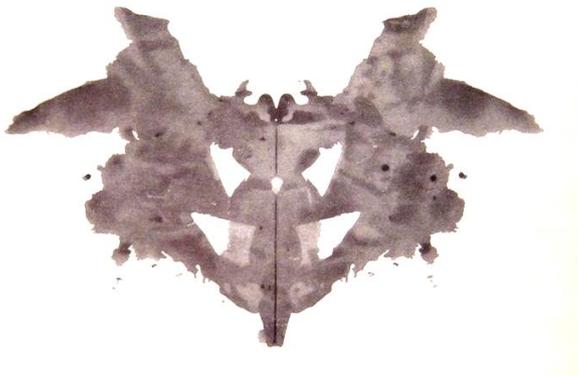


Figure 2.3.5.3a – Rorschach Ink Blot (WikiMedia 2009)

A Thematic Apperception Card



Figure 2.3.5.3b –Thematic Apperception Card

A key advantage of projective techniques, which is of particular importance in selecting psychometric instruments for integration with a computer game – and might explain why the majority of the activities in *Silent Hill: Shattered Memories* (Konami Digital Entertainment 2009), one of the only major software releases to incorporate pseudo-psychometric instruments, are of this nature – is that the “task is usually intrinsically more interesting [than a personality inventory] and often entertaining” (Anastasi & Urbina 1997, p.433). Unfortunately, because “[projective techniques are] characterised by a global approach to the appraisal of personality, focusing on a composite picture of the whole personality rather than on the measurement of separate traits,” (Anastasi & Urbina 1997, p.411) a degree of expertise is required in interpreting the complex responses which makes computerised marking and interpretation difficult. Furthermore, while the survival horror genre lends itself relatively well to the inclusion of such elements – with games like *Fahrenheit* (Quantic Dream 2005), *Clock Tower 3* (Capcom 2003), and *Eternal Darkness* (Silicon

Knights 2002), all incorporating the protagonist’s sanity as something the player must maintain throughout the game – in other genres it may be distinctly out of place, making the unobtrusive capture of psychometric data preferable.

Sanity as Represented in Clock Tower 3



Figure 2.3.5.3c – Sanity in Clock Tower 3 (Capcom 2003)

Sanity as Represented in Fahrenheit



Figure 2.3.5.3d – Sanity in Fahrenheit (Quantic Dream 2005)

2.3.6. INSTRUMENT CONSTRUCTION

The creation and validation of psychometric instruments can be a complex process; even where validity is built in, using content validation – discussed in section 2.3.2 validity – it is necessary to define the domain accurately, while the assessment of validity against an external criterion, using concurrent or predictive validation, requires determining an approach to statistical error – illustrated in figures 2.3.2c/d – which depends on the purpose for which the instrument will be used (Anastasi & Urbina 1997, p.114–119; Cronbach & Meehl 1955). In the case of instruments intended to predict personality, the domain has traditionally been defined through an examination of natural language, which has more recently been subject to factor analytical techniques, while instruments for psychiatric diagnosis have employed a criterion based approach to differentiate groups of individuals with a psychiatric condition from the general population (Anastasi & Urbina 1997, p.348–385). In the interest of brevity, the following discussion provides only a broad outline of these methodologies, leaving the specifics to a treatise on the subject, such as Aiken’s (1997) ‘Questionnaires & Inventories’.

2.3.6.1. THE RATIONAL THEORETICAL APPROACH

The rational-theoretical approach is founded on the Lexical Hypothesis (Klages, 1932 cited in Waller 1999 p.157) – previously mentioned in relation to trait theories in section 2.3.5.1 – which posits that “those individual differences that are most salient and socially relevant in people’s lives will eventually become encoded into their language; the more important such a difference, the more likely is it to become expressed as a single word” (Goldberg, 1982 cited in Waller 1999 p.157). It is the process of distilling traits from natural language – such as the list of personality traits compiled by Allport and Odbert in 1936, through the elimination of synonyms from the descriptive terms found in Webster’s New International Dictionary (Waller 1999 p.159) – which defines the rational theoretical approach, and formed a foundation for Cattell’s (1946) factor analytical efforts and, by extension, modern trait theories.

Given that unlike the totality of human behaviour, which has 10,000 years of description by human gossips and playwrights from which to identify traits (Cattell 1979 p.27), commercial computer games have only existed since the late 1970’s, and there would therefore be scant resources from which more specific traits than those already determined to represent the breadth of human behaviour might be compiled.

2.3.6.2. THE FACTOR ANALYTICAL APPROACH

Utilizing statistical methods, such as factor analysis or component analysis, the factor-analytical approach aims to account for the variation in respondents’ responses by gathering items together to create highly inter-correlated sets with a strong internal consistency and low inter-set correlations (Field 2009 p.627; Anastasi & Urbina 1997 p.362; Duntman 1989 p.7); a paradigm which has been used to develop a number of notable instruments, including Cattell’s Sixteen Personality Factors Questionnaire (Heather, Cattell & Mead 2008), which express personality in terms of traits. Over the past century, researchers have repeatedly noted that the majority of personality differences measured by various instruments can be accounted for with just five common factors (Digman 1996; Norman 1963; Thurstone 1936) – agreeableness, conscientiousness, extraversion, neuroticism, and openness to experience – and

although there is still contention (Block 2010), “an unusual level of consensus among personality researchers from the various factor analytic traditions” (Anastasi & Urbina 1997, p.364) has formed around a hierarchical trait theory known as the Five Factor Model (Digman 1996; Hayes 1994, p.244) – discussed in section 2.3.5.2 Five Robust Factors.

It should be possible to employ the factor analytical approach to distil the wealth of information that can be extracted from a player’s interaction with a computer game, producing a smaller, more manageable number of highly inter-correlated factors; although this may be a time consuming process, as the development of a multi-score psychometric instrument to measure internally consistent independent traits using this method is normally an iterative procedure, with refinements resulting from successive analyses (Aiken 1997).

2.3.6.3. THE EMPIRICAL CRITERION KEYING APPROACH

“The MMPI [Minnesota Multiphasic Personality Inventory] is, and has been for many years, the most widely used inventory of personality and psychopathology” (Wiggins 2003 p.176). It was developed using a contrasted-groups strategy, which focuses on identifying items that differentiate a group of individuals who meet a specific criterion, such as a diagnosis of clinical Schizophrenia, from those that do not. This is achieved through an iterative process, where a prototype instrument is administered to a group of subjects for who the criterion of interest is known, allowing items which fail to discriminate on the basis of the criterion to be identified and eliminated – an approach which can be problematic because it presupposes the criterion exists in a binary state, where it may be present or absent, but not in between, and tends to produce less homogeneous items than other techniques, which may lead to a lack of face validity (Aiken 1997).

The empirical criterion keying approach has received heavy criticism, with Wiggins (2003 p.165) describing it as a “shaky foundation” and Norman (1972 p.72) going so far as to call it “empiricism gone mad as well as blind,” but it is important to remember its origins in the 1920’s and that “the MMPI was developed before factor

analysis was easily computed on a large item pool. In its day it was no doubt splendid but half a century later, with little evidence for validity other than screening ability, it is surely time to turn to personality tests devised on a better psychometric rationale” (Kline 2000 p.512).

2.3.7. THE COMPUTERISATION OF PSYCHOMETRIC INSTRUMENTS

In transferring any psychometric instrument from one format to another, consideration should be given to the variation between formats which may affect the suitability of normative data. Substantive changes clearly necessitate new normative data, but the deliberation ought to also include elements which might otherwise be considered minor changes, such as “variations in [the] visual scanning patterns of the material, which can affect the speed of response,” and “the extent of the tendency to scan forward or backward to review answers,” (Edenborough 1994, p.194) as this can have a marked effect, particularly in tests with time constraints. It is also worth taking note of any novel opportunities the new format presents; an aspect which is particularly prominent in the computerisation of psychometric instruments, where it may be possible to capture additional data relevant to the qualities being assessed – such as the time it takes a subject to respond to each question, which has been shown to provide indications of deviant responses in the Minnesota Multiphasic Personality Inventory (Dunn, Lushene & O’Neil 1972) – or to present the content in a new way – such as dynamically selecting questions based on the subject’s performance, reducing the time required to administer the test or allowing a more extensive evaluation to be conducted in a given time-frame, while making the instrument more resilient to contamination resulting from a subject’s prior exposure to it (Anastasi & Urbina 1997, p.274).

In this chapter, the discussion of intelligence and personality testing has included some consideration of the potential for, and problems associated with, the computerisation of specific types of psychometric instrument. One of the reoccurring issues in this discussion has been the need to adapt unengaging instruments with lengthy testing protocols – such as a large number of closed questions – for a medium that is used primarily for entertainment. While a laborious or repetitive testing

procedure might be alleviated through the use of a persistent profile – minimising the need for repetition to the degree it is necessary to maintain an up-to-date record – it may still prove onerous, even where the instrument is inherently interesting, and might be avoided by the player. Obfuscating the testing procedure, by integrating psychometric instruments directly into thematically appropriate commercial computer games – such as *Silent Hill: Shattered Memories* (Konami Digital Entertainment 2009) – might provide a partial solution to this problem, allowing the player’s profile to be created or updated as they progress through different games; although there is no assurance that any individual player would complete a suitable game, and therefore have a profile, and both the number and variety of games which could gracefully integrate psychometric instruments are likely to be severely limited (Entertainment Software Association ESA 2010).

Perhaps, instead of adapting existing instruments for such a disparate medium, the solution lies in developing new psychometric instruments which leverage the wealth of information the player already provides in their interaction with a computer game, and can therefore be integrated invisibly into a wide variety of commercial titles.

2.3.8. SUMMARY

Silent Hill: Shattered Memories (Konami Digital Entertainment 2009), a recently released computer game, boasts that, “it gets to know who you really are,” and “plays you as much as you play it,” but the review of psychometric instruments in this chapter suggests that these claims are likely to be a gross exaggeration. While there are a multitude of psychometric instruments, purporting to measure a variety of criteria and constructs pertaining to ability and personality (Cook 2004; Edenborough 1994), the pseudo-projective techniques used in the game – which are characterised by a global approach to the appraisal of personality, that endeavours to make predictions on the basis of the subject’s behaviour during an unstructured task (Anastasi & Urbina 1997, p.411) – are difficult for a computer to interpret, as making inferences from behaviour requires a degree of expertise, and were likely chosen more for their ability to entertain than their predictive power.

Silent Hill: Psychological Profiling Warning

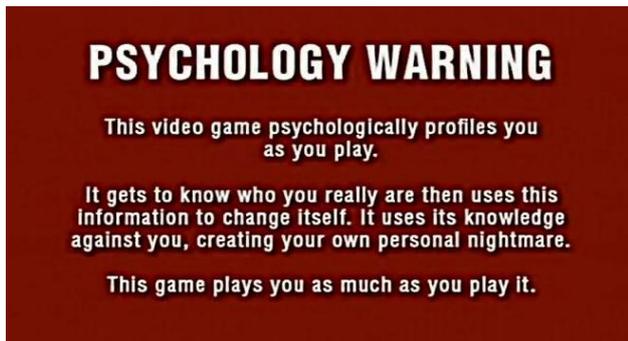


Figure 2.3.8a – Silent Hill: Psychological Profiling Warning (Konami Digital Entertainment 2009)

Silent Hill: Pseudo Psychometric Instrument

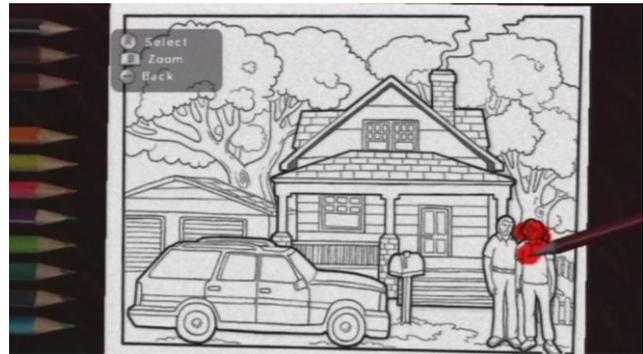


Figure 2.3.8b – Silent Hill: Pseudo Psychometric Instrument (Konami Digital Entertainment 2009)

“In principle any test can be represented on computer” (Kline 1986 p.193), but it is with objective techniques – as opposed to projective techniques, which take a holistic approach to personality (Anastasi & Urbina 1997, p.411) that is ill-suited for computerised interpretation – where computerisation offers the most advantages (Rust & Golombok 1989 p.131; Kline 1986 p.193). Although care should be taken when altering an instrument, as even minor changes in the visual scanning patterns of the material can necessitate new normative data (Edenborough 1994, p.194), computerisation makes it practical to tailor instruments in real-time, allowing a more extensive evaluation, with superior precision at the upper and lower extremes, to be conducted in the same amount of time through dynamic question selection (Anastasi & Urbina 1997, p.277). There may also be novel opportunities to collect additional data which may be relevant to the qualities being assessed, such as reading and response times (Dunn, Lushene & O'Neil 1972), which would be difficult to measure using a traditional pen and paper instrument. Interpreting the test results is relatively straightforward for a computer (Kline 1986 p.193), as scoring is based on mathematical formulae and comparison with normative data (Cook 2004, p.96), and may be represented in the form of a narrative report using an expert system – as demonstrated by Krug (1981, cited in Edenborough 1994, p.55) who reduced the Sixteen Personality Factor Questionnaire’s (16PF) 1×10^{16} possible score combinations to just 81 written descriptions. Finally, there are advantages in computerised storage, particularly with respect to an online repository that can be accessed anywhere there is an internet connection, as this minimises the need to

repeat the testing procedure, to the degree it is necessary to maintain an up-to-date profile, and ensures the availability of current normative data.

Personality is not the only trait which might be of use in tailoring a computer game, and while assessment centres – which involve distilling a list of qualities that are important in performing a task and then selecting a range of exercises which will thoroughly assess them – consistently fail to demonstrate construct validity (Woodruff 1993 p.203; Klimoski & Brickner 1987), which makes any modification of the approach a risky proposition, it may be possible to decompose a player's performance in order to assess elements common in many computer games. In terms of cognitive ability, the presence of a general intelligence factor (g), or major groups of factors which contribute substantially toward performance in all aspects of intelligence (Johnson & Bouchard 2005), provides a solid foundation for predicting a player's performance on the basis of their prior performance in game elements where the general intelligence factor (g) is highly influential, or which involve similar high level groups of factors. An approach which might also be applied to the prediction of physical ability, allowing prior performance in specific game elements, such as quick-time events, to act as predictors for future performance in tasks involving similar physical elements.

Finally, given the difficulties in adapting existing psychometric instruments to such a disparate medium – specifically the risk of invalidating the instrument or necessitating the acquisition of fresh normative data (Edenborough 1994, p.194) – and the potential for novel approaches, perhaps the solution lies in developing new instruments that minimise the imposition on the player by leveraging the wealth of information provided by their interactions with a computer game. Having examined three paradigms which have been popular in the construction of psychometric instruments during the past century, the factor analytical approach – having grown out of the rational theoretical approach (Cattell 1979; 1946) and supplanted the systemically flawed empirical criterion keying approach (Wiggins 2003 p.165; Kline 2000 p.512; Norman 1972 p.72), as computerisation reduced the computational burden – clearly holds the most promise for developing new psychometric instruments using this data.

CHAPTER 3
MATERIALS & METHODS

3. MATERIALS & METHODS

The literature review has highlighted the potential for creating novel psychometric instruments, using a factor analytical approach, as a means of exploring the hypotheses outlined in the introduction. In order to assess the degree to which psychometric information is revealed through interactions with a computer game, and its suitability for constructing player profiles, a substantial quantity of data detailing those interactions will be compared with personality data acquired using traditional instruments. If the results are promising, then an attempt will be made to construct a rudimentary model for the assessment of a player's personality on the basis of their interactions with a computer game; while such a model will be limited by the scope of the experiment – with generalisation anticipated to be difficult given the wide variety of commercial computer games – the process through which it is developed may provide a foundation for further work on the construction of a more general model.

3.1. OVERVIEW

An exhaustive search of secondary sources has failed to yield personality characteristic and computer game interaction data which would be suitable for assessing the hypotheses, and it is therefore necessary to conduct primary research to obtain it. There are a variety of reputable inventories (The British Psychological Society 2010; Cook 2004, p.166 – 170; Anastasi & Urbina 1997, p.348 – 385) for capturing a snapshot of an individual's personality – ranging from comprehensive instruments with hundreds of questions, to comparatively simple ones with less than fifty – from which a suitable instrument might be selected. Capturing computer interaction data is more complicated. Self administered methods – such as a journal documenting the player's actions in a computer game – allow a large quantity of low fidelity data to be obtained relatively easily, but risk substantial reporting bias; while independent observation of computer game play can offer a high level of accuracy and detail, but greatly constrains the quantity of data it is feasible to collect. A third alternative, made possible because the data is based entirely on interaction with a computer, could provide a large quantity of rich data through the use of a computerised observer program to monitor the player's interactions with the game; an approach which would be ideal, were it not for the resources required to develop the

observer program, which would be most easily incorporated during the development of the software to be observed, but in this instance would need to be integrated after the fact, and may well require substantial adjustment during the course of the study as the methods are refined.

3.1.1. STATISTICAL POWER

“The power of a statistical test is the probability that it will yield statistically significant results” (Cohen 1988, p.1), which is expressed as the complement of the beta (β) value, the probability of committing a ‘Type II Error’ and obtaining a false negative, and often accompanied with a significance criterion, the alpha (α) value, which reflects the probability of committing a ‘Type I Error’ and obtaining a false positive. While the determination of statistical power can be complex, depending on the nature of the statistical techniques, anticipated effect sizes, and acceptable degrees of error, over which the experimenter may have little control, “the reliability (or precision) of a sample value ... is *always* dependent upon the size of the sample” (Cohen 1988, p.6). “The larger the sample size, other things being equal, the smaller the error and the greater the reliability or precision of the results ... thus we can directly formulate the relationship between sample size and power ... increases in sample size increase statistical power” (Cohen 1988, p.7).

In considering a preliminary study to explore large effect sizes using a correlation analysis, it would be necessary to obtain samples from 28 subjects in order to meet Cohen’s (1988, 1992 p.75) recommended power of 0.8 (β 0.2) with a 5% chance of obtaining a false positive (α 0.05); while the same analysis investigating medium effect sizes would require 85 samples if it were to maintain the same statistical power at those error levels. Increasing the sample size further continues to offer benefits with respect to statistical power, but the prior overview of data capture suggests that obtaining a large quantity of data will compromise either the quality of that data or flexibility of the investigation. Independent observation will therefore be employed to capture a modest quantity of rich data which can be used to explore the hypotheses, while retaining the option to revise the procedure after a preliminary investigation.

3.1.2. STATISTICAL TECHNIQUES

Given the limited resources available and the time intensive nature of independent observation, a small scale preliminary study will be conducted to examine the potential of this approach. In order to achieve this: demographic data will be captured and descriptive statistics computed, which will allow the sample composition to be compared with the composition of the target population; and a correlation analysis will be employed to identify relationships between psychometric data captured from a traditional instrument and computer game interaction elements. If there are sufficient correlates, as determined by calculating the binomial probability of the correlates in excess of those anticipated due to error levels all being false positives, then this preliminary study will act as a foundation for capturing further data – potentially involving the development of a computerised observer program. In addition to improving the statistical power of the correlation analysis, an increased sample size will enable further investigation using multivariate techniques, such as factor analysis, multiple linear regression, and clustering, which can require large quantities of data to be effective, but could be useful in the construction of a predictive model (Clark-Carter 2004, p.296, 330, 582, 614; Cohen 1988 p.407).

3.2. ETHICAL CONSIDERATIONS

It is good scientific practice to document the instruments and procedures used in an experiment, as this aids in its reproduction, and in conjunction with details of the analysis and the inclusion of the anonymised raw data obtained, assists in maintaining accountability and supporting related work – an aspect which is of particular importance to this dissertation as it aims to provide a foundation for future development. To these ends, the subsequent sections and appendices include full details of the instruments and procedures used during the experiment, the raw data captured, the data cleansing procedure, and the techniques employed during the analysis.

In addition to good practice, the instrument design and procedural format of the experiment will include a number of elements intended to fulfil the experimenter's ethical duty to the participants. In order to ensure they are able to make an informed

decision, prospective candidates should be provided with preliminary information about the study, such as its aims and objectives, and details of what would be involved should they decide to take part. If they choose to participate, then the experimenter will provide a detailed explanation of the activities to be undertaken, their associated risks, and the process for withdrawing from the experiment, emphasising that candidates may withdraw at any point and have all data pertaining to them destroyed. If both the candidate and experimenter are satisfied, then consent may be formally obtained and the experiment undertaken. During the experiment, it may be desirable for the experimenter to avoid contact with the candidate, in order to avoid influencing the results (Atkinson et al. 2000, p.641; Hayes 1994, p.555), but they should continue to monitor the situation, perhaps from an adjacent room, and be available to address any pressing questions or problems the candidate may have. It may also be prudent, where practicable, to provide a summary of the information covered in the briefing for the candidate's reference during the procedure. At the conclusion of the experiment, the experimenter should debrief the candidate, addressing any questions they might have, reaffirming their consent, and reviewing the procedure for having their data destroyed should they later change their mind. Finally, the data capture should be securely stored in an anonymised form, which is typically achieved by replacing a candidates name with a unique, but meaningless, reference number.

3.3. EXPERIMENT STRUCTURE

The experiment will be conducted in a usability laboratory – a sound proofed room equipped with multiple angle video and audio recording equipment, which may be monitored from an adjacent room through either a one-way-mirror or the real-time video and audio feeds – allowing the experimenter to minimise their contact with the candidate, to avoid influencing their behaviour (Atkinson et al. 2000, p.641; Hayes 1994, p.555), and to make a recording of the session, which can be reviewed during the data capture process or subsequent analysis. Building on the framework laid out for the ethical treatment of candidates, and the requirements outlined in the overview of the primary research for obtaining data suitable for exploring the hypotheses, the experiment will be broken into four parts: a briefing, to prepare candidates and obtain their consent; a traditional paper based task, which will be used to capture

demographic and psychometric data; an observed computer game activity, during which their actions will be recorded; and a debriefing to address any outstanding questions and reaffirm their consent.

Each session will involve a single participant, who, on arriving at the usability laboratory, will be welcomed by the experimenter and shown around the facility. During this tour the experimenter will brief the candidate and determine their suitability for the experiment, giving them some background information on the study, a broad overview of the structure of the experiment, and addressing any questions they might have. If both parties are amenable, then the experimenter will show the candidate to a desk, where copies of the paper based materials used in the experiment will have been prepared, and review the specifics of each task, with a particular emphasis on their associated risks – which consist of the potential for the computer game activity to induce a seizure in candidates with photosensitive epilepsy – and the procedure for withdrawing from the study, and having any data pertaining to them destroyed. If the candidate consents, the experiment will then begin, and the experimenter will retreat under the pretext of preparing the equipment for the next activity, allowing the candidate a degree of privacy in an effort to avoid influencing their behaviour. Once the paper-based activity has been completed, the experimenter will return and prepare the candidate for the computer-based activity, reviewing the procedure and drawing their attention to the second page of the questionnaire, which has some questions that should be completed at specific points during the computer game. If the candidate wishes to continue then the experimenter will once again withdraw, this time to an adjacent room with real-time video and audio feeds, to monitor the experiment and document the candidate's actions. Contact between the experimenter and the candidate during this time will once again be kept to a minimum, with the experimenter eschewing interaction, save to provide assistance should a problem arise, and to remind the candidate to complete the relevant sections of the questionnaire at the appropriate junctures in the activity. Once the computer-based activity has been completed the experimenter will return to debrief the candidate and thank them for their participation. A discussion which should revolve around the candidate's experience during the experiment and address any questions

they have, and must re-establish the candidate’s consent to retain the data captured for use in the study and review the process through which they can request it is destroyed, should they change their mind.

Experiment Structure

| Time | Experimenter | Participant |
|------|---|---|
| -10- | Prepare a desk with the paper based materials for the experiment. | Arrival. |
| 00 | Welcome the participant as they arrive, and discuss the nature of the study and the structure of the session, paying particular attention to the risks associated with the study and the procedure for withdrawal – confirming the participant still wishes to be involved. | |
| 08 | Review the two paper based tasks and the instructions for completing them. Prepare the computer equipment, and paper based observation forms, for the subsequent activity. | Complete the Big Five Inventory, and the first part of the Participant Details Questionnaire. |
| 20 | Review the computer activity and way in which it will be observed and recorded. Observe the computer activity tracking the participant’s actions, prompting them to complete the second section of the questionnaire at the appropriate juncture. | Play through the opening section of the Persona 3 computer game, pausing to complete the second section of the questionnaire at the appropriate juncture. |
| 110 | Review the final part of the Questionnaire and the instructions for completing it | Complete the final section of the questionnaire. |
| 118 | Thank the participant for their involvement, and debrief them. Discuss any questions or concerns raised by the session, reaffirm the participant’s continuing willingness to be involved in the study, and reiterate the procedure for withdrawal should they reconsider. | |
| 120 | File the participant’s paperwork and shut down the computer equipment used. | Departure. |

Figure 3.3a – Experiment Structure

3.4. ACTIVITY DESIGN

In the prior consideration of statistical power it became apparent that capturing a large quantity of rich data while maintaining a flexible approach would prove difficult, and that balancing the quality and quantity of the data obtained would be a major aspect of developing the instruments and procedures for the preliminary study. Given that it is not possible to compensate participants, nor mandate their involvement – eliminating the self-selection bias introduced by compensation seeking participants, at the expense of compounding bias arising from relying on participants volunteering (Fink &

Kosecoff 1998, p.9; Hague 1993, p.64) – it is therefore vital to minimise the barriers to participation, and to effectively exploit opportunities to engage and interest potential candidates.

In an effort to maximise the appeal for potential candidates, and ensure that the experiment is an authentic simulation of computer use in the home, the main activity will take the form of a commercial computer game, during which the experimenter will observe the candidate's actions. In addition to providing an engaging and entertaining experience, which is anticipated to make attracting sufficient candidates easier, the high degree of interaction involved in a computer game should provide a rich source of interaction data. The software selected, *Persona 3* (Atlus 2006), a standalone role-playing game in the *Persona* series, offers a relatively linear opening segment which is well suited to data capture, affording opportunities to observe a variety of tactical and twitch based game play, in addition to dialogue driven interaction with a range of distinct non-player characters. In addition, as commercial software released for the PlayStation 2 toward the end of the console's life cycle, its exposure was limited, mitigating the difficulty of attracting participants with no prior experience of the game, which might influence their behaviour during the experiment.

In order to minimise the influence of extraneous variables, which may confound the investigation, the format of the activity will be kept as consistent as possible – with particular attention paid to elements known to influence presence in media, such as the quality and intensity of the visual and auditory channels (Lombard & Ditton 1997). In addition, the experimenter will endeavour to avoid irreproducible interactions with participants, save to provide assistance should a problem arise, enquiring only as to their preferred selection of non-player characters at the mid-point and conclusion of the activity – occasions when the software provides the player with a predetermined group of non-player characters, but where the players preferred selection may provide an indication of the non-player characters with whom they connect. In order to facilitate the capture of such a large quantity of data while minimising interaction with participants, the video output from the computer games console will be recorded, allowing the experimenter to review the player's actions should clarification be required.

Observation Form: Computer Game Activity – Persona 3

PERSONA EXPERIMENT: OBSERVATION FORM

| | | | | | |
|---|------------------------------|--------------------------|------|--|--|
| OPTION: Select Difficulty | | | | | |
| Normal | Easy | Time | | | |
| Yes | No | Time | | | |
| Skip CUT SCENE: Opening Sequence | | | | | |
| OPTION: Enter Name | | | | | |
| Actual Name | Pseudonym | Garbage | Time | | |
| Skip CUT SCENE: A Late Night Arrival | | | | | |
| CONVERSATION: A Late Night New Arrival (Yukari) | | | | | |
| Nice to meet you. | Why do you have a gun? | Is this the girls' dorm? | Time | | |
| Nice to meet you. | Is this the girls' dorm? | Why do you have a gun? | Time | | |
| What's the contract for? | Does that kid live here too? | Time | | | |
| Yeah. | What do you mean? | Time | | | |
| Skip CONVERSATION: 1 st Morning (Yukari) | | | | | |
| Open the Door. | Ignore her. | Time | | | |
| Yeah, I'm ready. | I can find it myself. | Time | | | |
| Skip CUT SCENE: Arriving on the Train | | | | | |
| CONVERSATION: Arriving at School (Yukari) | | | | | |
| Which class are you in? | No, not really. | Time | | | |
| TASK: Locate Faculty Office | | | | | |
| NPC Interactions | Objects Examined | Items Purchased | Time | | |
| Enter. | Don't Enter. | Time | | | |
| Skip CONVERSATION: Meeting Class Teacher (Teacher-F) | | | | | |
| Oh... Thanks. | Nice to meet you. | Time | | | |
| Skip CONVERSATION: Assembly Whispers (Yukari's Boyfriend) (Classmate-M) | | | | | |
| She does. (Lie) | She doesn't. (Lie) | I don't know. (Truth) | Time | | |
| She does. (Lie) | She doesn't. (Lie) | Time | | | |
| Skip CONVERSATION: Meeting Classmates (Yukari) (Junpei) | | | | | |
| Who are you? | What do you want? | Time | | | |
| Yeah I know. | It's just a coincidence. | It must be fate. | Time | | |
| Uh uh. | You know what? | Time | | | |
| TASK: Locate Bedroom | | | | | |
| NPC Interactions | Objects Examined | Items Purchased | Time | | |
| Empty Rooms Examined | Empty Rooms Explored | Game Saved | Time | | |
| Enter. | Don't Enter. | Time | | | |
| Skip DIALOGUE: Akihiko Goes Out | | | | | |
| DIALOGUE: School Gates (Rumours) | | | | | |

Participant Number

1 | Page

PERSONA EXPERIMENT: OBSERVATION FORM

| | | | | | |
|---|-------------------------------|-------------------------------|------|---------------------------|------|
| QUESTION: Class, Literature Question (Junpei, Teacher-F) | | | | | |
| Hakuhiko Kitahara. (Wrong) | Fuyuhiko Yoshimura. (Correct) | Junpei L01. (Lie) | Time | | |
| Hakuhiko Kitahara. (Wrong) | Junpei L01. (Lie) | Fuyuhiko Yoshimura. (Correct) | Time | | |
| Junpei L01. (Lie) | Hakuhiko Kitahara. (Wrong) | Fuyuhiko Yoshimura. (Correct) | Time | | |
| Skip CONVERSATION: Class, Literature Question (Chairman-M) (Yukari) | | | | | |
| 4 | 3 | 2 | 0 | Why are you here? | Time |
| 4 | 3 | 2 | 0 | Who else lives here? | Time |
| 4 | 3 | 2 | 0 | The other night, I saw... | Time |
| 4 | 3 | 2 | 1 | No, I'm good. | Time |
| Skip DIALOGUE: The Dark Hour, Exposition | | | | | |
| Skip CUT SCENE: The Dark Hour | | | | | |
| Skip DIALOGUE: The Dark Hour, Exposition | | | | | |
| Skip CUT SCENE: The Velvet Room | | | | | |
| Skip CONVERSATION: The Velvet Room's Contract (gor) (Elizabeth) | | | | | |
| I understand. | I don't understand. | Is this a dream? | Time | | |
| I understand. | Is this a dream? | I don't understand. | Time | | |
| Skip CONVERSATION: School Gates (Junpei) | | | | | |
| You're full of energy. | I thank you need to rest. | Time | | | |
| OPTION: Sleep Through Class (Teacher-M) | | | | | |
| Stay awake. | Doze off. | Time | | | |
| Skip DIALOGUE: The Dark Hour, Watching Them Watching You | | | | | |
| Skip DIALOGUE: The Dark Hour, Akihiko Under Attack | | | | | |
| Skip CONVERSATION: The Dark Hour, Dorm Evacuation (Yukari) | | | | | |
| What's going on? | Okay. | Time | | | |
| TASK: Run Away (Upstairs) | | | | | |
| Objects Examined | Attempts to Attack Enemy | Attempts to Explore | Time | | |
| Skip CUT SCENE: The Dark Hour, Danger on the Roof | | | | | |
| COMBAT: Danger on the Roof (Main Character) | | | | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Wait | Attack | Skill (Bash) | Time | | |
| Review Post Combat Stats | | | | | |
| Skip DIALOGUE: Collapse on the Roof | | | | | |
| Skip CUT SCENE: Return to the Velvet Room | | | | | |

2 | Page

Figure 3.4a – Observation Form: Computer Game Activity

3.5. INSTRUMENT DESIGN

It is imperative, if correlations are to be calculated between candidates' interactions with a computer game and aspects of their personality, to select a suitable psychometric instrument to capture the personality data. While it is desirable to minimise the use of the traditional pen and paper methods common in psychological research, as they may be perceived as onerous by participants, it is impractical to eliminate them completely, as altering the format of a standardised psychometric instrument may lead to “variations in visual scanning patterns of the material, which can affect the speed of response,” and “the extent of the tendency to scan forward or backward to review answers,” necessitating new normative data (Edenborough 1994, p.194). The use of clinical instruments, such as the Minnesota Multiphasic Personality Inventory (MMPI-2) which consists of 567 items, would be excessive, yielding data far beyond the scope of this study and requiring a great deal of time to administer; but

even non-clinical instruments, such as the NEO Personality Inventory (NEO PI-R) which measures the major dimensions of Five Factor Theory and their subordinate facets using 240 items, can require a substantial time investment. While there is a cut down version of the NEO PI-R, the NEO-FFI, which uses just 60 items to measure the five major aspects of personality, there is a slightly shorter non-commercial alternative, The Big Five Inventory (BFI), which assesses responses to 44 descriptive phrases, presented in relatively accessible vocabulary on a five-point Likert scale, to determine personality using the major dimensions of Five Factor Theory (John, Naumann & Soto 2008; Benet-Martinez & John 1998; John, Donahue & Kentle 1991). Requiring only five minutes to complete and available for free for use in research (John 2004), the BFI is ideal for the experiment.

Questionnaire: The Big Five Inventory (BFI)

PERSONA EXPERIMENT: PSYCHOMETRIC TEST

Participant
Number

The Big Five Inventory (BFI)

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

| Disagree strongly 1 | Disagree a little 2 | Neither agree nor disagree 3 | Agree a little 4 | Agree strongly 5 |
|---------------------------|---------------------------|------------------------------------|------------------------|------------------------|
|---------------------------|---------------------------|------------------------------------|------------------------|------------------------|

I see Myself as Someone Who...

| | |
|--|---|
| ___ 1. Is talkative | ___ 23. Tends to be lazy |
| ___ 2. Tends to find fault with others | ___ 24. Is emotionally stable, not easily upset |
| ___ 3. Does a thorough job | ___ 25. Is inventive |
| ___ 4. Is depressed, blue | ___ 26. Has an assertive personality |
| ___ 5. Is original, comes up with new ideas | ___ 27. Can be cold and aloof |
| ___ 6. Is reserved | ___ 28. Perseveres until the task is finished |
| ___ 7. Is helpful and unselfish with others | ___ 29. Can be moody |
| ___ 8. Can be somewhat careless | ___ 30. Values artistic, aesthetic experiences |
| ___ 9. Is relaxed, handles stress well | ___ 31. Is sometimes shy, inhibited |
| ___ 10. Is curious about many different things | ___ 32. Is considerate and kind to almost everyone |
| ___ 11. Is full of energy | ___ 33. Does things efficiently |
| ___ 12. Starts quarrels with others | ___ 34. Remains calm in tense situations |
| ___ 13. Is a reliable worker | ___ 35. Prefers work that is routine |
| ___ 14. Can be tense | ___ 36. Is outgoing, sociable |
| ___ 15. Is ingenious, a deep thinker | ___ 37. Is sometimes rude to others |
| ___ 16. Generates a lot of enthusiasm | ___ 38. Makes plans and follows through with them |
| ___ 17. Has a forgiving nature | ___ 39. Gets nervous easily |
| ___ 18. Tends to be disorganized | ___ 40. Likes to reflect, play with ideas |
| ___ 19. Worries a lot | ___ 41. Has few artistic interests |
| ___ 20. Has an active imagination | ___ 42. Likes to cooperate with others |
| ___ 21. Tends to be quiet | ___ 43. Is easily distracted |
| ___ 22. Is generally trusting | ___ 44. Is sophisticated in art, music, or literature |

Please check: Did you write a number in front of each statement?

Figure 3.5a – The Big Five Inventory (John, Naumann & Soto 2008; John, Donahue & Kentle 1991)

In addition to measuring personality, a degree of demographic information would be useful for comparing the sample to the population, and in conjunction with details of participants' prior experience with and preference for computer games, should assist

in contextualising the findings and understanding discrepancies, potentially opening avenues for further investigation. This data will be captured using a traditional paper-based questionnaire, as although a computerised method could be used it is convenient to be able to administer it alongside the personality inventory and have it follow the candidate throughout the experiment, ensuring a textual summary of the briefing and procedure for withdrawing is available at all times, and allowing questions to be included that pertain to the computer game activity. Unlike the personality inventory, which cannot be modified without potentially compromising its validity (Anastasi & Urbina 1997, p.118; Edenborough 1994, p.194), this supplementary questionnaire will include a list of the possible responses beside each question in an effort to improve clarity and reduce errors. These responses will typically be presented on a four-point Likert scale, which excludes the middle ‘neither’ option, requiring respondents to express a preference, no matter how slight, and allowing the results to be represented dichotomously during the analysis, without losing data from what is likely to already be a small sample.

Questionnaire: Participant Details (Demographics, Experience & Preferences)

PERSONA EXPERIMENT: PERSONAL DETAILS

Personal Details Questionnaire

You have been invited to take part in research being conducted at Staffordshire University. If you choose to participate you will be asked to provide a small amount of personal information and details of your interests related to computer games. You will also be asked to complete a basic personality test and to play a computer game, rated 12+ for violence and strong language, during which you will be observed. In accordance with the university's ethical guidelines all information will be stored anonymously and used solely for research purposes. If you wish to withdraw from the study at any time please notify the experimenter, who will destroy any data which has been collected from you.

Please provide the following information by circling your answer or entering it in the space provided.

1.

| Gender | |
|--------|--------|
| Male | Female |

2.

| Age (Years) |
|-------------|
| |

3.

| Average Time Spent Gaming Per Week (Hours) | | | | |
|--|------------|-------------|-------------|-----------|
| 0-5 Hours | 6-12 Hours | 12-18 Hours | 18-24 Hours | 24+ Hours |

4.

| Preference in Computer Game Genres | Dislike a lot | Dislike a little | Like a little | Like a lot |
|-------------------------------------|---------------|------------------|---------------|------------|
| Action / Adventure | | | | |
| Action / Tactical | | | | |
| Action / Horror | | | | |
| Vehicle / Racing | | | | |
| Vehicle / Simulation | | | | |
| Strategy / Real Time | | | | |
| Strategy / Turn Based | | | | |
| Simulation / Management | | | | |
| RPG / Massively Multiplayer | | | | |
| RPG / Story Driven (Final Fantasy) | | | | |
| RPG / Free Exploration (D&D/Divion) | | | | |
| Beat 'em up Games | | | | |
| Platform Games | | | | |
| Puzzle Games | | | | |
| Sports Games | | | | |
| Party Games | | | | |

5.

| Level of Gaming Experience | | | |
|----------------------------|----------------------|--------------------|------------------|
| Very Inexperienced | Fairly Inexperienced | Fairly Experienced | Very Experienced |

6.

| Preference in Role-Playing Game (Offline) Elements | Dislike a lot | Dislike a little | Like a little | Like a lot |
|--|---------------|------------------|---------------|------------|
| Exploration | | | | |
| Combat / Action | | | | |
| Combat / Tactics | | | | |
| Character Customization | | | | |
| Character Relationships | | | | |
| Story & Plot | | | | |

7.

| Preferred Level of Difficulty in Role-Playing Games (Offline) | | | |
|---|-------------|-------------|-----------|
| Very Easy | Fairly Easy | Fairly Hard | Very Hard |

8.

| Level of Role-Playing Game (Offline) Experience | | | |
|---|----------------------|--------------------|------------------|
| Very Inexperienced | Fairly Inexperienced | Fairly Experienced | Very Experienced |

PERSONA EXPERIMENT: PERSONAL DETAILS

Party Selection Questionnaire

You should complete these questions upon arriving at Tartarus in the Persona 3 game.

Please answer the following questions by circling your answer or entering it in the space provided.

9a.

| Who would you choose to lead the exploration of Tartarus? (Select One) | | | | |
|---|--|---|---|---|
| Main Character | Yukari | Misuru | Akihiko | Junpei |
|  |  |  |  |  |

9b.

| Who would you choose to explore Tartarus with the Leader? (Select Two Others) | | | | |
|---|--|---|---|---|
| Main Character | Yukari | Misuru | Akihiko | Junpei |
|  |  |  |  |  |

Post Game Questionnaire

You should complete this question after you finish exploring Tartarus in the Persona 3 Game.

Please answer the following questions by circling your answer or entering it in the space provided.

10a.

| In future, who would you choose to lead the exploration of Tartarus? (Select One) | | | | |
|---|--|---|---|---|
| Main Character | Yukari | Misuru | Akihiko | Junpei |
|  |  |  |  |  |

10b.

| Who would you choose to explore Tartarus with the Leader? (Select Two Others) | | | | |
|---|--|---|---|---|
| Main Character | Yukari | Misuru | Akihiko | Junpei |
|  |  |  |  |  |

11.

| What did you think of the characters in the Persona 3 Game? | | | | |
|---|---------------|------------------|---------------|------------|
| Main Character | Dislike a lot | Dislike a little | Like a little | Like a lot |
| Yukari | Dislike a lot | Dislike a little | Like a little | Like a lot |
| Misuru | Dislike a lot | Dislike a little | Like a little | Like a lot |
| Akihiko | Dislike a lot | Dislike a little | Like a little | Like a lot |
| Junpei | Dislike a lot | Dislike a little | Like a little | Like a lot |

12.

| How would you rate the Persona 3 game? | | | | |
|--|------------------|---------------|------------|--|
| Dislike a lot | Dislike a little | Like a little | Like a lot | |

END OF QUESTIONS

Figure 3.5b – Questionnaire: Participant Details

3.6. SAMPLE SELECTION

In the prior discussion of statistical power – detailed in section 3.1.1 – it was determined that a preliminary study to detect large effect sizes using a correlation analysis would require a minimum of 28 participants, with an additional 57 candidates – bringing the total to 85 – being required to detect medium effect sizes (Cohen 1992, 1988 p.75) and enable multiple linear regression using three or four independent variables (Clark-Carter 2004, p.296 & 582; Cohen 1988 p.407). Attracting 28 candidates is not anticipated to be problematic, as every effort has been made to develop an experiment which will engage and interest prospective candidates and minimise barriers to their participation; however, it will not be possible to compensate participants for their time, nor to reimburse expenses they incur in travelling to the usability laboratory, and obtaining data for the full 85 participants is therefore expected to prove challenging. In an attempt to mitigate these factors, candidates will be recruited primarily from amongst the university’s student population – a diverse mixture of engineering and computing graduates and undergraduates, from a range of social, economic, and cultural backgrounds – as they are likely to be in the physical locale and have idle time in between their commitments. In the interest of improving sample diversity, particularly with respect to age and educational background, this will be supplemented by recruiting candidates with an interest in computer games from outside the university. In combination, these groups are anticipated to form a sample which is a reasonable representation of computer game players in their generation.

The nature of the selection process means that the sample, and by extension the data captured, will inevitably reflect certain biases; indeed, this is all but impossible to avoid, as were it practicable to compensate participants for their time then bias would arise from qualities common in those motivated by the financial incentive, while without compensation those traits are under represented (Fink & Kosecoff 1998, p.9; Hague 1993, p.64). It is, however, important to be aware of the biases inherent in the sample, that they might be taken into account during the analysis and when generalizing findings. In this instance there is a particularly high degree of variation in the subjective experience of successive generations with computer games – stemming from the rapid development of home computer technology since its inception in the

late 1970's – which will not be adequately represented in the sample, due to the difficulty of attracting more mature participants and obtaining informed parental consent and arranging travel and supervision for adolescent volunteers (Fromme 2003).

3.7. DATA CAPTURE

Initial recruitment took two directions. The experimenter visited lectures and tutorials taking place on the university campus, giving a brief presentation about the study to the students present and inviting them to make contact via email should they wish to be involved; an approach which saw limited success, attracting a comparatively small number of participants for the time invested – approximately two or three per hundred students. The second strand of recruitment, aimed at attracting candidates with a diverse range of academic backgrounds, involved a series of conversations about the study with the experimenter's contacts from outside the university. Interest amongst these non-students was greater than that seen at the university, which greatly mitigated the smaller pool of potential volunteers, however the burden of travelling to the university was more substantial amongst this group, and a second site for the experiment – using marginally inferior equipment – was established to mitigate this barrier. Overall, recruitment succeeded in attracting a good mixture of candidates, although interest tailed off toward the end of the preliminary study, which suggests the potential volunteers in the groups being reached might be near exhaustion, in which case an alternative approach to recruitment will be required if the sample size is to be increased.

The instruments performed well, with minor changes required to clarify a question on the Participant Details Questionnaire – to ensure that the candidates specify an appropriate number of characters for use in the combat section of the game, and revisit their preference for the group's leader at the conclusion of the session – with the only substantive changes being limited to the Observation Form, which was revised to allow participants actions to be tracked more easily, and to include some new options where unanticipated actions lead to annotations on the original form.

Overall, these changes are relatively minor, or limited to documentation used solely by the experimenter, and should therefore have little to no effect on participants' behaviour or performance during the experiment.

Although promising, the preliminary study indicated that attracting sufficient volunteers to increase the data set to a total of 85 participants would prove challenging, and investing resources in a computer observer program capable of processing large numbers of candidates – as proposed in the materials and methods overview, in section 3.1 – is therefore unnecessary. Anticipating a lack of interest amongst the experimenter's untapped contacts, the focus for recruitment was shifted to reaching a sufficiently large number of students at the university campus to ameliorate the low response rate. An email was prepared, highlighting the computer games aspect of the study, and disseminated amongst students based at the campus, yielding approximately 80 responses. A follow up email, with further details of the study and how to get involved, was sent to each respondent, which, in conjunction with a handful of the experimenters contacts, yielded an additional 40 volunteers, bringing the total to 60.

It was initially believed that obtaining further volunteers would prove problematic, as the population of potential candidates appeared to have been largely exhausted, with those remaining pressured by exams and assignment deadlines, however, delays in identifying a robust approach to the statistical analysis of the data afforded an opportunity to repeat the experiment at the beginning of the next academic year. This time, in order to maximise respondents, the experiment was conducted after the university's enrolment date, but prior to a full schedule of classes commencing. Once again, details of the study were emailed to students across the campus, with additional details pertaining to the format of the experiment and the procedure for taking part being sent to respondents. This two week process netted an additional 19 sets of data, obtained primarily from freshmen and students returning from industrial placements who had not been at the university during the prior experiment, increasing the total sample size to 79; although still short of the 85 volunteer target, this will have to be sufficient for the analysis, as it is not logistically possible to capture additional data in the time available.

Recruitment E-Mails

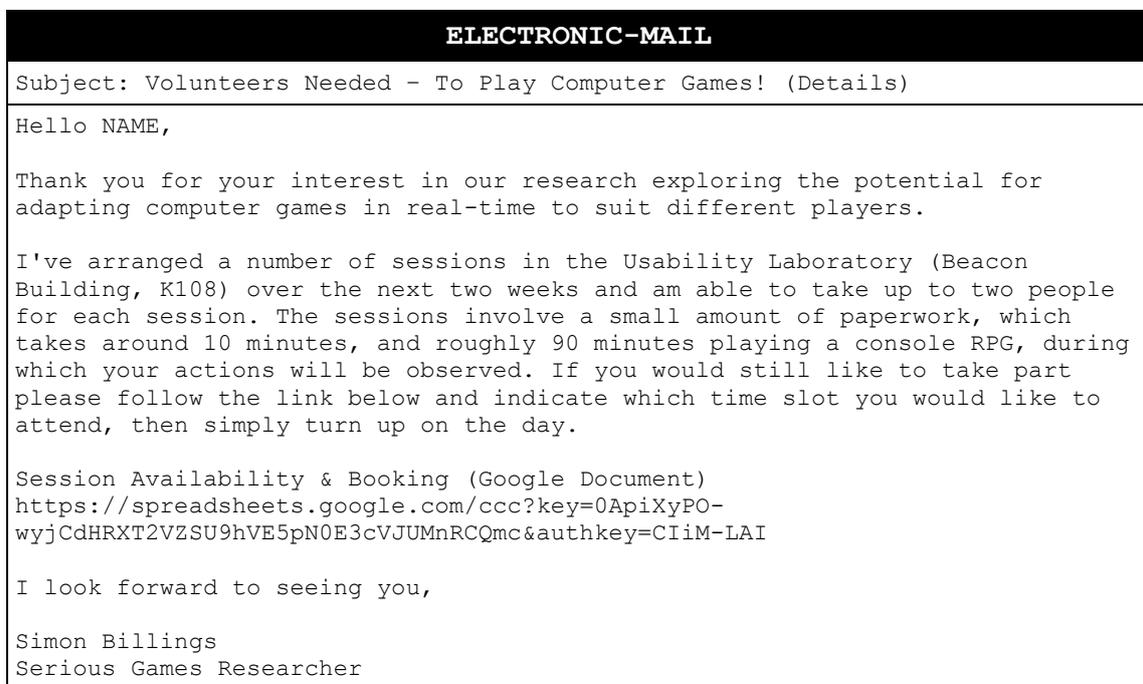
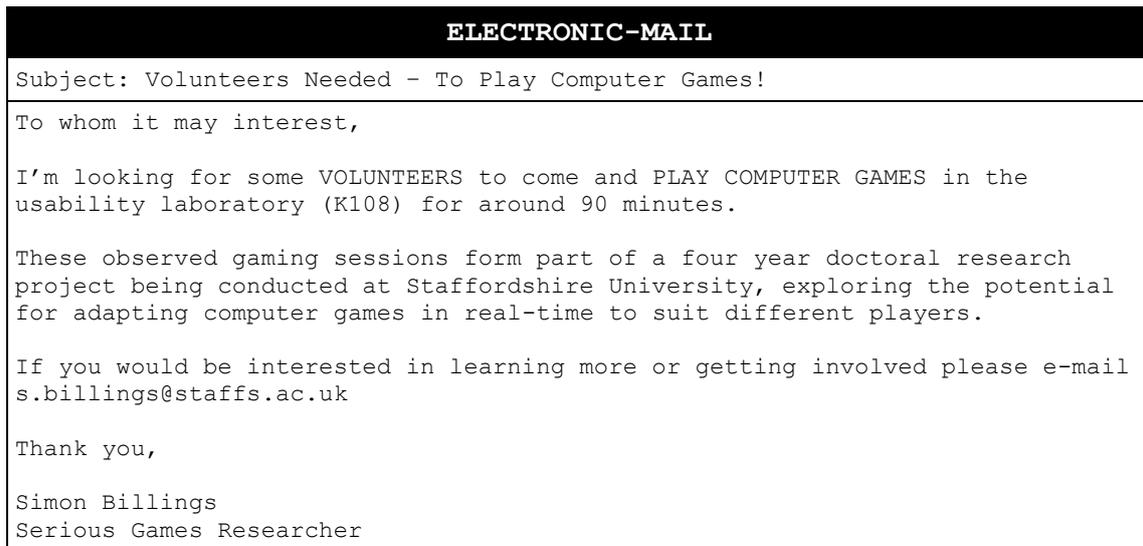


Figure 3.7a – Recruitment E-Mails

The instruments once again performed well, with the aforementioned minor changes eliminating confusion on questions 9 and 10 of the Participant Details Questionnaire, while the revised Observation Form allowed the observer to more easily track the participant's actions, largely eliminating the need to consult the video record of the session. Motivated by concerns that volunteers would dry up as pressure from assignments and exams mounted, these improvements allowed two sessions to be run concurrently, with the experimenter observing one session while monitoring a second through a one-way mirror, which was recorded for the experimenter to review in

detail later. Clearly this adjusts the parameters of the data capture session slightly, and there may be some influence of social facilitation (Atkinson et al. 2000, p.641; Hayes 1994, p.555) – where the subject observed through the one-way mirror behaves differently than the subject observed from the same room – but this was deemed an acceptable trade to ensure that sufficient data could be captured while minimising variation between data capture sessions.

CHAPTER 4
ANALYSIS & DISCUSSION

4. ANALYSIS & DISCUSSION

In order to maximise accessibility, and ensure all pertinent information is presented concisely, the statistical analysis will be interwoven with discussion of the rationale for the selection of these techniques and the interpretation of their results. Initially this discussion will focus on raw data captured during the experiment – a copy of which is available in Appendix B – and document the data cleansing process, which addresses missing and erroneous values and details the transformation, aggregation, and formatting, of the data in preparation for the analysis proper. Descriptive statistics will then be calculated and examined in order to determine the suitability of the sample for investigating the hypotheses, and if everything is in order a correlation analysis will be employed to assess hypotheses H1 and H2. If the results are promising, as determined by examining the binomial probability of the observed number of correlates occurring by chance, then multivariate techniques, such as factor analysis, multiple linear regression, and clustering will be employed to explore the possibility of constructing a model to satisfy hypothesis H3.

4.1. DATA CLEANSING

In addition to a small amount of missing data, several issues became apparent during the data capture process – primarily resulting from subjects behaving in ways which had not been anticipated during the activity design – that should be addressed prior to a statistical analysis.

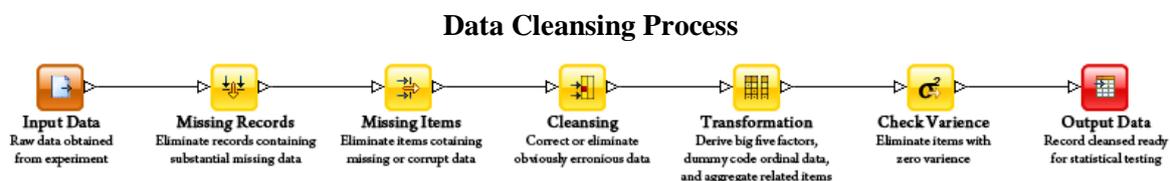


Figure 4.1a – Data Cleansing Process

4.1.1. DATA CAPTURE ISSUES

The first issue arose as a result of 7 players electing to revise the game difficulty (*OF#1.01.1–Option–Difficulty*) they had selected – an option which had not been constrained as it has no impact on the section of game used in the activity, save in the

event of the player’s defeat when they are revived and healed instead of proceeding to the ‘game over’ screen. Recording the player’s final decision was not an issue, however determining the time taken (*OF#1.01.1T–Option–Difficulty*) to make this decision is difficult due to the question being posed twice. Using the total time is problematic, as each response consists of the time needed for the player to read, consider, and respond to the question, and it is not desirable to over emphasise the reading and response times. Since observation indicated that player’s appeared to either consider their initial decision carefully, then quickly change their mind, or make a snap decision, and reconsider it more thoroughly when prompted with the ramifications of their choice, it was decided that using the greatest time from either event would best reflect the period spent considering the desired level of difficulty.

Persona 3 – Name Input Interface

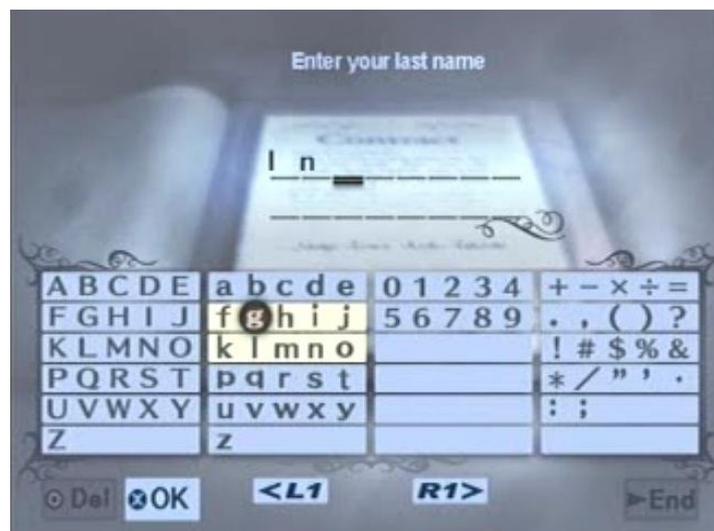


Figure 4.1.1a – Name Input Interface (*OF#1.03.1–Input–Name*) (Atlus 2006)

The interface through which the player names the main character at the start of the game is poorly designed (illustrated in figure 4.1.1a). The player is required to enter a surname, using the directional pad to select letters from a grid, and then repeatedly press R1, moving the cursor to the right until it drops onto a second line, before a forename can be entered and the Start button used to proceed. This process of pressing R1 repeatedly to reach the second line proved unintuitive, with many participants requiring assistance from the experimenter to continue, and the failure to localise the order of the surname and forename for a western audience lead to a number of players

entering them in the wrong order, and subsequently returning to make corrections; as a result, the time recorded for players to input a name (*OF#1.03.IT-Input-Name*) was primarily a factor of the point at which the experimenter interceded, and was therefore discarded from the analysis.

During the second exploration task (*OF#1.12.T-Task-Locate.Bedroom*) a small number of players discovered a quick travel option, which allowed them to complete the task swiftly, by interacting with the reception desk near their starting point. Since players are shown their destination earlier in the game, and the experimenter observed no apparent difficulties locating it, the time taken for the task was determined primarily to reflect the player's inclination to explore the area prior to proceeding to the specified destination. In order to mitigate the influence of discovering the quick travel option as a confounding factor, those players who used it had 15 seconds added onto their time for completing the task – reflecting the additional time required to travel to the prescribed destination by normal means.

The data captured during the turn based combat section of the game was aggregated, in order to reflect the player's use of consumable resources more accurately (*OF#4.05.2-Option-Exploring.Tartarus-Items.Used*) and healing abilities in various forms (*OF#4.05.3-Option-Exploring.Tartarus-Party.Healed*), and to provide a supplementary overview of the recurring elements in the major combat scenario (*OF#4.04.A-Combat-Tartarus.Battles-[Element]*). A series of transformations were also computed to reflect the changes in a player's preferred party composition – those characters selected for use in the turn based combat sections of the game.

Finally, in order to provide an overview of other aspects of a player's interaction with the game, totals were calculated for a number of recurring non-combat events, including: the total number of cut scenes and dialogue that was skipped; the amount of time spent on various activities; and the total number of game elements, of various types, with which the player interacted.

4.1.2. MISSING DATA

Of the 79 participants involved in the study, two require special consideration. The first (3P/76) failed to complete the computer based activity as a result of reaching the game over screen – having repeatedly elected to ‘wait’ while under attack in the preliminary combat scenario (illustrated in figure 4.1.2a) – without saving the game state; an outcome which the experimenter attributed to lack of experience with console role-playing games, based on their observations and the player’s prior self reported inexperience on the Participant Details Questionnaire. Proceeding irrespective of this setback would have required repeating the first half of the activity, which was impractical due to time constraints, and the session was therefore abandoned. As a result, over 60% of the data from the computer based activity is missing, and this subject’s record will be excluded from the analysis.

Persona 3 – Preliminary Combat Scenario



Figure 4.1.2a – Preliminary Combat Scenario (*OF#2.15.1–Combat–Rooftop.Battle*) (Atlus 2006)

The second noteworthy case (1P/37) was flagged by the experimenter due to skipping a large number of the cut scenes and dialogue at the start of the activity, in apparent contradiction to the strong preference for story elements in computer role-playing games, expressed on the Participant Details Questionnaire. While suspect, it is important that this data is retained, as it may represent a small subset of the population, and running the analysis both with and without this data may yield an indication of its influence in the sample.

In addition to these major cases, preliminary examination of the data identified six missing items amongst the remaining records, one of which (*IU/42*) pertains to the time required for the player to input a name (*OF#1.03.1T-Input-Name*) and is already being discarded, as detailed in the preceding section on data capture issues, due to the influence of an unintuitive interface. Of the remaining five, four were discovered on the Participant Details Questionnaires (*OH/08, OT/20, 2K/53, 2M/73*), which was commissioned as an auxiliary source of information, and will therefore have a limited impact; retaining this data for the majority of the analysis should not prove problematic, as the major dependent variables are derived entirely from the Big Five Inventory, although it may become necessary to exclude some of these records from supplementary analysis, should a missing item be used as a dependent, or influential independent, variable. The final item (*IK/32*), a missing dialogue choice and its associated timing (*OF#4.08.1-Conversation-Tartarus-Debriefing*), will be retained during the analysis, where the statistical methods employed are able to handle missing data gracefully, in order to maximise the sample size and available data.

Finally, although the software was selected in part for its relatively linear structure, it is necessary to consider a small number of sections where some players were able to bypass parts of the computer activity. In the majority of these cases the player is made aware of the bypassed section, such as the presence of menus detailing their character's status, through on screen prompts or dialogue (illustrated in figure 4.1.2b), and avoiding these sections represents a deliberate choice which may be coded amongst the possible responses. In instances where this is not the case, it will be necessary to exclude items from the analysis based on the amount of missing data and the ability of specific statistical method to tolerate it.

Persona 3 – Prompt Informing the Player of Status Menus

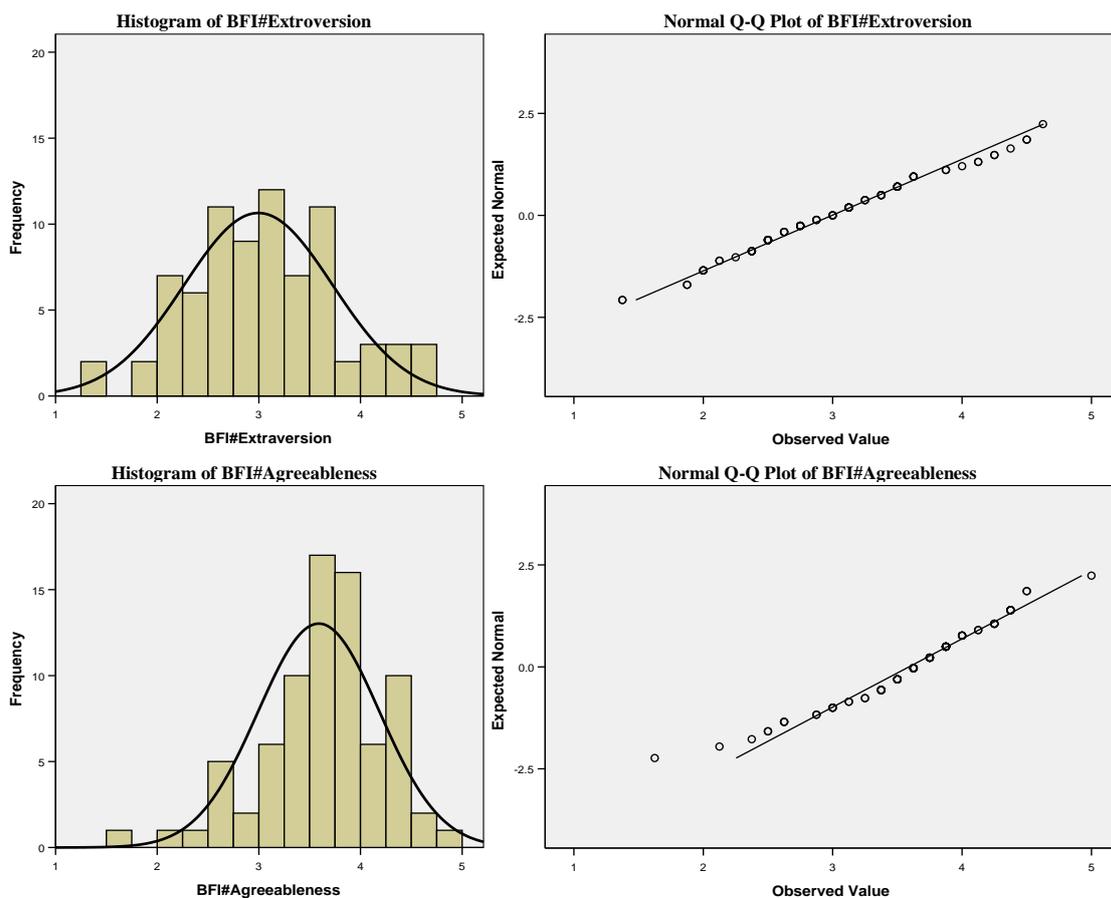


Figure 4.1.2b – Prompt Informing the Player of Status Menus (Atlus 2006)

4.1.3. DATA TRANSFORMATION

Using the data from the Big Five Inventory, and the method specified in its accompanying documentation (John & Naumann & Soto 2008; John 2004; John, Donahue & Kentle 1991), continuous variables were derived to represent the major personality factors (*BFI#Extraversion*, *BFI#Agreeableness*, *BFI#Neuroticism*, *BFI#Openness*, *BFI#Conscientiousness*); since examination indicates that these factors approximate a normal distribution (Shapiro-Wilk: *BFI#Extraversion* $p=0.428$; *BFI#Agreeableness* $p=0.030$; *BFI#Neuroticism* $p=0.415$, *BFI#Openness* $p=0.338$, *BFI#Conscientiousness* $p=0.377$), with the exception of Agreeableness which exhibits a significant negative skew (Skew: -0.593 ; S^E -Skew: 0.272), they may be further transformed, utilizing their mean and standard deviation, to create dichotomous measures of personality, which may be better suited to the construction of a classifier.

Probability Distribution: Major Personality Factors



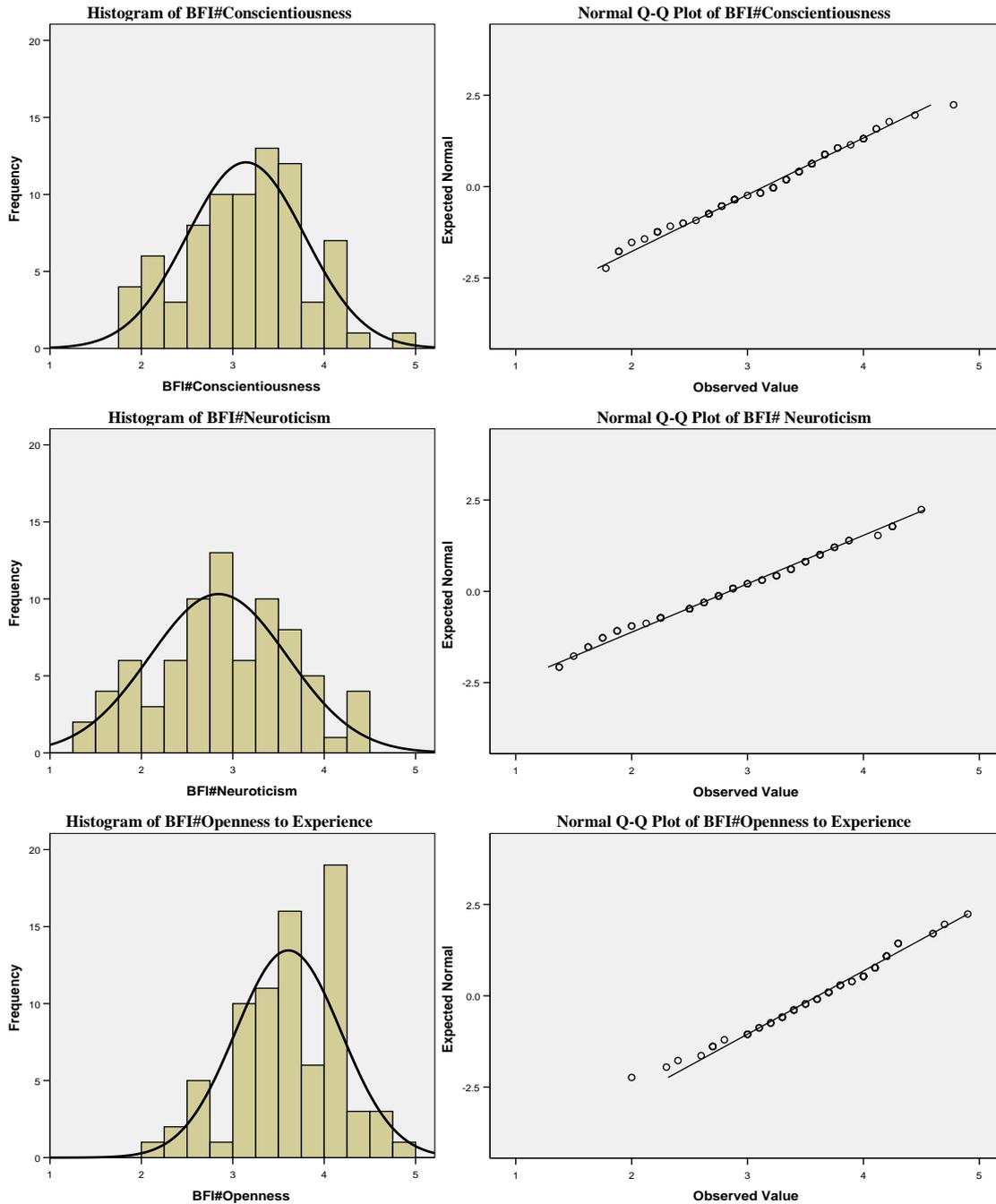


Figure 4.1.3a – Probability Distribution: Major Personality Factors

Tests of Normality: Major Personality Factors

| | Kolmogorov-Smirnov ^(a) | | | Shapiro-Wilk | | |
|-----------------------|-----------------------------------|----|---------------------|--------------|----|------|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| BFI#Extraversion | .072 | 78 | .200 ^(*) | .984 | 78 | .428 |
| BFI#Agreeableness | .129 | 78 | .003 | .965 | 78 | .030 |
| BFI#Conscientiousness | .100 | 78 | .053 | .984 | 78 | .415 |
| BFI#Neuroticism | .067 | 78 | .200 ^(*) | .982 | 78 | .338 |
| BFI#Openness | .085 | 78 | .200 ^(*) | .983 | 78 | .377 |

^(a) Lilliefors Significance Correction

^(*) This is a lower bound of the true significance

Figure 4.1.3b – Tests of Normality: Major Personality Factors

In order to facilitate the construction of a model, it is necessary to dummy code much of the captured nominal data – such as those dialogue responses which present more than two alternatives. It is also expeditious, although not a requirement, to eliminate those items which have zero variance, as this reduces the amount of data by removing items which contain no information useful in discriminating between records.

4.2. SAMPLE DEMOGRAPHICS

In order to explore the composition of the sample, basic demographic data was obtained for all participants, using the Participant Details Questionnaire, and examined using descriptive statistics and simple graphical representation (figures 4.2a/b/c).

Graphical Representations: Demographic Information (Age & Gender)

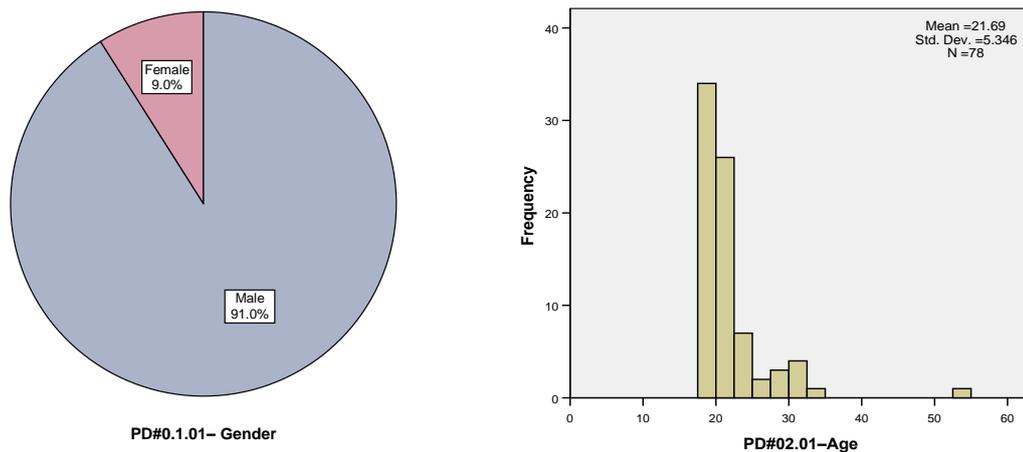


Figure 4.2a – Graphical Representations: Age & Gender

The results of this examination indicated that the sample population was predominantly male (91.0%) with a median age of 20 years (Mean: 21.69; Confidence 95%: 20.49 – 22.90; Std.D: 5.35), in stark contrast with figures published by the Entertainment Software Association (ESA) (2010 p. 2–3), which shows a 60% male, 40% female, gender split and an average age of 34 years. Unfortunately, the consumer survey data used by the ESA is not available, but further examination of the summary reveals that the role-playing game genre accounts for only 5.8% of console game

sales, so their sample may be heavily influenced by genres with distinctly different demographics – particularly given the recent explosion of the casual and web-based social gaming markets.

Descriptive Statistics & Box Plot: Age and Variation Dependent on Gender

| Descriptive Statistics Age | | Age | | Age (Male) | | Age (Female) | |
|----------------------------------|-------------|-------|-------|------------|-------|--------------|-------|
| | | Stat | Error | Stat | Error | Stat | Error |
| Mean | | 21.69 | 0.61 | 21.63 | 0.65 | 22.29 | 1.74 |
| 95% Confidence Interval for Mean | Lower Bound | 20.49 | | 20.35 | | 18.02 | |
| | Upper Bound | 22.90 | | 22.92 | | 26.55 | |
| 5% Trimmed Mean | | 20.97 | | 20.87 | | 21.93 | |
| Median | | 20 | | 20 | | 20 | |
| Variance | | 28.58 | | 29.58 | | 21.24 | |
| Std. Deviation | | 5.35 | | 5.44 | | 4.61 | |
| Minimum | | 18 | | 18 | | 19 | |
| Maximum | | 55 | | 55 | | 32 | |
| Range | | 37 | | 37 | | 13 | |
| Interquartile Range | | 3 | | 3 | | 4 | |
| Skewness | | 3.72 | 0.27 | 3.84 | 0.28 | 1.96 | 0.79 |
| Kurtosis | | 19.29 | 0.54 | 20.03 | 0.56 | 4.11 | 1.59 |

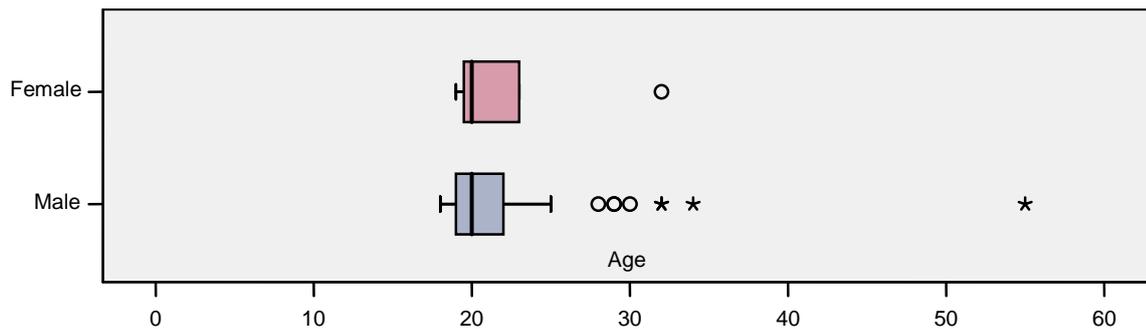


Figure 4.2b – Descriptive Statistics & Box Plot: Age & Gender

Although not directly comparable, due to their focus on massively multiplayer online role-playing games, Yee’s (2005) and Billings’ (2006) data may prove to be a better estimation of the console role-playing game market’s composition. Reassuringly, their samples are not radically dissimilar to the data captured in this study, although they exhibit a more leptokurtic age distribution, an older average age (Mean: 26.6), and a higher percentage of female respondents (14.6%) – who, in all three studies, tend to be slightly older than their male counterparts (illustrated in figure 4.2b). Given the fluctuation in demographics observed by Yee (2005) between different games in the massively multiplayer online role-playing game genre – which have mean player ages ranging from 23 to 30 years and populations consisting of between 9 and 20% female players – the sample obtained during data capture appears plausible.

Box Plot: Experience with Computer Role-Playing Games

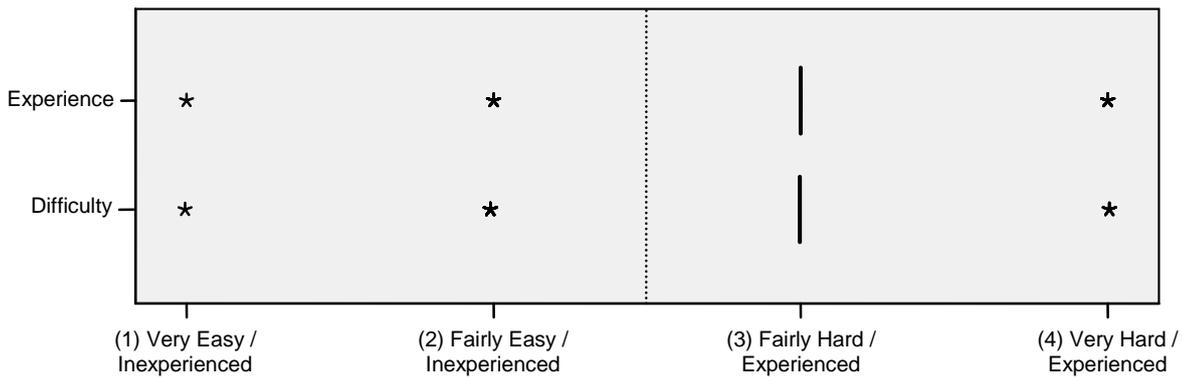


Figure 4.2c – Box Plot: Experience with Computer Role-Playing Games

The veracity of the sample is further supported by the tight, negatively skewed, clustering of participants' experience with none massively multi-playable computer role-playing games around the #3 'fairly experienced' category (Mean: 3.08; Confidence 95%: 2.68 – 2.93; Std.D: 0.56; Skew: -0.372; ^{S.E.}Skew: 0.272), as while it is impossible to be certain that the participants are representative of the target population, that 85.9% describe themselves as fairly or very experienced with computer role-playing games confirms that the majority of the sample was drawn from the target population.

4.3. CORRELATION ANALYSIS

Although slightly short of the desired 85 participants, the data captured supports a correlation analysis capable of identifying medium sized effects with a 5% chance of a false positive (α 0.05) and a statistical power of 0.77 (β 0.23) – marginally below the 0.80 power (β 0.20) recommended by Cohen (1992, 1988 p.75) for psychological research.

Given an inability to satisfy the requirements of Pearson's (r) product moment correlation coefficient, in that many of the independent variables are not measured on an appropriate scale and cannot be assumed to be normally distributed, it is necessary to employ a non-parametric method. Although Spearman's (ρ) rank correlation coefficient is the popular non-parametric alternative – in part due to historically being computationally inexpensive – Kendall's (τ) rank correlation coefficient is superior when the data has a large number of tied ranks, as is the case with much of the ordinal

data captured, and is generally a better estimate of correlation with the population (Howell 2009 p.304, Field 2009 p. 181).

Calculating correlation coefficients, given the large number of independent variables (328), is problematic, as a set of correlations for a single dependent variable computed at α 0.05 has approximately 16.4 statistically significant correlates which are false positives. Identifying these erroneous results is difficult, but by counting the number of significant correlations, subtracting the expected number of false positives, and computing the binomial probability of the observed correlations being false positives, it is possible to identify those dependent variables which are likely to be related in some way to part of the data captured through the observed computer activity.

Kendall's (τ) Correlation Coefficient & Binomial Probabilities

| Kendall's Tau_b | Observed Correlations | Corrected Correlations | Binomial Probability |
|---------------------------------------|-----------------------|------------------------|----------------------|
| BFI#Extraversion | 24.0 | 7.6 | 0.042 ^(*) |
| BFI#Agreeableness | 16.0 | -0.4 | 0.576 |
| BFI#Conscientiousness | 30.0 | 13.6 | 0.001 ^(*) |
| BFI#Neuroticism | 13.0 | -3.4 | 0.839 |
| BFI#Openness | 26.0 | 9.6 | 0.015 ^(*) |
| PD#03.01-Experience-Weekly.Gaming | 41 | 24.6 | 0.000 ^(*) |
| PD#05.01-Experience-General.Gaming | 38 | 21.6 | 0.000 ^(*) |
| PD#08.01-Experience-RPG | 20 | 3.6 | 0.212 |
| PD#06.01-Preference-RPG.Exploration | 8 | -8.4 | 0.993 |
| PD#06.02-Preference-RPG.Combat.Action | 13 | -3.4 | 0.839 |
| PD#06.03-Preference-RPG.Tactics | 9 | -7.4 | 0.984 |
| PD#06.04-Preference-RPG.Customization | 21 | 4.6 | 0.150 |
| PD#06.05-Preference-RPG.Relationships | 45 | 28.6 | 0.000 ^(*) |
| PD#06.06-Preference-RPG.Story | 39 | 22.6 | 0.000 ^(*) |
| PD#07.01-Preference-RPG.Difficulty | 46 | 29.6 | 0.000 ^(*) |
| PD#12.01-Opinion-Main.Character | 14 | -2.4 | 0.763 |
| PD#12.02-Opinion-Yukari | 15 | -1.4 | 0.674 |
| PD#12.03-Opinion-Mitsuru | 11 | -5.4 | 0.940 |
| PD#12.04-Opinion-Akihiko | 9 | -7.4 | 0.984 |
| PD#12.05-Opinion-Junpei | 33 | 16.6 | 0.000 ^(*) |
| PD#13.01-Opinion-Persona.3 | 25 | 8.6 | 0.025 ^(*) |

^(*) Significant based on Binomial Probability Distribution

Figure 4.3a – Kendall's (τ) Correlation Coefficient & Binomial Probabilities

After accounting for the presence of false positives (illustrated in figure 4.3a), it appears that data pertaining to three of the five personality factors assessed was captured through observation of the computer game activity. The best candidate for prediction appears to be conscientiousness, which correlates with approximately 14 elements, followed by openness to experience with 10 correlates, and extraversion with 8; neither neuroticism, nor agreeableness, correlated with a sufficient number of elements to discount those observed being wholly attributed to false positives. It should also be noted that although in these three instances there are a statistically significant number of correlates, the relationships are universally weak, with an absolute average strength of just 0.211 and no individual correlation coefficient exceeding +0.303 / -0.298, which may inhibit the construction of a predictive model.

Considered from a theoretical perspective, the number of correlations observed can be explained in terms of the quality and quantity of opportunities present in the computer based activity for the player to exhibit behaviours related to specific personality factors, the presence of which will therefore determine the effectiveness of personality assessment through observation of those interactions, subject to our ability to observe and interpret them. In this instance, the exploration and management of consumable resources provides abundant opportunities to demonstrate the sort of methodically organised approach associated with conscientiousness, while the wide variety of non-player characters support interactions that allow the player to project aspects of extraversion and agreeableness through character they control – the absence of correlates with agreeableness in this instance possibly resulting from the artificial nature of these interactions. Openness to experience is more difficult to explain, and there are fewer correlates, but imagination and curiosity are likely to increase engagement with the supernatural mystery elements of the game, and might therefore be represented in the player's attentiveness during exposition and steady progress in advancing the story. Significant correlates with Neuroticism are notably absent from the data, although this is not entirely unexpected given the inherent difficulties associated with measuring enduring emotional states, and the relatively stress free 'tutorial' like nature of the activity, however failing to detect aspects of shyness and self-consciousness in interactions with non-player characters furthers suspicions that they are not analogous to normal social interactions.

4.4. FACTOR ANALYSIS

One of the major barriers to further analysis is the high dimensionality of the data, as the statistical power of many analytical techniques, such as multiple regression analysis (illustrated in figure 4.4a), drops rapidly as the number of independent variables increases (Cohen 1988 p.407); even with careful selection it would be difficult to reduce the 328 independent variables sufficiently to retain the statistical power of these techniques, without discarding substantial quantities of potentially useful data.

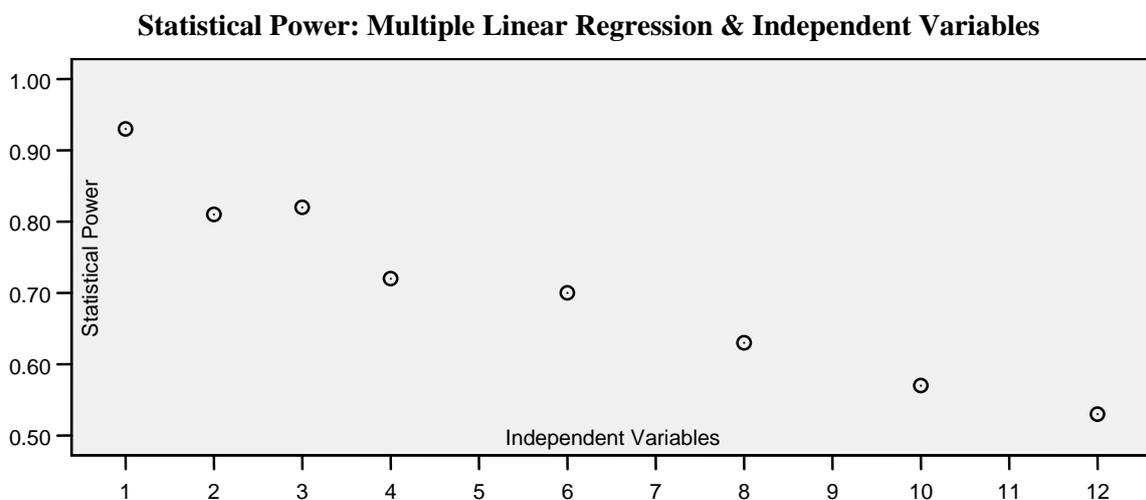


Figure 4.4a – Statistical Power: Multiple Linear Regression ($\alpha = 0.05$; Medium Effect Size = 0.13)

One solution to this problem lies in transforming the data from a collection of interrelated variables into a smaller set of unobserved latent variables called factors – a technique which is popular in the construction of trait based personality inventories as discussed in section 2.3.6.2 The Factor Analytical Approach.

There are two major approaches to the identification of factors: component analysis, which “decomposes the original data into a set of linear variants” (Field 2009 p.638); and factor analysis, which employs a mathematical model – that assumes “the i^{th} variable in the variable set x_i , can be expressed as a linear combination of hypothetical unobservable common factors plus a unique factor to that variable” (Dunteman 1989 p.55) – to perform a similar procedure on a reduced correlation matrix with communalities in the principal diagonal. In practice “principal-components solutions

differ little from the solutions generated from factor analysis methods,” and “do not suffer from some of the convergence problems, boundary cases, and computational limitations” (Guadagnoli & Velicer 1988) (Velicer & Jackson 1990a, 1990b; Velicer, Peacock & Jackson 1982), nor the controversy surrounding factor indeterminacy (Steiger 1990; McDonald & Mulaik 1979; Steiger & Schonemann 1978) – “the inability to determine uniquely the common and unique factor variables of the common factor model from the uniquely defined observed variables because the number of observed variables is smaller than the number of common and unique factors,” (Mulaik & McDonald, 1978 cited in Velicer & Jackson 1990a) meaning that “for a given individual two different factor scores could be calculated, both of which fit the factor model perfectly” (Velicer & Jackson 1990a). A component analysis technique, principal component analysis, will therefore be used to reduce the dimensionality of the independent variables and to eliminate multicollinearity – a phenomenon where one or more independent variables can be expressed as a linear combination of other independent variables.

The variety of data available for use in the principal component analysis presents a problem, as “the correlation between any given pair of items will be affected, in part, by the similarity of their distributions as well as by the similarity in their content. Specifically, two items that assess the same content but differ in their response levels must correlate more poorly than two such items that are similar in their response levels”, and therefore “factors may arise in the data based on dissimilarity of response level in addition to those reflecting content” (Bernstein & Teng 1989). Although there are methods for conducting component analysis with dichotomous, or ordinal, data – by postulating that they represent cuts through unobserved continuous variables with normal, or normalized, distributions and calculating a polychoric or tetrachoric correlation matrix accordingly (Bonnet & Price 2005; Panter et. al 1997; Bernstein & Teng 1989) – dealing with a mixture of nominal, ordinal, and continuous data remains problematic; work continues on this problem – with, amongst others, Quinn’s (2004) formulation of a “[factor analytical] model that is appropriate for multivariate responses that have some continuous and some ordinal components” and which “can be applied to strictly continuous, strictly ordinal, or combinations of continuous and

ordinal data” – but, at present, there is no established solution for use in principal component analysis. Despite this issue, “provided that inferential techniques that depend on assumptions such as multivariate normality are not invoked, there is no real necessity for the variables to have any particular distribution” (Jolliffe 2002. p 68) and the “basic objective of principal component analysis – to summarize most of the ‘variation’ that is present in the original set of p variables using a smaller number of derived variables – can be achieved regardless of the nature of the original variables” (Jolliffe 2002 p. 339). It is therefore possible to proceed with a conventional principal component analysis, provided that care is taken to avoid extracting factors resulting from the dissimilarity of response levels, and subsequent analytical techniques do not rely on assumptions of multivariate normality.

Taking into account the advice of Guadagnoli & Velicer (1988) – that “given the importance of component saturation in determining comparability [with the population], the researcher, prior to an analysis, should select variables that will be good markers for a component” – two different methods will be employed to select variables for the principal component analysis: a statistical approach, which will select those independent variables that correlate with the dependent variable being examined; and a theoretical approach, which will select the independent variables that, based on psychological theory, are anticipated to be good predictors of the personality trait being examined. In order to proceed with the principle component analysis, any items which inhibit the creation of a positive definite matrix will need to be removed. The Kaiser Meyer Olkin measure of sampling adequacy (Kaiser 1970) – which is the ratio of the squared correlations to squared partial correlations between the variables – can then be calculated, and used to eliminate any remaining items with a value below Kaiser & Rice’s (1974) recommendation of 0.5. Once the item selection is finalised, Bartlett’s Test of Sphericity (Field 2009, p.782) will be employed to verify that the matrix is not proportional to an identity matrix – as this would make a factor model inappropriate – and the principle component analysis can then be performed.

Predictor Selection: Statistical Approach

| | Mean | Std. Deviation |
|--|---------|----------------|
| OF#1.01.2-Option-Confirm.Difficulty#Yes | .91 | .282 |
| OF#1.02.S-Scene-Opening.Sequence#Watched | .87 | .337 |
| OF#1.04.S-Scene-Midnight.Arrival#Watched | .93 | .259 |
| OF#1.05.2T-Conversation-Midnight.Welcome | 4.71 | 2.491 |
| OF#1.06.1-Conversation-First.Morning#Default | .86 | .352 |
| OF#1.09.T-Task-Locate.Faculty.Office | 113.96 | 54.130 |
| OF#1.10.1T-Conversation-Meeting.Teacher | 2.83 | 1.769 |
| OF#1.11.S-Conversation-Assembly#Read | .47 | .503 |
| OF#1.12.1-Conversation-Meeting.Classmates#Default | .74 | .440 |
| OF#1.12.2-Conversation-Meeting.Classmates#Opt3 | .27 | .448 |
| OF#1.13.S-Dialogue-Akiko.Goes.Out#Read | .37 | .487 |
| OF#2.02.0-Conversation-Meeting.Principle-Who.else.lives.here | 2.86 | 1.376 |
| OF#2.02.2T-Conversation-Meeting.Principle | 3.17 | 1.744 |
| OF#2.02.S-Conversation-Meeting.Principle#Listened | .50 | .504 |
| OF#2.05.S-Dialogue-Dark.Hour.Exposition.II#Read | .37 | .487 |
| OF#2.08.1-Conversation-Good.Morning.Junpei#Default | .83 | .380 |
| OF#2.10.S-Dialogue-Watch.The.Watchers#Read | .50 | .504 |
| OF#2.11.S-Dialogue-Akiko.Attacked#Read | .41 | .496 |
| OF#2.13.3-Task-Run.Away-Attempts.To.Explore | 1.16 | 1.451 |
| OF#2.13.T-Task-Run.Away | 34.30 | 21.893 |
| OF#2.15.1T-Combat-Rooftop.Battle | 21.76 | 10.559 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Listened | .64 | .483 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Read | .34 | .478 |
| OF#3.01.2-Conversation-What.Is.Persona#Default | .81 | .392 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .44 | .500 |
| OF#3.02.S-Conversation-In.Hospital#Listened | .43 | .498 |
| OF#3.02.S-Conversation-In.Hospital#Read | .53 | .503 |
| OF#3.02.3-Conversation-In.Hospital#Default | .83 | .380 |
| OF#3.04.1-Question-History.Class.Question#Opt1-Correct | .77 | .423 |
| OF#3.05.1-Task-Locate.Fourth.Floor-Objects.Examined | .61 | 1.344 |
| OF#3.05.5-Task-Locate.Fourth.Floor-Game.Saved | .30 | .462 |
| OF#3.05.T-Task-Locate.Fourth.Floor | 41.01 | 30.943 |
| OF#3.06.5-Conversation-Society.Meeting#Default | .86 | .352 |
| OF#3.06.6-Conversation-Society.Meeting#Opt1 | .04 | .204 |
| OF#3.12.S-Dialogue-Tartarus.Outside#Listened | .44 | .500 |
| OF#3.14.S-Conversation-My.Power#Listened | .40 | .493 |
| OF#3.14.S-Conversation-My.Power#Read | .57 | .498 |
| OF#3.14.1-Conversation-My.Power#Opt1 | .89 | .320 |
| OF#3.14.1-Conversation-My.Power#Opt2 | .09 | .282 |
| OF#3.15.S-Conversation-Mysterious.Door#Listened | .46 | .502 |
| OF#3.15.S-Conversation-Mysterious.Door#Read | .53 | .503 |
| OF#3.15.1-Conversation-Mysterious.Door#Default | .43 | .498 |
| OF#4.02.1-Option-Menu.Outside-Skill | .36 | .483 |
| OF#4.02.5-Option-Menu.Outside-Status | .47 | .503 |
| OF#4.02.T-Option-Menu.Outside | 42.81 | 69.532 |
| OF#4.03.1-Task-Enter.Tartarus-NPC.Interactions | 1.37 | 1.599 |
| OF#4.04.1T-Combat-Tartarus.Battles | 30.44 | 17.939 |
| OF#4.04.4-Combat-Tartarus.Battles-Perfect | .49 | .503 |
| OF#4.04.4T-Combat-Tartarus.Battles | 89.04 | 43.329 |
| OF#4.04.A-Combat-Tartarus.Battles-Advantage | 2.00 | 1.239 |
| OF#4.05.3-Option-Exploring.Tartarus-Party.Healed | 1.10 | .801 |
| OF#4.06.5-Option-Menu.Inside-Status | .33 | .473 |
| OF#4.08.S-Conversation-Tartarus.Debriefing#Read | .57 | .498 |
| OF#4.09.1-Option-Fusions-Help | .30 | .462 |
| OF#4.09.1T-Option-Fusions | 62.50 | 72.854 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | 2.06 | 1.463 |
| OF#4.10.2-Task-Leave.Tartarus-Objects.Examined | 1.24 | 1.185 |
| OF#4.10.3-Task-Leave.Tartarus-Attempts.To.Reenter.Tartarus | .14 | .352 |
| OF#4.10.4-Task-Leave.Tartarus-Game.Saved | .61 | .490 |
| OF#4.10.1T-Task-Leave.Tartarus | 44.99 | 26.645 |
| DD#1.01-Total.Conversation.Defaults | 23.36 | 3.765 |
| DD#1.03-Total.Scenes.Skipped | .33 | 1.032 |
| DD#2.00-Time.Total | 1026.11 | 371.619 |
| DD#2.03-Time.Combat.Ratio | .2822 | .07299 |
| DD#2.04-Time.Menu | 172.53 | 124.758 |
| DD#3.01-Total.Total.Games.Saved | 2.39 | 1.300 |
| DD#3.02-Total.Total.Menus.Examined | 3.36 | 2.823 |
| DD#3.04-Total.Total.NPC.Interactions | 7.91 | 4.024 |

Figure 4.4b – Predictor Selection: Statistical Approach

Predictor Selection: Theoretical Approach

| | Mean | Std. Deviation |
|---|--------|----------------|
| OF#1.01.1T-Option-Difficulty | 2.16 | 1.892 |
| OF#1.05.1-1-Conversation-Midnight.Welcome#Opt1 | .48 | .503 |
| OF#1.05.1-1-Conversation-Midnight.Welcome#Opt2 | .39 | .491 |
| OF#1.06.1-1-Conversation-First.Morning#Default | .87 | .338 |
| OF#1.08.1-1-Conversation-School.Entrance#Default | .71 | .455 |
| OF#1.09.1-1-Task-Locate.Faculty.Office-NPC.Interactions | 2.83 | 1.773 |
| OF#1.09.T-1-Task-Locate.Faculty.Office | 113.53 | 53.675 |
| OF#1.10.1-1-Conversation-Meeting.Teacher#Default | .32 | .471 |
| OF#1.12.2-2-Conversation-Meeting.Classmates#Opt1 | .57 | .498 |
| OF#1.12.2-2-Conversation-Meeting.Classmates#Opt2 | .18 | .388 |
| OF#1.12.1-1-Task-Locate.Bedroom-NPC.Interactions | 1.58 | .965 |
| OF#1.12.T-1-Task-Locate.Bedroom | 169.95 | 130.379 |
| OF#2.01.1-1-Question-Literature.Class.Question#Opt2-Correct | .51 | .503 |
| OF#2.01.1-1-Question-Literature.Class.Question#Opt3-Joke | .25 | .434 |
| OF#2.01.1T-1-Question-Literature.Class.Question | 5.90 | 3.459 |
| OF#2.02.0-1-Conversation-Meeting.Principle-Questions.Asked | 2.06 | .922 |
| OF#2.03.S-1-Dialogue-Dark.Hour.Exposition.II#Listened | .66 | .476 |
| OF#2.05.S-1-Dialogue-Dark.Hour.Exposition.II#Listened | .62 | .488 |
| OF#2.08.1-1-Conversation-Good.Morning.Junpei#Default | .83 | .377 |
| OF#3.04.1-1-Question-History.Class.Question#Opt1-Correct | .77 | .426 |
| OF#3.05.T-1-Task-Locate.Fourth.Floor | 39.57 | 29.833 |
| OF#3.06.4-1-Conversation-Society.Meeting#Default | .78 | .417 |
| OF#3.06.5-1-Conversation-Society.Meeting#Default | .83 | .377 |
| OF#3.14.1-1-Conversation-My.Power#Opt1 | .90 | .307 |
| OF#3.14.1-1-Conversation-My.Power#Opt2 | .08 | .270 |
| OF#4.03.T-1-Task-Enter.Tartarus | 45.55 | 24.845 |
| OF#4.04.A-1-Combat-Tartarus.Battles-Help | 2.61 | 1.216 |
| OF#4.07.1T-1-Conversation-Leaving.Tartarus | 2.26 | 1.261 |
| OF#4.08.1-1-Conversation-Tartarus.Debriefing#Opt1 | .91 | .289 |
| OF#4.08.1-1-Conversation-Tartarus.Debriefing#Opt2 | .04 | .195 |
| OF#4.09.1-1-Option-Fusions-Help | .30 | .461 |
| OF#4.09.1-1-Option-Fusions-System#Fused | .23 | .426 |
| OF#4.09.1T-1-Option-Fusions | 66.52 | 77.869 |
| OF#4.10.1T-1-Task-Leave.Tartarus | 42.88 | 26.485 |
| DD#1.02-Total.Dialogue.Listened | 13.90 | 10.932 |
| DD#1.02-Total.Dialogue.Skipped | .60 | 2.456 |
| DD#1.03-Total.Scenes.Skipped | .29 | .985 |
| DD#2.01-1-Time.Conversation | 119.97 | 40.012 |
| DD#2.01-1-Time.Conversation.Ratio | .1237 | .03279 |
| DD#2.03-1-Time.Combat | 275.97 | 94.972 |
| DD#2.04-1-Time.Menu | 174.01 | 126.757 |
| DD#3.03-Total.Objects.Examined | 10.66 | 5.821 |
| DD#3.04-Total.NPC.Interactions | 7.68 | 4.080 |
| DD#3.05-Total.Items.Purchased | .49 | .821 |
| DD#3.06-Total.Empty.Rooms.Examined | 2.16 | 2.611 |
| DD#3.07-Total.Empty.Rooms.Explored.Ratio | .3259 | .38074 |

Figure 4.4c – Predictor Selection: Theoretical Approach

Determining the number of factors to be extracted from the analysis is also of critical importance, with Zwick & Velicer (1986) going so far as to say it is “likely to be the most important decision a researcher will make,” as “decisions involving choice of method, type of rotation, and type of score will have relatively less impact because of the demonstrated robustness of results across different alternatives in these areas”. Although it is not included in the Statistical Package for the Social Sciences (SPSS), it would be preferable to employ Parallel Analysis – Horn’s (1965) adaptation of the population based K1 Rule – as it is clearly the premier method (Zwick & Velicer 1988), and failing to extract the correct number of factors will distort subsequent analysis. The mixture of nominal, ordinal, and continuous data – discussed in the preceding paragraph – continues to be problematic in this endeavour however, as “the eigenvalues in item-level raw data based on dichotomous or Likert response scales cannot be meaningfully compared to the eigenvalues from parallel analyses based on normally distributed random numbers” (O’Connor 2011), nor can random permutations of the raw data be used as a basis for parallel analysis, as distribution similarity factors may still emerge. It therefore falls to Cattell’s (1966) Scree Test – which sequentially plots the eigenvalues from the component analysis, retaining those factors above a cut-off point determined by plotting a straight line through the smaller values – to determine the number of factors for retention. Although a relatively simple method, and not immune to the selection of factors arising from the dissimilarity of response levels (Bernstein & Teng 1989), it is better able to detect them than the other viable alternatives, and generally performs well (Zwick & Velicer 1988, 1982).

Factor Extraction: Cattell’s Scree Test

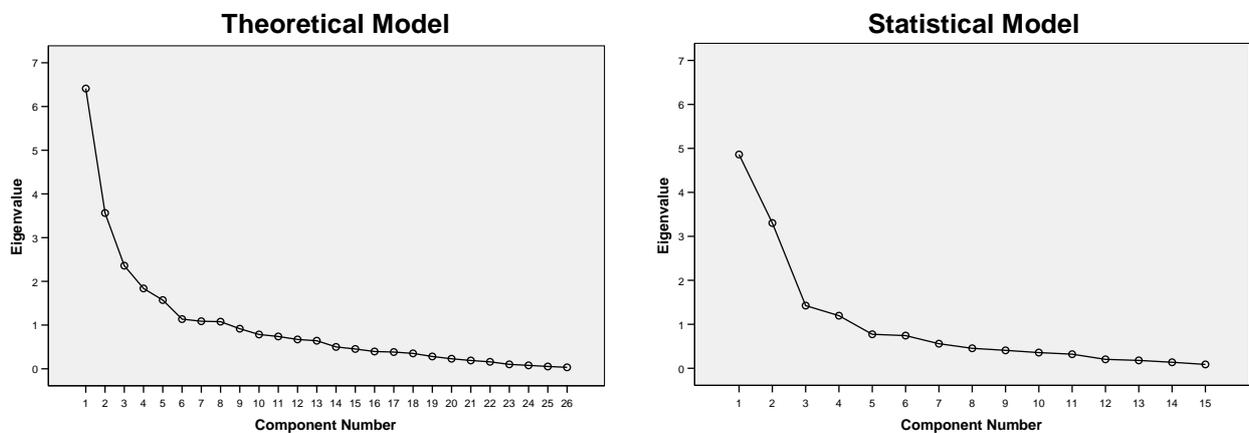


Figure 4.4d – Factor Extraction: Cattell’s Scree Test

Finally, because there is not a unique orthogonal decomposition of the correlation matrix it is possible to transform the solution, rotating it in an effort to improve the interpretability of the retained factors. Two types of rotation are possible: orthogonal rotation, which maintains factor independence in the rotated solution; and oblique rotation, where a degree of correlation between the transformed factors is permitted. Since the data pertains to psychological constructs, which are likely interrelated to a degree, oblique rotation is the more appropriate technique – specifically the use of the direct oblimin algorithm, as computational time and power is not an issue (Field 2009 p.643; Dunteman 1989 p.63).

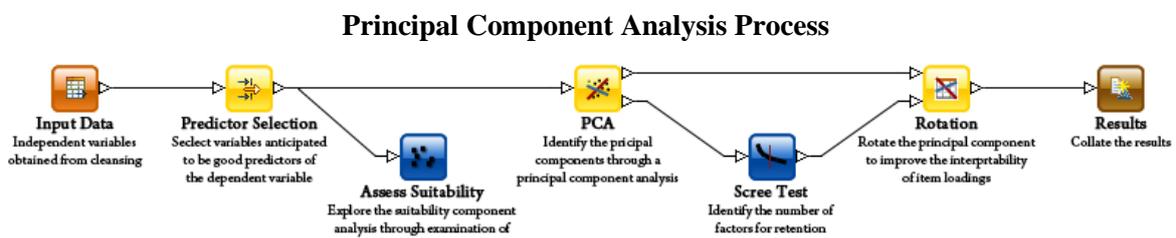


Figure 4.4e – Principal Component Analysis Process

4.4.1. RESULTS: EXTRAVERSION

A series of principal component analyses (PCA) with varimax orthogonal rotation were conducted – the complete matrices for which are presented in Appendix D – to explore the potential for predicting the three personality factors, extraversion, conscientiousness, and openness to experience, which were identified as having a significant number of correlates during the correlation analysis.

The first PCA used a set of 18 items, selected to represent extraversion on a theoretical basis, having eliminated 11 items which failed to meet a minimum Kaiser Meyer Olkin (KMO) sampling adequacy of 0.4 – selected as Kaiser & Rice’s (1974) recommendation of 0.5 would have eliminated all but 5 items. The remaining items yielded an overall KMO of 0.533, with 72% of the individual items above the 0.5 KMO threshold; while Bartlett’s test of sphericity $\chi^2 (153) = 563.235, p < 0.001$ indicated that inter-item correlations were sufficient to proceed with the PCA. Cattell’s (1966) Scree Test supported extracting 3 factors, which in combination accounted 45.2% of the variance, but interpretation must be cautious as 69% of the

non redundant residuals have absolute values above 0.05 and only $\frac{1}{3}$ of the factors possess four or more items with loadings above 0.6 – as recommended by Guadagnoli & Velicer (1988) for PCA with small samples. That said, the items which load highly on individual factors do appear homogeneous, and might represent the following.

1. **Exploration**, reflecting a tendency to seek out non-player characters during exploration tasks and interrogate them for information, but spent a relatively small amount of time in conversation in comparison with that spent exploring.
2. **Role-Playing**, reflecting a tendency to spend a relatively long time selecting dialogue responses, which were often consistent with the perspective of the character controlled by the player, such as, “I’m not sure I’m ready,” when unexpectedly asked to join a secret society, or “I’m exhausted,” after completing the combat tutorial section.
3. **Sociable**, reflecting a tendency to make non-player characters welcome, saying “nice to meet you,” and, “you’re full of energy [this morning],” while avoiding those responses which might cause conflict.

Factor Analysis: Extraversion (Theoretical)

Structure Matrix

| | Component | | |
|--|--------------|--------------|--------------|
| | 1 | 2 | 3 |
| DD#3.04–Total.NPC.Interactions | .868 | .252 | .035 |
| OF#1.12.1–Task–Locate.Bedroom–NPC.Interactions | .726 | -.007 | .082 |
| DD#2.01–Time.Conversation.Ratio | -.720 | .113 | .229 |
| OF#1.09.1–Task–Locate.Faculty.Office–NPC.Interactions | .677 | .134 | -.051 |
| OF#2.02.0–Conversation–Meeting.Principle–Questions.Asked | .428 | .012 | .029 |
| DD#2.01–Time.Conversation | -.064 | .684 | .190 |
| OF#3.06.5–Conversation–Society.Meeting#Default | .158 | -.672 | -.075 |
| OF#4.08.1–Conversation–Tartarus.Debriefing#Opt1 | -.203 | -.588 | .112 |
| OF#3.06.4–Conversation–Society.Meeting#Default | .144 | -.495 | .339 |
| OF#4.08.1–Conversation–Tartarus.Debriefing#Opt2 | .197 | .447 | .115 |
| OF#1.08.1–Conversation–School.Entrance#Default | .337 | .340 | .171 |
| OF#1.10.1–Conversation–Meeting.Teacher#Default | -.108 | -.301 | -.064 |
| OF#3.14.1–Conversation–My.Power#Opt1 | -.011 | -.244 | .828 |
| OF#3.14.1–Conversation–My.Power#Opt2 | .008 | .346 | -.728 |
| OF#2.08.1–Conversation–Good.Morning.Junpei#Default | .171 | .271 | .619 |
| OF#1.05.1–Conversation–Midnight.Welcome#Opt1 | -.391 | .259 | .557 |
| OF#1.05.1–Conversation–Midnight.Welcome#Opt2 | .248 | -.391 | -.548 |
| OF#1.06.1–Conversation–First.Morning#Default | -.006 | .242 | .428 |

Extraction Method: Principal Component Analysis.
 Rotation Method: Oblimin with Kaiser Normalization.

Figure 4.4.1a – Factor Analysis: Extraversion (Theoretical)

A second PCA was conducted on a set of 18 items selected to represent extraversion on the basis of statistical correlation, having eliminated 6 items with less than 0.5 KMO. The remaining items yielded a KMO of 0.655, and Bartlett’s Sphericity indicated sufficient inter-item correlations. Cattell’s Scree Test supported extracting 3 factors, accounting for 60.8% of the variance, and while interpretation must be cautious – as only $\frac{2}{3}$ of the factors possess four or more items with loadings above 0.6, and 49% of the non redundant residuals have absolute values above 0.05 – based on their loadings they might represent the following.

1. **Listening**, reflecting a tendency to listen to the narration of dialogue, rather than read the subtitles and skip the recital.
2. **Preparation**, reflecting a tendency to thoroughly explore the menu system and examine the skills possessed by the playable characters prior to engaging in combat, as well as to seek feedback from non-player characters after completing the combat tutorial.
3. **Unknown**, this factor is difficult to interpret as there are only 3 items with substantial loadings, and they follow no easily discernable pattern.

Factor Analysis: Extraversion (Statistical)

| Structure Matrix | | | |
|---|--------------|-------------|--------------|
| | Component | | |
| | 1 | 2 | 3 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .901 | .061 | .067 |
| OF#3.02.S-Conversation-In.Hospital#Listened | .894 | .204 | .125 |
| OF#3.14.S-Conversation-My.Power#Listened | .871 | .158 | .118 |
| OF#3.02.S-Conversation-In.Hospital#Read | -.830 | -.148 | -.196 |
| OF#3.14.S-Conversation-My.Power#Read | -.826 | -.104 | -.115 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Listened | .726 | .056 | -.382 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Read | -.704 | -.034 | .395 |
| DD#1.03-Total.Scenes.Skipped | -.237 | -.126 | -.029 |
| OF#4.02.T-Option-Menu.Outside | .089 | .873 | -.045 |
| DD#3.02-Total.Menu.Examined | .079 | .863 | -.179 |
| DD#2.04-Time.Menu | .084 | .861 | .127 |
| OF#4.02.1-Option-Menu.Outside-Skill | .004 | .790 | -.260 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .272 | .576 | .141 |
| OF#2.15.1T-Combat-Rooftop.Battle | .403 | .425 | .229 |
| OF#1.05.2T-Conversation-Midnight.Welcome | .177 | .021 | .745 |
| OF#2.02.2T-Conversation-Meeting.Principle | -.100 | -.181 | .664 |
| OF#4.10.1T-Task-Leave.Tartarus | .336 | .497 | .590 |
| OF#1.12.2-Conversation-Meeting.Classmates#Opt3 | .151 | .336 | -.343 |

Extraction Method: Principal Component Analysis.
 Rotation Method: Oblimin with Kaiser Normalization.

Figure 4.4.1b – Factor Analysis: Extraversion (Statistical)

4.4.2. RESULTS: CONSCIENTIOUSNESS

Another PCA was conducted on a set of 23 items selected to represent conscientiousness on a theoretical basis, after several passes eliminated 14 items with less than 0.5 KMO. The remaining items yielded a KMO of 0.711, and Bartlett's Sphericity indicated sufficient inter-item correlations. Cattell's Scree Test supported extracting 4 factors, accounting for 56.1% of the variance, and while interpretation must be cautious – as only $\frac{1}{4}$ of the factors possess four or more items with loadings above 0.6, and 54% of the non redundant residuals have absolute values above 0.05 – based on their loadings they might represent the following.

1. **Exploration**, reflecting a tendency to invest a substantial amount of time in exploration tasks, entering many of the identical empty rooms, and interacting with, or purchasing items from, non-player characters and vending machines that are discovered.
2. **Skipped Fusion**, reflecting a tendency to bypass the optional fusion tutorial, typically as a result of quickly departing from Tartarus after completing the combat tutorial.
3. **Efficiency**, reflecting a tendency to spend little time making decisions in conversation or combat, and to progress swiftly through areas that have previously been explored when required to revisit them.
4. **Eagerness**, reflecting a tendency to fast-forward through dialogue and cinematic sequences, to avoid unnecessary interactions with non-player characters, and to pass up opportunities to save the game, particularly with respect to reaching the latter combat section of the game – reflected in a hurried approach to the immediately preceding exploration task and skipping through the introductory 'help' section of the combat tutorial.

Factor Analysis: Conscientiousness (Theoretical)

Structure Matrix

| | Component | | | |
|---|-------------|---------------|---------------|---------------|
| | 1 | 2 | 3 | 4 |
| OF#1.12.T-Task-Locate.Bedroom | .875 | -.206 | -.290 | -.158 |
| DD#3.03-Total.Objects.Examined | .837 | -.271 | -.059 | -.066 |
| DD#3.06-Total.Empty.Rooms.Examined | .830 | .008 | -.198 | -.126 |
| DD#3.07-Total.Empty.Rooms.Explored.Ratio | .653 | -.343 | -.203 | .087 |
| DD#3.04-Total.NPC.Interactions | .634 | -.347 | .231 | -.385 |
| DD#3.05-Total.Items.Purchased | .569 | -.021 | -.019 | .150 |
| OF#3.05.T-Task-Locate.Fourth.Floor | .494 | -.084 | -.397 | -.202 |
| OF#1.09.T-Task-Locate.Faculty.Office | .412 | -.375 | -.273 | -.073 |
| OF#4.09.1T-Option-Fusions | .140 | -1.909 | -.086 | -.037 |
| DD#2.04-Time.Menu | .348 | -.828 | -.252 | -.207 |
| OF#4.09.1-Option-Fusions-Help | .129 | -1.790 | .048 | -.104 |
| OF#4.10.1T-Task-Leave.Tartarus | .451 | -.508 | -.236 | -.337 |
| OF#1.01.1T-Option-Difficulty | -.141 | -1.483 | -.312 | -.319 |
| OF#4.09.1-Option-Fusions-System#Fused | .045 | -1.404 | -.270 | .370 |
| DD#2.01-Time.Conversation | .378 | -.294 | -1.825 | -.326 |
| OF#4.07.1T-Conversation-Leaving.Tartarus | -.024 | -.049 | -1.797 | .025 |
| DD#2.03-Time.Combat | .318 | -.332 | -1.743 | -.123 |
| OF#2.01.1T-Question-Literature.Class.Question | .159 | -.094 | -1.532 | -.183 |
| DD#1.03-Total.Scenes.Skipped | .115 | .020 | .133 | .709 |
| DD#1.02-Total.Dialogue.Skipped | .006 | .047 | .165 | .699 |
| OF#4.04.A-Combat-Tartarus.Battles-Help | .086 | -.324 | -.291 | -1.619 |
| OF#4.03.T-Task-Enter.Tartarus | .490 | -.319 | -.100 | -1.595 |
| DD#3.01-Total.Games.Saved | .359 | -.262 | .162 | -1.442 |

Extraction Method: Principal Component Analysis.
 Rotation Method: Oblimin with Kaiser Normalization.

Figure 4.4.2a – Factor Analysis: Conscientiousness (Theoretical)

A second PCA was conducted on a set of 20 items selected to represent conscientiousness on the basis of statistical correlation, having eliminated 4 items which inhibited the creation of a positive definite matrix, due to high colinearity, and 6 items with less than 0.5 KMO. The remaining items yielded a KMO of 0.852, and Bartlett’s Sphericity indicated sufficient inter-item correlations. Cattell’s Scree Test supported extracting 2 factors, accounting for 63.5% of the variance, and interpretation should prove reliable – as all of the factors possess four or more items with loadings above 0.6, and only 38% of the non redundant residuals have absolute values above 0.05 – so based on their loadings they could represent the following.

1. **Listening**, reflecting a tendency to listen to the narration of dialogue, rather than read the subtitles and skip the recital.

2. **Exploration**, reflecting a tendency to prioritise interactions with non-player characters, investing time in conversation and exploration relative to that spent making decisions in combat.

Factor Analysis: Conscientiousness (Statistical)

Structure Matrix

| | Component | |
|--|-----------|-------|
| | 1 | 2 |
| OF#3.01.S-Conversation-What.Is.Person#Listened | .918 | .157 |
| OF#2.10.S-Dialogue-Watch.The.Watchers#Read | -.905 | -.162 |
| OF#3.12.S-Dialogue-Tartarus.Outside#Listened | .898 | .212 |
| OF#2.02.S-Conversation-Meeting.Principle#Listened | .895 | .101 |
| OF#3.14.S-Conversation-My.Power#Listened | .835 | .282 |
| OF#4.08.S-Conversation-Tartarus.Debriefing#Read | -.832 | -.221 |
| OF#2.11.S-Dialogue-Akihiko.Attacked#Read | -.829 | -.108 |
| OF#3.15.S-Conversation-Mysterious.Door#Listened | .829 | .334 |
| OF#3.15.S-Conversation-Mysterious.Door#Read | -.816 | -.327 |
| OF#2.05.S-Dialogue-DarkHour.Exposition.II#Read | -.812 | -.113 |
| OF#1.13.S-Dialogue-Akihiko.Goes.Out#Read | -.772 | .145 |
| OF#1.11.S-Conversation-Assembly#Read | -.738 | .044 |
| DD#3.04-Total.NPC.Interactions | .075 | .875 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .067 | .798 |
| OF#4.02.5-Option-Menu.Outside-Status | .015 | .765 |
| OF#4.03.1-Task-Enter.Tartarus-NPC.Interactions | .193 | .756 |
| DD#2.03-Time.Combat.Ratio | -.046 | -.693 |
| OF#4.10.1T-Task-Leave.Tartarus | .157 | .653 |
| OF#3.05.5-Task-Locate.Fourth.Floor-Game.Saved | .201 | .490 |
| OF#2.02.0-Conversation-Meeting.Principle-Who.else.lives.here | .155 | .475 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Figure 4.4.2b – Factor Analysis: Conscientiousness (Statistical)

4.4.3. RESULTS: OPENNESS TO EXPERIENCE

Another PCA was conducted on a set of 14 items selected to represent openness to experience on a theoretical basis, after several passes eliminated 6 items with less than 0.5 KMO. The remaining items yielded a KMO of 0.600, and Bartlett’s Sphericity indicated sufficient inter-item correlations. Cattell’s Scree Test supported extracting 7 factors, accounting for 87.8% of the variance, but interpretation is extremely difficult due to the small number of items with substantial loadings on each factor. It is possible that factor 1 might represent **Listening**, although *DD#1.03–Total.Scenes.Skipped* and *DD#1.02–Total.Dialogue.Skipped* would be anticipated to have more substantial negative loadings were that the case, and factor 5 might represent **Efficiency**, but again a higher negative loading on *DD#1.02–Total.Dialogue.Listened* would be expected; the other five factors can be explained in terms of artefacts arising from the dummy coding of trichotomous, and will therefore be ignored.

Factor Analysis: Openness to Experience (Theoretical)

Structure Matrix

| | Component | | | | | | |
|---|-------------|--------------|--------------|--------------|-------------|--------------|-------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| OF#2.05.S-Dialogue-Dark Hour.Exposition.I##Listened | .950 | .012 | .142 | -.171 | -.164 | .212 | .064 |
| OF#2.03.S-Dialogue-Dark Hour.Exposition.I#Listened | .945 | .046 | .158 | -.045 | -.256 | .207 | .013 |
| DD#1.02-Total.Dialogue.Listened | .921 | -.080 | .226 | -.123 | -.252 | .289 | .151 |
| OF#3.14.1-Conversation-My.Power#Opt1 | -.006 | -.960 | .252 | .002 | -.158 | .111 | .301 |
| OF#3.14.1-Conversation-My.Power#Opt2 | -.017 | .953 | -.164 | -.187 | .167 | -.072 | -.209 |
| OF#1.05.1-Conversation-Midnight.Welcome#Opt1 | .189 | -.204 | .941 | .048 | -.124 | .057 | .046 |
| OF#1.05.1-Conversation-Midnight.Welcome#Opt2 | -.163 | .180 | -.939 | -.057 | .219 | .120 | -.107 |
| OF#2.01.1-Question-Literature.Class.Question#Opt3-Joke | -.072 | -.043 | .077 | .906 | .211 | -.174 | .013 |
| OF#2.01.1-Question-Literature.Class.Question#Opt2-Correct | .200 | .158 | -.029 | -.844 | -.100 | -.043 | .292 |
| DD#1.03-Total.Scenes.Skipped | -.195 | .165 | -.207 | .267 | .906 | -.259 | -.038 |
| DD#1.02-Total.Dialogue.Skipped | -.270 | .168 | -.136 | .047 | .897 | -.267 | -.315 |
| OF#1.12.2-Conversation-Meeting.Classmates#Opt1 | .230 | -.028 | -.007 | .053 | -.201 | .900 | .130 |
| OF#1.12.2-Conversation-Meeting.Classmates#Opt2 | -.281 | .201 | .045 | .297 | .375 | -.841 | -.069 |
| OF#3.04.1-Question-History.Class.Question#Opt1-Correct | .080 | -.358 | .106 | -.158 | -.264 | .181 | .945 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Figure 4.4.3a – Factor Analysis: Openness to Experience (Theoretical)

A second PCA was conducted on a set of 21 items selected to represent openness to experience on the basis of statistical correlation, after several passes eliminated 5 items with less than 0.5 KMO. The remaining items yielded a KMO of 0.676, and Bartlett’s Sphericity indicated sufficient inter-item correlations. Cattell’s Scree Test supported extracting 4 factors, accounting for 57.7% of the variance, and while interpretation must be cautious – as only $\frac{3}{4}$ of the factors possess four or more items with loadings above 0.6, and 54% of the non redundant residuals have absolute values above 0.05 – based on their loadings they might represent the following.

1. **Preparation**, reflecting a tendency to examine the available commands and menu system at the start of the combat tutorial, and to explore the fusion mechanic and its ancillary documentation as soon as it becomes available.
2. **Unknown**, this factor is difficult to interpret as although there are 5 substantial loadings, they follow no easily discernable pattern.
3. **Unknown**, this factor is also difficult to interpret as there are a mixture of elements reflecting exploration, as well as an investment of time in both the introductory and the final combat scenario.
4. **Caution**, reflecting a tendency to save the game, especially prior to, or just after, the highest risk activity, the combat tutorial.

Factor Analysis: Openness to Experience (Statistical)

Structure Matrix

| | Component | | | |
|---|--------------|--------------|-------------|--------------|
| | 1 | 2 | 3 | 4 |
| OF#4.09.1T-Option-Fusions | .877 | -.108 | .007 | -.157 |
| DD#2.04-Time.Menu | .816 | -.164 | .364 | .175 |
| OF#4.09.1-Option-Fusions-Help | .770 | -.031 | .027 | .212 |
| OF#4.10.2-Task-Leave.Tartarus-Objects.Examined | .540 | -.220 | .229 | .450 |
| OF#1.01.2-Option-Confirm Difficulty#Yes | -.516 | -.125 | -.020 | .136 |
| OF#1.10.1T-Conversation-Meeting.Teacher | .408 | .030 | .233 | .075 |
| DD#1.01-Total.Conversation.Defaults | .078 | .842 | -.264 | -.135 |
| OF#3.14.1-Conversation-My.Power#Opt1 | -.141 | .817 | -.026 | -.148 |
| OF#3.14.1-Conversation-My.Power#Opt2 | .176 | -.722 | -.047 | .112 |
| OF#1.12.1-Conversation-Meeting.Classmates#Default | .203 | .716 | -.099 | -.145 |
| OF#1.04.S-Scene-Midnight.Arrival#Watched | .052 | .538 | -.085 | -.029 |
| OF#4.06.5-Option-Menu.Inside-Status | .137 | -.404 | .176 | .171 |
| OF#3.05.T-Task-Locate.Fourth.Floor | .067 | -.076 | .846 | .386 |
| OF#3.05.1-Task-Locate.Fourth.Floor-Objects.Examined | .001 | -.037 | .832 | .299 |
| DD#2.00-Time.Total | .642 | -.263 | .701 | .115 |
| OF#4.04.1T-Combat-Tartarus.Battles | .532 | -.225 | .691 | -.026 |
| OF#4.04.4T-Combat-Tartarus.Battles | .219 | -.309 | .571 | -.193 |
| DD#3.01-Total.Games.Saved | .219 | -.165 | .215 | .844 |
| OF#3.05.5-Task-Locate.Fourth.Floor-Game.Saved | .060 | -.096 | .239 | .825 |
| OF#4.10.4-Task-Leave.Tartarus-Game.Saved | .278 | -.140 | .042 | .736 |
| OF#3.02.3-Conversation-In.Hospital#Default | .129 | .296 | -.130 | -.445 |

Extraction Method: Principal Component Analysis.
 Rotation Method: Oblimin with Kaiser Normalization.

Figure 4.4.3b – Factor Analysis: Openness to Experience (Statistical)

4.4.4. RESULTS: COMBINED BFI FACTORS

The penultimate PCA was conducted on a set of 26 items selected to represent all three factors – extraversion, conscientiousness, and openness to experience – on a theoretical basis, after several passes eliminated 20 items with less than 0.5 KMO. The remaining items yielded a KMO of 0.661, and Bartlett’s Sphericity indicated sufficient inter-item correlations. Cattell’s Scree Test supported extracting 5 factors, accounting for 60.5% of the variance, and while interpretation must be cautious – as only $\frac{2}{5}$ of the factors possess four or more items with loadings above 0.6, and 40% of the non redundant residuals have absolute values above 0.05 – based on their loadings they might represent the following.

1. **Exploration**, reflecting a tendency to invest a substantial amount of time in exploration tasks, entering many of the identical empty rooms, examining objects, interacting with non-player characters, and purchasing items.
2. **Hesitancy**, reflecting a tendency to say, “I’m not sure I’m ready,” when asked to get involved in the plot, and to take a long time to choose dialogue responses, make tactical combat decisions, or select the game’s difficulty;

3. **Skipped Fusion**, reflecting a tendency to bypass the optional fusion tutorial, typically as a result of quickly departing from Tartarus after completing the combat tutorial, which, given the positive loading on *DD#2.01–Time.Conversation.Ratio*, may be indicative of generally swift progress through the game.
4. **Listening**, reflecting a tendency to listen to the narration of dialogue, rather than read the subtitles and skip the recital, but includes several confounding elements, most notably dialogue responses that favour social harmony.
5. **Investigation**, reflecting a tendency to seek out and interrogate non-player characters, while exploration is involved the focus is on locating and interacting with non-player characters.

Factor Analysis: Combined (Theoretical)

Structure Matrix

| | Component | | | | |
|---|--------------|--------------|--------------|--------------|--------------|
| | 1 | 2 | 3 | 4 | 5 |
| DD#3.06–Total.Empty.Rooms.Examined | .868 | .189 | -.089 | .109 | -.189 |
| OF#1.12.T–Task-Locate.Bedroom | .852 | .313 | -.226 | .190 | -.392 |
| DD#3.03–Total.Objects.Examined | .800 | .080 | -.302 | -.038 | -.348 |
| OF#1.12.1–Task-Locate.Bedroom–NPC.Interactions | .692 | -.183 | -.171 | .140 | -.371 |
| DD#3.05–Total.Items.Purchased | .646 | .025 | -.050 | -.239 | -.095 |
| DD#3.07–Total.Empty.Rooms.Explored.Ratio | .551 | .247 | -.341 | -.150 | -.437 |
| DD#2.01–Time.Conversation.Ratio | -.529 | .245 | .461 | .220 | .526 |
| DD#2.01–Time.Conversation | .236 | .840 | -.219 | .445 | -.189 |
| DD#2.03–Time.Combat | .220 | .777 | -.294 | .078 | -.289 |
| OF#4.07.1T–Conversation–Leaving.Tartarus | -.003 | .695 | .018 | .167 | .156 |
| OF#3.06.5–Conversation–Society.Meeting#Default | .113 | -.649 | .125 | -.212 | .340 |
| OF#2.01.1T–Question–Literature.Class.Question | .171 | .462 | -.096 | .268 | .006 |
| OF#4.09.1T–Option–Fusions | .075 | .098 | -.923 | .087 | -.185 |
| DD#2.04–Time.Menu | .280 | .271 | -.868 | .122 | -.302 |
| OF#4.09.1–Option–Fusions–Help | .081 | -.038 | -.845 | .096 | -.050 |
| OF#1.01.1T–Option–Difficulty | -.256 | .398 | -.472 | .176 | -.177 |
| OF#4.04.A–Combat–Tartarus.Battles–Help | -.018 | .248 | -.306 | .658 | -.249 |
| DD#1.03–Total.Scenes.Skipped | .029 | -.114 | .060 | -.602 | -.167 |
| OF#4.03.T–Task–Enter.Tartarus | .338 | .116 | -.281 | .595 | -.497 |
| OF#1.05.1–Conversation–Midnight.Welcome#Opt1 | -.272 | .156 | .086 | .579 | .166 |
| DD#1.02–Total.Dialogue.Listened | .080 | .263 | .045 | .463 | -.042 |
| OF#1.06.1–Conversation–First.Morning#Default | -.268 | .094 | -.191 | .393 | -.118 |
| OF#1.09.T–Task-Locate.Faculty.Office | .170 | .319 | -.209 | .016 | -.807 |
| OF#1.09.1–Task-Locate.Faculty.Office–NPC.Interactions | .306 | -.146 | -.082 | -.092 | -.794 |
| DD#3.04–Total.NPC.Interactions | .513 | -.250 | -.320 | .259 | -.740 |
| OF#4.10.1T–Task–Leave.Tartarus | .205 | .254 | -.403 | .366 | -.535 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Figure 4.4.4a – Factor Analysis: Combined (Theoretical)

The final PCA was conducted on a set of 15 items selected to represent all three factors – extraversion, conscientiousness, and openness to experience – on the basis of statistical correlation, after eliminating 4 items which inhibited the creation of a

positive definite matrix, due to high colinearity, and 52 items with less than 0.5 KMO. The remaining items yielded a KMO of 0.734, and Bartlett’s Sphericity indicated sufficient inter-item correlations. Cattell’s Scree Test supported extracting 4 factors, accounting for 71.9% of the variance, and while interpretation must be cautious – as only $\frac{2}{4}$ of the factors possess four or more items with loadings above 0.6, and 34% of the non redundant residuals have absolute values above 0.05 – based on their loadings they might represent the following.

1. **Listening**, reflecting a tendency to listen to the narration of dialogue, rather than read the subtitles and skip the recital.
2. **Exploration**, reflecting a tendency to invest time in exploration tasks and interaction with non-player characters, and **Preparation**, reflecting a tendency to examine the menu system prior to the start of the combat tutorial.
3. **Unknown**, it is difficult to interpret this factor due to few loadings beyond time spent on activities, which suggests an element of **Exploration**.
4. **Unknown**, this factor is difficult to interpret as there are only 3 items with substantial loadings, and they follow no easily discernable pattern.

Factor Analysis: Combined (Statistical)

Structure Matrix

| | Component | | | |
|---|--------------|-------------|-------------|--------------|
| | 1 | 2 | 3 | 4 |
| OF#3.01.S-Conversation-What.Is.Person#Listened | .919 | .030 | .226 | -.032 |
| OF#2.02.S-Conversation-Meeting.Principle#Listened | .874 | -.017 | .231 | .041 |
| OF#4.08.S-Conversation-Tartarus.Debriefing#Read | -.845 | -.089 | -.185 | -.013 |
| OF#2.05.S-Dialogue-Dark.Hour.Exposition.II#Read | -.844 | -.034 | -.131 | -.027 |
| OF#3.02.S-Conversation-In.Hospital#Read | -.798 | -.046 | -.325 | .015 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Listened | .747 | .083 | .118 | .035 |
| DD#3.04-Total.NPC.Interactions | .121 | .860 | .216 | -.337 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .147 | .811 | .083 | -.478 |
| OF#4.02.5-Option-Menu.Outside-Status | .019 | .793 | .303 | .161 |
| OF#4.02.1-Option-Menu.Outside-Skill | -.062 | .671 | .235 | .182 |
| OF#4.10.1T-Task-Leave.Tartarus | .220 | .598 | .441 | -.533 |
| DD#2.00-Time.Total | .170 | .496 | .867 | -.287 |
| OF#2.15.1T-Combat-Rooftop.Battle | .337 | .024 | .853 | .162 |
| OF#1.09.T-Task-Locate.Faculty.Office | .168 | .297 | .679 | -.374 |
| DD#1.01-Total.Conversation.Defaults | .144 | -.052 | -.108 | .811 |

Extraction Method: Principal Component Analysis.
 Rotation Method: Oblimin with Kaiser Normalization.

Figure 4.4.4b – Factor Analysis: Combined (Statistical)

4.4.5. RESULTS: SUMMARY

It is clear, from the consistently high percentage of non redundant residuals with absolute values in excess of 0.05 and the relatively small number of factors with four or more item loadings above 0.6, that replication with an increased sample size of at least 150, and ideally 300 participants, would be appropriate to ensure the accuracy of the analysis; that said, there are several repeating patterns in the component analysis that may be of interest, and could inform the design of any subsequent experiments.

On five occasions a factor was interpreted, based on item loadings, to represent a quality termed ‘Exploration’ – a tendency to invest time in the exploration of an environment, interacting with objects and non-player characters encountered, when given the opportunity to do so – the presence of which is supported by a high degree of statistically significant intercorrelation between each of the 5 occurrences. In addition, ‘Exploration’ correlated significant, but weakly, with another statistically significant strongly intercorrelated factor, identified on 3 occasions to be ‘Preparation’ – a tendency to prepare for the combat tutorial, exemplified by the examination of a menu system detailing all of the controllable character’s abilities, strengths, and weaknesses.

Factor Analysis: Intercorrelations (Exploration & Preparation)

| | | PCA# Extraversion- Theory.1 (Exploration) | PCA# Conscientious- ness-Theory.1 (Exploration) | PCA# Conscientious- ness-Stats.2 (Exploration) | PCA# Complete- Theory.1 (Exploration) | PCA# Complete-Stats. 2 (Exploration & Preparation) | PCA# Extraversion- Stats.2 (Preparation) | PCA# Openness- Stats.1 (Preparation) |
|--|---------------------|--|--|---|--|---|---|---|
| PCA#Extraversion -Theory.1 (Exploration) | Pearson Correlation | 1 | .656** | .723** | .614** | .731** | .523** | .255* |
| | Sig. (2-tailed) | | .000 | .000 | .000 | .000 | .000 | .026 |
| | N | 77 | 77 | 77 | 77 | 76 | 69 | 76 |
| PCA#Conscientiousness -Theory.1 (Exploration) | Pearson Correlation | .656** | 1 | .606** | .914** | .528** | .409** | .230* |
| | Sig. (2-tailed) | .000 | | .000 | .000 | .000 | .000 | .044 |
| | N | 77 | 78 | 78 | 78 | 77 | 70 | 77 |
| PCA#Conscientiousness -Stats.2 (Exploration) | Pearson Correlation | .723** | .606** | 1 | .455** | .929** | .663** | .393** |
| | Sig. (2-tailed) | .000 | .000 | | .000 | .000 | .000 | .000 |
| | N | 77 | 78 | 78 | 78 | 77 | 70 | 77 |
| PCA#Complete -Theory.1 (Exploration) | Pearson Correlation | .614** | .914** | .455** | 1 | .388** | .304* | .111 |
| | Sig. (2-tailed) | .000 | .000 | .000 | | .000 | .010 | .339 |
| | N | 77 | 78 | 78 | 78 | 77 | 70 | 77 |
| PCA#Complete -Stats.2 (Exploration & Preparation) | Pearson Correlation | .731** | .528** | .929** | .388** | 1 | .771** | .477** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | | .000 | .000 |
| | N | 76 | 77 | 77 | 77 | 77 | 70 | 77 |
| PCA#Extraversion -Stats.2 (Preparation) | Pearson Correlation | .523** | .409** | .663** | .304* | .771** | 1 | .605** |
| | Sig. (2-tailed) | .000 | .000 | .000 | .010 | .000 | | .000 |
| | N | 69 | 70 | 70 | 70 | 70 | 70 | 70 |
| PCA#Openness -Stats.1 (Preparation) | Pearson Correlation | .255* | .230* | .393** | .111 | .477** | .605** | 1 |
| | Sig. (2-tailed) | .026 | .044 | .000 | .339 | .000 | .000 | |
| | N | 76 | 77 | 77 | 77 | 77 | 70 | 77 |

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

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

Figure 4.4.5a – Factor Analysis: Intercorrelations (Exploration & Preparation)

Two other factors were also observed on multiple occasions, the most prominent of which, ‘Listening’ – a tendency to listen to the narration of dialogue, rather than read the subtitles and skip the recital – occurred on 5 occasions, and also exhibited a high degree of statistically significant intercorrelation; while the other, ‘Skipped Fusion’ – a tendency to bypass the optional tutorial on fusion mechanics, typically as a result of quickly departing from Tartarus after completing the combat tutorial – was identified on 2 occasions, again supported by a high degree of statistically significant intercorrelation, and may reflect an instance when it was easy to identify more general swift progress throughout the game.

Factor Analysis: Intercorrelations (Listening & Skipped Fusion)

| | | PCA# Extraversion-Stats.1 (Listening) | PCA# Conscientiousness-Stats.1 (Listening) | PCA# Openness-Theory.1 (Listening) | PCA# Complete-Theory.4 (Listening) | PCA# Complete-Stats.1 (Listening) | PCA# Conscientiousness-Theory.2 (Skipped Fusion) | PCA# Complete-Theory.3 (Skipped Fusion) |
|---|--|---------------------------------------|--|------------------------------------|------------------------------------|-----------------------------------|--|---|
| PCA#Extraversion-Stats.1 (Listening) | Pearson Correlation Sig. (2-tailed) N | 1 70 | .902** .000 70 | .777** .000 70 | .501** .000 70 | .940** .000 70 | | |
| PCA#Conscientiousness-Stats.1 (Listening) | Pearson Correlation Sig. (2-tailed) N | .902** .000 70 | 1 78 | .891** .000 78 | .417** .000 78 | .961** .000 77 | | |
| PCA#Openness-Theory.1 (Listening) | Pearson Correlation Sig. (2-tailed) N | .777** .000 70 | .891** .000 78 | 1 78 | .397** .000 78 | .909** .000 77 | | |
| PCA#Complete-Theory.4 (Listening) | Pearson Correlation Sig. (2-tailed) N | .501** .000 70 | .417** .000 78 | .397** .000 78 | 1 78 | .469** .000 77 | | |
| PCA#Complete-Stats.1 (Listening) | Pearson Correlation Sig. (2-tailed) N | .940** .000 70 | .961** .000 77 | .909** .000 77 | .469** .000 77 | 1 .000 77 | | |
| PCA#Conscientiousness-Theory.2 (Skipped Fusion) | Pearson Correlation Sig. (2-tailed) N | | | | | | 1 78 | .954** .000 78 |
| PCA#Complete-Theory.3 (Skipped Fusion) | Pearson Correlation Sig. (2-tailed) N | | | | | | .954** .000 78 | 1 78 |

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

Figure 4.4.5b – Factor Analysis: Intercorrelations (Listening & Skipped Fusion)

Several other factors, which did not reoccur, were also identified: ‘Caution’ – a tendency to save the game, especially prior to, or just after combat; ‘Eagerness’ – a tendency to hurry through the game, avoiding nonessential interactions and activities, and skipping dialogue and cinematic sequences; ‘Efficiency’ – a tendency toward quick decision making in both combat and dialogue, and swift progress when revisiting areas; ‘Hesitancy’ – a tendency for slow decision making, particularly with respect to selecting the game’s difficulty, and a degree of apprehension in accepting ‘the call to adventure’ (Campbell 2008 p.41); ‘Investigation’ – a tendency to seek out and interrogate non-player characters; ‘Role-Playing’ – a tendency to respond to

dialogue in a manner consistent with the character of the game’s protagonist; and ‘Sociable’ – a tendency to select affable dialogue responses and promote social harmony.

4.5. REGRESSION ANALYSIS

An examination of the correlations between measures of personality, obtained from the big five inventory, and the factors extracted via principal component analysis, from observation of players actions, reveals between 4 and 6 statistically significant correlates, at the 0.05 level, for each personality trait. Initially this appears promising, but the relationships are relatively weak, with an average absolute strength of 0.302 and no individual correlate exceeding +0.401 / –0.228; furthermore, having selected half of the items for inclusion in the principal component analysis on the basis of statistical correlation, albeit by Kendall’s (τ) rank correlation coefficient which is calculated differently to Pearson’s (r) product moment correlation coefficient (Howell 2009 p.304), it is important to recognise that any false positive correlates included in the analysis could result in misleading correlations in the factors extracted.

Correlation Analysis: Big Five Personality Traits & Extracted Factors

| | | PCA# Extraversion– Theory.1 (Exploration) | PCA# Extraversion– Theory.2 (Role-Playing) | PCA# Extraversion– Theory.3 (Sociable) | PCA# Extraversion– Stats.1 (Listening) | PCA# Extraversion– Stats.2 (Preparation) | PCA# Extraversion– Stats.3 (UNKNOWN) |
|-------------------|---------------------|---|--|--|--|--|--------------------------------------|
| BFI# Extraversion | Pearson Correlation | -.212 | -.123 | -.095 | -.311** | -.343** | .089 |
| | Sig. (2-tailed) | .065 | .285 | .410 | .009 | .004 | .463 |
| | N | 77 | 77 | 77 | 70 | 70 | 70 |

| | | PCA# Conscientiousness –Theory.1 (Exploration) | PCA# Conscientiousness –Theory.2 (Skipped Fusion) | PCA# Conscientiousness –Theory.3 (Efficiency) | PCA# Conscientiousness –Theory.4 (Eagerness) | PCA# Conscientiousness –Stats.1 (Listening) | PCA# Conscientiousness –Stats.2 (Exploration) |
|------------------------|---------------------|--|---|---|--|---|---|
| BFI# Conscientiousness | Pearson Correlation | -.195 | .095 | -.186 | .098 | -.274* | -.401** |
| | Sig. (2-tailed) | .086 | .408 | .103 | .393 | .015 | .000 |
| | N | 78 | 78 | 78 | 78 | 78 | 78 |

| | | PCA# Openness– Theory.1 (Listening) | PCA# Openness– Theory.2 (UNKNOWN) | PCA# Openness– Theory.3 (UNKNOWN) | PCA# Openness– Theory.4 (UNKNOWN) | PCA# Openness– Theory.5 (UNKNOWN) | PCA# Openness– Theory.6 (UNKNOWN) | PCA# Openness– Theory.7 (UNKNOWN) | PCA# Openness– Stats.1 (Preparation) | PCA# Openness– Stats.2 (UNKNOWN) | PCA# Openness– Stats.3 (UNKNOWN) | PCA# Openness– Stats.4 (Caution) |
|---------------|---------------------|-------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|--------------------------------------|----------------------------------|----------------------------------|----------------------------------|
| BFI# Openness | Pearson Correlation | .064 | -.274* | .111 | -.100 | -.130 | .131 | .176 | -.361** | .364** | -.221 | -.295** |
| | Sig. (2-tailed) | .576 | .015 | .332 | .384 | .256 | .253 | .122 | .001 | .001 | .053 | .009 |
| | N | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 77 | 77 | 77 | 77 |

| | | PCA# Complete– Theory.1 (Exploration) | PCA# Complete– Theory.2 (Hesitancy) | PCA# Complete– Theory.3 (Skipped Fusion) | PCA# Complete– Theory.4 (Listening) | PCA# Complete– Theory.5 (Investigation) | PCA# Complete– Stats.1 (Listening) | PCA# Complete– Stats.2 (Exploration & Preparation) | PCA# Complete– Stats.3 (UNKNOWN) | PCA# Complete– Stats.4 (UNKNOWN) |
|------------------------|---------------------|---------------------------------------|-------------------------------------|--|-------------------------------------|---|------------------------------------|--|----------------------------------|----------------------------------|
| BFI# Extraversion | Pearson Correlation | .041 | .014 | .228* | -.242* | .187 | -.238* | -.275* | -.159 | .157 |
| | Sig. (2-tailed) | .718 | .906 | .045 | .032 | .101 | .037 | .015 | .168 | .172 |
| | N | 78 | 78 | 78 | 78 | 78 | 77 | 77 | 77 | 77 |
| BFI# Conscientiousness | Pearson Correlation | -.170 | .221 | .083 | -.078 | .158 | -.210 | -.323** | .107 | .258* |
| | Sig. (2-tailed) | .138 | .052 | .468 | .497 | .166 | .067 | .004 | .365 | .023 |
| | N | 78 | 78 | 78 | 78 | 78 | 77 | 77 | 77 | 77 |
| BFI# Openness | Pearson Correlation | -.118 | -.146 | .402** | .062 | .211 | .072 | -.175 | -.198 | .250* |
| | Sig. (2-tailed) | .301 | .201 | .000 | .589 | .064 | .533 | .128 | .085 | .028 |
| | N | 78 | 78 | 78 | 78 | 78 | 77 | 77 | 77 | 77 |

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

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

Figure 4.5a – Correlation Analysis: BFI Traits & Extracted Factors

In addition, given the relatively small number of factors with four or more item loadings in excess of 0.6 and the consistently high percentage of non redundant residuals with absolute values exceeding 0.05, discussed in the preceding section, it would be risky to base a regression analysis on the back of the principal component analysis. A situation which is made still worse by the limitations of performing a principal component analysis using a mixture of dichotomous, ordinal, and continuous data – specifically that “the correlation between any given pair of items will be affected, in part, by the similarity of their distributions” and therefore “factors may arise in the data based on dissimilarity of response level in addition to those reflecting content” (Bernstein & Teng 1989) – which prior discussion concluded was acceptable, “provided that inferential techniques that depend on assumptions such as multivariate normality are not invoked,” (Jolliffe 2002 p.68) a condition which would be violated by a regression analysis. Taking all these issues into consideration, it would be irresponsible to proceed with a multiple regression analysis.

4.6. CLUSTERING

Computerized pattern recognition, which we can define as “the categorization of input data into identifiable classes, via the extraction of significant features or attributes of the data from a background of irrelevant detail” (Tou & Gonzalez 1974 p.6), offers a number of approaches to classification which do not rely on assumptions of multivariate normality, therefore providing a viable alternative to multiple linear regression, which was determined to be unsuitable – in part due to its dependence on multivariate normality – in the preceding section.

One of the simplest methods of classification, k nearest neighbour (kNN), stems from the work of Fix and Hodges (1951) and involves identifying a number of ‘features’, variables anticipated to discriminate between the classes under investigation, and projecting the data set as a series of points in an n dimensional ‘feature space’, where n is the number of features selected. The kNN algorithm can then be employed to determine the class, or value, of an unknown point in the feature space by consideration of the classes, or values, of its k nearest neighbours, as determined by a distance function – the motivation for which “follows naturally from the fact that the

most obvious way of establishing a measure of similarity between pattern vectors, which we also consider points in Euclidean space, is by determining their proximity” (Tou & Gonzalez 1974 p.75).

“In designing a classifier, we generally expect that using more data in its design will improve its performance, and that using more data in its testing will improve the accuracy of the estimate of its error rate” (Gose, Johnsonbaugh & Jost 1996 p.127); this causes a conundrum, in that it is desirable to maximise the data used to both build and test the classifier, yet data used for one cannot be used for the other without introducing bias. An elegant solution to this problem lies in the ‘leaving-one-out’ technique, also known as the ‘jack-knife’ procedure, in which n different classifiers are created, each based on $n - 1$ samples, with the remaining sample being retained for testing. Once this process is completed, a final classifier can be constructed using all n samples, with the certainty that its expected error rate is no higher than e / n , where e is the sum of errors from testing the n alternate classifiers. In this way all n samples are used for both classifier construction and testing, yet bias is avoided as no sample is used for both the training and testing of any given classifier. “The leaving-one-out-technique is particularly convenient for nearest neighbour decision making and does not require any more computing effort than would the use of a single pair of training sets” (Gose, Johnsonbaugh & Jost 1996 p.173), as this sort of lazy learning technique defers processing until classifying a new sample – an approach which has drawn criticism for the amount of storage and computational power required, although “in many problems it is only necessary to retain a small proportion of the training set to approximate very well the decision boundary of the kNN classifier” (Ripley 1996 p.198). The leaving-one-out technique can therefore be employed in kNN simply by selecting each of the n samples in turn, and comparing its actual class, or value, to the class, or value, it would have been assigned based on its nearest neighbours as though it were unknown; the expected error rate can be calculated as e / n , where e is the number of misclassified samples.

The high dimensionality of the data may also prove problematic with kNN classification, as it has with other multivariate techniques, because “as dimensionality increases, the distance to the nearest neighbour approaches the distance to the furthest neighbour. In other words, the contrast in distances to different data points becomes

non existent.” “[This] distinction in distance decreases fastest in the first 20 dimensions, quickly reaching a point where the difference in distance between a query point and the nearest and furthest data points drops below a factor of four” (Beyer et al. 1999). The data in this study, and indeed much real world data, exhibits a rich correlation structure – which is far from the independent identically distributed dimensions considered in many studies – and the effective dimensionality of the feature space may therefore be substantially lower than it might at first appear, if, as it is anticipated in this study, the dependence of the data reflects underlying latent variables; Durrant & Kaban (2009) suggest that “for a class of realistic data distributions having non-independent and identically distributed dimensions, namely the family of linear latent variable models, that the Euclidean distance will not concentrate as long as the amount of ‘relevant’ dimensions grows no slower than the overall data dimensions.” Dimensionality is therefore unlikely to be an issue under the circumstances, provided that features are carefully selected.

As Dunteman (1989 p.78) observes, “there is no advantage in transforming the original observations to principal component scores prior to the clustering since the same information is contained in the original and transformed data.” The factors extracted from the principal component analysis will therefore be discarded, removing concerns associated with their validity, and the two original sets of variables used in each analysis – one determined statistically based on correlations with the dependent variable, and the other selected to predict the dependent variable on the basis of psychological theory (detailed in section 4.4 Factor Analysis) – will form the feature sets for a series of kNN classifiers.

4.6.1. RESULTS: CLASSIFIERS

A series of k nearest neighbour (kNN) classifiers were constructed using a Euclidean distance function with a majority vote of the 3 nearest neighbours determining the class – $k = 3$ based on Fukunaga’s (1990 p.273) guidance for selecting a value for k given the sample size and feature space dimensionality – in an effort to model extraversion, conscientiousness and openness to experience. In order to better support this, the features were max-min normalized, preventing the item scales from

influencing the results, and the continuous dependent variables, consisting of the three major personality factors, were each split into three categories: low, normal, and high, using a simple binning procedure that aimed to place an approximately even number of cases into each group.

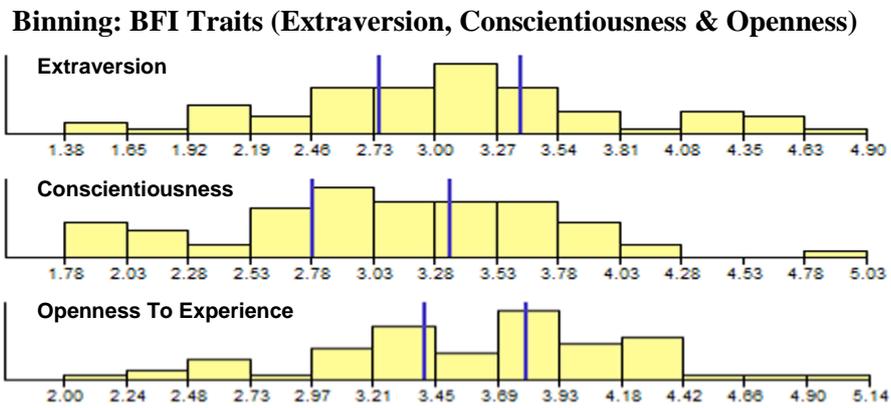


Figure 4.6.1a – Binning: BFI Traits

Finally, two classifiers were constructed for each of the three personality factors, one based on features selected on a theoretical basis, and a second using features selected for their statistical correlation, mirroring the item selection process used for the principal component analysis in section 4.4 Factor Analysis.

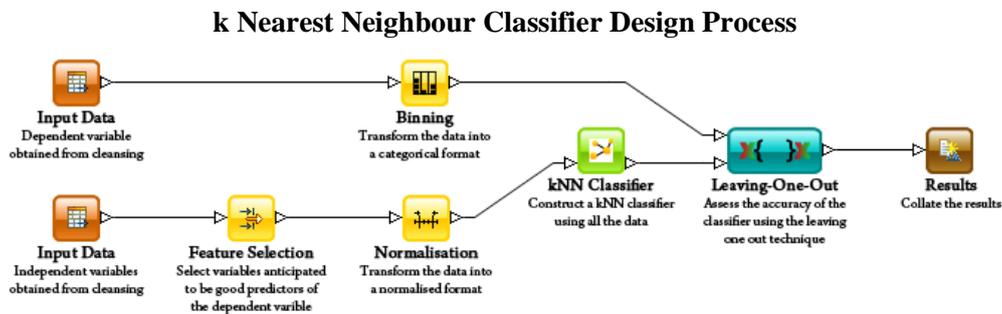


Figure 4.6.1b – k Nearest Neighbour Classifier Design Process

The normalized theoretical data, which consisted of 37 items for extraversion, 29 for conscientiousness, and 20 for openness to experience, developed ineffective classifiers with an error rate comparable to a simple random guess; although it was possible to marginally improve the error rate in one instance, without inhibiting the other two classifiers, by weighting those features anticipated to be more important in determining a classification, specifically those dimensions representing aggregate data – denoted by names beginning with ‘DD’ – which were multiplied by a factor of 1.5.

The normalized statistical data, which consisted of 26 items for extraversion, 24 for conscientiousness, and 26 for openness to experience, performed marginally better, producing weak classifiers with an average error rate of 7.4% better than a simple random guess; although since the correlations, on the basis of which the features were selected, are relatively consistent, there is no basis for weighting the features in an effort to improve performance.

Classifier Performance: Normalized Theoretical Features (Normal & Weighted)

| | Extraversion | Conscientiousness | Openness |
|----------------------------|---------------------|--------------------------|-----------------|
| Number of Features | 37 | 29 | 20 |
| Accuracy (Normal) | 33.3% (+0.0%) | 36.8% (+3.5%) | 32.1% (-1.2%) |
| Accuracy (Weighted) | 41.0% (+7.7%) | 36.8% (+3.5%) | 32.1% (-1.2%) |

Figure 4.6.1c – Classifier Performance: Normalized Theoretical Features (Normal & Weighted)

Classifier Performance: Normalized Statistical Features (Normal)

| | Extraversion | Conscientiousness | Openness |
|---------------------------|---------------------|--------------------------|-----------------|
| Number of Features | 26 | 24 | 26 |
| Accuracy (Normal) | 42.9% (+9.6%) | 41.4% (+8.1%) | 37.7% (+4.4%) |

Figure 4.6.1d – Classifier Performance: Normalized Statistical Features (Normal)

4.6.2. RESULTS: SUMMARY

Overall, classifier performance was consistently weak, failing to provide more than a marginal improvement, if any, over a simple random guess; although refining the feature selection process, to weight the most promising features as well as better identify and eradicate irrelevant ones, would almost certainly lead to a degree of improvement. That these results mirror the correlation and preliminary regression analyses – which found correlates between the big five factors and independent variables were generally weak, although present in significant numbers for extraversion, conscientiousness, and openness to experience, as discussed in sections 4.3 Correlation Analysis and 4.5 Regression Analysis – suggests that the degree of improvement possible may be limited however, as the data captured may not contain features well suited to the prediction of the big five factors.

At this stage, continuing to pursue the analysis in an effort to construct an effective classifier or model seems likely to prove fruitless without substantially increasing the

amount of data available for analysis; while the acquisition of some additional data might be feasible, it is not practicable to capture sufficient data to make a substantial difference given the multivariate techniques employed, and the analysis highlights several issues which might be better addressed through a redesign of the data capture process, or a fresh approach.

CHAPTER 5
CONCLUSIONS

5. CONCLUSIONS

“One way to characterize machines is by the severe constraints on their access to the evidential resources on which human communication of intent routinely relies” (Suchman 2006, p.167), but while traditional media are fixed after development, computational media are capable of adapting themselves on the basis of all available information (Fisher 2001). Although a number of academics have observed that tailoring computer software to individual users at run-time offers substantial advantages over the current practice of tailoring software to groups of users during the development process (Stewart 2007; Charles et al. 2005; Charles & Black 2004; Houlette 2004), commercial applications consistently fail to leverage the information available to them, typically providing only basic context sensitive interfaces (Redmond 2001; Horvitz et al. 1998). In the field of computer games there has been greater interest in tailoring the experience to the player, and it is not uncommon for a game’s difficulty to be adapted on the basis of performance metrics or for the player’s choices to shape the overarching story (Charles et al. 2005; Charles & Black 2004; Houlette 2004), although the degree of adaptation is still relatively limited. If this situation is to improve then it is important to develop techniques to allow the computer to learn about the user (Fisher 2001). Postulating that a player’s interactions with a computer game reveals a substantial quantity of information about them, this dissertation therefore focused on identifying methods for capturing and processing these interactions, in an effort to construct a psychometric profile of the player suitable for tailoring a computer game.

Initial efforts focused on sensor based approaches to the determination of emotion; beginning with an examination of the potential for identifying an individual’s emotional state from the activity of their autonomic nervous system (Levenson 2003, 1992; Picard 1997; Ekman, Levenson & Friesen 1983). An endeavour that has seen a degree of success, detecting a range of emotions under controlled conditions (Hazlett 2006; Sykes & Brown 2003; Levenson 1992), but must address increased sensor noise in uncontrolled environments (Prendinger & Ishizuka 2005; Conati, Chabbal & Maclaren 2003), and resolve difficulties pertaining to the reliable determination of distinct emotions – as “physiological responses similar to those in an emotional state can arise without corresponding to an emotion,” and the “variation in signals for the

same emotion over different days can be greater than the difference between two different emotions on the same day” (Picard 1997 p.31 & p.161). “In recent years, the spotlight in affective science has moved away from the autonomic nervous system and toward the brain” (Levenson 2003 p.222), but the “highly focused approach centred on the study of fear” (LeDoux 2000 p.177) is not broad enough to build meaningful profiles.

A promising alternative, or augmentation, to the analysis of physiological signs, identified in the literature review, was D’Mello et al.’s (2005) “endeavours to classify emotions on the bases of facial expressions, gross body movements, and conversational cues”. Their approach, which relies on the use of computer vision to identify facial expressions – thought to be integral to the expression of emotion and its recognition by other human beings (Lazarus 1991; Osgood, 1966 cited in Hayes 1994, p.516) – appeared relatively practical, having achieved a 68% accuracy in identifying facial action units without calibration, which is just 7% below the minimum needed to be considered a human expert. There have been substantial improvements in facial feature recognition during the course of this project (Ong & Bowden 2011; Tsalakanidou & Malassiotis 2010; Bailenson et al. 2008), and unlike physiologically based methods which require cumbersome, and often expensive, sensory equipment, which makes them impractical for integration with computer games consoles and personal computers; cameras and microphones are readily available, unobtrusive, and are being integrated into computer games consoles as part of the trend toward motion control (Ogg 2011; Microsoft 2010b; Portnow, Floyd & Theus 2010; Sony 2010; Gaudiosi 2007). We are still far from Markin & Prakash’s (2006) ‘ideal facial expression analysis system’, but Keio University’s real-time facial tracking using a standard webcam (Takahashi 2012) demonstrates that commercial applications may already be within our grasp, and given the success (Guinness World Records 2011) of Microsoft’s (2010b) Kinect, with its premise of ‘you are the controller’, we might see applications of this technology as soon as the next generation of consoles (Yin-Poole 2011; Microsoft 2010a).

The other major avenue of investigation was the computerisation of psychometric instruments. Projective techniques, which are characterised by a global approach to the appraisal of personality and typically involve observing a subject’s behaviour

during an unstructured task, were quickly dismissed as they are difficult for a computer to interpret, and “most of these instruments are not ready for routine operational use in helping to make decisions and predictions about people” (Anastasi & Urbina 1997, p.441). Instead, it is with objective techniques that computerisation offers the most advantages, enabling a more extensive evaluation to be conducted in a given time-frame by presenting content dynamically, providing novel opportunities to collect additional data relevant to the qualities being assessed, minimising the need for repetition to the degree it is necessary to maintain an up-to-date record using online storage, and supporting expedient scoring and interpretation through expert systems and artificial neural networks (Vlachonikolis et al. 2000; Krug 1981 cited in Edenborough 1994, p.55). The utility of psychometric instruments is not limited to personality, however, and tests of mental ability can be useful to predict aspects of performance which are not otherwise represented during such assessment (Cook 2004 p.152). The presence of a general intelligence factor (g), or major groups of factors that make a substantial contribution to performance in all aspects of intelligence (Johnson & Bouchard 2005), provides a solid foundation for predicting a player’s performance on the basis of their prior performance in game elements where the general intelligence factor (g) is highly influential, or which involve similar high level groups of factors.

Ultimately, while the computerisation of psychometric instruments offered a number of advantages, the difficulties of adapting existing instruments to such a disparate medium without invalidating them or necessitating the acquisition of fresh normative data (Edenborough 1994, p.194), in conjunction with the incentive to leverage the wealth of information players already provide in interacting with a computer game, prompted an examination of three paradigms of instrument design that had been popular during the past century. Just one, the factor analytical approach – which developed from the rational theoretical approach (Cattell 1979; 1946), supplanting the systemically flawed empirical criterion keying approach as computerisation reduced the computational burden (Wiggins 2003 p.165; Kline 2000 p.512; Norman 1972 p.72) – appeared viable, able to distil large quantities of data extracted from players’ interactions with a computer game into a smaller, more manageable number of highly inter-correlated sets with a strong internal consistency and low inter-set correlations (Field 2009 p.627; Anastasi & Urbina 1997 p.362; Duntman 1989 p.7).

In order to explore this potential, and evaluate factor analysis as a technique for constructing a profile on the basis of a user's interaction with a computer game, an experiment was conducted to monitor players during the 90 minute introductory section of the Persona 3 (Atlus 2006) role-playing game, selected for its relatively linear structure, distinct non-player characters, and variety of dialogue driven, tactical, and twitch based game play. In addition, personality and preference data was collected for each of the 79 participants, using the Big Five Inventory (John, Naumann & Soto 2008; Benet-Martinez & John 1998; John, Donahue & Kentle 1991) and a bespoke questionnaire, to provide context and for use as dependent variables. After a strict data cleaning process, which eliminated 1 record due to a large quantity of missing data – resulting from the player's defeat in the preliminary combat scenario without previously saving the game – the demographics (Age: 21.7 Mean, 5.4 Std.D; 91% Male) of the remaining 78 records were examined and determined likely to be a reasonable reflection of computer game players in their generation, on the bases of comparison with data obtained by Yee (2005) and Billings (2006) and self reported measures of familiarity with computer role-playing games, which indicated 86% considered themselves fairly or very experienced.

A series of Kendall's (τ) rank correlation coefficients were computed to identify medium sized effects (α 0.05; β 0.23) in the computer game interaction data, in order to evaluate the hypotheses:

***H1** In interacting with the underlying model of reality presented in a computer game, players reveal information about their psychology.*

***H2** If, during the course of their interactions with a computer game, players reveal aspects of their psychology, it is possible for the computer to capture and process that information.*

The large number of independent variables in such analyses makes distinguishing correlates from false positives problematic, but by subtracting the anticipated number of false positives based on the α level and computing the binomial probability of the observed correlations being false positives, it was possible to identify those dependent variables which are likely to be related in some way to part of the data captured through the observed computer activity.

Kendall's (τ) Correlation Coefficient: Major Personality Factors

| Kendall's Tau_b | Observed Correlations | Corrected Correlations | Binomial Probability |
|-----------------------|-----------------------|------------------------|----------------------|
| BFI#Extraversion | 24.0 | 7.6 | 0.042 ^(*) |
| BFI#Agreeableness | 16.0 | -0.4 | 0.576 |
| BFI#Conscientiousness | 30.0 | 13.6 | 0.001 ^(*) |
| BFI#Neuroticism | 13.0 | -3.4 | 0.839 |
| BFI#Openness | 26.0 | 9.6 | 0.015 ^(*) |

^(*) Significant based on Binomial Probability Distribution

Figure 5a – Kendall's (τ) Correlation Coefficient: Major Personality Factors

The results of this analysis (illustrated in figure 5a) supported both hypotheses H1 and H2, suggesting that correlates with three of the five personality factors assessed – Extraversion, Conscientiousness, and Openness to Experience – were present in the data captured through observation of the computer game activity; the presence of which can be attributed to opportunities for the player to demonstrate behaviours specific to each personality factor in a manner consistent with that of the real world – although media specific behaviours dissimilar to those in the real world might also exist. It is therefore anticipated that the degree to which a computer game provides these opportunities, and our ability to observe and interpret them, will determine the efficacy of personality assessment through observation of the player's interactions.

Further investigation was hindered by the high dimensionality of the data, as the statistical power of many multivariate techniques falls rapidly as the number of independent variables increases (Cohen 1988). While universally weak relationships between the dependent and independent variables – with no correlation coefficient exceeding ± 0.30 – meant no variable was a viable predictor in isolation, making it difficult to assess the hypothesis:

***H3** If, during the course of their interactions with a computer game, it is possible for the computer to capture and process information pertaining to the psychology of a player, that information will be of sufficient quantity and quality as to allow the construction of a psychological profile of that player.*

One solution to this problem was identified in k Nearest Neighbour (kNN) classification (Fix and Hodges 1951), because although “as dimensionality increases ... the contrast in distances to different data points becomes non existent” (Beyer et al.

1999), the rich correlation structure, which was anticipated to reflect underlying latent variables, meant that the effective dimensionality of the feature space should be substantially lower than it might otherwise appear (Durrant & Kaban 2009). Two kNN classifiers were constructed – with a majority vote of the 3 nearest neighbours, as determined by a Euclidean distance function, determining the class, and error estimated using the leaving-one-out technique – for each of the three major personality factors; one using features selected on the basis of psychological theory, and the other for statistically significant Kendall's (τ) rank correlation coefficients with the dependent variable. The performance of these classifiers was relatively poor, achieving only marginally better results than a simple random guess, and although there was some scope for improvement in the selection and weighting of features, it was insufficient to support hypothesis H3.

The use of component analysis to transform the data from a collection of interrelated variables into a smaller set of unobserved latent variables, reducing the dimensionality to a more manageable level, eliminating multicollinearity, and revealing the underlying structure of the data, provided an alternative approach. Mirroring the kNN classification, two principal component analyses – one based on psychological theory and the other on statistical correlation – were conducted for each of the three major personality factors, in isolation and combination, with Cattell's (1966) Scree Test determining how many factors to extract. The results were disappointing, suggesting the sample size might be insufficient – as evidenced by the consistently high percentage of non redundant residuals with absolute values in excess of 0.05, and the relatively small number of factors with four or more item loadings above 0.6 (Guadagnoli & Velicer 1988). In combination with the risk of correlates arising from the mixture of input data (Bernstein & Teng 1989), and the associated prohibition on the use of techniques which assume multivariate normality (Jolliffe 2002. p 68), this dissuaded further analysis utilising the principal components. Hypothesis H3 therefore remains unsupported.

5.1. FURTHER WORK

This initial foray into the computerised capture and interpretation of psychometric data on the basis of interactions with a computer game, in an effort to provide a foundation for the real-time tailoring of the computer system to the user, offers some support for the hypotheses. It has been possible to demonstrate that data pertaining to at least some of the big five personality factors can be captured from the player's interactions with a commercial computer game, without engineering specific scenarios; however the quantity of data captured, in conjunction with its high dimensionality, varied levels of measurement, and consistently weak correlates, have thus far prohibited the construction of an effective model of the player's personality. A more focused approach, assessing an individual personality factor such as conscientiousness, may achieve superior results, provided a large quantity of data can be captured for a computer activity that affords the user abundant opportunity to demonstrate behaviour specific to that personality factor. With factors which depend on human interaction, it is important to be aware that computer simulations of these interactions may not yield behaviour consistent with their real world counterparts. In such cases, there might be merit in starting with massively multiplayer online games, where these interactions involve real people and there is a wealth of research investigating the differences in communication and behaviour that can provide context (Yee, Schroeder & Axelsson 2005; Brown & Bell 2004; Ducheneaut & Moore 2004; Seay et al. 2004; Preece 2001; Yee 2001; Drucker, Farnham & Smith 2000; Joinson 1998; Clark & Brennan 1991).

An effective user profile need not necessarily be based on aspects of personality. Secondary research highlighted the potential for predicting an individual's performance in all aspects of intelligence on the basis of an underlying general intelligence factor (g) – discussed in section 2.3.3.1 General Intelligence – which suggests that it would be possible to predict performance in a wide variety of tasks on the basis of a player's prior performance in g loaded games, or game elements. While aspects of physical ability, such as reaction time or the accuracy of button inputs, might be measured through quick time events or 'Simon says' sequences in order to predict performance in game elements with similar mechanics.

Correlation analysis of the primary research data also revealed a number of items, pertaining to the player’s experience with computer games and preference in role-playing elements (shown in figure 5.1a), which might be useful in tailoring a computer game, on the basis that they exhibited a substantially greater number of correlates with the data captured than the big five personality factors, potentially making them easier to predict. In addition, an examination of the item loadings for the principal component analyses identified a number of patterns which might have predictive value if they recur beyond the introductory section of the game, within the role-playing genre, or more widely in computer games. The most prominent of these, which recurred in several analyses, appeared to reflect the player’s tendency to: explore the game world; examine tactical options and underlying mechanics; listen to the narration of dialogue; and progress swiftly through the game. Component analyses of interaction data captured from other computer games would not only be useful to determine if these factors generalise, but to identify factors not present in the Persona 3 game, or the role-playing genre, which might be common in other titles.

Kendall’s (τ) Correlation Coefficients: Experience & Preferences

| Kendall's Tau_b | Observed Correlations | Corrected Correlations | Binomial Probability |
|---------------------------------------|-----------------------|------------------------|----------------------|
| PD#03.01–Experience–Weekly.Gaming | 41 | 24.6 | 0.000 ^(*) |
| PD#05.01–Experience–General.Gaming | 38 | 21.6 | 0.000 ^(*) |
| PD#08.01–Experience–RPG | 20 | 3.6 | 0.212 |
| PD#06.01–Preference–RPG.Exploration | 8 | –8.4 | 0.993 |
| PD#06.02–Preference–RPG.Combat.Action | 13 | –3.4 | 0.839 |
| PD#06.03–Preference–RPG.Tactics | 9 | –7.4 | 0.984 |
| PD#06.04–Preference–RPG.Customization | 21 | 4.6 | 0.150 |
| PD#06.05–Preference–RPG.Relationships | 45 | 28.6 | 0.000 ^(*) |
| PD#06.06–Preference–RPG.Story | 39 | 22.6 | 0.000 ^(*) |
| PD#07.01–Preference–RPG.Difficulty | 46 | 29.6 | 0.000 ^(*) |

^(*) Significant based on Binomial Probability Distribution

Figure 5.1a – Kendall’s (τ) Correlation Coefficients: Experience & Preferences

If these techniques gain traction, and it becomes practicable to construct a profile of the user on the basis of their interaction with a computer system, it is likely to be of interest in the field of psychometrics, as the data captured would be distinctly different to that currently obtained using self reported inventories. While the applications would depend on the nature and fidelity of the data captured, there are a number of issues which would require consideration for the effective real-time

tailoring of computer software. It would be necessary to either defer or minimise the processing required to profile the user, in order to prevent a resource drain on intensive applications, such as games, and the adaptation must be continually assessed to detect if it has been compromised, perhaps as a result of several users taking turns, variation in the input device or sensory capabilities of the hardware platform, or unanticipated cultural factors. There are also cost and quality implications, as it will take more time to develop an adaptive product – particularly with respect to cross-platform applications, where substantial variation in input devices and sensory capabilities may require different approaches to user profiling and additional normative data – and exhaustively testing adaptive software is likely to prove challenging, resulting in an increase in the number and severity of bugs. In some instances, it will not be necessary, or even desirable, to introduce adaptive elements, particularly in competitive games, where it is important the performance of players can be directly compared, but also where the activity is intended to form a common experience, or the narrative structure dictates otherwise. Finally, there is a privacy issue, particularly in the event that the information obtained is comparable with traditional psychometric instruments, as data with this level of fidelity could have a wide range of applications; but even relatively innocuous data, such as the games a player has purchased, could be cause for concern were it readily available – with some employers having specifically instructed recruiters to avoid sending them players of Blizzard Entertainment’s (2004) *World of Warcraft* game (Fahey 2008). Although important, this is just one aspect of a much larger issue pertaining to personal and informational privacy (Gynn 2012; Angwin & Valentino-Devries 2011), which has become increasingly significant with the proliferation of networked computer technology and is deserving of serious public discourse.

CHAPTER 6
GLOSSARY

6. GLOSSARY

Agreeableness: one of the big five personality traits, which reflects an optimistic view of human nature and a tendency toward social harmony.

Assessment Centre: an approach to personnel selection that employs a combination of psychometric instruments and simulated work activities.

Autonomic Nervous System: “the part of the nervous system that regulates involuntary action, as of the intestines, smooth muscle, heart, and glands” (The American Heritage Medical Dictionary 2008, p. 53).

Bartlett’s Test of Sphericity: a test which establishes if a correlation matrix is an identity matrix, and therefore unsuitable for factor analysis.

Cattell’s Scree Test: a technique for determining the number of factors to extract during a factor, or component, analysis, using a graph of the eigen values.

Classifier: an algorithm places items into one of several discrete classes, or sets.

Clustering: a collection of techniques for grouping items into homogeneous sets.

Component: an unobserved latent variable also referred to as a ‘factor’.

Component Analysis: a collection of descriptive techniques for representing a set of variables as a potentially smaller number of unobserved latent variables.

Computer Game: “any game played on an electronic device” (Griffiths cited in Newman & Simons 2004, p.33) or, in this dissertation, computer software that manages a model of reality with which humans interact for entertainment.

Conscientiousness: one of the big five personality traits, which reflects self-discipline and attention to detail.

Correlation: a statistical measurement of the relationship between two variables, expressed as a value between 0 and ± 1 , indicating strength and directionality.

Dependent Variable: a variable which ‘depends on’ and therefore might be predicted using independent variables.

Electromyography: a technique for measuring the electrical activity of muscle tissue.

Emotion: a complex condition consisting of at least six interrelated components: the subjective experience, physiological responses, facial expressions, cognitions, behavioural tendencies; and global reactions (Lazarus 1991).

Extraversion: one of the big five personality traits, which reflects a propensity for activity and a desire to interact with others.

Factor: an unobserved latent variable also referred to as a ‘component’.

Factor Analysis: a collection of techniques which use mathematical models to transform a set of variables into potentially fewer unobserved latent variables.

Feature Space: an abstract representation of data in which items are considered to be points in n dimensional space, where n are qualities used to describe the data.

Five Factors: a collection of traits identified through the factor analysis of personality data, which appears to encompass the major aspects of personality; typically designated: extraversion, conscientiousness, neuroticism, and openness to experience.

General Intelligence: the theory that that “all branches of intellectual activity have in common one fundamental function (or group of functions)” (Spearman 1904, p.284).

Horn’s Parallel Analysis: a technique for determining the number of factors to extract during a factor, or component, analysis, using a Monte-Carlo based simulation.

Independent Variable: a variable which influences the dependent variable.

Kendall’s (τ) Correlation Coefficient: a non-parametric technique for measuring correlation.

KMO Sampling Adequacy: a measurement of the magnitude of partial correlations in a set of variables, often used to assess the suitability of a sample for factor analysis.

k Nearest Neighbour (kNN): a type of classifier which determines an items class on the basis of its k ‘nearest neighbours’ in the feature space.

Leaving-One-Out Procedure: a technique which allows all the available samples to be used in both the construction and testing of a classifier, while avoiding bias.

Lexical Hypothesis: the theory that the “individual differences that are most salient and socially relevant in people’s lives will eventually become encoded into their language” (Goldberg, 1982 cited in Waller 1999 p.157).

Neuroticism: one of the big five personality traits, which reflects a predisposition toward depression and emotional instability.

Openness to Experience: one of the big five personality traits, which reflects an appreciation of aesthetics and art.

Pearson’s (r) Correlation Coefficient: a technique for measuring linear correlation.

Personality Trait: an adjective derived from natural language which is intended to describe an aspect of personality.

Player: an individual who ‘plays’, or interacts with, a computer game.

Principle Component Analysis: a technique for representing a set of variables as a potentially smaller number of unobserved latent variables.

Profile: “a set of characteristics or qualities that identify a type or category of person or thing” (Dictionary.com 2012).

Psychological Profile: a description of the “distinctive and characteristic patterns of thought, emotion and behaviour that define an individual’s personal style of interacting with physical and social environments” (Atkinson et al. 2000, p.435).

Psychology: “the science that deals with mental processes and behaviour” or “the emotional and behavioural characteristics of an individual, a group, or an activity” (The American Heritage Medical Dictionary 2008, p. 446).

Psychometrics: “the branch of psychology that deals with the design, administration, and interpretation of quantitative tests for the measurement of psychological variables” (The American Heritage Medical Dictionary 2008, p. 446)

Regression: a collection of statistical techniques for estimating a dependent variable from one or more independent variables.

Reliability: the degree to which an instrument gives consistent results.

Rotation: a collection of techniques for transforming a factor, or component, analysis solution in order to improve the interpretability of the retained factors.

Spearman’s (ρ) Correlation Coefficient: a non-parametric technique for measuring correlation.

Statistical Power: the probability that a statistical test will yield statistically significant results.

Type I Error: the occurrence, or chance of, a false positive.

Type II Error: the occurrence, or chance of, a false negative.

Usability Laboratory: an environment in which users’ interactions with a system can be studied; a typical setup might employ a one way mirror, or video and audio recording equipment, in order to facilitate the unobtrusive observation of the user.

User: an individual who ‘uses’, or interacts with, computer software or hardware.

Validity: the degree to which an instrument measures what it purports to.

CHAPTER 7
REFERENCES

7. REFERENCES

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APPENDIX A
EXPERIMENT MATERIALS

PERSONA EXPERIMENT: BIG FIVE INVENTORY

Participant
Number

The Big Five Inventory (BFI)

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

| Disagree strongly 1 | Disagree a little 2 | Neither agree nor disagree 3 | Agree a little 4 | Agree strongly 5 |
|---------------------------|---------------------------|------------------------------------|------------------------|------------------------|
|---------------------------|---------------------------|------------------------------------|------------------------|------------------------|

I see Myself as Someone Who...

- | | |
|--|---|
| ___ 1. Is talkative | ___ 23. Tends to be lazy |
| ___ 2. Tends to find fault with others | ___ 24. Is emotionally stable, not easily upset |
| ___ 3. Does a thorough job | ___ 25. Is inventive |
| ___ 4. Is depressed, blue | ___ 26. Has an assertive personality |
| ___ 5. Is original, comes up with new ideas | ___ 27. Can be cold and aloof |
| ___ 6. Is reserved | ___ 28. Perseveres until the task is finished |
| ___ 7. Is helpful and unselfish with others | ___ 29. Can be moody |
| ___ 8. Can be somewhat careless | ___ 30. Values artistic, aesthetic experiences |
| ___ 9. Is relaxed, handles stress well | ___ 31. Is sometimes shy, inhibited |
| ___ 10. Is curious about many different things | ___ 32. Is considerate and kind to almost everyone |
| ___ 11. Is full of energy | ___ 33. Does things efficiently |
| ___ 12. Starts quarrels with others | ___ 34. Remains calm in tense situations |
| ___ 13. Is a reliable worker | ___ 35. Prefers work that is routine |
| ___ 14. Can be tense | ___ 36. Is outgoing, sociable |
| ___ 15. Is ingenious, a deep thinker | ___ 37. Is sometimes rude to others |
| ___ 16. Generates a lot of enthusiasm | ___ 38. Makes plans and follows through with them |
| ___ 17. Has a forgiving nature | ___ 39. Gets nervous easily |
| ___ 18. Tends to be disorganized | ___ 40. Likes to reflect, play with ideas |
| ___ 19. Worries a lot | ___ 41. Has few artistic interests |
| ___ 20. Has an active imagination | ___ 42. Likes to cooperate with others |
| ___ 21. Tends to be quiet | ___ 43. Is easily distracted |
| ___ 22. Is generally trusting | ___ 44. Is sophisticated in art, music, or literature |

Please check: Did you write a number in front of each statement?

PERSONA EXPERIMENT: PARTICIPANT DETAILS

Participant
Number

Participant Details Questionnaire

You have been invited to take part in research being conducted at Staffordshire University. If you choose to participate you will be asked to provide a small amount of personal information and details of your interests related to computer games. You will also be asked to complete a basic personality test and to play a computer game, rated 12+ for violence and strong language, during which you will be observed. In accordance with the university's ethical guidelines all information will be stored anonymously and used solely for research purposes. If you wish to withdraw from the study at any time please notify the experimenter, who will destroy any data which has been collected from you.

Please provide the following information by circling your answer or entering it in the space provided.

| | | | | | |
|--------------|--|----------------------|--------------------|------------------|------------|
| 1. | Gender | | | | |
| | Male | | Female | | |
| 2. | Age (Years) | | | | |
| | | | | | |
| 3. | Average Time Spent Gaming Per Week (Hours) | | | | |
| | 0–6 Hours | 6–12 Hours | 12–18 Hours | 18–24 Hours | 24+ Hours |
| 4. | Preference in Computer Game Genres | | | | |
| | Action / Adventure | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Action / Tactical | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Action / Horror | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Vehicle / Racing | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Vehicle / Simulation | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Strategy / Real Time | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Strategy / Turn Based | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Simulation / Management | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | RPG / Massively Multiplayer | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | RPG / Story Driven (Final Fantasy) | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | RPG / Free Exploration (Oblivion) | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Beat 'em up Games | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Platform Games | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Puzzle Games | Dislike a lot | Dislike a little | Like a little | Like a lot |
| Sports Games | Dislike a lot | Dislike a little | Like a little | Like a lot | |
| Party Games | Dislike a lot | Dislike a little | Like a little | Like a lot | |
| 5. | Level of Gaming Experience | | | | |
| | Very Inexperienced | Fairly Inexperienced | Fairly Experienced | Very Experienced | |
| 6. | Preference in Role-Playing Game (Offline) Elements | | | | |
| | Exploration | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Combat / Action | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Combat / Tactics | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Character Customization | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Character Relationships | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Story & Plot | Dislike a lot | Dislike a little | Like a little | Like a lot |
| 7. | Preferred Level of Difficulty in Role-Playing Games (Offline) | | | | |
| | Very Easy | Fairly Easy | Fairly Hard | Very Hard | |
| 8. | Level of Role-Playing Game (Offline) Experience | | | | |
| | Very Inexperienced | Fairly Inexperienced | Fairly Experienced | Very Experienced | |

PERSONA EXPERIMENT: PARTICIPANT DETAILS

Party Selection Questionnaire

You should complete these questions upon arriving at Tartarus in the Persona 3 game.

Please answer the following questions by circling your answer or entering it in the space provided.

| | | | | | |
|-----|--|---|---|--|---|
| 9a. | Who would <u>you</u> choose to lead the exploration of Tartarus? (Select One) | | | | |
| | Main Character | Yukari | Mitsuru | Akihiko | Junpei |
| |  |  |  |  |  |
| 9b. | Who would <u>you</u> choose to explore Tartarus with the Leader? (Select Two Others) | | | | |
| | Main Character | Yukari | Mitsuru | Akihiko | Junpei |

Post Game Questionnaire

You should complete this question after you finish exploring Tartarus in the Persona 3 Game.

Please answer the following questions by circling your answer or entering it in the space provided.

| | | | | | |
|------|--|---|---|--|---|
| 10a. | In future, who would <u>you</u> choose to lead the exploration of Tartarus? (Select One) | | | | |
| | Main Character | Yukari | Mitsuru | Akihiko | Junpei |
| |  |  |  |  |  |
| 10b. | Who would <u>you</u> choose to explore Tartarus with the Leader? (Select Two Others) | | | | |
| | Main Character | Yukari | Mitsuru | Akihiko | Junpei |
| 12. | What did you think of the characters in the Persona 3 Game? | | | | |
| | Main Character | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Yukari | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Mitsuru | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Akihiko | Dislike a lot | Dislike a little | Like a little | Like a lot |
| | Junpei | Dislike a lot | Dislike a little | Like a little | Like a lot |
| 13. | How would you rate the Persona 3 game? | | | | |
| | Dislike a lot | Dislike a little | Like a little | Like a lot | |

END OF QUESTIONS

PERSONA EXPERIMENT: OBSERVATION FORM

Participant
Number

| | | | | |
|------|---|---------------------------------|-------------------------------|------|
| | OPTION: Select Difficulty | | | |
| | Normal | Easy | | Time |
| | Yes | No | | Time |
| Skip | CUT SCENE: Opening Sequence | | | |
| | OPTION: Enter Name | | | |
| | Actual Name | Pseudonym | Garbage | Time |
| Skip | CUT SCENE: A Late Night Arrival | | | |
| Skip | CONVERSATION: A Late Night New Arrival {Yukari} | | | |
| | Nice to meet you. | Why do you have a gun? | Is this the girls' dorm? | Time |
| | <i>Nice to meet you.</i> | <i>Is this the girls' dorm?</i> | <i>Why do you have a gun?</i> | |
| | What's the contract for? | Does that kid live here too? | | Time |
| | Yeah. | What do you mean? | | Time |
| Skip | CONVERSATION: 1st Morning {Yukari} | | | |
| | Open the Door. | Ignore her. | | Time |
| | Yeah, I'm ready. | I can find it myself. | | Time |
| Skip | CUT SCENE: Arriving on the Train | | | |
| Skip | CONVERSATION: Arriving at School {Yukari} | | | |
| | Which class are you in? | No, not really. | | Time |
| | TASK: Locate Faculty Office | | | |
| | NPC Interactions | Objects Examined | Items Purchased | Time |
| | Enter. | Don't Enter. | | Time |
| Skip | CONVERSATION: Meeting Class Teacher {Teacher-F} | | | |
| | Oh... Thanks. | Nice to meet you! | | Time |
| Skip | CONVERSATION: Assembly Whispers (Yukari's Boyfriend) {Classmate-M} | | | |
| | She does. (Lie) | She doesn't. (Lie) | I don't know. (Truth) | Time |
| | <i>She does. (Lie)</i> | <i>She doesn't. (Lie)</i> | | |
| Skip | CONVERSATION: Meeting Classmates {Yukari} [Junpei] | | | |
| | Who are you? | What do you want? | | Time |
| | Yeah I know. | It's just a coincidence. | It must be fate. | Time |
| | Uh uh. | You know what? | | Time |
| | TASK: Locate Bedroom | | | |
| | NPC Interactions | Objects Examined | Items Purchased | Time |
| | Empty Rooms Examined | Empty Rooms Explored | Game Saved | |
| | Enter. | Don't Enter. | | Time |
| Skip | DIALOGUE: Akihiko Goes Out | | | |
| | DIALOGUE: School Gates (Rumours) | | | |

PERSONA EXPERIMENT: OBSERVATION FORM

| | | | | | |
|---|---|---|---------------------------|--|------|
| QUESTION: Class, Literature Question {Junpei, Teacher-F} | | | | | |
| Hakushu Kitahara. (Wrong) | | Fuyuhiko Yoshimura. (Correct) | | Junpei Lori. (Joke) | |
| <i>Hakushu Kitahara. (Wrong)</i> | | <i>Junpei Lori. (Joke)</i> | | <i>Fuyuhiko Yoshimura. (Correct)</i> | |
| <i>Junpei Lori. (Joke)</i> | | <i>Hakushu Kitahara. (Wrong)</i> | | <i>Fuyuhiko Yoshimura. (Correct)</i> | |
| Skip | CONVERSATION: Class, Literature Question {Chairman-M} [Yukari] | | | | |
| 4 | 3 | 2 | 0 | Why are you here? | |
| 4 | 3 | 2 | 0 | Who else lives here? | |
| 4 | 3 | 2 | 0 | The other night, I saw... | |
| 4 | 3 | 2 | 1 | No. I'm good. | |
| Skip | DIALOGUE: The Dark Hour, Exposition | | | | |
| Skip | CUT SCENE: The Dark Hour | | | | |
| Skip | DIALOGUE: The Dark Hour, Exposition | | | | |
| Skip | CUT SCENE: The Velvet Room | | | | |
| Skip | CONVERSATION: The Velvet Room's Contract {Igor} [Elizabeth] | | | | |
| I understand. | | I don't understand. | | Is this a dream? | |
| <i>I understand.</i> | | <i>Is this a dream?</i> | | <i>I don't understand.</i> | |
| CONVERSATION: School Gates {Junpei} | | | | | |
| You're full of energy. | | | I think you need to rest. | | |
| OPTION: Sleep Through Class [Teacher-M] | | | | | |
| Stay awake. | | | Doze off. | | |
| Skip | DIALOGUE: The Dark Hour, Watching Them Watching You | | | | |
| Skip | DIALOGUE: The Dark Hour, Akihiko Under Attack | | | | |
| Skip | CONVERSATION: The Dark Hour, Dorm Evacuation {Yukari} | | | | |
| What's going on? | | | Okay. | | |
| TASK: Run Away (Upstairs) | | | | | |
| Objects Examined | | Attempts to Attack Enemy | | Attempts to Explore | |
| Skip | CUT SCENE: The Dark Hour, Danger on the Roof | | | | |
| Rush | COMBAT: Danger on the Roof {Main Character} | | | | |
| Wait | | Attack | | Skill (Bash) | |
| Wait | | Attack | | Skill (Bash) | |
| Wait | | Attack | | Skill (Bash) | |
| Wait | | Attack | | Skill (Bash) | |
| Wait | | Attack | | Skill (Bash) | |
| Total Waits | | Total Attacks | | Total Skills (Bash) | |
| Review Post Combat Stats | | | | | Time |
| Skip | DIALOGUE: Collapse on the Roof | | | | |
| Skip | CUT SCENE: Return to the Velvet Room | | | | |

PERSONA EXPERIMENT: OBSERVATION FORM

| | | | | |
|-------------|--|---|---|------|
| Skip | QUESTION: The Velvet Room and the Power of Persona { Igor } [Elizabeth] | | | |
| | Persona? | My psyche? | I don't understand. | Time |
| | Whaddya mean weak? | You lost me. | | Time |
| Skip | CONVERSATION: The Hospital (About Yukari) {Yukari} | | | |
| | Where am I...? | Why are you here? | | Time |
| | What were those things? | What'd I do...? | | Time |
| | What do you mean? | Why're you telling me this? | | Time |
| | It's not your fault. | I was scared, too. | | Time |
| | CONVERSATION: School Gates {Yukari} | | | |
| | Yeah, I'm alright. | Not really. | | Time |
| | QUESTION: Class, History Question {Junpei, Teacher-F} | | | |
| | How the tools were made. (Correct) | Who used the tools. (Wrong) | The patterns on the tools. (Wrong) | Time |
| | <i>Who used the tools. (Wrong)</i> | <i>The patterns on the tools. (Wrong)</i> | <i>How the tools were made. (Correct)</i> | |
| | TASK: Locate 4th Floor Meeting | | | |
| | Objects Examined | Items Purchased | | Time |
| | Empty Rooms Examined | Empty Rooms Explored | Game Saved | |
| Skip | CONVERSATION: SEES Meeting {Chairman-M, Mitsuru} [Yukari, Akihiko] | | | |
| | No. | Excuse me? | | Time |
| | Hidden? | Between? | I don't get it. | Time |
| | How do you fight them? | What about the police? | | Time |
| | I see. | So...? | | Time |
| | Alright. | I'm not sure I'm ready. | | Time |
| | ...Alright. | Okay, for now. | I don't mind. | Time |
| | ...Alright. | <i>I don't mind.</i> | <i>Okay, for now.</i> | |
| Skip | CONVERSATION: Midnight Dream Meeting {Mystery Boy} | | | |
| | And you are...? | How'd you get in here? | | Time |
| | The end? | I don't care. | | Time |
| Skip | CONVERSATION: Junpei Moves In {Junpei} [Akihiko, Yukari] | | | |
| | Uh huh. | Nope. | Didn't happen to me. | Time |
| | <i>Uh huh.</i> | <i>Didn't happen to me.</i> | <i>Nope.</i> | |
| | DIALOGUE: School Gates (Rumours) | | | |
| Skip | DIALOGUE: After Class, Meeting Tonight. | | | |
| Skip | DIALOGUE: Dorm, SEES Meeting / Tartarus Plans | | | |
| Skip | CUT SCENE: Materializing Tartarus | | | |
| Skip | DIALOGUE: Outside Tartarus | | | |
| Skip | DIALOGUE: Inside Tartarus | | | |
| Skip | QUESTION: The Velvet Room and... {Igor} [Elizabeth] | | | |
| | The nature of my power? | About that door... | I don't want to know. | Time |
| Skip | CONVERSATION: Leaving the Velvet Room {Junpei} [Yukari] | | | |
| | Nothing. | I opened this door, and... | | Time |

PERSONA EXPERIMENT: OBSERVATION FORM

| | | | | | | | | | | | |
|---|---|------------------|----------------------------|----------------------|---------------|-----------------------------------|----------------|------------------------------|----------------|------------------|---------------|
| FAKE TASK: Select Leader | | | | | | | | | | | |
| Main Character | Yukari | Mitsuru | Akihiko | Junpei | | | | | | | |
| FAKE TASK: Select Party (Three Members) | | | | | | | | | | | |
| Main Character | Yukari | Mitsuru | Akihiko | Junpei | | | | | | | |
| OPTIONAL: Explore Menus | | | | | | | | | | | |
| Skill | Item | Persona | Equip | Status | S.Link | System | Time | | | | |
| Calendar | Quest | Fusion Spells | Dictionary | Config | | | | | | | |
| TASK: Enter Tartarus | | | | | | | | | | | |
| NPC Interactions | | | Objects Examined | | | Game Saved | | | Time | | |
| Yes, I'm ready. | | | Hold on. | | | Time | | | | | |
| COMBAT: Exploring Tartarus {Main Character} [Yukari, Junpei] | | | | | | | | | | | |
| Rush | Advantage (Player / Enemy) | Help | Wait | Heal | Attack | Skill | Analyse | Victory (Basic / Perfect) | | Time | |
| Rush | Advantage (Player / Enemy) | Help | Wait | Heal | Attack | Skill | Analyse | Victory (Basic / Perfect) | | Time | |
| Rush | Advantage (Player / Enemy) | Help | Wait | Heal | Attack | Skill | Analyse | Victory (Basic / Perfect) | | Time | |
| Rush | Advantage (Player / Enemy) | Help | Wait | Heal | Attack | Skill | Analyse | Victory (Basic / Perfect) | | Time | |
| Total Rushes | Total Player | Total Enemy | Total Help | Total Wait | Total Heal | Total Attack | Total Skill | Total Analyse | Total Basic | Total Perfect | Total Time |
| OPTIONAL: Exploring Tartarus (Main Character) [Yukari, Junpei] | | | | | | | | | | | |
| Items Found | | Items Used | | Party Healed | | Evaded Enemy | | | | | |
| OPTIONAL: Explore Menus | | | | | | | | | | | |
| Skill | Item | Persona | Equip | Status | S.Link | System | Time | | | | |
| Calendar | Quest | Fusion Spells | Dictionary | Config | | | | | | | |
| TASK: Leaving Tartarus {Main Character} [Yukari, Junpei] | | | | | | | | | | | |
| Let's go back. | | | | Let's keep going. | | | | Time | | | |
| All Right. | | | | Go on. | | | | Time | | | |
| Skip | CONVERSATION: Tatarus Debriefing {Mitsuru} [Akihiko, Yukari, Junpei] | | | | | | | | | | |
| No problem. | | | I don't know about this... | | | I'm exhausted. | | | Time | | |
| <i>No problem.</i> | | | <i>I'm exhausted.</i> | | | <i>I don't know about this...</i> | | | | | |
| OPTIONAL: Explore Fusion | | | | | | | | | | | |
| Reads Help | | | Explores Fusion Options | | | Creates New Persona | | | Time | | |
| TASK: Leaving Tartarus (Main Character) [Mitsuru, Akihiko] | | | | | | | | | | | |
| NPC Interactions | | Objects Examined | | Attempts to Re-enter | | Game Saved | | Time | | | |
| Return to the dorm. | | | | Continue exploring. | | | | Time | | | |
| FAKE TASK: Re-Select Leader | | | | | | | | | | | |
| Main Character | Yukari | Mitsuru | Akihiko | Junpei | | | | | | | |
| FAKE TASK: Re-Select Party (Three Members) | | | | | | | | | | | |
| Main Character | Yukari | Mitsuru | Akihiko | Junpei | | | | | | | |

APPENDIX B
RAW DATA

DIGITAL VERSION

<https://docs.google.com/spreadsheet/pub?key=0ApiXyPO-wyjCdG1EMXBYcjZlYVZYbnFyc1RqRVU1U2c>

APPENDIX C
CLEANSED DATA

DIGITAL VERSION

<https://docs.google.com/spreadsheet/pub?key=0ApiXyPO-wyjCdG1EMXBYcjZlYVZYbnFyc1RqRVU1U2c>

APPENDIX D
FACTOR ANALYSIS MATRICES

Expanded Factor Analysis Matrices: Extraversion (Theoretical)

Component Matrix^a

| | Component | | |
|--|--------------|--------------|--------------|
| | 1 | 2 | 3 |
| DD#3.04–Total.NPC.Interactions | .758 | .420 | .214 |
| DD#2.01–Time.Conversation.Ratio | -.717 | .027 | -.259 |
| OF#1.09.1–Task-Locate.Faculty.Office–NPC.Interactions | .623 | .237 | .165 |
| OF#1.12.1–Task-Locate.Bedroom–NPC.Interactions | .584 | .240 | .374 |
| OF#1.05.1–Conversation–Midnight.Welcome#Opt1 | -.577 | .418 | -.022 |
| OF#2.02.0–Conversation–Meeting.Principle–Questions.Asked | .355 | .140 | .197 |
| OF#2.08.1–Conversation–Good.Morning.Junpei#Default | -.122 | .615 | .254 |
| DD#2.01–Time.Conversation | -.068 | .556 | -.422 |
| OF#1.05.1–Conversation–Midnight.Welcome#Opt2 | .434 | -.538 | .063 |
| OF#1.06.1–Conversation–First.Morning#Default | -.185 | .428 | .080 |
| OF#1.08.1–Conversation–School.Entrance#Default | .246 | .423 | .000 |
| OF#4.08.1–Conversation–Tartarus.Debriefing#Opt2 | .165 | .422 | -.177 |
| OF#1.10.1–Conversation–Meeting.Teacher#Default | -.097 | -.269 | .137 |
| OF#3.14.1–Conversation–My.Power#Opt2 | .400 | -.226 | -.703 |
| OF#3.14.1–Conversation–My.Power#Opt1 | -.439 | .356 | .687 |
| OF#3.06.4–Conversation–Society.Meeting#Default | -.098 | -.077 | .642 |
| OF#3.06.5–Conversation–Society.Meeting#Default | .094 | -.451 | .526 |
| OF#4.08.1–Conversation–Tartarus.Debriefing#Opt1 | -.296 | -.374 | .419 |

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Pattern Matrix^a

| | Component | | |
|--|--------------|--------------|--------------|
| | 1 | 2 | 3 |
| DD#3.04–Total.NPC.Interactions | .858 | .207 | .028 |
| OF#1.12.1–Task-Locate.Bedroom–NPC.Interactions | .730 | -.052 | .098 |
| DD#2.01–Time.Conversation.Ratio | -.723 | .129 | .205 |
| OF#1.09.1–Task-Locate.Faculty.Office–NPC.Interactions | .671 | .106 | -.051 |
| OF#2.02.0–Conversation–Meeting.Principle–Questions.Asked | .429 | -.013 | .037 |
| OF#1.08.1–Conversation–School.Entrance#Default | .324 | .310 | .146 |
| OF#3.06.5–Conversation–Society.Meeting#Default | .192 | -.681 | -.005 |
| DD#2.01–Time.Conversation | -.066 | .677 | .122 |
| OF#4.08.1–Conversation–Tartarus.Debriefing#Opt1 | -.171 | -.596 | .167 |
| OF#3.06.4–Conversation–Society.Meeting#Default | .177 | -.542 | .394 |
| OF#4.08.1–Conversation–Tartarus.Debriefing#Opt2 | .177 | .431 | .076 |
| OF#1.10.1–Conversation–Meeting.Teacher#Default | -.094 | -.292 | -.037 |
| OF#3.14.1–Conversation–My.Power#Opt1 | .019 | -.328 | .860 |
| OF#3.14.1–Conversation–My.Power#Opt2 | -.024 | .422 | -.769 |
| OF#2.08.1–Conversation–Good.Morning.Junpei#Default | .170 | .204 | .602 |
| OF#1.05.1–Conversation–Midnight.Welcome#Opt1 | -.395 | .227 | .529 |
| OF#1.05.1–Conversation–Midnight.Welcome#Opt2 | .258 | -.354 | -.510 |
| OF#1.06.1–Conversation–First.Morning#Default | -.010 | .203 | .408 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 33 iterations.

Structure Matrix

| | Component | | |
|--|--------------|--------------|--------------|
| | 1 | 2 | 3 |
| DD#3.04–Total.NPC.Interactions | .868 | .252 | .035 |
| OF#1.12.1–Task-Locate.Bedroom–NPC.Interactions | .726 | -.007 | .082 |
| DD#2.01–Time.Conversation.Ratio | -.720 | .113 | .229 |
| OF#1.09.1–Task-Locate.Faculty.Office–NPC.Interactions | .677 | .134 | -.051 |
| OF#2.02.0–Conversation–Meeting.Principle–Questions.Asked | .428 | .012 | .029 |
| DD#2.01–Time.Conversation | -.064 | .684 | .190 |
| OF#3.06.5–Conversation–Society.Meeting#Default | .158 | -.672 | -.075 |
| OF#4.08.1–Conversation–Tartarus.Debriefing#Opt1 | -.203 | -.588 | .112 |
| OF#3.06.4–Conversation–Society.Meeting#Default | .144 | -.495 | .339 |
| OF#4.08.1–Conversation–Tartarus.Debriefing#Opt2 | .197 | .447 | .115 |
| OF#1.08.1–Conversation–School.Entrance#Default | .337 | .340 | .171 |
| OF#1.10.1–Conversation–Meeting.Teacher#Default | -.108 | -.301 | -.064 |
| OF#3.14.1–Conversation–My.Power#Opt1 | -.011 | -.244 | .828 |
| OF#3.14.1–Conversation–My.Power#Opt2 | .008 | .346 | -.728 |
| OF#2.08.1–Conversation–Good.Morning.Junpei#Default | .171 | .271 | .619 |
| OF#1.05.1–Conversation–Midnight.Welcome#Opt1 | -.391 | .259 | .557 |
| OF#1.05.1–Conversation–Midnight.Welcome#Opt2 | .248 | -.391 | -.548 |
| OF#1.06.1–Conversation–First.Morning#Default | -.006 | .242 | .428 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Figure D/a – Expanded Factor Analysis Matrices: Extraversion (Theoretical)

Expanded Factor Analysis Matrices: Extraversion (Statistical)

Component Matrix^a

| | Component | | |
|---|--------------|-------------|--------------|
| | 1 | 2 | 3 |
| OF#3.02.S-Conversation-In.Hospital#Listened | .872 | -.206 | .059 |
| OF#3.14.S-Conversation-My.Power#Listened | .839 | -.243 | .052 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .838 | -.350 | -.006 |
| OF#3.02.S-Conversation-In.Hospital#Read | -.800 | .237 | -.133 |
| OF#3.14.S-Conversation-My.Power#Read | -.783 | .275 | -.051 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Listened | .668 | -.259 | -.440 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Read | -.641 | .271 | .453 |
| OF#2.15.1T-Combat-Rooftop.Battle | .489 | .226 | .211 |
| DD#1.03-Total.Scenes.Skipped | -.251 | -.015 | -.014 |
| OF#4.02.T-Option-Menu.Outside | .320 | .817 | -.019 |
| DD#3.02-Total.Menus.Examined | .305 | .816 | -.152 |
| DD#2.04-Time.Menu | .316 | .801 | .152 |
| OF#4.02.1-Option-Menu.Outside-Skill | .215 | .782 | -.230 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .408 | .437 | .140 |
| OF#1.05.2T-Conversation-Midnight.Welcome | .183 | -.087 | .731 |
| OF#2.02.2T-Conversation-Meeting.Principle | -.127 | -.156 | .666 |
| OF#4.10.1T-Task-Leave.Tartarus | .455 | .313 | .581 |
| OF#1.12.2-Conversation-Meeting.Classmates#Opt3 | .223 | .273 | -.343 |

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Pattern Matrix^a

| | Component | | |
|---|--------------|-------------|-------------|
| | 1 | 2 | 3 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .921 | -.113 | .025 |
| OF#3.02.S-Conversation-In.Hospital#Listened | .883 | .038 | .085 |
| OF#3.14.S-Conversation-My.Power#Listened | .869 | -.006 | .079 |
| OF#3.14.S-Conversation-My.Power#Read | -.833 | .053 | -.078 |
| OF#3.02.S-Conversation-In.Hospital#Read | -.825 | .008 | -.159 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Listened | .761 | -.087 | -.416 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Read | -.744 | .107 | .429 |
| DD#1.03-Total.Scenes.Skipped | -.220 | -.084 | -.019 |
| OF#4.02.T-Option-Menu.Outside | -.076 | .887 | -.042 |
| DD#3.02-Total.Menus.Examined | -.079 | .877 | -.175 |
| DD#2.04-Time.Menu | -.087 | .877 | .130 |
| OF#4.02.1-Option-Menu.Outside-Skill | -.139 | .816 | -.254 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .163 | .545 | .133 |
| OF#2.15.1T-Combat-Rooftop.Battle | .325 | .363 | .214 |
| OF#1.05.2T-Conversation-Midnight.Welcome | .146 | -.007 | .738 |
| OF#2.02.2T-Conversation-Meeting.Principle | -.100 | -.163 | .669 |
| OF#4.10.1T-Task-Leave.Tartarus | .225 | .454 | .580 |
| OF#1.12.2-Conversation-Meeting.Classmates#Opt3 | .107 | .316 | -.348 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Structure Matrix

| | Component | | |
|---|--------------|-------------|-------------|
| | 1 | 2 | 3 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .901 | .061 | .067 |
| OF#3.02.S-Conversation-In.Hospital#Listened | .894 | .204 | .125 |
| OF#3.14.S-Conversation-My.Power#Listened | .871 | .158 | .118 |
| OF#3.02.S-Conversation-In.Hospital#Read | -.830 | -.148 | -.196 |
| OF#3.14.S-Conversation-My.Power#Read | -.826 | -.104 | -.115 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Listened | .726 | .056 | -.382 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Read | -.704 | -.034 | .395 |
| DD#1.03-Total.Scenes.Skipped | -.237 | -.126 | -.029 |
| OF#4.02.T-Option-Menu.Outside | .089 | .873 | -.045 |
| DD#3.02-Total.Menus.Examined | .079 | .863 | -.179 |
| DD#2.04-Time.Menu | .084 | .861 | .127 |
| OF#4.02.1-Option-Menu.Outside-Skill | .004 | .790 | -.260 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .272 | .576 | .141 |
| OF#2.15.1T-Combat-Rooftop.Battle | .403 | .425 | .229 |
| OF#1.05.2T-Conversation-Midnight.Welcome | .177 | .021 | .745 |
| OF#2.02.2T-Conversation-Meeting.Principle | -.100 | -.181 | .664 |
| OF#4.10.1T-Task-Leave.Tartarus | .336 | .497 | .590 |
| OF#1.12.2-Conversation-Meeting.Classmates#Opt3 | .151 | .336 | -.343 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Figure D/b – Expanded Factor Analysis Matrices: Extraversion (Statistical)

Expanded Factor Analysis Matrices: Conscientiousness (Theoretical)

Component Matrix^a

| | Component | | | |
|---|-------------|--------------|--------------|--------------|
| | 1 | 2 | 3 | 4 |
| OF#1.12.T-Task-Locate.Bedroom | .775 | .422 | -.154 | -.012 |
| DD#3.03-Total.Objects.Examined | .687 | .482 | .093 | -.007 |
| DD#2.04-Time.Menu | .683 | -.305 | .374 | .177 |
| DD#2.01-Time.Conversation | .682 | -.279 | -.502 | .142 |
| OF#4.10.1T-Task-Leave.Tartarus | .646 | -.112 | .118 | -.062 |
| DD#3.06-Total.Empty.Rooms.Examined | .625 | .539 | -.237 | -.092 |
| OF#4.03.T-Task-Enter.Tartarus | .615 | -.039 | .042 | -.420 |
| DD#3.07-Total.Empty.Rooms.Explored.Ratio | .603 | .308 | .069 | .232 |
| DD#2.03-Time.Combat | .587 | -.235 | -.374 | .304 |
| DD#3.04-Total.NPC.Interactions | .575 | .267 | .346 | -.380 |
| OF#3.05.T-Task-Locate.Fourth.Floor | .519 | .123 | -.313 | -.016 |
| OF#1.09.T-Task-Locate.Faculty.Office | .517 | .013 | .030 | .149 |
| OF#1.01.1T-Option-Difficulty | .268 | -.590 | .082 | .024 |
| DD#3.05-Total.Items.Purchased | .350 | .492 | -.015 | .105 |
| OF#4.04.A-Combat-Tartarus.Battles-Help | .415 | -.443 | -.082 | -.324 |
| OF#4.09.1-Option-Fusions-Help | .413 | -.308 | .612 | .140 |
| OF#4.09.1-Option-Fusions | .491 | -.381 | .605 | .298 |
| OF#4.07.1T-Conversation-Leaving.Tartarus | .232 | -.329 | -.587 | .393 |
| OF#2.01.1T-Question-Literature.Class.Question | .340 | -.190 | -.387 | .090 |
| OF#4.09.1-Option-Fusions-System#Fused | .185 | -.117 | .144 | .583 |
| DD#1.03-Total.Scenes.Skipped | -.136 | .430 | .188 | .561 |
| DD#1.02-Total.Dialogue.Skipped | -.225 | .365 | .198 | .537 |
| DD#3.01-Total.Games.Saved | .394 | .042 | .237 | -.408 |

Extraction Method: Principal Component Analysis.
a. 4 components extracted.

Pattern Matrix^a

| | Component | | | |
|---|-------------|--------------|--------------|--------------|
| | 1 | 2 | 3 | 4 |
| DD#3.06-Total.Empty.Rooms.Examined | .857 | .222 | -.129 | -.050 |
| OF#1.12.T-Task-Locate.Bedroom | .851 | .015 | -.186 | -.047 |
| DD#3.03-Total.Objects.Examined | .824 | -.109 | .054 | .038 |
| DD#3.07-Total.Empty.Rooms.Explored.Ratio | .615 | -.222 | -.110 | .200 |
| DD#3.05-Total.Items.Purchased | .611 | .076 | .022 | .205 |
| DD#3.04-Total.NPC.Interactions | .592 | -.235 | .371 | -.318 |
| OF#3.05.T-Task-Locate.Fourth.Floor | .458 | .093 | -.346 | -.132 |
| OF#1.09.T-Task-Locate.Faculty.Office | .334 | -.275 | -.188 | .023 |
| OF#4.09.1-Option-Fusions | -.045 | -.943 | .061 | .093 |
| OF#4.09.1-Option-Fusions-Help | -.027 | -.828 | .185 | -.001 |
| DD#2.04-Time.Menu | .165 | -.767 | -.096 | -.065 |
| OF#1.01.1T-Option-Difficulty | -.300 | -.467 | -.244 | -.260 |
| OF#4.10.1T-Task-Leave.Tartarus | .329 | -.384 | -.110 | -.232 |
| OF#4.07.1T-Conversation-Leaving.Tartarus | -.101 | .058 | -.827 | .082 |
| DD#2.01-Time.Conversation | .246 | -.080 | -.763 | -.215 |
| DD#2.03-Time.Combat | .198 | -.171 | -.689 | -.011 |
| OF#2.01.1T-Question-Literature.Class.Question | .090 | .032 | -.515 | -.130 |
| DD#1.03-Total.Scenes.Skipped | .196 | -.064 | .100 | .732 |
| DD#1.02-Total.Dialogue.Skipped | .087 | -.060 | .120 | .707 |
| OF#4.04.A-Combat-Tartarus.Battles-Help | -.049 | -.214 | -.208 | -.573 |
| OF#4.03.T-Task-Enter.Tartarus | .400 | -.158 | .024 | -.528 |
| OF#4.09.1-Option-Fusions-System#Fused | -.027 | -.436 | -.241 | .455 |
| DD#3.01-Total.Games.Saved | .306 | -.181 | .267 | -.406 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 13 iterations.

Structure Matrix

| | Component | | | |
|---|-------------|--------------|--------------|--------------|
| | 1 | 2 | 3 | 4 |
| OF#1.12.T-Task-Locate.Bedroom | .875 | -.206 | -.290 | -.158 |
| DD#3.03-Total.Objects.Examined | .837 | -.271 | -.059 | -.066 |
| DD#3.06-Total.Empty.Rooms.Examined | .830 | .008 | -.198 | -.126 |
| DD#3.07-Total.Empty.Rooms.Explored.Ratio | .653 | -.343 | -.203 | .087 |
| DD#3.04-Total.NPC.Interactions | .634 | -.347 | .231 | -.385 |
| DD#3.05-Total.Items.Purchased | .569 | -.021 | -.019 | .150 |
| OF#3.05.T-Task-Locate.Fourth.Floor | .494 | -.084 | -.397 | -.202 |
| OF#1.09.T-Task-Locate.Faculty.Office | .412 | -.375 | -.273 | -.073 |
| OF#4.09.1-Option-Fusions | .140 | -.909 | -.086 | -.037 |
| DD#2.04-Time.Menu | .348 | -.828 | -.252 | -.207 |
| OF#4.09.1-Option-Fusions-Help | .129 | -.790 | .048 | -.104 |
| OF#4.10.1T-Task-Leave.Tartarus | .451 | -.508 | -.236 | -.337 |
| OF#1.01.1T-Option-Difficulty | -.141 | -.483 | -.312 | -.319 |
| OF#4.09.1-Option-Fusions-System#Fused | .045 | -.404 | -.270 | .370 |
| DD#2.01-Time.Conversation | .378 | -.294 | -.825 | -.326 |
| OF#4.07.1T-Conversation-Leaving.Tartarus | -.024 | -.049 | -.797 | .025 |
| DD#2.03-Time.Combat | .318 | -.332 | -.743 | -.123 |
| OF#2.01.1T-Question-Literature.Class.Question | .159 | -.094 | -.532 | -.183 |
| DD#1.03-Total.Scenes.Skipped | .115 | .020 | .133 | .709 |
| DD#1.02-Total.Dialogue.Skipped | .006 | .047 | .165 | .699 |
| OF#4.04.A-Combat-Tartarus.Battles-Help | .086 | -.324 | -.291 | -.619 |
| OF#4.03.T-Task-Enter.Tartarus | .490 | -.319 | -.100 | -.595 |
| DD#3.01-Total.Games.Saved | .359 | -.262 | .162 | -.442 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Figure D/c – Expanded Factor Analysis Matrices: Conscientiousness (Theoretical)

Expanded Factor Analysis Matrices: Conscientiousness (Statistical)

Component Matrix^a

| | Component | |
|--|--------------|--------------|
| | 1 | 2 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .907 | -.139 |
| OF#3.12.S-Dialogue-Tartarus.Outside#Listened | .897 | -.078 |
| OF#2.10.S-Dialogue-Watch.The.Watchers#Read | -.896 | .129 |
| OF#2.02.S-Conversation-Meeting.Principle#Listened | .877 | -.187 |
| OF#3.15.S-Conversation-Mysterious.Door#Listened | .850 | .067 |
| OF#3.14.S-Conversation-My.Power#Listened | .848 | .013 |
| OF#3.15.S-Conversation-Mysterious.Door#Read | -.837 | -.064 |
| OF#4.08.S-Conversation-Tartarus.Debriefing#Read | -.835 | .047 |
| OF#2.11.S-Dialogue-Akihiko.Attacked#Read | -.814 | .159 |
| OF#2.05.S-Dialogue-Dark.Hour.Exposition.II#Read | -.799 | .149 |
| OF#1.13.S-Dialogue-Akihiko.Goes.Out#Read | -.718 | .394 |
| OF#1.11.S-Conversation-Assembly#Read | -.702 | .282 |
| DD#3.04-Total.NPC.Interactions | .213 | .851 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .193 | .777 |
| OF#4.02.5-Option-Menu.Outside-Status | .138 | .761 |
| OF#4.03.1-Task-Enter.Tartarus-NPC.Interactions | .308 | .694 |
| DD#2.03-Time.Combat.Ratio | -.156 | -.679 |
| OF#4.10.1T-Task-Leave.Tartarus | .257 | .602 |
| OF#2.02.0-Conversation-Meeting.Principle-Who.else.lives.here | .226 | .426 |
| OF#3.05.5-Task-Locate.Fourth.Floor-Game.Saved | .272 | .425 |

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Pattern Matrix^a

| | Component | |
|--|--------------|--------------|
| | 1 | 2 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .916 | .008 |
| OF#2.02.S-Conversation-Meeting.Principle#Listened | .903 | -.046 |
| OF#2.10.S-Dialogue-Watch.The.Watchers#Read | -.902 | -.015 |
| OF#3.12.S-Dialogue-Tartarus.Outside#Listened | .887 | .067 |
| OF#2.11.S-Dialogue-Akihiko.Attacked#Read | -.834 | .028 |
| OF#4.08.S-Conversation-Tartarus.Debriefing#Read | -.817 | -.088 |
| OF#1.13.S-Dialogue-Akihiko.Goes.Out#Read | -.817 | .278 |
| OF#2.05.S-Dialogue-Dark.Hour.Exposition.II#Read | -.816 | .020 |
| OF#3.14.S-Conversation-My.Power#Listened | .811 | .150 |
| OF#3.15.S-Conversation-Mysterious.Door#Listened | .795 | .205 |
| OF#3.15.S-Conversation-Mysterious.Door#Read | -.784 | -.200 |
| OF#1.11.S-Conversation-Assembly#Read | -.765 | .168 |
| DD#3.04-Total.NPC.Interactions | -.070 | .886 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | -.065 | .809 |
| OF#4.02.5-Option-Menu.Outside-Status | -.112 | .783 |
| OF#4.03.1-Task-Enter.Tartarus-NPC.Interactions | .072 | .744 |
| DD#2.03-Time.Combat.Ratio | .069 | -.704 |
| OF#4.10.1T-Task-Leave.Tartarus | .052 | .644 |
| OF#3.05.5-Task-Locate.Fourth.Floor-Game.Saved | .125 | .469 |
| OF#2.02.0-Conversation-Meeting.Principle-Who.else.lives.here | .080 | .462 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Structure Matrix

| | Component | |
|--|--------------|--------------|
| | 1 | 2 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .918 | .157 |
| OF#2.10.S-Dialogue-Watch.The.Watchers#Read | -.905 | -.162 |
| OF#3.12.S-Dialogue-Tartarus.Outside#Listened | .898 | .212 |
| OF#2.02.S-Conversation-Meeting.Principle#Listened | .895 | .101 |
| OF#3.14.S-Conversation-My.Power#Listened | .835 | .282 |
| OF#4.08.S-Conversation-Tartarus.Debriefing#Read | -.832 | -.221 |
| OF#2.11.S-Dialogue-Akihiko.Attacked#Read | -.829 | -.108 |
| OF#3.15.S-Conversation-Mysterious.Door#Listened | .829 | .334 |
| OF#3.15.S-Conversation-Mysterious.Door#Read | -.816 | -.327 |
| OF#2.05.S-Dialogue-Dark.Hour.Exposition.II#Read | -.812 | -.113 |
| OF#1.13.S-Dialogue-Akihiko.Goes.Out#Read | -.772 | .145 |
| OF#1.11.S-Conversation-Assembly#Read | -.738 | .044 |
| DD#3.04-Total.NPC.Interactions | .075 | .875 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .067 | .798 |
| OF#4.02.5-Option-Menu.Outside-Status | .015 | .765 |
| OF#4.03.1-Task-Enter.Tartarus-NPC.Interactions | .193 | .756 |
| DD#2.03-Time.Combat.Ratio | -.046 | -.693 |
| OF#4.10.1T-Task-Leave.Tartarus | .157 | .653 |
| OF#3.05.5-Task-Locate.Fourth.Floor-Game.Saved | .201 | .490 |
| OF#2.02.0-Conversation-Meeting.Principle-Who.else.lives.here | .155 | .475 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Figure D/d – Expanded Factor Analysis Matrices: Conscientiousness (Statistical)

Expanded Factor Analysis Matrices: Openness to Experience (Theoretical)

Component Matrix^a

| | Component | | | | | | |
|---|--------------|--------------|--------------|--------------|--------------|--------------|-------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| DD#1.02–Total.Dialogue.Listened | .791 | .276 | .321 | .138 | .199 | -.032 | .025 |
| OF#2.05.S–Dialogue–Dark Hour.Exposition.I##Listened | .724 | .407 | .357 | .126 | .273 | -.054 | -.026 |
| OF#2.03.S–Dialogue–Dark Hour.Exposition.I##Listened | .721 | .386 | .412 | .171 | .130 | -.152 | -.033 |
| DD#1.02–Total.Dialogue.Skipped | -.612 | .138 | .265 | .041 | .399 | .468 | -.106 |
| DD#1.03–Total.Scenes.Skipped | -.581 | .090 | .315 | .233 | .433 | .350 | .219 |
| OF#1.12.2–Conversation–Meeting.Classmates#Opt2 | -.572 | -.105 | .441 | -.279 | .186 | -.362 | .140 |
| OF#3.14.1–Conversation–My.Power#Opt1 | .338 | -.771 | -.177 | .118 | .383 | .051 | -.193 |
| OF#3.14.1–Conversation–My.Power#Opt2 | -.287 | .766 | .090 | -.277 | -.333 | .088 | .234 |
| OF#2.01.1–Question–Literature.Class.Question#Opt3–Joke | -.260 | -.333 | .539 | .478 | -.189 | -.194 | .283 |
| OF#1.05.1–Conversation–Midnight.Welcomes#Opt1 | .392 | -.411 | .478 | -.412 | -.207 | .367 | -.004 |
| OF#2.01.1–Question–Literature.Class.Question#Opt2–Correct | .264 | .377 | -.364 | -.559 | .367 | .077 | .090 |
| OF#1.05.1–Conversation–Midnight.Welcomes#Opt2 | -.364 | .439 | -.486 | .517 | .208 | -.158 | -.051 |
| OF#1.12.2–Conversation–Meeting.Classmates#Opt1 | .433 | .094 | -.236 | .470 | -.361 | .469 | .141 |
| OF#3.04.1–Question–Hi story.Class.Question#Opt1–Correct | .402 | -.350 | -.377 | -.061 | .241 | -.027 | .669 |

Extraction Method: Principal Component Analysis.

a. 7 components extracted.

Pattern Matrix^a

| | Component | | | | | | |
|---|-------------|--------------|--------------|--------------|-------------|--------------|-------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| OF#2.05.S–Dialogue–Dark Hour.Exposition.I##Listened | .961 | -.015 | -.015 | -.070 | .061 | -.003 | -.021 |
| OF#2.03.S–Dialogue–Dark Hour.Exposition.I##Listened | .949 | .042 | -.013 | .075 | -.079 | -.021 | -.066 |
| DD#1.02–Total.Dialogue.Listened | .887 | -.063 | .069 | -.015 | -.003 | .071 | .047 |
| OF#3.14.1–Conversation–My.Power#Opt2 | -.047 | .951 | .043 | -.129 | .030 | .048 | -.008 |
| OF#3.14.1–Conversation–My.Power#Opt1 | -.026 | -.936 | .078 | -.069 | .041 | .011 | .089 |
| OF#1.05.1–Conversation–Midnight.Welcomes#Opt1 | .016 | -.026 | .950 | -.006 | .064 | .101 | -.031 |
| OF#1.05.1–Conversation–Midnight.Welcomes#Opt2 | -.007 | -.011 | -.916 | -.022 | .097 | .118 | -.036 |
| OF#2.01.1–Question–Literature.Class.Question#Opt3–Joke | .059 | .029 | .025 | .906 | .069 | -.102 | .118 |
| OF#2.01.1–Question–Literature.Class.Question#Opt2–Correct | .121 | .133 | .001 | -.813 | .040 | -.128 | .249 |
| DD#1.03–Total.Scenes.Skipped | .030 | .030 | -.078 | .144 | .885 | -.025 | .128 |
| DD#1.02–Total.Dialogue.Skipped | -.072 | -.031 | .036 | -.127 | .879 | -.012 | -.190 |
| OF#1.12.2–Conversation–Meeting.Classmates#Opt1 | .023 | .111 | .032 | .140 | .030 | .920 | .100 |
| OF#1.12.2–Conversation–Meeting.Classmates#Opt2 | -.066 | .134 | .061 | .221 | .115 | -.764 | .060 |
| OF#3.04.1–Question–Hi story.Class.Question#Opt1–Correct | -.047 | -.140 | .014 | -.070 | -.072 | .084 | .893 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 10 iterations.

Structure Matrix

| | Component | | | | | | |
|---|-------------|--------------|--------------|--------------|-------------|--------------|-------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| OF#2.05.S–Dialogue–Dark Hour.Exposition.I##Listened | .950 | .012 | .142 | -.171 | -.164 | .212 | .064 |
| OF#2.03.S–Dialogue–Dark Hour.Exposition.I##Listened | .945 | .046 | .158 | -.045 | -.256 | .207 | .013 |
| DD#1.02–Total.Dialogue.Listened | .921 | -.080 | .226 | -.123 | -.252 | .289 | .151 |
| OF#3.14.1–Conversation–My.Power#Opt1 | -.006 | -.960 | .252 | .002 | -.158 | .111 | .301 |
| OF#3.14.1–Conversation–My.Power#Opt2 | -.017 | .953 | -.164 | -.187 | .167 | -.072 | -.209 |
| OF#1.05.1–Conversation–Midnight.Welcomes#Opt1 | .189 | -.204 | .941 | .048 | -.124 | .057 | .046 |
| OF#1.05.1–Conversation–Midnight.Welcomes#Opt2 | -.163 | .180 | -.939 | -.057 | .219 | .120 | -.107 |
| OF#2.01.1–Question–Literature.Class.Question#Opt3–Joke | -.072 | -.043 | .077 | .906 | .211 | -.174 | .013 |
| OF#2.01.1–Question–Literature.Class.Question#Opt2–Correct | .200 | .158 | -.029 | -.844 | -.100 | -.043 | .292 |
| DD#1.03–Total.Scenes.Skipped | -.195 | .165 | -.207 | .267 | .906 | -.259 | -.038 |
| DD#1.02–Total.Dialogue.Skipped | -.270 | .168 | -.136 | .047 | .897 | -.267 | -.315 |
| OF#1.12.2–Conversation–Meeting.Classmates#Opt1 | .230 | -.028 | -.007 | .053 | -.201 | .900 | .130 |
| OF#1.12.2–Conversation–Meeting.Classmates#Opt2 | -.281 | .201 | .045 | .297 | .375 | -.841 | -.069 |
| OF#3.04.1–Question–Hi story.Class.Question#Opt1–Correct | .080 | -.358 | .106 | -.158 | -.264 | .181 | .945 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Figure D/e – Expanded Factor Analysis Matrices: Openness to Experience (Theoretical)

Expanded Factor Analysis Matrices: Openness to Experience (Statistical)

Component Matrix^a

| | Component | | | |
|---|--------------|--------------|--------------|--------------|
| | 1 | 2 | 3 | 4 |
| DD#2.00–Time.Total | .790 | .189 | -.043 | -.362 |
| DD#2.04–Time.Menu | .737 | .363 | -.237 | -.028 |
| OF#4.04.1T–Combat–Tartarus.Battles | .659 | .162 | -.052 | -.476 |
| OF#4.10.2–Task–Leave.Tartarus–Objects.Examined | .638 | .128 | -.020 | .238 |
| OF#4.09.1T–Option–Fusions | .597 | .437 | -.446 | .246 |
| DD#3.01–Total.Games.Saved | .568 | -.049 | .416 | .494 |
| OF#4.09.1–Option–Fusions–Help | .537 | .431 | -.303 | .255 |
| OF#4.06.5–Option–Menu.Inside–Status | .352 | -.252 | -.084 | .007 |
| OF#1.10.1T–Conversation–Meeting.Teacher | .346 | .275 | -.041 | -.061 |
| DD#1.01–Total.Conversation.Defaults | -.405 | .736 | .162 | .127 |
| OF#1.12.1–Conversation–Meeting.Classmates#Default | -.225 | .714 | .111 | .009 |
| OF#3.14.1–Conversation–My.Power#Opt1 | -.428 | .589 | .393 | -.101 |
| OF#3.14.1–Conversation–My.Power#Opt2 | .372 | -.490 | -.425 | .138 |
| OF#1.04.S–Scene–Midnight.Arrival#Watched | -.203 | .469 | .182 | .059 |
| OF#1.01.2–Option–Confirm.Difficulty#Yes | -.213 | -.426 | .295 | .035 |
| OF#3.02.3–Conversation–In.Hospital#Default | -.239 | .345 | -.259 | -.207 |
| OF#3.05.T–Task–Locate.Fourth.Floor | .550 | -.023 | .614 | -.359 |
| OF#3.05.1–Task–Locate.Fourth.Floor–Objects.Examined | .463 | -.026 | .611 | -.422 |
| OF#3.05.5–Task–Locate.Fourth.Floor–Game.Saved | .455 | -.088 | .541 | .438 |
| OF#4.10.4–Task–Leave.Tartarus–Game.Saved | .483 | .009 | .238 | .557 |
| OF#4.04.4T–Combat–Tartarus.Battles | .403 | -.090 | -.086 | -.557 |

Extraction Method: Principal Component Analysis.
a. 4 components extracted.

Pattern Matrix^a

| | Component | | | |
|---|--------------|--------------|-------------|--------------|
| | 1 | 2 | 3 | 4 |
| OF#4.09.1T–Option–Fusions | .895 | -.076 | -.173 | .096 |
| OF#4.09.1–Option–Fusions–Help | .779 | .013 | -.128 | .169 |
| DD#2.04–Time.Menu | .771 | -.082 | .208 | .072 |
| OF#1.01.2–Option–Confirm.Difficulty#Yes | -.541 | -.122 | .032 | .156 |
| OF#4.10.2–Task–Leave.Tartarus–Objects.Examined | .491 | -.125 | .073 | .381 |
| OF#1.10.1T–Conversation–Meeting.Teacher | .379 | .082 | .176 | .033 |
| OF#3.14.1–Conversation–My.Power#Opt1 | -.120 | .827 | .130 | -.028 |
| DD#1.01–Total.Conversation.Defaults | .146 | .825 | -.158 | .003 |
| OF#3.14.1–Conversation–My.Power#Opt2 | .173 | -.744 | -.197 | .010 |
| OF#1.12.1–Conversation–Meeting.Classmates#Default | .246 | .717 | -.020 | -.051 |
| OF#1.04.S–Scene–Midnight.Arrival#Watched | .078 | .547 | -.019 | .052 |
| OF#4.06.5–Option–Menu.Inside–Status | .096 | -.371 | .088 | .094 |
| OF#3.05.1–Task–Locate.Fourth.Floor–Objects.Examined | -.157 | .124 | .849 | .216 |
| OF#3.05.T–Task–Locate.Fourth.Floor | -.096 | .098 | .838 | .295 |
| OF#4.04.1T–Combat–Tartarus.Battles | .432 | -.131 | .618 | -.165 |
| DD#2.00–Time.Total | .535 | -.147 | .590 | -.031 |
| OF#4.04.4T–Combat–Tartarus.Battles | .137 | -.265 | .549 | -.319 |
| DD#3.01–Total.Games.Saved | .140 | -.019 | .076 | .820 |
| OF#3.05.5–Task–Locate.Fourth.Floor–Game.Saved | -.027 | .052 | .141 | .816 |
| OF#4.10.4–Task–Leave.Tartarus–Game.Saved | .236 | -.032 | -.103 | .726 |
| OF#3.02.3–Conversation–In.Hospital#Default | .186 | .230 | -.070 | -.415 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 13 iterations.

Structure Matrix

| | Component | | | |
|---|--------------|--------------|-------------|--------------|
| | 1 | 2 | 3 | 4 |
| OF#4.09.1T–Option–Fusions | .877 | -.108 | .007 | .157 |
| DD#2.04–Time.Menu | .816 | -.164 | .364 | .175 |
| OF#4.09.1–Option–Fusions–Help | .770 | -.031 | .027 | .212 |
| OF#4.10.2–Task–Leave.Tartarus–Objects.Examined | .540 | -.220 | .229 | .450 |
| OF#1.01.2–Option–Confirm.Difficulty#Yes | -.516 | -.125 | -.020 | .136 |
| OF#1.10.1T–Conversation–Meeting.Teacher | .408 | .030 | .233 | .075 |
| DD#1.01–Total.Conversation.Defaults | .078 | .842 | -.264 | -.135 |
| OF#3.14.1–Conversation–My.Power#Opt1 | -.141 | .817 | -.026 | -.148 |
| OF#3.14.1–Conversation–My.Power#Opt2 | .176 | -.722 | -.047 | -.112 |
| OF#1.12.1–Conversation–Meeting.Classmates#Default | .203 | .716 | -.099 | -.145 |
| OF#1.04.S–Scene–Midnight.Arrival#Watched | .052 | .538 | -.085 | -.029 |
| OF#4.06.5–Option–Menu.Inside–Status | .137 | -.404 | .176 | .171 |
| OF#3.05.T–Task–Locate.Fourth.Floor | .067 | -.076 | .846 | .386 |
| OF#3.05.1–Task–Locate.Fourth.Floor–Objects.Examined | .001 | -.037 | .832 | .299 |
| DD#2.00–Time.Total | .642 | -.263 | .701 | .115 |
| OF#4.04.1T–Combat–Tartarus.Battles | .532 | -.225 | .691 | -.026 |
| OF#4.04.4T–Combat–Tartarus.Battles | .219 | -.309 | .571 | -.193 |
| DD#3.01–Total.Games.Saved | .219 | -.165 | .215 | .844 |
| OF#3.05.5–Task–Locate.Fourth.Floor–Game.Saved | .060 | -.096 | .239 | .825 |
| OF#4.10.4–Task–Leave.Tartarus–Game.Saved | .278 | -.140 | .042 | .736 |
| OF#3.02.3–Conversation–In.Hospital#Default | .129 | .296 | -.130 | -.445 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Figure D/f – Expanded Factor Analysis Matrices: Openness to Experience (Statistical)

Expanded Factor Analysis Matrices: Combined (Theoretical)

Component Matrix^a

| | Component | | | | |
|---|--------------|--------------|--------------|-------|--------------|
| | 1 | 2 | 3 | 4 | 5 |
| OF#1.12.T-Task-Locate.Bedroom | .821 | -.130 | .364 | -.055 | .188 |
| DD#3.03-Total.Objects.Examined | .713 | -.336 | .153 | -.153 | .164 |
| DD#3.04-Total.NPC.Interactions | .683 | -.344 | -.159 | .491 | -.034 |
| DD#2.04-Time.Menu | .672 | .192 | -475 | -.297 | .096 |
| DD#3.06-Total.Empty.Rooms.Examined | .658 | -.246 | .432 | -.109 | .324 |
| DD#3.07-Total.Empty.Rooms.Explored.Ratio | .643 | -.166 | .072 | -.243 | -.146 |
| OF#4.03.T-Task-Enter.Tartarus | .608 | .145 | -.010 | .474 | .133 |
| OF#4.10.1T-Task-Leave.Tartarus | .589 | .213 | -.123 | .228 | -.109 |
| DD#2.01-Time.Conversation.Ratio | -.586 | .499 | .283 | .047 | .082 |
| OF#1.12.1-Task-Locate.Bedroom-NPC.Interactions | .580 | -.406 | .094 | .198 | .238 |
| DD#2.03-Time.Combat | .536 | .442 | -.224 | -.338 | -.252 |
| OF#1.09.1-Task-Locate.Faculty.Office-NPC.Interactions | .474 | -.374 | -.026 | .345 | -.474 |
| DD#3.05-Total.Items.Purchased | .391 | -.390 | .266 | -.279 | .135 |
| DD#2.01-Time.Conversation | .548 | .633 | .346 | -.123 | .003 |
| OF#4.07.1T-Conversation-Leaving.Tartarus | .115 | -.543 | .362 | -.300 | -.006 |
| OF#3.06.5-Conversation-Society.Meeting#Default | -.299 | -.536 | -.150 | .014 | .396 |
| OF#1.01.1T-Option-Difficulty | .214 | .501 | -.330 | -.122 | -.192 |
| OF#1.05.1-Conversation-Midnight.Welcome#Opt1 | -.128 | .482 | .049 | .349 | .242 |
| OF#4.04.A-Combat-Tartarus.Battles-Help | .355 | .461 | -.127 | .375 | -.148 |
| OF#1.06.1-Conversation-First.Morning#Default | .045 | .365 | -.232 | .279 | -.002 |
| OF#2.01.1T-Question-Literature.Class.Question | .275 | .350 | .236 | -.106 | .120 |
| DD#1.02-Total.Dialogue.Listened | .176 | -.317 | .223 | -.239 | .169 |
| OF#4.09.1T-Option-Fusions | .483 | .184 | -.702 | -.285 | .134 |
| OF#4.09.1-Option-Fusions-Help | .374 | .103 | -.693 | -.251 | .276 |
| OF#1.09.T-Task-Locate.Faculty.Office | .572 | .066 | .030 | .171 | -.612 |
| DD#1.03-Total.Scenes.Skipped | -.055 | -.375 | -.024 | -.281 | -.434 |

Extraction Method: Principal Component Analysis.
a. 5 components extracted.

Pattern Matrix^a

| | Component | | | | |
|---|-------------|--------------|--------------|--------------|--------------|
| | 1 | 2 | 3 | 4 | 5 |
| DD#3.06-Total.Empty.Rooms.Examined | .884 | .151 | .042 | -.113 | -.041 |
| OF#1.12.T-Task-Locate.Bedroom | .808 | -.247 | -.035 | .148 | -.151 |
| DD#3.03-Total.Objects.Examined | .747 | .044 | -.178 | -.051 | -.110 |
| DD#3.05-Total.Items.Purchased | .652 | .062 | -.004 | -.227 | .060 |
| OF#1.12.1-Task-Locate.Bedroom-NPC.Interactions | .649 | -.260 | -.041 | .199 | -.199 |
| DD#3.07-Total.Empty.Rooms.Explored.Ratio | .443 | .243 | -.209 | -.231 | -.266 |
| DD#2.01-Time.Conversation.Ratio | -.391 | .277 | .371 | .216 | .357 |
| DD#2.03-Time.Combat | .136 | .769 | -.151 | -.113 | -.168 |
| DD#2.01-Time.Conversation | .207 | .765 | -.055 | .276 | -.050 |
| OF#4.07.1T-Conversation-Leaving.Tartarus | .040 | .706 | .056 | .036 | .201 |
| OF#3.06.5-Conversation-Society.Meeting#Default | .213 | -.623 | -.028 | -.048 | .357 |
| OF#2.01.1T-Question-Literature.Class.Question | .189 | .420 | -.028 | .188 | .103 |
| OF#4.09.1T-Option-Fusions | -.028 | -.007 | -.949 | -.019 | .071 |
| OF#4.09.1-Option-Fusions-Help | .021 | -.142 | -.912 | .034 | .202 |
| DD#2.04-Time.Menu | .167 | .169 | -.821 | -.007 | -.020 |
| OF#1.01.1T-Option-Difficulty | -.349 | .339 | -.439 | .032 | -.119 |
| DD#1.03-Total.Scenes.Skipped | -.045 | .011 | .048 | -.617 | -.233 |
| OF#4.04.A-Combat-Tartarus.Battles-Help | -.066 | .085 | -.187 | .604 | -.166 |
| OF#1.05.1-Conversation-Midnight.Welcome#Opt1 | -.209 | .056 | .098 | .580 | .129 |
| OF#4.03.T-Task-Enter.Tartarus | .253 | -.051 | -.084 | .579 | -.373 |
| DD#1.02-Total.Dialogue.Listened | .105 | .180 | .134 | .442 | -.010 |
| OF#1.06.1-Conversation-First.Morning#Default | -.308 | -.003 | -.153 | .357 | -.129 |
| OF#1.09.1-Task-Locate.Faculty.Office-NPC.Interactions | .115 | -.169 | .128 | -.093 | -.819 |
| OF#1.09.T-Task-Locate.Faculty.Office | -.042 | .291 | .035 | -.101 | -.815 |
| DD#3.04-Total.NPC.Interactions | .360 | -.378 | -.112 | .297 | -.622 |
| OF#4.10.1T-Task-Leave.Tartarus | .075 | .135 | -.226 | .283 | -.424 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 17 iterations.

Structure Matrix

| | Component | | | | |
|---|--------------|--------------|--------------|--------------|--------------|
| | 1 | 2 | 3 | 4 | 5 |
| DD#3.06-Total.Empty.Rooms.Examined | .868 | .189 | -.089 | .109 | -.189 |
| OF#1.12.T-Task-Locate.Bedroom | .852 | .313 | -.226 | .190 | -.392 |
| DD#3.03-Total.Objects.Examined | .800 | .080 | -.302 | -.038 | -.348 |
| OF#1.12.1-Task-Locate.Bedroom-NPC.Interactions | .692 | -.183 | -.171 | .140 | -.371 |
| DD#3.05-Total.Items.Purchased | .646 | .025 | -.050 | -.239 | -.095 |
| DD#3.07-Total.Empty.Rooms.Explored.Ratio | .551 | .247 | -.341 | -.150 | -.437 |
| DD#2.01-Time.Conversation.Ratio | -.529 | .245 | .461 | .220 | .526 |
| DD#2.01-Time.Conversation | .236 | .840 | -.219 | .445 | -.189 |
| DD#2.03-Time.Combat | .220 | .777 | -.294 | .078 | -.289 |
| OF#4.07.1T-Conversation-Leaving.Tartarus | -.003 | .695 | .018 | .167 | .156 |
| OF#3.06.5-Conversation-Society.Meeting#Default | .113 | -.649 | .125 | -.212 | .340 |
| OF#2.01.1T-Question-Literature.Class.Question | .171 | .462 | -.096 | .268 | .006 |
| OF#4.09.1T-Option-Fusions | .075 | .098 | -.923 | .087 | -.185 |
| DD#2.04-Time.Menu | .280 | .271 | -.868 | -.122 | -.302 |
| OF#4.09.1-Option-Fusions-Help | .081 | -.038 | -.845 | .096 | -.050 |
| OF#1.01.1T-Option-Difficulty | -.256 | .398 | -.472 | .176 | -.177 |
| OF#4.04.A-Combat-Tartarus.Battles-Help | -.018 | .248 | -.306 | .658 | -.249 |
| DD#1.03-Total.Scenes.Skipped | .029 | -.114 | .060 | -.602 | -.167 |
| OF#4.03.T-Task-Enter.Tartarus | .338 | .116 | -.281 | .595 | -.497 |
| OF#1.05.1-Conversation-Midnight.Welcome#Opt1 | -.272 | .156 | .086 | .579 | .166 |
| DD#1.02-Total.Dialogue.Listened | .080 | .263 | .045 | .463 | -.042 |
| OF#1.06.1-Conversation-First.Morning#Default | -.268 | .094 | -.191 | .393 | -.118 |
| OF#1.09.T-Task-Locate.Faculty.Office | .170 | .319 | -.209 | .016 | -.807 |
| OF#1.09.1-Task-Locate.Faculty.Office-NPC.Interactions | .306 | -.146 | -.082 | -.092 | -.794 |
| DD#3.04-Total.NPC.Interactions | .513 | -.250 | -.320 | .259 | -.740 |
| OF#4.10.1T-Task-Leave.Tartarus | .205 | .254 | -.403 | .366 | -.535 |

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Figure D/g – Expanded Factor Analysis Matrices: Combined (Theoretical)

Expanded Factor Analysis Matrices: Combined (Statistical)

Component Matrix^a

| | Component | | | |
|---|--------------|--------------|--------------|-------------|
| | 1 | 2 | 3 | 4 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .823 | -.396 | -.072 | -.090 |
| OF#2.02.S-Conversation-Meeting.Principle#Listened | .769 | -.424 | -.036 | -.023 |
| OF#4.08.S-Conversation-Tartarus.Debriefing#Read | -.764 | .336 | .135 | .035 |
| OF#3.02.S-Conversation-In.Hospital#Read | -.754 | .299 | -.043 | .019 |
| OF#2.05.S-Dialogue-Dark.Hour.Exposition.II#Read | -.732 | .393 | .152 | .053 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Listened | .662 | -.313 | -.169 | -.022 |
| DD#3.04-Total.NPC.Interactions | .423 | .704 | -.332 | -.064 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .404 | .657 | -.406 | -.258 |
| OF#4.02.5-Option-Menu.Outside-Status | .311 | .603 | -.268 | .443 |
| OF#4.10.1T-Task-Leave.Tartarus | .506 | .572 | .055 | -.255 |
| DD#2.00-Time.Total | .537 | .571 | .488 | .104 |
| OF#4.02.1-Option-Menu.Outside-Skill | .198 | .528 | -.235 | .422 |
| OF#2.15.1T-Combat-Rooftop.Battle | .506 | .020 | .653 | .390 |
| OF#1.09.T-Task-Locate.Faculty.Office | .434 | .401 | .459 | -.089 |
| DD#1.01-Total.Conversation.Defaults | .016 | -.354 | -.257 | .708 |

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Pattern Matrix^a

| | Component | | | |
|---|--------------|-------------|-------------|--------------|
| | 1 | 2 | 3 | 4 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .915 | -.032 | .027 | -.028 |
| OF#2.02.S-Conversation-Meeting.Principle#Listened | .864 | -.074 | .061 | .041 |
| OF#2.05.S-Dialogue-Dark.Hour.Exposition.II#Read | -.857 | -.005 | .059 | -.028 |
| OF#4.08.S-Conversation-Tartarus.Debriefing#Read | -.845 | -.049 | .014 | -.025 |
| OF#3.02.S-Conversation-In.Hospital#Read | -.763 | .039 | -.164 | .001 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Listened | .757 | .063 | -.063 | .045 |
| DD#3.04-Total.NPC.Interactions | .080 | .831 | -.031 | -.214 |
| OF#4.02.5-Option-Menu.Outside-Status | -.065 | .806 | .138 | .295 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .141 | .793 | -.182 | -.373 |
| OF#4.02.1-Option-Menu.Outside-Skill | -.114 | .694 | .111 | .296 |
| OF#4.10.1T-Task-Leave.Tartarus | .134 | .460 | .256 | -.439 |
| OF#2.15.1T-Combat-Rooftop.Battle | .151 | -.175 | .883 | .215 |
| DD#2.00-Time.Total | -.023 | .272 | .787 | -.176 |
| OF#1.09.T-Task-Locate.Faculty.Office | .021 | .093 | .624 | -.304 |
| DD#1.01-Total.Conversation.Defaults | .166 | .085 | -.094 | .817 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 12 iterations.

Structure Matrix

| | Component | | | |
|---|--------------|-------------|-------------|--------------|
| | 1 | 2 | 3 | 4 |
| OF#3.01.S-Conversation-What.Is.Persona#Listened | .919 | .030 | .226 | -.032 |
| OF#2.02.S-Conversation-Meeting.Principle#Listened | .874 | -.017 | .231 | .041 |
| OF#4.08.S-Conversation-Tartarus.Debriefing#Read | -.845 | -.089 | -.185 | -.013 |
| OF#2.05.S-Dialogue-Dark.Hour.Exposition.II#Read | -.844 | -.034 | -.131 | -.027 |
| OF#3.02.S-Conversation-In.Hospital#Read | -.798 | -.046 | -.325 | .015 |
| OF#2.16.S-Dialogue-Collapse.Exhausted#Listened | .747 | .083 | .118 | .035 |
| DD#3.04-Total.NPC.Interactions | .121 | .860 | .216 | -.337 |
| OF#4.10.1-Task-Leave.Tartarus-NPC.Interactions | .147 | .811 | .083 | -.478 |
| OF#4.02.5-Option-Menu.Outside-Status | .019 | .793 | .303 | .161 |
| OF#4.02.1-Option-Menu.Outside-Skill | -.062 | .671 | .235 | .182 |
| OF#4.10.1T-Task-Leave.Tartarus | .220 | .598 | .441 | -.533 |
| DD#2.00-Time.Total | .170 | .496 | .867 | -.287 |
| OF#2.15.1T-Combat-Rooftop.Battle | .337 | .024 | .853 | .162 |
| OF#1.09.T-Task-Locate.Faculty.Office | .168 | .297 | .679 | -.374 |
| DD#1.01-Total.Conversation.Defaults | .144 | -.052 | -.108 | .811 |

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

Figure D/h – Expanded Factor Analysis Matrices: Combined (Statistical)