Video Game Addiction and Engagement in Adult Gamers: Differentiation Based on Relationships with Health and Functioning

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Declaration

I, Daniel John Loton, declare that the PhD thesis entitled ‘Video Game Addiction and Engagement in Adult Gamers: Differentiation Based on Relationships with Health and Functioning’ is no more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

Signature: 

Date: 05/03/2014

Abstract

Video game addiction now has a tentative diagnosis in the DSM-5, with its validity hinging on differentiation from close constructs and demonstrable negative consequences. Investigations of candidate consequences have produced mixed results. Deleterious correlates vary across studies, and the few which have investigated confounding factors or temporal precedence draw opposing conclusions. Resultantly expert opinions range from an example of dangerous superficial mental illness proliferation to a genuinely new, pathogenic condition.

This PhD measured video game addiction, engagement and the possible negative consequences of diminished health (mental, social and physical) and functioning (at work, study, parenting and in romantic relationships), in adult avid gamers. Possible confounds included measures of satisfaction, stressful events, mental illness history, treatment seeking and coping styles. 506 geographically dispersed participants (84.7% male, mostly mid-twenties in age) were surveyed, with 111 returning to complete the measures six consecutive times. Life circumstances were diverse at baseline, with 62.8% working, 55.3% studying, 14.9% seeking work, 48.9% in a romantic relationship and 9.5% acting in a parenting role.

Confirmatory factor analysis of the addiction-engagement scale provided mixed results: a ‘close fit’ by some standards with mostly sensibly correlated error terms. Discriminant validity was confirmed. Individual scale item analysis indicated some less frequently endorsed ‘symptoms’ of addiction are more strongly associated with poorer health and may require diagnostic weightings. Some engagement items showed relationships with increased health and functioning. Total score analyses showed health and functioning were more highly related to addiction than engagement; health moreso than functioning, especially mental, social and sleep health. Three diagnostic cut-off points used in past studies were compared on ability to predict poorer health and functioning, all showing equal validity.

Yet further models suggested confounding factors, particularly coping styles, are important. Addiction contributed no variance beyond satisfaction to functioning at work or study, but did explain a marginal amount of relationship conflict and a large amount of parental performance. Job-seeking activities were unrelated. Multiple mediation analysis indicated engagement had no direct connection with poorer mental health, unless paired with maladaptive coping styles, while addiction retained a direct

connection. Finally, the longitudinal analysis using six time points indicated worsening mental health is an antecedent to addiction, consistent with the strong cross-sectional mediating effect of coping styles.

Overall results suggest the need for further empirical testing of the proposed negative consequences for this potential new disorder, particularly establishing temporal precedence and relative importance amongst other contributors to health. Limitations included a targeted sample which was gender biased and geographically diverse, a lack of data triangulation with a reliance on self-response and recollection, and the use of some composites and indicators with limited validity.

Structure

The formatting of this thesis follows the publication manual of the American Psychological Association 6th edition (APA 6th) with some minor departures to conform to the Victoria University PhD style guide. All effort was made to fit tables on a single page, including changing line spacing if necessary. Where tables were not able to fit on a single page, the heading column has been reproduced on following pages for ease of the reader. The use of asterisks in tables is standard throughout, with $^{*}p<.05$, $^{**}p<.01$ and $^{***}p<.001$, and the table notes only specify the significance levels actually present in the table.

- Chapter 1 presents a literature review of video game addiction.
- Chapter 2 is the method, detailing procedures, measures, and the sample, including some analyses situating the sample relative to available norms.
- Chapter 3 presents a psychometric analysis of the addiction-engagement scale factorial structure.
- Chapter 4 details an item-level analysis of the addiction-engagement scale, exploring relationships with indicators of health and functioning.
- Chapter 5 reports analyses of relationships between total scores for addiction and engagement, and indicators of health and functioning.
- Chapter 6 introduces confounding factors to the models exploring relationships between addiction and health.
- Chapter 7 introduces confounding factors to the models exploring relationships between addiction and functioning.
- Chapter 8 delves further into the mediating effect of coping styles in the relationships between addiction, engagement and mental health, utilising a multiple mediation analysis.
- Chapter 9 compares three previously used diagnostic cut-off points on their ability to distinguish participants experiencing declined health and functioning.
- Chapter 10 details a longitudinal analysis of mental health and video game addiction, including six waves over a roughly seven month period.
- Chapter 11, the epilogue, summarises the results of the thesis and limitations of the study, and considers the implications of the findings.

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Prologue

The term ‘video game addiction’ appears to have become part of the common vernacular. Anecdotes recounting experiences of video game addiction are abundant, particularly in online gaming forums and the news media. Since some of the earliest video games, gamers have described difficulties in controlling their playing habits, to the point that they incur negative consequences. Gamers have described the need to delete games from computers or remove game systems from the house, as their presence made it too difficult to control play. More colourful accounts include the cathartic burning of video game equipment upon making the commitment to stop playing after prolonged ‘addiction’. While the term addiction can be used in a lay context to indicate an intense but unproblematic enjoyment of a particular activity, it is common for video game addiction anecdotes to attribute severe negative outcomes to gaming habits. These include the loss of relationships, jobs, or failing at studies, poor sleep, fitness, and diet; as well as sadness, loneliness and poorer mental health. Extreme negative outcomes, which currently do not have supporting scientific evidence, attribute deaths to video game addiction, either through lack of movement, hydration or indirectly through neglecting dependants (Cho, 2010; Si-soo, 2010; The Huffington Post, 2012). This is not to suggest that the less severe negative consequences, such as loss of jobs, have unequivocal scientific support: empirically testing these negative consequences is a central topic of this thesis. Alternatively, other anecdotes describe several positive features of video gaming such as the challenge and skill development, enjoyment, socialisation, relaxation and distraction; including in difficult times (Owen, 2012; Reinecke, 2009b).

Alongside anecdotal accounts, a body of research began to emerge in the 1980s and 1990s investigating whether the tenets of addiction can be appropriately applied to video game playing, with most studies taking a very similar method to studies of television addiction, some of which pre-dated the literature on video game addiction (S. Fisher, 1994; Harry, 1983; R. N. Smith, 1983). In some ways, most research on video game addiction can be characterised as a search for negative consequences. The majority of studies are quantitative and use scales adapted from the measurement or diagnosis of other addictive conditions, to target video game playing. Relationships with associated factors are then analysed, typically at a single point in time, and correlates are usually assumed to denote negative consequences resulting from the condition.

Some studies on video game addiction fall under the umbrella of internet addiction, which has been thoroughly investigated (K. S. Young, 1998), with video game addiction being but one sub-type. The other types of internet addiction are highly varied and not investigated in this PhD. They include using chat rooms, multi-user-dungeons (MUDs), news groups, email, searching for information, viewing pornography and gambling (K. S. Young, 1998). The concept of an overarching addiction to the internet, denoted by the term 'internet addiction', given these varied purposes and uses, has been criticised (Starcevic, 2013a). As it is supposed that these activities vary greatly in nature and content, this PhD has chosen to focus specifically on video gaming and hence does not reference many findings relevant to other forms of internet addiction. In recent years video game addiction research has drastically accelerated (Ferguson, Coulson, & Barnett, 2011; King, Haagsma, Delfabbro, Gradisar, & Griffiths, 2013; Starcevic, 2013b).

The American Psychiatric Association's Diagnostic and Statistical Manual V (2013) [DSM-V], included for the first time, a statement on Internet Gaming Disorder in their Appendix, as an area requiring further investigation. DSM-V's proposed criteria are as follows:

Persistent and recurrent use of the internet to engage in games, often with other players, leading to clinically significant impairment or distress as indicated by five (or more) of the following in a 12 month period:

1. Preoccupation with internet games (The individual thinks about previous gaming activity or anticipates playing the next game; Internet gaming becomes the dominant activity in daily life)

2. Withdrawal symptoms when Internet gaming is taken away. (These symptoms are typically described as irritability, anxiety or sadness, but there are physical signs of pharmacological withdrawal)

3. Tolerance - the need to spend increasing amounts of time engaged in internet games.

4. Unsuccessful attempts to control the participation in internet games

5. Loss of interests in previous hobbies and entertainment as a result of, and with the exception of, Internet games

6. Continued excessive use of internet games despite knowledge of psychosocial problems

7. Has deceived family members, therapists, or others regarding the amount of internet gaming.

8. Use of internet games to escape or relieve a negative mood (e.g. feelings of helplessness, guilt, anxiety)

9. Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of participation in internet games

This inclusion of proposed criteria for internet video gaming in the DSM-V has been questioned by several leading researchers in this field, who argue that "in practice, this diagnostic category may promote further confusion with its conflation of video-gaming and internet use for other purposes" (King & Delfabbro, 2013, p. 1). The lack of a standard definition for internet-related disorders has led to conflicting accounts of the underlying pathology and its symptoms, and how it should be diagnosed or measured (Griffiths, 2008b; Weinstein & Lejoyeux, 2010; Wood, 2008b). Moreover the DSM–V states further research is needed, such as epidemiological studies to determine prevalence, before the disorder can progress through official channels. Commentators have made similar observations, noting that inclusion of an official diagnosis on the topic may help individuals suffering from the condition, but on the other hand proliferation of psychiatric conditions may also promote harm through misdiagnosis and misdirection of clinical resources (Petry, 2013; Starcevic, 2013b).

This suggests that defining video game addiction is challenging, despite many researchers drawing from the same, or very similar, underlying components of addiction described in the DSM V criteria and past literature. Efforts are still underway to distinguish addiction from close constructs such as high engagement and to understand the nature of correlates (Charlton & Danforth, 2007).

This PhD

As the field remains uncertain how to precisely define video game addiction and distinguish it from close constructs, identifying the features (sometimes called 'symptoms'), or combinations

thereof, which are most important in predicting a range of associated problems is critical to establishing validity. So far, findings connecting video game addiction to possible negative consequences have produced mixed results with regards to effect size and significance, across a range of measures. In instances where a co-occurrence has met criteria for statistical significance, directionality and temporal precedence are not yet well established, with most studies favouring a cross-sectional design and many not incorporating confounding variables. Other presumed negative consequences of video game addiction which are often mentioned anecdotally and relate to impaired functioning, such as loss of relationships or jobs, await empirical testing. Most studies have focussed on youth rather than the most populous gamer demographic, young adults, and few studies have targeted samples which endorse high levels of video game addiction criteria. As such, this PhD focusses on video game addiction and its relationships with a broad range of health and functioning indicators. These include mental, social and physical health as well as functioning in the life domains of work, study, parenting and romantic relationships, in self-identified possible video game addicts. The study will also measure change over nine months and test for several possible confounding variables, which may help to contextualise any cross-sectional relationships. These variables represent potential extraneous mediators or moderators between video game addiction and any possible negative consequence, and include satisfaction with life domains, global stressful events, coping styles, treatment seeking, socio-economic status and social support.

Terminology

For the purposes of this PhD, unless otherwise specified, when the terms video game playing, or gaming, are used, they are in reference to gaming as a leisure pursuit, also called a hobby, and not for the purposes of medical treatment, training, or work (such as for professionals in the gaming industry).

Addiction.

The term ‘addiction’ has had a tumultuous recent history, with previous editions of the Diagnostic and Statistical Manual (DSM) deliberately not including the term, and scholars discussing its conflation with purely physiological dependence (O'Brien, 2011). Less specific umbrella terms such as ‘pathological’ or ‘problem’ have in the past been preferred, or terms which are argued to be more accurate and less laden with negative connotation, such as

‘dependence’ and ‘abuse’. The latest edition of the DSM has reintroduced the term. In studying video game addiction, researchers using very similar methods and near-identical definitions and scales have adopted a range of terms to denote the construct which do not necessarily include the term addiction, including: intemperate, problematic/problem/pathological, overuse, abuse, obsessive, compulsive, dependent and excessive (D. Gentile, 2009; Griffiths & Hunt, 1998; Hellman, Schoenmakers, Nordstrom, & van Holst, 2012; Messias, Castro, Saini, Usman, & Peeples, 2011; Phillips, Rolls, Rouse, & Griffiths, 1995; Shaffer, Hall, & VanderBilt, 2000; Tejeiro, Gómez-Vallecillo, Pelegrina, Wallace, & Emberley, 2012).

While the term ‘addiction’ is often used colloquially and has been avoided in diagnostic manuals up until the DSM V, the term has been utilised throughout this PhD. The impact of the terminology used in the study of addiction, including how research and media messages inform community understandings, and how these may in-turn influence relationships between clinical systems, clients and the community is deserving of further research. It is, however, not investigated in this thesis. In relation to other substance-abuse disorders, research has not provided a strong case that being described as a ‘dependant’ or ‘abuser’ of a substance or hobby, rather than addict, is less negative or more accurate for non-clinical stakeholders. In fact, some researchers and substance abuse measures use both terms concurrently to avoid confusion (Halkitis, 2009; Islam, 2011; Samuelsson, Blomqvist, & Christophs, 2013).

Confounds.

Other terms requiring explanation are confounds/confounding factors, and mediators or moderators. Confounds/confounding factors typically denotes variables which were omitted from a study design, either by fault, difficulty or impossibility, which may substantially alter findings if included. In this study, several possible confounds which may alter relationships between video game addiction and deleterious correlates have been tested. These factors are sometimes referred to as confounds or confounding factors in the thesis, even though they are actually included (i.e. not omitted) in the study design. They are also sometimes called possible mediators or moderates. It was difficult to be specific about whether these confounds represent a clear mediator (i.e. indicating that the other factors involved have no direct connection), or a moderator (conditions which can alter a direct relationship); see Preacher and Hayes (2008) for a discussion on the distinction. In this study, it is theoretically possible to speculate that some of these variables are more likely to be a mediator (e.g. coping styles), rather than moderator (e.g.

socio-economic status), but other times the theoretical directionality has no empirical evidence. As such, some are referred to as potential mediators or moderators, with the implication that future studies may test for which explanation is more suitable. It must be noted that while there is a clear theoretical distinction between mediation and moderation, statistical methods and evidence required for testing the nature of such relationships can vary.

Features or Symptoms

Video game addiction scales are made up of what are thought to be key characteristics of the construct. These characteristics are henceforth referred to by many words, alternatively features, characteristics, aspects, items, or symptoms. At times ‘symptoms’ appears in inverted commas. This is to denote that terms which draw heavily from medical nomenclature may imply more confidence in the nature of these feature as representative of an illness, than is currently supported by evidence. This same implication is present for the words ‘condition’ and ‘syndrome’. It is important to exercise caution in the use of language from the outset of this thesis, as one aim is to test the differentiation of addiction from a close but non-pathological construct, engagement. Using terms which suggest these behavioural or emotional features, many of which may be ubiquitous in leisure pursuits in lower intensities, are unquestionably symptoms of an illness, may detract from the need to test these assertions empirically.

Negative consequences.

This is also the case for the term ‘negative consequences’. It is common in past studies of video game addiction, which generally conclude, either tacitly or explicitly, that deleterious correlates of video game addiction represent ‘negative consequences’. Proposed diagnostic criteria in the DSM adopt the term ‘leads to’, which arguably falls short of causality, but it is clearly implied. As in the use of medical terminology to describe behavioural or emotional features of leisure activities, describing correlates as negative consequences without unequivocal empirical support may again detract from the need to test these assumptions. Another aim of this thesis is to test for the temporal precedence, and relative importance after including accounting for confounds, of proposed negative consequences of video game addiction. Such tests may help to provide empirical evidence for directionality of correlates (i.e. the ‘leads to’). As such, when the term negative consequences is used in this thesis, its full weight is implied, in that the

variable of interest is a direct consequence, at least in part, of video game addiction, rather than a co-occurrence, co-morbid condition or antecedent.

Engagement.

Engagement is a key measure in this thesis. The term engagement has been challenged by researchers who study why people play video games. Some prefer the term attention, or to break engagement/attention into several sub-categories such as enchantment, enjoyment, retention, etc . Other researchers have also described distinct psychometric dimensions to motivations of play (Yee, 2006b). When the term engagement is used in this thesis, it is used to denote a unitary measure of what may also be termed passion, enjoyment, or prioritisation of gaming. In this thesis it is measured by the central scale adopted, the Charlton and Danforth Computer Addiction-Engagement Scale (CAES). Many broader theories of engagement, which arguably explore the needs met via gaming at a deeper and more nuanced level than this thesis, are generally developed from less pathologically oriented research aims. These include understanding video gaming more from consumer, media theory and user-design viewpoints. While these aspects of engagement deserve further study, a key focus of this thesis is on differentiation of addiction from what may be termed an unproblematic engagement, even in a sample of high playing gamers. Therefore, the more nuanced sub-components of engagement are not investigated extensively in this thesis.

Chapter 1: Literature Review

What Are Video Games

In order to discuss video game addiction, it is essential to first define video games, and develop an understanding of gaming in contemporary times. Accordingly the following section will provide a brief introduction to trends in popular contemporary video gaming, including indications that government regulation may soon play a greater role.

Video games are a contemporary, interactive audio-visual communication medium, primarily delineated from cinema or television by the presence of direct interactivity. Gamers interact with games via several means, mostly by manipulating controllers and/or sensors that send signals back to the game. Most commonly this involves pushing buttons on a controller, but there are ever advancing interfaces, including portable accelerometers, treadmills and cameras which detect and interpret movement characteristics (Klevjer, 2012). These interfaces will continue to advance and capacitate more immersive game settings, including simulating an environment that envelops the gamers whole field of vision, hearing and allows tactile interaction in ways similar to interacting with the physical world. The epitome of this interface is often described as ‘virtual reality’.

Currently, most games present a set of challenges that occur within a narrative and a set of rules, and the gamer is placed in a competition against obstacles, artificial intelligence and/or other gamers to succeed in these challenges. It is impossible to describe all of the functions and purposes that video games have. As a communication medium like film, video games have practically unlimited purposes. This includes entertainment (Zackariasson & Wilson, 2012), training (Hoberman, Krum, Suma, & Bolas, 2012), education (Soriani, 2012), therapy (Fernández-Aranda et al., 2012), socialisation (McEwan, Gutwin, Mandryk, & Nacke, 2012), professional collaboration (Flowers & Gregson, 2012) and creative expression (Fromme & Unger, 2012), to name a few.

The video games industry is enormous, with a current net worth rivalling the film industry, and there is nothing to suggest it will not continue to grow and expand both in the mainstream market in ever more varied and niche markets. While some analyses recently indicate a contraction of the industry, or slowed growth, many of these analyses do not include online retail

or virtual economies, which are increasingly used revenue models, thus industry growth is still strongly expected (Agnello, 2012; Masnick, 2012).

Contemporary trends.

The video games industry is characterised by rapid advancements in technological capabilities, reciprocally influencing and being influenced by progression in computing power and portability (Wesley & Barczak, 2012). However, some have argued that the modes of video game storytelling have remained stagnant relative to the technological advances since the 1980s (Black, 2012). While this may be correct for some genres, narrative modes have also seen some recent and large innovations, even in mainstream games. These include the sandpit model and the burgeoning indie games market, the latter characterised by quirky or unique narrative modes (Wilson & Zackariasson, 2012). Other trends include persistent state world games, the greater involvement of gaming communities, new economic models utilising micro-transactions, increasing user-generated content, the ‘casual’ and ‘serious’ game genres and even the introduction or consideration of greater government regulation. Gaming is more ubiquitous and mobile than ever before, with gaming available on most mobile devices, which are now prolific in developed countries. Gaming business models have also changed, primarily with the introduction of free-to-play games, with revenue generated by the sale of add-ons, or ongoing subscription fees in order to continue cooperative online play. Some researchers have also raised concerns about a possible increase in gambling devices in video games targeted at young people, especially in the free-to-play gaming models, which may foster a greater affinity and preparedness to engage in gambling activities (King, Delfabbro, Kaptsis, & Zwaans, 2014).

Increasing government regulation.

Often citing video game or internet addiction as a direct reason, many nations are now considering, or introducing, regulations to control or limit gaming in order to offset perceived negative effects. China recently introduced a cap which limits the amount of in-game rewards a player can achieve in a single sitting ("China to develop technologies fighting minors' Internet addiction," 2006). Live-in treatment centres have also now been established by the Chinese Government across the country which attempt to treat young people identified as addicted, usually by their parents. Little information has been made available about their operations, and some documentary films have described them as ‘boot camps’, using unorthodox treatment

methods (Medialia & Shlam, 2013). In 2010 South Korea introduced a video game curfew for children under 18 years of age, which attempts to restricts play between 12am and 6am (Frucci, 2010). In 2011 Vietnam introduced a similar curfew, after conducting government research which suggested many youths have problems associated with gaming and internet use (G. Smith, 2011). In the United States, senators have recently called for a tax to be imposed on violent video games in order to fund recovery from gun-related crime as well as mental health and addiction services (Chalk, 2013). Some researchers have already considered the benefits and detriments of a self-regulation and tax-rebate approaches to controlling play behaviour (Park & Ahn, 2010). These regulations are highly connected to the debates around effects of video games, including addiction. Other regulations relate to adult content, with Australia finally introducing an 'R' rating only very recently. Prior to this, gaming companies would sometimes incur substantial fees to make alterations in order to be compliant with the censorship and ratings body, or have that product refused entry. Changing or increasing regulation of video game play appears be a characteristic of the contemporary industry. However, like earlier attempts to regulate television, whether they prove to be effective or beneficial is a question for future research.

Video Game Playing in the General Population: Who Plays and How Much?

The following section summarises demographics, playing habits and motivations of video gaming within the general population, facilitating comparisons to studies of video game addiction, which are later discussed. While video game playing varies across people and contexts, this section situates the most common modes of play. This includes the average amount of time spent gaming, which demographics are associated with play and reasons most people play video games.

Since the mid-1980s, video games have been experienced by almost everyone in developed countries. Most people have played at least one video game, with market research and studies using school based samples reporting between 95% and 100% of participants having experienced play (Barnett et al., 1997; Entertainment Software Association, 2011). In some developed countries, most households contain at least one gaming console, with three out of four families owning a console or PC capable of playing games in Australia (Brand, 2007).

Video gaming can also take place outside of the home, such as in Local Area Networks (or LANs), where many PCs are linked to facilitate network gaming; or at the increasingly obsolete

arcade parlour. These gaming settings vary quite drastically in popularity, with LANs being very common in South-East Asian countries such as South Korea, Singapore, Malaysia and China, but less common in Western countries (Price-Waterhouse-Coopers, 2012b) .

Given the ubiquity of the technology it is unsurprising the age range of the average gamer stretches over the lifespan, with the mean age first playing video games often reported to be around 5 years of age, and the mean gamer age now appearing to be around 31 years of age (Entertainment Software Association, 2011). Other market research reports place this age at 33 (Interactive Games & Entertainment Association, 2012). Industry data suggests 40% of adults play regularly, alongside 83% of teenagers, with 63% of this play online (Interactive Games & Entertainment Association, 2012).

Time commitment.

Studies which include measures of time commitment demonstrate that average playing time varies substantially across genres, age, gender, and from market research to academic studies. The Digital Australia 2012 report (DA-12) suggests most gamers play every other day rather than daily, and most play for between half an hour to one hour in each sitting; summarised as one hour every second day (Brand, 2012). This report did not include the mean hours of play per week or analyses of heavier playing groups. Earlier industry studies in the USA indicate adults play for an average of 7.5 hours per week (Insight, 2005). More recent data from another industry source, using a geographically dispersed sample of 570 adults, provided weekly time commitment across several types of gaming. In this sample the average gamer played, per week, on consoles for 3.7 hours, online computer games for 3.2 hours, smartphone games for 2.7 hours and tablet games for 1 hour. However, the authors also described a ‘heavy gamer’ category, who played for 6.8 hours on consoles and 6.3 hours on PC. Notably, gamers who played massively multiplayer online games (or MMOGs) in the heavy group played for 19 hours per week. It’s unclear whether these figures can be tallied, indicating a larger total time (Price-Waterhouse-Coopers, 2012a). Notably, gamers who played MMOGs in the heavy group played for 19 hours per week.

Some academic studies show similar playing times, especially in younger ages, while others indicate far higher time commitment. Secondary analysis of a recent longitudinal Australian sample of children indicates that the average 10 year old plays video games for 20 minutes per day (Sweetser, Johnson, Ozdowska, & Wyeth, 2012). Television viewing accounted for far more

media consumption, ranging from 1.31 – 3.08 hours per day. Moving up the age range, a stratified, 2-stage random sample design yielded media time use and well-being data from 925 Victorian 13-19 year old students (Mathers et al., 2009). Results indicated these students spent 35 minutes playing video games per day, on average. Once again, television viewing was higher. In a normative sample of family media habits, Gentile and Walsh (2002) surveyed 422 randomly selected American parents with children aged between 2-17. They indicated their children play video games for an average of 1 hour per day (*SD*=1.3), with time commitment marginally increasing with age.

Other academic studies which recruit samples through game-related environments, such as in LANs, retail outlets, or most commonly, online video game websites and forums, suggest adults and teenagers play for far more time. Griffiths, Davies and Chappell (2004) recruited 540 gamers, mostly adults, via online forums, who played the very popular online game Everquest. They found the mean gaming time was 25 hours per week, but with high variability (*SD*=14). Other academic studies with mostly adult MMOG players, using similar recruitment strategies, yielded stunningly large sample sizes. One such sample of MMOG players (*N*=30000) suggest the average gamer plays for 22.7 hours per week, but again with high variability (*SD*=14.98) (Yee, 2006a). Another large sample, recruited with the help of a gaming magazine (*N*=7069), indicated that participants not meeting the criteria for addiction played for 2.49 hours per *day*, again with very high variability (*SD*=2.22). This study did not report overall weekly gaming time (Grüsser, Thalemann, & Griffiths, 2006). A master's thesis which studied video game addiction in 1217 Norwegian teens indicated males played for an average of 10.5 hours per week while girls played for 4.3 hours per week, again with very high variability (*SD*=9.9 for boys and 4.3 for girls). Some participants reported they played up to 63 hours per week (Arnesen, 2010).

In a study that recruited 416 adult gamers from LANs, internet cafes and gaming retail outlets in Australia, rather than the more common recruitment strategies of online forums, found a mean weekly playing time of 17.8 hours, with variability not reported (King, Delfabbro, & Zajac, 2011). The same study also recruited University students who played video games to complete an online survey (*n*=373). In this subsample average playing time was 21 hours per week (*SD*=17.4). This is similar to the LAN and retail outlet sample, and other online samples obtained via online forums.

There seems to be substantial differences in the average playing time of gamers across market research and academic research, and smaller differences across recruitment strategies. These

discrepancies may reflect the more intense gamers who populate meta-game environments, generally targeted by studies interested in video game addiction. These participants are likely to fall along the more engaged spectrum of video gamers; hence their playing times may not be representative of the average gamer. In almost all studies on the topic since the 1980s, time commitment differs across gender.

Gender bias.

While overall market research figures suggest 47% of people who play video games are female (Entertainment Software Association, 2011), comparisons of time commitment and engagement, along with participation rates in several academic studies, reveal a large difference across genders. Males play more and participate in studies more. The vast majority of studies across a range of ages and nationalities indicate that males play more frequently and for greater durations (Barnett et al., 1997; Durkin & Barber, 2002; D. Gentile, 2009; Gentile et al., 2011; Greenberg, Sherry, Lachlan, Lucas, & Holmstrom, 2010; Griffiths et al., 2004; Grüsser, Thalemann, & Griffiths, 2006; Phillips et al., 1995; Sakamoto, 2005; Yee, 2006a). Studies into why people play suggest reasons, in that most video games since the 1980s have been tailored for the satisfaction of male gamers, although this may be now changing (Bryce & Rutter, 2002; Entertainment Software Association, 2011; Kafai, 1996; Ogletree & Drake, 2007; Wohn, 2011).

Taken together, the results suggest a bias in the mainstream video game market, with most games catering for the needs of male players, although the ‘casual games’ market has been more successful in attracting female gamers. This gender bias is likely to be evident in higher rates of video game engagement and addiction for males, particularly in the more traditional and mainstream game systems and genres.

Why do people play?

Decades of research into the uses and gratifications of television media indicate that why people use entertainment media is not simple, even though it is a commonplace everyday activity (Bryant & Oliver, 2009; Coyne, Padilla-Walker, & Howard, 2013). One clear premise which has emerged from decades of uses and gratifications research is that there is no universal set of reasons for why people consume entertainment media. This is likely to also

apply to video game playing. This section will summarise the literature on why the average player engages with video games.

While this section focusses on why most people (i.e. not video game addicts) play video games, one of the earliest studies taking a uses and gratifications approach was slanted towards a pathological focus by studying whether video game play may be socially detrimental. Results indicated that arcade game players play because the activity provides companionship, is preferable to human companionship, allows one to learn about others and provides action, solitude and escape (Selnow, 1984). Other early research, also with arcade gamers, indicated they play for excitement, the satisfaction of beating the challenges of the game and relaxation (Wigand, Borstelmann, & Boster, 1985). Some years later Phillips et al. (1995) found console gamers played to pass time, avoid other activities, 'cheer up' and for enjoyment. Commensurate with developments in video game innovation, more recent studies highlight the significance of in-game interactivity, including socialisation. In a very large sample study of adults who play MMORPGs, Yee (2006b) factor analysed reasons for play and identified ten, which are summarised by three second-order factors: achievement, social and immersion (see table 1).

Yee's study provided a detailed taxonomy of why people play MMORPGs. Other studies have indicated video games are efficient in bringing people into 'flow', through optimising attention and cognitive ability via the immediate feedback required, and provided, by video games (Cowley, Charles, Black, & Hickey, 2008; Csikszentmihalyi, 2009). Flow involves a kind of optimal engagement which allows people to lose track of time, experience pleasurable feelings and forget about negative thoughts while performing better at in-game tasks. Like the well-known curvilinear relationship between motivation and challenge of a task, research indicates the same balance of skill and challenge is important in reaching flow states while gaming (Ghani, 1995).

Aside from these specific self-reported reasons, many scholars have placed motivations to play video games in a broader theoretical context. Evolutionary explanations posit that humans have an instinctive desire to play, including video games. Play can be thought of as a tool for learning about the environment and the possible range of behaviours available to an organism. Species that play are more likely to adapt to the environment and survive (Burghardt, 2001; Byers, 1998). Others place video game play in a bio-social-cultural nexus in systems theory. This theory attempts to understand how biological entities interface with their contexts, and asserts that people consume media in order to solve perceived problems and maintain an equilibrium

(Buckley, 1967). There are dovetails between this theory and notions of addiction, such as mood maintenance, which suggest than people feel certain needs and respond to them with media use, thus their motivations to play are important.

Table 1

Yee's Factor Structure of Motivations to Play MMMORPGs

Achievement	Social	Immersion
Advancement	Socialising	Discovery
Progress, power accumulation, status	Casual chat, helping others, making friends	Exploration, lore, finding hidden things
Mechanics	Relationships	Role-Playing
Numbers, optimisation, templating, analysis	Personal, self-disclosure, find and give support	Story line, character history, roles, fantasy
Competition	Teamwork	Customisation
Challenging others, provocation, domination	Collaboration, groups, group achievements	Appearances, accessories, style, colour schemes
		Escapism
		Relax, escape from real life, avoid real-life problems

Conclusions for general video game playing.

While the average gamer is not the focus of this research, this information is useful in providing a basis of comparison for gaming habits described throughout the remainder of the PhD, which focusses on gamers who fall at the more intense end of the playing spectrum. For these players, gaming may have become problematic and may even be considered a potential addiction. It is interesting that in market-research, even when adopting recruitment strategies aimed at capturing a sample representative of the very broad population of video gamers, subgroups did emerge who played far more than the norm. Industry studies are yet to investigate extreme gaming or video game addiction, and instead studies on this topic originate from academia.

Addiction: From Ancient History to Video Game Addiction

This section will introduce addiction, briefly discussing its historical development and the broad characteristics of the contemporary concept, including the development of, and tensions around, a general model; finishing with how it has ultimately been applied to video game playing. Defining addiction and video game addiction is difficult, with no consensus around one theory or definition (Starcevic, 2013b). The topic is surrounded by heated debate and plagued with limitations and complexities, which all manifest in research and, eventually, in related areas such as clinical practice, law and regulations. As video game addiction is such a new topic, with far less research devoted to it than substance abuse and dependence, which have historically received the most research attention, it is important to consider the historical context of addiction. This includes how the construct is now being applied to substance-free activities, highlighting, especially, the limitations and under-researched aspects of this application.

The concept of addiction has existed for a very long time, although it has undergone several evolutions. The term 'addiction' originates from the Latin 'addicere', which roughly translates to slave, or someone who has given themselves over to something or someone (Adams, 1935). In historical documents, the notion of addiction first arose in relation to the use of alcohol, and has been solely focussed on the use of psychoactive substances throughout most of history until very recently. As early as the 3rd Century B.C., Plato detailed rules of alcohol consumption and highlighted the dangers of over-use, including the possibility of damage to pregnancy (D. J. Hanson, 1995). Much later, Sigmund Freud discussed the effects of cocaine in his essay 'Über Coca', including how to reduce severity of withdrawal symptoms through use of morphine (Freud, 1885).

Societal approaches to psychoactive substances, including what defines overuse and the legality of production and use, have fluctuated dramatically throughout history and are still starkly different from country to country in present times. How such regulations will apply to non-substance related hobbies such as video gaming is a highly contentious and, aside from gambling, as yet largely unexplored topic in research (Park & Ahn, 2010).

Characterisation of addiction has generally moved away from a moral deficit model (G. L. Fisher & Harrison, 2013). Such models attributed addictions almost solely to moral failures in decision making of the individual. Current models focus instead on addiction as a disease, made up of complex, interconnected bio-psycho-social components culminating in a condition (Hyman, 2005). These theories arguably reduce the emphasis on individual's poor decision making and instead take more account of the individual's context. Other models describe addiction as

characteristics of the relationships between people and a particular object or behaviour of interest (Larkin, Wood, & Griffiths, 2006).

Variety of theories.

"Certain individuals use certain substances in certain ways, thought at certain times to be unacceptable by certain other individuals for reasons both certain and uncertain." (Burglass & Shaffer, 1984, p. 94)

The above quote expresses the complexity surrounding the use of substances and when they can be considered problematic, including the notion of addiction. It is logical to expect that the application of addiction to activities that do not involve a substance at all will be even more difficult to establish and validate. By one count there are over 65 different theories of addiction, with many specific to different addictive conditions (West & Hardy, 2006). Given the vast differences among some of these theories, whether addiction can be discussed as a unitary concept at all is open to debate (Chassin, Presson, Rose, & Sherman, 2007). A comprehensive comparison of the different theories, relating to both substance and non-substance addiction, is beyond this thesis. However, the lack of a clear definition of what addiction is, and tensions in defining the concept must be acknowledged, as they are directly relevant to the application of aspects of addiction to video game playing.

The most common aspects of addiction.

Due to the variety of theories and lack of consensus on only one, a conclusive, all-encompassing definition of addiction is not possible at this time. However, some broader and more common aspects can be identified. Most definitions describe a repetitive and compulsive goal-directed behaviour with a reported inability to reduce or stop it, with heightened awareness to the activity, mounting adverse effects when abstaining, which when satisfied deliver short term relief with negative consequences compounding over time for the individual, those close to them and society (Brown, 1997; Goodman, 1990; I. Marks, 1990; Walker, 1989). This impaired

ability to prioritise and direct behaviour is tied to emotional dysregulation, with many addicts describing the addiction coming to dominate their thoughts and behaviour, as well as their regulation of mood or arousal, with the inability to enjoy any other activity or aspect of life (Brown, 1997). This latter component is sometimes termed ‘anhedonia’, but this term is also a component of broader theories attempting to map the underlying processes behind hedonic dysregulation which are relevant to mental health beyond theories of addiction (Der-Avakian & Markou, 2012; Watson, Klett, & Lorei, 1970).

The vast majority of addiction studies relate to substances (Karim & Chaudhri, 2012). Studies investigating how organisms become accustomed to substances have advanced understanding of the underlying biological and neurological processes that occur during substance-related addiction (Koob & Le Moal, 1997). Exposure to a drug prompts a compensatory physiological reaction in an organism, in an attempt to maintain homeostasis and reverse the acute effects of the drug (Nestler & Aghajanian, 1997). With increased exposure this compensatory reaction strengthens, and when unopposed, as in the case of drug cessation, withdrawal symptoms occur, manifesting the opposite to the acute effects of the drug; all generally experienced as negative. Tolerance implies that addictive activities or substances lose their ‘buzz’ with prolonged use, encouraging increasing dosages to get the same effects. Withdrawal symptoms upon reduction or cessation can be so severe as to lead to death in complex and rare cases, with other drugs commonly used to counteract withdrawal symptoms in medical treatment (Gold, Redmond, & Kleber, 1978). Together tolerance and withdrawal are features of physiological dependence (G. L. Fisher & Harrison, 2013; Gold et al., 1978; Nestler & Aghajanian, 1997). There is debate over the terminology of dependence in the current version of the DSM, and the application to non-substance behaviours (K. Kim et al., 2006; O'Brien, 2011; Starcevic, 2013b).

Recently, functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) have furthered the investigation of underlying biological processes in addiction, adding brain anatomy and chemical activity to studies already investigating brain electrical activity using electro-encephalography (EEG). fMRI and PET studies have identified certain brain chemicals, including dopamine, and anatomical structures, which are significantly different across addicts and non-addicts, with some similarities noted across different addictive conditions, including those which do not involve a substance (Han, Hwang, & Renshaw, 2011; Tapert et al., 2001; Volkow, Fowler, Wang, Baler, & Telang, 2009). The comparability of behavioural and substance based addiction is a primary focus for these studies, some of which are discussed below in

relation to video game addiction. In fact, many researchers look to these ‘biobehavioural’ studies to understand the underlying neurological and genetic markers of addiction, as a more objective means of validating the construct than self or other-report surveys, interviews or observations (Shaffer et al., 2004).

However, modern definitions, including operational diagnoses employed in the DSM-IV-TR and DSM-V, emphasize the social and psychological aspects with equal importance to notions of tolerance and withdrawal (American Psychiatric Association, 2000; Brown, 1997; McMurran, 1994). Contemporary diagnoses of substance dependence, abuse and pathological gambling include conflict in important social relationships, the inability to undertake expected life roles such as work, study and domestic duties, legal issues arising from committing addiction-related crimes, subjecting oneself to physically dangerous situations as well as excessive time spent pursuing the activity or substance. Many of the most serious negative consequences relate to psychosocial aspects of the condition, which fall outside the typical categorisation of the physiological.

The broad description of addiction in this section frames the construct, yet defining the precise components and respective intensities is more difficult and, arguably, more important than in other mental illnesses. In much mental illness symptomatology, any degree of symptom is problematic, even if the overall number of symptoms does not reach a diagnosable threshold. The presence of a symptom may be normal, depending on intensity and duration, but generally symptoms are negative. However, for many hobbies certain components of addiction, or ‘symptoms’, if inappropriately applied by not taking into account the context or the intensity, may not be problematic, such as the hobby altering one’s mood, which is currently a feature in some video game addiction scales (Charlton & Danforth, 2007). Or at least, identifying when such features should be considered a diagnostic marker is difficult. They may require a means of identifying a dramatic enough shift in behavioural preferences and mood and arousal management, in order to identify a narrowing of satisfying activities, taking into account the context of an individual (Brown, 1997). Substances may lend themselves to a more easily identifiable point at which they become pathological due to measurable physical effects on the body, which will culminate in more disability and shorter lifespans, such as in the case of smoking nicotine. But in the case of applying addiction to hobbies, they may be less amenable to accurate and reliable identifiers and may require more research to establish reliable thresholds. As this section will highlight, such definitional matters are still very much being debated and explored in current research.

General Theories: The Components and Syndrome Models.

Some theorists argue that there are common 'core' components to the differing addictive illnesses and theories, with similar or the same underlying vulnerabilities, pathways, expressions and even outcomes, across all substances or behaviours (Griffiths, 2005; McMurran, 1994; Shaffer et al., 2004). These arguments provide a step in the direction of validating and operationalizing the construct of non-substance addiction, and are cited in support of the validity for video game addiction (Griffiths, 2005). After examining the breadth of addiction theories and the possible application of addiction to criminal behaviour, Brown (1997) proposed the 'Components Model', which argues that, after accounting for idiosyncrasies, addictions are characterized by several common features. Prior to initiation of an addictive activity, Brown notes the activity has to be available and accessible, which includes social acceptability as social norms will govern self-monitoring and management. Brown also describes several underlying vulnerabilities important in initiation and development of addiction, including:

- deficient self-awareness or vigilance;
- deficient short term planning and crisis management skills;
- inability to maintain adequate arousal levels and/or a stable and positive mood;
- low tolerance for negative mood or frustration;
- high sensation seeking;
- manipulative, hysterical or psychopathic personalities;

Brown then goes on to detail the common identifying features of addiction. These features are succinctly described by Griffiths (2005) as follows:

1. Tolerance, meaning that one must increase the behaviour* in order to attain the same level of enjoyment or 'buzz';
2. Withdrawal, referring to the unpleasant physical or affective states experienced when the behaviour is ceased or reduced;
3. Salience, referring to the behaviour becoming the most important priority in the persons' life and dominating their thoughts, often with supporting and distorted attentional profiles, rituals, cognitions and belief systems (Brown described the activity moving up in a hierarchy of preferred activities);

4. Mood modification, referring to the subjective feelings reported as a consequence of the behaviour. Note these are most often reported as either an increase in arousal or a ‘high’, or a reduction in arousal and relaxation, and are often accompanied by dissociative states (Brown indicated these mood-modifying characteristics are highly reliable and immediate for the addictive activity compared with other activities, with a steep gradient in hedonic tone and a pronounced return down to a normal mood, with this gap in hedonic tone increasing over the course of addiction, producing adaptation, opponent processes and conditioning);
5. Conflict. This can be represented by three main categories, intrapsychic, interpersonal or with other important activities. Intrapsychic refers to conflict within the person regarding the activity. Interpersonal conflict occurs within social relationships. Finally, conflict can also be present with other important activities in the persons’ life, usually what is commonly required to function, such as work, study or domestic tasks. This latter aspect of conflict is often displaced by the amount of time spent engaging or pursuing the addictive behaviour; and
6. Relapse and reinstatement, which refers to repeated failures to cut back or stop the addictive behaviour, as well as the tendency for behavioural patterns at the height of the addiction to return after substantial time passed and with few triggers.

* Note ‘behaviour’ in the above definition may refer to either an activity such as exercising or gambling; or use of a psychoactive substance.

Grusser and Thaleman (2006) also reviewed the criteria for behavioural addiction and included certain additional components which add to the specificity of some components above, namely:

7. The behaviour is prolonged, over 12 months;
8. The perception of the behaviour moves from pleasant to unpleasant throughout the course of addiction;
9. The behaviour exhibits a limited pattern;
10. The preoccupation (described as salience above) builds in intensity until the behaviour is carried out after which it is relieved for a time;
11. Irrational or contorted views of the behaviour;
12. Suffering and a desire to alleviate the perceived suffering (note this is similar to conflict identified above.

Brown also highlighted that low self-esteem, as distinct from low self-efficacy, is likely to be a part of addiction, adding to the dysphoria sometimes driving the behaviour. Brown (1997) placed a lot of emphasis on this notion of salience, indicating that “Salience is here taken as the major identifying feature of the phenomenon of addiction” (p. 32), and considered tolerance and withdrawal to be “by-products” (p. 33). Partly because of this emphasis, he used the terms ‘reward specialism’ and ‘motivational monopoly’ (p. 34) instead of ‘addiction’, in order to de-prioritise the notion of ‘loss of control’, or ‘impaired free-will’, usually mentioned in disease models of addiction.

Brown (1997) further discusses a change in goal-seeking towards attainment of the goal states as the sole driver for the addictive behaviour. The development of an addiction is accompanied by a series of feedback loops, which arise partly from underlying vulnerabilities and faulty thinking, as well as the effects on arousal and hedonic tone, which encourage a person to gradually forego making decisions or planning for any kind of medium or long-term satisfaction from other activities in life. Options for other sources of reward are narrowed, both via negative consequences related to the addiction and also via changing motivations and decisions, until, eventually, the person is in a constant state of crisis, using the addiction to maintain any kind of positive mood or functioning. This concept of the negative feedback loop, or downward spiral, is also now being discussed in relation to video game addiction (Gentile et al., 2011). Brown also compared features of addiction to criminals and criminal behaviour in general, including a lack of forward-planning and empathy, although this analysis was only exploratory and did not explore the substantial heterogeneity across individuals or crimes.

Shaffer et al. (2004) also outlaid evidence in favour of a general model of addiction, under the title of the ‘syndrome’ model. Shaffer included many of the same non-specific manifestations of addiction at the pre-morbid and subsequent expression, manifestation and sequelae stages (see page 368) as Brown (1997). Shaffer et al. (2004) also noted some neurobiological, genetic and psychosocial antecedents common across many specific addictive conditions. Likewise, Shaffer highlights common experiences and natural histories which are present in the final manifestation, and outcomes, of different addictive conditions. Both Shaffer et al (2004) and Brown (1997) highlight a degree of treatment non-specificity, particularly in the syndrome model. However, Shaffer et al (2004) also cautions that many aspects are still under-researched. These include the temporal patterns of psychiatric sign/symptom and disorders, including chemical and non-chemical addiction hopping. The authors did not specify the exact meaning of ‘addiction hopping’, but it infers a possible complementary relationship between different addictive

conditions, including non-substance and substance addictions. This may denote how one condition may transition to another, possibly more severe addiction; similar to the concept to the ‘gateway’ drug. Or, it may also refer to how some combinations of non-substance and substance addictions encourage or complement the initiation, development or maintenance of each other. Other areas suggested for further research include treatment non-specificity across different addictive conditions.

The components and syndrome models resonate with many theories explaining addiction and are represented in the spread of respective diagnosable conditions, such as pathological gambling, substance dependence and abuse or substance use disorder in the DSM-5 (American Psychiatric Association, 2000, 2013). Controversially, the components or syndrome models suggest there are identifiable ‘core’ aspects underlying the disparate addiction theories and illnesses, asserting they share a common base. This general approach to addiction is present across many studies, but is sometimes only implied (Shaffer et al., 2004).

Criticisms of the general models of addiction.

General models of addiction have not come without criticism. There have been several reviews and editorials debating the topic in relation to the application to video gaming (Blaszczynski, 2008; Griffiths, 2008b; Petry, 2006, 2013; Westphal, 2007; Wood, 2008a, 2008b). As yet, there is no consensus on what should define a general model of addiction, nor on the evidence required to conclusively validate the construct (Petry, 2013). Criticisms include: the current lack of empirical evidence for negative consequences, doubts over the applicability of tolerance and withdrawal, absence of idiosyncratic aspects for each activity, differentiation from close concepts and a reductionist approach.

Both Brown (1997) and Shaffer et al. (2004) place differing emphases on different components, with Brown (1997) reducing the importance of tolerance and withdrawal and placing salience at the centre; while Shaffer et al (2004) does not specify which components may be most important. While general models do still allow for unique aspects across addictive conditions and do not require all aspects to be present at all times, neither model makes it clear how these unique aspects will be identified and how their importance will be assessed and operationalized, alongside general components.

Further, these theorists highlight the importance of intensity of symptoms, particularly Brown (1997), yet intensity is not currently well-investigated in studies applying addiction to video

gaming. In fact, symptoms are often dichotomised, even for research purposes (King, Haagsma, et al., 2013). Given the likely ubiquity of some non-substance addiction 'symptoms', accurately delineating the problematic intensity is likely to be very difficult. For example, identifying the level of intensity required to constitute "domination" of thoughts and activities (Griffiths, 2005), or a "powerful and effective means of manipulating hedonic tone" (Brown, 1994, p.27), or even a dramatic enough shift in behavioural preferences, are all relative to characteristics of the person and the context of their life. This confusion of intensity translates into diagnostic and research tools measuring video game addiction.

Tolerance and withdrawal in non-substance addiction.

Some theorists argue the concept makes light of substance dependence and abuse as there is not yet indisputable proof of tolerance and withdrawal in relation to non-substance behaviours (Larkin & Griffiths, 1998; Shaffer, 1996). Whether undertaking a leisure activity in increasing amounts to get the same level of enjoyment, or having a negative emotional reaction if unable to undertake a leisure activity is comparable to physiological dependence is yet to be conclusively established (Shaffer et al., 2000). Yet, most scales operationalizing the components model to measure video game addiction include simple representations of what are argued to be tolerance and withdrawal, usually with a single survey item representing each (King, Haagsma, et al., 2013).

Nonetheless, given that most studies of non-substance addiction have investigated tolerance and withdrawal using a single survey item representing each, whether a participants' (partial) endorsement of these survey items is enough to be considered comparable to physiological dependence is uncertain (King, Haagsma, et al., 2013). As yet, few studies have investigated tolerance and withdrawal symptoms of non-substance addiction intensely over a short time period, or in extensive detail in order to determine similarities to substance dependence or abuse, or to identify the relative intensities/gradients at which should denote an imbalance, or the point at which negative consequences appear.

Further, some studies have questioned the applicability of tolerance and withdrawal to video game play specifically, as heavy players have reported intense periods of play after the release of a new game, which subsides after the player masters the game and loses interest, and a substantial period may elapse before another game captures their interest (Tejeiro Salguero & Morán, 2002). Other studies have shown a steady decline in video game addiction symptoms

over time, with no intervention (King, Delfabbro, & Griffiths, 2013). These patterns seem inconsistent with the concept of dependence, both physical and psychological, under which would be expected some approximation of a continually increasing trajectory of video game play and addiction, which is difficult for the individual to reduce or cease. Such an increasing trajectory is described in detail by Brown (1997), and also suggested in the syndrome model described by Shaffer et al. (2004).

Discriminant validity.

Some researchers argue that there is too little discriminant validity for new, non-substance addictions from other mental disorders or close concepts, and therefore these problematic aspects of hobbies may be better explained as symptomatic of other more important factors, including underlying and/or co-morbid mental illnesses (Blaszczynski, 2008; Charlton & Danforth, 2007; Petry, 2006, 2011, 2013; Shaffer et al., 2000; Wood, 2008a). These close concepts include engagement, habits, obsessions, compulsions, attachments and dependencies. Shaffer et al (2004) notes the high instance of co-morbid conditions with addictive conditions, and also the range of disorders as predictive of later developing an addiction, such as low self-esteem or problematic family environment or functioning in academic studies. Brown (1997) also discussed underlying vulnerabilities which are likely to precede addiction. Even outside of addiction theory, studies have highlighted the shared variance in the symptomatology of many psychological conditions (Lovibond & Lovibond, 1995). Addictive conditions therefore operate within complex, interconnected and dynamic psychological settings, and may often sit ‘above’ preceding conditions or vulnerabilities. Therefore research is required for each proposed behavioural addiction to differentiate close concepts and investigate the relative importance of that addiction among other causes of the same negative outcomes, such as other co-morbid conditions.

This lack of discriminant validity partly arises from the research methods used to study the phenomena. Most non-substance addiction studies are correlational rather than longitudinal and unable to investigate temporal precedence (i.e. which factor tends to occur before the other). Even in cross-sectional studies, few attempt to test or account for confounding variables in statistical models (Petry, 2013). The importance of controlling for other contributing factors in addiction studies has been demonstrated by secondary analyses of datasets. Despite this,

many researchers finding cross-sectional relationships between possible behavioural addictions and problems use the term ‘negative consequences’ to refer to what are, without further evidence, associated problems. Many studies on possible behavioural addictions tacitly suggest the addictive behaviour or object is the cause of any associated problems, rather than an expression of other, more primary, problems (Shaffer, 1996). In the context of behaviours which are enjoyable and adaptive to most people, and the common incidence of co-morbidities, it is increasingly important to test for possible mediating or moderating contextual factors in any associations between behavioural addictions and problems. These issues are further compounded by differing views on the methods by which knowledge on these matters may be generated, including varied statistical techniques. Resultantly, one strategy may be to encourage the open access of de-identified datasets in large studies, which can be explored using several statistical approaches.

Establishing negative consequences.

To satisfy these criticisms, research must demonstrate that proposed behavioural addictions are at least a partial, if not the primary, cause of negative consequences, rather than a superficial expression of a deeper underlying cause (Griffiths, 2005; Kuss & Griffiths, 2012; Petry, 2011). Addressing what is sometimes called the pathogenesis of non-substance addiction is extremely difficult given current research methods. To further complicate efforts to develop a meaningful classification of non-substance addiction, studies of pathological gambling indicate that even when using an established diagnostic classification, pathological gamblers are not homogenous and instead represent unique subtypes with different causes, expressions and outcomes (Blaszczynski & Nower, 2002; Ledgerwood & Petry, 2006). Whether this will also be the case for video game addiction is currently unknown. At the very least, intensive, mixed-methods longitudinal studies are required to begin to establish the order of events and the importance of confounding factors, along with further understandings of the common underlying bio-psycho-social processes across different substance and proposed non-substance addictions. With regards to video game addiction, longitudinal research is only very recently attempting to identify what associations may primarily represent negative outcomes, risk factors or mutually reinforcing co-morbidities (Gentile et al., 2011; King, Delfabbro, et al., 2013; Lemmens, Valkenburg, & Peter, 2011).

Reductive.

Another criticism of the syndrome or components model of addiction is that it is inherently reductionist. When the common factors are identified across addictive conditions, those which are more unique to certain conditions may be downplayed or discarded, and these are often the most severe and undoubtedly pathological components (Larkin et al., 2006; Shaffer et al., 2004; Sussman et al., 2011). Theorists have noted that if the definition becomes too broad, the 'flood gates' may be open for the unwarranted application of addiction to any activity judged as excessive or having negative consequences, without supporting evidence (Starcevic, 2013b). While the components model does allow for idiosyncrasies for each specific addictive condition, many components of the more established addictive disorders are deemed inapplicable to video games and other possible behavioural addictions, and these discarded components appear to be more serious, at least at face value (Tejeiro Salguero & Morán, 2002).

Lack of Severity.

In the case of adapting substance use disorder components, and the specific sub-categories such as alcohol or stimulant use disorder to video game play, those which are inapplicable include criminality and legal issues (dropped from the DSM-V due to some international inapplicability), and a host of direct physical risks and physiological damage. These relatively direct physical risks include the dangers of illegally and poorly manufactured drugs which can cause rapid organ damage, overdose or other adverse reactions, the risk of operating machinery such as driving a car while impaired, sharing of needles spreading diseases and even the incorrect cannulation of veins leading to infection and in-turn amputation (American Psychiatric Association, 2000; Ritter & Cameron, 2006; Stein, 1999). In fact, many of these consequences carry the direct risk of death, even in the short term. In adapting pathological gambling criteria to video gaming, legal issues and financial ruin are unlikely to be applicable, although jeopardising occupational opportunities is considered a potential negative consequence of video game addiction (American Psychiatric Association, 2013)

Yet, the absence of certain harms does not rule out other harms for proposed non-substance addictions, including video game addiction. Most likely less severe or immediate, but harms nonetheless. Assessing the point at which some of the general components should be considered problematic will be difficult. The DSM-5 specifies internet gaming disorder must

"lead to" clinically significant impairment or distress, but an exact threshold for this impairment/distress is not provided.

This lack of idiosyncrasy and severity may be a by-product of the current approach to applying the general model to hobbies. Identifying what constitutes a severe shift in hedonic tone and/or behavioural preference is relativistic. For example, losing two hours of sleep may be common for one person to pursue a leisure activity, whereas for others who keep to a more regular sleeping routine this may be an indicator of a striking shift in behavioural priorities. Therefore, these intensities are likely relative to each person's context and history, which will be difficult to capture in quantitative measures with any degree of brevity. However, when general addiction components are applied and measured in possibly new, non-substance addictions, such as video game addiction, intensity has rarely been the focus, and therefore does not facilitate detailed exploration of these ratios. Instead intensity of features is usually covered with very few survey items and measured with dichotomous answers or Likert scales, which are sometimes converted to dichotomous responses (Choo et al., 2010). Further research may be able to address the lack of idiosyncrasy and severity by building further information about each possible behavioural addiction and the importance of the specific components, or combinations of specific components, thought to represent addiction.

Support for the components model.

Griffiths (2005) and others (Brown, 1997; West & Hardy, 2006) argue that if hobbies or other pursuits can be characterised by most of the same components that are included in the clinical diagnosis of pathological gambling, they then warrant consideration as distinct pathological phenomena and are not simply the outward expression, or benign side-effect, of a hidden disorder. The broadening of addiction in the DSM-5 could also be interpreted as supportive of this perspective (Starcevic, 2013b). However, proponents of the components model also acknowledge that it is likely a history of mental health problems will be present in people experiencing non-substance addiction, including the possibility of co-morbid conditions which may be mutually reinforcing (Gentile et al., 2011). Many of the considerations relevant to general models of addiction are directly applicable to the investigation of video game addiction. Regarding clinically significant impairment or distress, and the range of associated harms, many studies have already reported associations that are discussed in full, after a definition of video game addiction is explored (Ferguson et al., 2011). This section dispenses with the discussion

of the general model of addiction, and the remainder of the literature review concerns the specific topic of this PhD: video game addiction.

What is Video Game Addiction

To date there is no universally accepted definition of video game addiction, or established point at which gaming can be considered an addictive syndrome (King, Haagsma, et al., 2013; Shaffer et al., 2000). As detailed above a tentative diagnosis has been included in the DSM-V, 'Internet Gaming Disorder', to encourage further research on the topic (American Psychiatric Association, 2013). By and large, the most detailed and functional definition of video game addiction is provided by scales that measure it, for the purposes of research.

Measuring video game addiction.

Many studies have now used modified diagnostic criteria for substance abuse and pathological gambling to study how similar video game playing can be, and insofar as self-reported answers to these modified diagnostic criteria indicate, it appears that some people's playing contains many of the same features (Griffiths, 2005; Tejeiro Salguero & Morán, 2002). Table 2 presents an example of one of these scales, with reference to the components from Brown's model reflected by each section (Lemmens, Valkenburg, & Peter, 2009).

Different scales have included or emphasized slightly different aspects of video game addiction (King, Haagsma, et al., 2013). Some have ramped together several features, usually aspects of negative consequences, into a single survey item, while others have included additional items which are not present in diagnostic criteria of pathological gambling or substance abuse (Tejeiro et al., 2012), while other scales have separate items for each type of negative consequence (King, Delfabbro, & Zajac, 2011).

A recent systematic review was conducted of the video game addiction measures published thus far in English, identifying and comparing eighteen scales (King, Haagsma, et al., 2013). The review concluded that video game addiction scales share the strengths of shortness, ease of scoring and administration and excellent internal consistency and convergent validity. But many are broadly inconsistent with their theoretical conceptualisation of video game addiction, measuring slightly different diagnostic signs and posing threats to meta-analysis and

standardisation. Different scales have placed differing levels of importance on the various components and respective intensities or timeframes required for endorsement. Some scales have used only dichotomous answers, or converted Likert responses to dichotomous answers in order to calculate the total number of components endorsed, limiting the importance or altogether discarding the intensity of symptoms. An age range is not specified for most scales and for those that have, no studies have yet investigated validity or whether interpretation of items varies across age.

This review called for, among other things, more longitudinal studies in order to assess predictive validity, greater consistency and item response theory analyses to explore which components are most predictive of detriment. But overall, most scales share more similarities than differences. Most are generally composed of reworded criteria for both pathological gambling and/or substance abuse; which reflect Brown's (1997) six components and/or aspects of Shaffer et al.'s (2013) syndrome model. Also, the claim that most video game addiction scales have excellent convergent validity is open to debate, given the varying and often small or moderate magnitude correlations with associated problems (Gentile et al., 2011; King & Delfabbro, 2009; King, Delfabbro, & Zajac, 2011; Lemmens et al., 2009; Mentzoni et al., 2011; Przybylski, Weinstein, Ryan, & Rigby, 2009; Skoric, Teo, & Neo, 2009; Wan & Chiou, 2006).

While video game addiction scales do strongly predict playing time, this factor is not a strong point of validity for the construct as it is not an explicit negative consequence. The section on negative consequences below expands on this point. The review also identified scales based on modified pathological gambling as the most comprehensive in terms of having representation of all components of addiction and negative consequences (Tejeiro et al., 2012). Table 3 is an abridged version of a table provided in King, Haagsma, et al. (2013) which summarises the characteristics of many video game addiction scales. Efforts are now underway investigating how to separate intense but largely unproblematic engagement with video games from addiction, by including a measure of engagement alongside components reflective of addiction (Charlton, 2002; Charlton & Danforth, 2007, 2010).

Table 2

Example Video Game Addiction Scale

Questions In the last six months…	Brown's Component
Did you think about playing games all day long? Did you spend much free time on games? Have you felt addicted to a game?	Salience
Did you play longer than intended? Did you spend increasing amounts of time on games? Were you unable to stop once you started playing?	Tolerance
Did you play games to forget about real life? Have you played games to release stress? Have you played games to feel better?	Mood modification
Were you unable to reduce your game time? Have others unsuccessfully tried to reduce your game use? Have you failed when trying to reduce game time?	Relapse and Reinstatement
Have you felt bad when you were unable to play? Have you become angry when unable to play? Have you become stressed when unable to play?	Withdrawal
Did you have fights with others (e.g. family, friends) over your time spent on games? Have you neglected others (e.g. family, friends) because you were playing games? Have you lied about time spent on games?	Conflict
Has your time on games caused sleep deprivation? Have you neglected other important activities (e.g. school, work, sports) to play games? Did you feel bad after playing for a long time?	Negative Consequences

Table 3

Overview of Video Game Addiction Scales to Date

Instrument title	Author(s)	Components	Number of items	Item sensitivity	Time	Language
Adapted DSM-IV-TR criteria for pathological gambling	American Psychiatric Association (2000)	Preoccupation; tolerance; loss of control; withdrawal; escape; chasing; lies; illegal acts; negative consequences; bail out	10/11	Yes/No	3-5 mins	English
Adapted DSM-IV-TR criteria for substance dependence	American Psychiatric Association (2000)	Loss of control, negative consequences of use	7	Yes/No	3-5 mins	English
Addiction-Engagement Questionnaire (revised)	Charlton and Danforth (2007)	Addiction; engagement	24/29	7-point	10-15 mins	English
Compulsive Internet Use Scale (CIUS)	Meerkerk, Van den Eijnden,Franken, and Garretsen (2006)	Loss of control; preoccupation; withdrawal; conflict; coping	14	5-point	10-15 mins	English; Dutch

Instrument title	Author(s)	Components	Number of items	Item sensitivity	Time	Language
Engagement-Addiction Questionnaire	Danforth (2003)	Engagement [tolerance; euphoria; cognitive salience]; addiction [behavioral salience; conflict; withdrawal]	19	6-point	10-15 mins	English
Exercise Addiction Inventory (adapted)	Hussain and Griffiths (2009)	Not reported	6	5-point	5-10 mins	English
Game Addiction Scale (GAS)	Lemmens et al. (2009)	Salience; tolerance; mood modification; withdrawal; relapse; conflict; problems	7/21	5-point	10-15 mins	English; Dutch; Norwegian
Korean Internet Addiction Test (KIAS)	Lee et al. (2007)	Disturbance of adaptive functions; disturbance of reality testing; addictive automatic thoughts; withdrawal; virtual interpersonal relationships; deviant behaviour; tolerance	40	4-point	10-15 mins	Korean

Instrument title	Author(s)	Components	Number of items	Item sensitivity	Time	Language
Online Game Addiction Scale for Adolescents in Taiwan (OAST)	Wan and Chiou (2006)	Compulsive use; Withdrawal; tolerance; conflict	29	4-point	10-15 mins	Taiwanese
Online Game Addiction Index (OGAI)	Zhou and Li (2009)	Control; conflict; injury	12	Not reported	5-10 mins	Not reported
Problem Videogame Playing (PVP) Scale	Salguero and Moran (2002)	Preoccupation; tolerance, loss of control; withdrawal; escape, lies & deception; disregard for physical or psychological consequences	9	Yes/No	3-5 mins	English; French; Chinese
Problematic Internet Use Scale (ISS-20) (adapted)	Stetina et al. (2011)	Loss of control; problems in social offline relationships; withdrawal symptoms; tolerance; impairments in daily life	20	6-point	5-10 mins	German

Instrument title	Author(s)	Components	Number of items	Item sensitivity	Time	Language
Problematic Online Game Use Scale (POGU)	Kim and Kim (2010)	Euphoria; health problems; conflict; failure of self-control; preference for virtual relationship	20	Not reported	5-10 mins	English; Korea
Problematic Online Gaming Questionnaire (POGQ)	Demetrovics et al. (2012)	Preoccupation; overuse; immersion; social isolation; interpersonal conflicts; withdrawal	18	5-point	5-10 mins	English
Video Game Addiction Test (VAT)	Van Rooij et al. (2012)	Loss of control; intra- and interpersonal conflict; preoccupation; mood modification; withdrawal	14	Not reported	5-10 mins	English; Dutch
Video Game Dependency Scale (KFN-CSAS-II)	Rehbein et al. (2010)	Preoccupation/salience; conflict; loss of control; withdrawal; tolerance	14	4-point	5-10 mins	German

Instrument title	Author(s)	Components	Number of items	Item sensitivity	Time	Language
Young Internet Addiction Scale (YIAS)	Young (1998)	Tolerance; loss of control; conflict; relapse; lack of desire to change online use	8	Yes/No	5-10 mins	English; Chinese; French; Italian; Turkish
Young Internet Addiction Test (YIAT)	Young (1996)	Salience, excessive use, neglect — work; anticipation; lack of control; neglect — Social	20	5-point	5-10 mins	Arabic; English; French; Chinese

Note. Complete references for the papers listed in this table can be found in the original article (King, Haagsma, et al., 2013).

While most video game addiction scales do not weight components in forming a cut-off and therefore place equal importance on the different components of addiction, some research suggests that at least some of the components thought to constitute a behavioural addiction would be present for a hobby in which a person is highly engaged, while others are inherently pathological (Charlton & Danforth, 2007; Charlton, 2002). This feature seems to distinguish non-substance addiction from most other mental illnesses, in which core symptoms are undoubtedly problematic in any intensity, even if there are not enough co-occurring at high enough intensity to meet a diagnostic threshold. Although some commentators claim that video game addiction scales are psychometrically weak and that their latent structures are mostly unexplored (Petry, 2011), almost all studies utilising video game addiction scales have reported some form of psychometrics, with many exploring factor structures extensively.

Scale Factorial Structures

Analysing the latent structure of video game addiction scales can contribute to the study of the validity for the components model applied to video game playing. The components and syndrome models imply that the various components of addiction should co-vary and represent an underlying latent variable of addiction. Psychometric analyses are able to give an indication of how likely items within scales are to 'hang together' or co-occur, which is to be expected if the condition represents a 'syndrome' of interconnected parts. Also, individual item frequency analyses give an indication of prevalence of addiction components, and item-total correlations give an indication of item fit. Other more advanced statistical procedures are also available to scrutinise how well a scale measures the theorised underlying traits. Psychometric analyses may therefore also contribute to distinguishing addiction from close constructs such as high engagement.

Several video game addiction scales, such as the one listed in Table 1, are based on very similar precepts and many have a unitary factorial structure good internal consistency (Hart et al., 2009; King, Delfabbro, & Zajac, 2011; Tejeiro et al., 2012; Tejeiro Salguero & Morán, 2002). Others have found several factors which all contribute to a second-order factor of addiction; which is a very similar conceptualisation to the unitary structure, as the variance in all components are explained through a single higher-order factor (Lemmens et al., 2009). However, some scales which include items tapping the same components, but also include other items measuring engagement to video game playing, have found a consistent two-factor solution (Charlton, 2002; Charlton & Danforth, 2007, 2010; Topor et al., 2011). The results of

these studies suggest that certain components currently considered part of general models of addiction may better represent an intense engagement in a hobby.

Uni-factorial scales.

The Problem Video Game Playing Scale (or PVP) is a nine item measure which adapts some DSM-IV-TR criteria for substance abuse and pathological gambling to video game playing. This scale was first tested with a sample of 223 Spanish adolescents ranging in age from 13 to 18 (Tejeiro Salguero & Morán, 2002). The authors reported the scale had acceptable internal consistency, with acceptable Chronbach's alpha coefficient (α=.69), and that removal of any of the nine items reduced the alpha score. A principle components analysis of the tetrachoric items-correlation matrix revealed one factor explained 39.1% of the variance across the items, which was accepted as evidence of a unifactoral structure. However, two items, one relating to using video games to alter mood and another asking about lying or deception to conceal video game playing from others showed low item-total correlations (*r*=<.30). Usefully, the authors also reported the percentage of endorsement for each item, which gives an indication of how prevalent the addiction components were in the sample. Interestingly, items representing withdrawal and lies and deception were the least common, and the item representing loss of control was the most common. Few other scales have reported the prevalence of individual scale items and given the uncertainty with regard to the applicability of addiction to video game playing, analysis of the individual items could prove fruitful. Later the PVP was again tested with a sample of 204 American adolescents, and a principle components analysis indicated only one factor present, and an identical Chronbach's alpha coefficient (α=.69) (Hart et al., 2009).

Other scales, such as the Problem Video Game Playing Test (PVGT), a 20 item scale adapted from Young's Internet Addiction Test, demonstrated even higher internal consistency (α=0.93) in a sample of 416 adult Australian gamers (King, Delfabbro, & Zajac, 2011). All items showed correlations with the item total (*r*=>.54), unlike some items in the PVP. Further, the authors conducted both an exploratory factor analysis (EFA) and a confirmatory factor analysis (CFA) to assess factor structures. The EFA suggested a single factor but the possibility of two factors. However, the results of a CFA indicated that a single factor model showed a better fit than a two-factor solution. With all items constrained to a single factor, Chi Square (χ^2), Tucker Lewis Index (TLI) and the Standardized Root Mean Square Residual (SRMSR) all indicated a good model fit ($\chi^2(63)=368.67$, $p<.001$; TLI=.978; SRMSR=.056). Lemmens, Valkenburg and Peter (2009) developed a 21 item scale and also used CFA to test its' factor structure in two samples

of Norwegian adolescents (*n*=352 and *n*=369). Using a model reflecting a second order factor structure, with 7 first order factors reflecting Brown's components, each measured using three individual items, the model showed a good fit (χ^2 (182)=594.2, *p*<.001; CFI=.903, RMSEA=.080), and this fit was replicated in the second sample. Other similar video game addiction scales have not reported factorial structure (Choo et al., 2010; D. Gentile, 2009; Gentile et al., 2011; Porter, Starcevic, Berle, & Fenech, 2010).

Two-factor and second-order structures.

Other scales, which postulated certain addiction components may actually fit better in a factor representing high engagement to a hobby rather than an addiction, have also found a consistent two-factor split supporting this interpretation. Charlton and Danforth (2007) proposed that certain components of video game addiction may be less problematic and likely to be present in people who are highly engaged with a hobby, while others are inherently pathological. While this scale was based on the same precepts for video game addiction; that is, modified diagnostic criteria for substance abuse and pathological gambling, with items representing all of Brown's components, the authors also included several items relating to high engagement. This 29 item scale specifically referred to an online role playing game and its' dimensional structure was tested in a sample of 442 adult gamers.

An initial Principle Components Analysis produced a Scree plot suggesting two factors. The two factors accounted for 32% of item variance, with the first showing 25% and the second 7%, with an inverse correlation (*r*= -.33, *p* <.05), justifying oblique rotation. After analysing item factor loadings after this solution, the authors concluded that items tapping conflict with other activities, inter-personal conflict, withdrawal symptoms, relapse and behavioural salience represented a clear addiction factor. Whereas items tapping tolerance, euphoria (also called mood modification) and cognitive salience loaded on a second factor representing engagement. This factor structure closely resembled that found in a previous study which applied this scale to general computer use, rather than to a specific video game (Charlton, 2002).

The two factors have been termed 'peripheral' and 'core', with core referring to the pathological addiction factor. Analysis of frequency of individual item endorsement revealed that these engagement items were also amongst the most commonly endorsed, far more so than items in the core factor. The most commonly endorsed item related to often thinking about video games (cognitive salience) and the second most endorsed related to feeling a buzz of excitement when

playing video games (mood modification). The least endorsed item related to often feeling agitated when not playing video games (withdrawal), and the second least related to failures to reduce time spent playing (relapse).

The authors concluded that this split between peripheral and core components will have a substantial effect on classification of addicted gamers in other studies, where these commonly endorsed but possibly non-pathological items are treated as symptoms of addiction. While this analysis draws an important distinction between certain features of the syndrome or components model of addiction, the authors still assumed that peripheral criteria are somewhat important in the context of addiction and are likely to predate development of addiction. Peripheral items still loaded, albeit weakly, on the addiction factor.

Longitudinal studies are required to validate the proposed developmental pathway from high engagement to addiction. Validity has already emerged supporting this proposed separation of addiction from engagement beyond just a psychometric analysis of dimensional and item frequency, and is discussed in the following section. The inclusion of these additional items representing engagement demonstrates a unique way of researching the possible dividing line between an intense hobby and addiction. This may lead to refinement of the definition of the syndrome and components models.

Summary of psychometric evidence.

Analyses of factorial structures provide evidence that many of the components thought to constitute addiction do tend to co-occur or to ‘hang together’, across different samples and a wide age range (Hart et al., 2009; King, Delfabbro, & Zajac, 2011; Tejeiro et al., 2012; Tejeiro Salguero & Morán, 2002). Yet Charlton and Danforth (2007) found two factors which suggest tolerance, euphoria and cognitive salience may not fit well with addiction. The total variance explained by a single factor, or even a two factor solution, didn’t exceed 40% and it is debateable how much variance would denote evidence of a syndrome. Statisticians have differing opinions on what level of variance explained is acceptable for a single factor solution, with some indicating 40% as a minimum (Carmines & Zeller, 1979), and others 20% (Reckase, Ackerman, & Carlson, 1988). In a syndrome model, the components of video game addiction are conceptualised as multiple expressions of the same underlying condition and should therefore ‘hang together’. Despite the components being highly varied, there is a generally high degree of inter-correlation in scale items measuring video game addiction. Depending on one’s

statistical interpretation of acceptable factor analysis solutions, these results can be thought to either provide some support for the existence of video game addiction as a condition; or they may be insufficient.

Confirmatory Factor Analysis (CFA) helped to provide further evidence of a single factor. The CFA of the PVGT (King, Delfabbro, & Zajac, 2011) showed a better fit as a single factor than two factor, despite this scale including reflection of all the components classed as peripheral by Charlton and Danforth (2007). Likewise, Lemmens, Valkenburg and Peter (2009) also found a good fit using a second order factor structure. Both essentially conceptualise the various components of addiction as explained by a single underlying factor. The Charlton and Danforth (2007) scale is yet to undergo a confirmatory factor analysis, which could further test the proposed differentiation.

Frequency analysis of item endorsement suggests that more pathological items are far less commonly endorsed than those described as peripheral. This will have implications on cut-off points used to denote an addicted group. However, many scale authors have not reported the endorsement of individual items. Prevalence rates vary greatly depending on the cut-off adopted, and future studies will likely be required to explore the impact these different points have on associated problems and accuracy of diagnosis. Many studies have now investigated validity for the construct beyond scale psychometrics; and another important step in defining video game addiction is the creation of a diagnostic threshold.

Prevalence: Defining an Addicted Group

Which video game addiction features, or combinations thereof, are most problematic, is only beginning to be explored. Further, how many features must co-occur, and at what intensities, to denote what may be called a positive ‘diagnosis’ of video game addiction is uncertain. Different cut-offs have resulted in vastly different prevalence rates. When delineating an addicted group, some studies have only required some of the components to be present, referred to as a polythetic diagnosis system, while others require all components to be present, referred to as monothetic (Charlton, 2002; Charlton & Danforth, 2007, 2010). Other approaches include latent class analysis and designation of a particular percentile of the total score to form a cut-off. These differences affect prevalence rates, group comparisons, explorations of possible negative consequences and ultimately the validity and reliability of the construct; which is intimately tied to the diagnosis. As noted, the intensity required to denote video game addiction may be more

seminal than in other mental illnesses, of which any intensity of symptomatology is arguably pathological, even if it falls below a diagnostic threshold. Overall, sampling strategies for prevalence studies have been valid, as many have utilised random sampling techniques with high participation rates and large samples drawn from schools or the public (Phillips et al., 1995; Rehbein, Psych, Kleimann, Mediasci, & Mößle, 2010; Van Rooij, Schoenmakers, Vermulst, Van Den Eijnden, & Van De Mheen, 2011). Rather than sampling differences, large variations in prevalence arise from the precise cut-off point used, including how response ranges are calculated to produce the cut-off.

Latent class analysis, time commitment and percentiles.

Some studies have formulated cut-off points for a possibly addicted problem gamer group using time commitment, latent class analysis and a high percentile of a total video game addiction score. King and Delfabbro (2009) used the criteria of playing for over 30 hours per week, at least 4 days per week, and playing for an average duration of 3 hours in a typical sitting, which resulted in a prevalence rate of 10.9%. This heavy gaming group scored significantly lower on measures of health when compared to Australian norms. Other studies using a video game addiction scale adopted the cut-off of those who scored in and above the 88th percentile of the overall score (Stetina, Kothgassner, Lehenbauer, & Kryspin-Exner, 2011), which yielded a prevalence rate of 8%.

Van Rooij, Schoenmakers, Vermulst, van den Eijden and van de Mheen (2011) used latent class analysis to identify distinctive subgroups within a longitudinal sample of Dutch adolescents. Time commitment and compulsive video game playing scores were used as the classifying variables, and six groups emerged. The first four groups showed a linear relationship between hours of play and addiction scores, whereas the fifth and sixth group showed a break from this trend, where increasing time commitment did not predict an increase in addiction scores for the fifth, but in the sixth group addiction scores increased disproportionately to an increase in playing time. The authors interpreted this split as representative of a high playing, but non-dependent group, and a high-playing dependent group. The study collected data longitudinally and found that 2.4% at time one and 3.3% at time two fell into the sixth group, in samples of 1572 and 1476 Dutch teens aged 13-16, respectively. This resulted in a slightly lower prevalence rate of video game addiction than some other studies and classification methods.

Polythetic cut-off points.

Polythetic cut-off points are associated with the highest prevalence rates. In one of the earliest studies of video game addiction, Fisher (1994) found a 6% addiction prevalence to arcade games (i.e. in arcade parlours) in a sample of 467 American adolescents. Similarly, Philips, Rolls, Rouse and Griffiths (1995) found 7.5% of their adolescent British sample met the criteria for addiction to home video game playing. In a large sample of 7069 gamers, mostly adults, Grusser, Thalemann and Griffiths (2006) found a prevalence of 11.5%; however the authors did not report the country of origin of the sample. In a longitudinal sample of 3034 Singaporean youth, Gentile et al (2011) found prevalence ranged from 7.6% to 9.9% across three time points. Consistent with other studies, boys showed a higher prevalence at each time point. Another study with a fairly large sample size and a rare gender balance stacked towards females, including both high School students (*n*=1326, 657 female) and university students (*n*=705, 507 female) from Australia, explored prevalence of addiction to different gaming systems (Thomas & Martin, 2010). Interestingly, prevalence of arcade-game addiction in teenagers has not changed much since Fisher's study in 1994, at 7% (9% for boys, 4% for girls), despite the waning popularity of arcade game spaces in many countries.

Monothetic cut-off points.

Monothetic cut-off points have produced much lower rates. One very large sample prevalence study of 15168 German ninth graders, randomly selected from a pool of 44610 students, found a prevalence of 0.3% for girls and 3% for boys (Rehbein et al., 2010). A randomly selected sample of 816 Norwegians aged between 15-40 indicated a prevalence of 0.6%, but if a polythetic cut-off was adopted, this rate jumped to 4.1% (Mentzoni et al., 2011). These cut-off points present several limitations that require consideration.

Total number of features present.

As polythetic prevalence rates rely on a total number of features to be present, they are sensitive to the amount of items in the scale. The more items, the smaller the prevalence rate as it is increasingly less likely that participants will endorse that many features of addiction. Therefore, most studies adopt a 'half-out-of-the-total' approach. For example, a scale of ten items will require endorsement of any five for a positive diagnosis. This approach is still

sensitive to the differing prevalence of certain features of video game addiction components, as demonstrated by the vast differences in endorsement of individual scale items, where they have been reported. Prevalence rates would likely be lower without these more common, possibly less pathological, features present. Future analyses may help to pinpoint which features, or which combinations, are most problematic, by developing a weighting system able to delineate the most problematic gamers.

Level of endorsement.

In order to compute a count of total items endorsed for a polythetic cut-off point, researchers must dichotomise item responses. In this process, valuable information regarding the intensity of symptoms is often discarded. The point at which a participant can be considered to have 'endorsed' an item is somewhat subjective and has drastic impacts on prevalence rates. To illustrate, consider these specific examples.

One study of 1178 American youth aged 8-18 found a very high prevalence rate of 19.8% when using the criteria of answering yes to 6 out of 11 scale items (D. Gentile, 2009). This sample is useful for estimating population prevalence as it had a close to 50/50 gender balance, at least 100 participants of each year of age, with an even geographic spread across the United States. The scale used a response set of either 'yes', 'no' or 'sometimes'. The prevalence rate of 19.8% was with the response of 'sometimes' classified as a 'yes'. When 'sometimes' was classified as a 'no', the prevalence rate was 7.9%. In another study using the same video game addiction measure, but this time with 3034 Singaporean adolescents, the prevalence rate again varied drastically (Choo et al., 2010; Gentile et al., 2011). When 'sometimes' was considered a 'no', prevalence was 5.1%. When 'sometimes' was considered a 'yes', prevalence jumped to 27.4%. The authors opted to rate 'sometimes' as a half-yes, yielding prevalence of between 7.6-9.9%, across three time points. The impact of classing 'sometimes' a yes supports the ubiquity of some symptoms of video game addiction Other scales which adopted a larger range of Likert type responses, 5 or 7 point response scales, present similar difficulties in classifying endorsement. Most studies which designate an addicted group accept the lowest level of endorsement as a 'yes'.

Prevalence over time.

Some studies have examined prevalence rates over time, which may help to determine whether video game addiction is more transitory, representative of what may be termed a 'phase', or whether it is a longer lasting condition. One study used latent class analysis to determine the addicted group and included a longitudinal analysis (Van Rooij et al., 2011). After extracting a matched sample across a two year period, they had 467 online gamers to analyse. However, only a very small number met the latent class group membership requirement (n=6) at time one, and three of these people remained addicted after one year, suggesting a persistent condition (p. 209). However, the sample of 6 addicted gamers is too small to be considered representative.

Using a larger sample, Gentile et al (2011) collected data across two years with 3034 Singaporean youth in grades 3, 4, 7, and 8. When prevalence rates were examined in the matched longitudinal sample using a cut-off of 5/10 items on the scale, 84% of the participants deemed addicted (n=219) at wave one were still addicted two years later. In the same time period, only 1% of participants developed video game addiction. In combination, these results suggest that video game addiction may develop prior to age 13 and remain highly stable over time.

However, another recent study examined the longitudinal trajectories of video game addiction symptoms and suggests they abate over time with no intervention. King, Delfabbro and Griffiths (2013) recruited 117 adult gamers with a mean age of 24 who completed a survey package three times across an 18 month period. Controlling for age, gaming time commitment and psychological distress, an ANCOVA indicated that problem gaming symptoms dropped significantly for each wave (p<.05). Interestingly the study also tested the predictive validity of a single item question asking participants "do you think that currently you may have a problem video gaming habit?". Results indicate that this question strongly correlated with scores on the video game addiction scale used and predicted several significant differences across the groups, however both the 'yes' and 'no' groups showed significantly reduced scores over the time period. These results strongly contradict those of Gentile et al. (2011), which may indicate that video game addiction is transient in some populations, such as adults, but more persistent in children, or possibly across cultures. No studies have yet investigated longitudinal fluctuations of video game addiction components intensely over a short period of time.

Summary of prevalence.

The drastic variations in prevalence rates across and within studies provide further evidence that some features of video game addiction are ubiquitous and there is no well-accepted diagnostic cut-off point yet. As such, intensity of symptoms may be even more important than their mere presence, yet diagnostic systems rarely take this into account. Given that video game addiction may likely rest on a continuum from high engagement to addiction, these findings also highlight the uncertainty in what may be considered ‘moderate’ or ‘excessive’ gaming. As yet, many studies have not explored which individual video game addiction components, or combinations thereof, are most associated with diminished health and well-being. Current longitudinal studies produce conflicting results with regard to the transience of video game addiction, and further longitudinal studies are needed.

At this stage, using cut-off points to represent a positive diagnosis and delineate an addicted group within a sample must be interpreted cautiously. Yet, experts have expressed the importance of a dependable cut-off point in order to advance research on the topic (Griffiths, 2005). Putting aside these limitations, even if the strictest monothetic cut-off point is assumed to be correct, which produces the lowest prevalence rate of 0.6% in teenagers (0.3% in girls), in Australia this equates to roughly 96000 people (Australian Bureau of Statistics, 2012a). A substantial number, especially given that Australia has a relatively small population and most studies report much higher prevalence.

The Search for Negative Consequences

As mentioned, most studies of video game addiction can be described as a search for negative consequences, with many identifying correlates of the condition which may represent negative consequences. Scholars and experts have commented on the possible negative consequences of video game addiction, thought to include diminished productivity at work or school, sleep health, deterioration of social relationships as well as physical and psychological well-being (American Psychiatric Association, 2013; Lemmens et al., 2011). However, few studies are able to investigate the directionality or primacy of problems found to be connected with video game addiction so far (Gentile et al., 2011; King, Delfabbro, et al., 2013; Lemmens et al., 2011).

This section will summarise the literature on video game addiction and associated problems, covering structural characteristics of video games and aspects of social, physical and mental health shown to be related, including limitations of the research. This section presents the literature under the broad headings of video game addiction and structural characteristics, social

well-being, psychological well-being, physical well-being and brain studies; however these categories are not mutually exclusive.

Structural characteristics and motivations for play.

Like earlier research on the needs and gratifications satisfied by media use, video game addiction has also been significantly related to playing motivations. Video game addiction has been tied to the desire to escape real life problems. Yee (2006a) found that a multi-level regression model using play motivations and demographic variables significantly accounted for variance in video game addiction scores (R^2=.34, p<.001), with the motivation of 'escape', defined as the motivation to 'escape from real life problems', emerging as the highest predictor (β=.31, p<0.01), followed by hours of play per week (β=.30, p<.01) and the desire to advance in the game (β=.17, p<.01). A later study also involving Yee (Caplan, Williams, & Yee, 2009) employed a hierarchical multiple regression with 4000 adult MMO gamers, which may have identified some of the things people are escaping from. The study explored relationships between demographics and internet usage characteristics in the first step, followed by personality characteristics and psychosocial wellbeing in the second step, and finally playing motivations and MMORPG usage characteristics in the third step, in predicting problematic internet usage (PIU). Demographics and internet usage aspects explained 14% of overall variance in PIU scores, personality and psychosocial wellbeing added an additional 22% of variance explained to the model, and finally playing motivations accounted for a significant but small 2% of additional variance. In the final step, higher loneliness (β=.30, p<.01), physical (β=.13, p<.01) and verbal (β=.08, p<.01) aggression, deriving a sense of community from online experiences (β=.12, p<.01), diagnoses of depression (β=.02, p<.01), substance addiction (β=.04, p<.01) and behavioural addiction (β=.07, p<.01) were all significant positive predictors of PIU, but anxiety was not (p>.05). Introversion (β=-.08, p<.01) and deriving a sense of community from non-online interactions (β=-.02, p<.01) were inversely related. The playing motivation of immersion (β=.08, p<.01), the use of voice chat (β=.07, p<.01) and time spent playing (β=.02, p<.01) were significant, but achievement motivation was not (p>.05), unlike Yee's (2006) earlier finding. This study utilised a novel approach whereby the game company

allowed access to back-end servers to provide data directly recorded about on their play, rather than relying on self-report.

Qualitative studies have provided some corroboration. Interviews conducted with Taiwanese students (Wan & Chiou, 2006) deemed as addicted to video games indicated their motivations to play fell into the following seven themes:

(1) entertainment and leisure;
(2) emotional coping (diversions from loneliness, isolation and boredom, releasing stress, relaxation, discharging anger and frustration);
(3) escaping from reality;
(4) satisfying interpersonal and social needs (making friends, strengthening friendships, and generating a sense of belonging and recognition);
(5) the need for achievement;
(6) the need for excitement and challenge; and
(7) the need for power (the sense of superiority, the desire for control, and facilitation of self-confidence)

By asking questions about, and prompting participants to contrast self-representation in the 'real' world and the virtual world, the authors concluded that this group of addicted gamers used their online play to compensate for roles that they were unable to fulfil in real-life; as well to escape from psychological distress. Further case study evidence would be particularly useful in providing rich information about the role that video games play in the lives of those experiencing problems, either relating directly to gaming or other aspects of their lives.

Another innovative study was recently conducted investigating the importance of structural characteristics in video game addiction (King, Delfabbro, & Griffiths, 2011). After proposing a five-factor taxonomy of video game structural features, the authors investigated whether these features were more highly valued by a video game addicted (termed 'problem' gamer, n=61) group, compared with their non-addicted counterparts (n=360). Taking a cautious approach to modelling these variables, a hierarchical multiple regression was conducted which controlled for the impact of time in the first step, therefore factoring out the relationship between time commitment and structural factors. Even after controlling for time, several structural characteristics explained a further 15% of variance in video game addiction scores. Adult

content, including violence, finding rare items, tactile sensation of playing, story cut-scenes and managing game resources were listed as significantly more important by problem gamers than non-problem gamers (for a complete list please see King, Delfabbro and Griffiths, 2010, p. 327). However, the beta coefficients in the hierarchical regression were small for each individual feature. These results complement the information provided by general motivations of play literature, described above.

Other qualitative studies have investigated how gamers perceive the concept of video game addiction themselves and relationships with video game structural characteristics. An analysis of the online forum accounts of 12 problematic Everquest players who had quit, or quit then returned to play, reveals descriptions of excessive gaming (Chappell, Eatough, Davies, & Griffiths, 2006). Participants described games as the main activity in their lives, with gaming being initially positive, with qualities of being fun, challenging and social, which later changed as games 'took over', and interfered with school, work, relationships or healthy eating. Hussain and Griffiths (2009) undertook e-interviews with 71 (19 female) World of Warcraft players, classifying 12 as excessive; although 40 reported their play had been excessive at some point in time. They identified six main themes relating to the role of video games in their lives. Namely, the integration of online games into many aspects of their life, excessive play and associated problems, addiction, the psychosocial impact of online gaming, dissociation and time loss and using online games for the alleviation of negative mood. While many described their play as excessive, a minority of the gamers believed that online games were addictive (*n*=14), describing social interaction, competition and in-game tasks as triggers. Most gamers also described positive effects as well as negative, increased socialisation, greater confidence and familiarity with computers, and even building leadership skills, comprehension and complex maths. Oggins and Sammis (2012) surveyed 438 adult World of Warcraft players from the United States and Canada, including open-ended questions about addiction, including a video game addiction scale. One purpose of the study was to contrast researcher notions of the construct from those of players. Through analysis of the open-ended questions it was found that many more participants describe themselves as addicted than actually met the addiction criteria. Also, players described both positive and negative consequences of addiction, and indicated that social norms around gaming also influence the acceptability of certain addiction features. Players also reported the importance of the context of play and other explanatory variables, such as deficient self-regulation and the ability to stop or reduce play, which seemed to be used as an indicator for not being addicted. These studies reveal interesting differences between

players' views and researcher notions of addiction, and the role of structural characteristics within games. In quantitative studies the importance of game characteristics is mixed, with some models suggesting play motivation is a relatively unimportant contributor to PIU (Caplan, Williams & Yee, 2009), and others highlighting in-game characteristics to account for 15% of video game addiction scores (King, Delfabbro & Griffiths, 2011). Future models which incorporate more of these features may help to assess their relative importance.

Social Health and Video Game Addiction

Social well-being can be defined as the availability of people whom the individual trusts, on whom they can rely, and who make them feel cared for and valued as a person (Goldberg, McDowell, & Newell, 1996; Keszei, Novak, & Streiner, 2010). This definition tacitly implies that social well-being also includes the skills required to develop and maintain such relationships, if they are absent. Social well-being is often measured in terms of structural characteristics, that is the size and frequency of social connections, as well as functional characteristics, subjective ratings of the quality of those connections (Goldberg et al., 1996). Social well-being has been demonstrated as an important predictor of morbidity and mortality over the lifespan, thought to be attributable to its' ability to buffer stress (Holt-Lunstad, Smith, & Layton, 2010). As such, it is an important component of health.

After reviewing the literature concerning video game addiction as part of an investigation into the emotional and behavioural effects of video game playing, the American Medical Association concluded that video game 'overusers' are likely to be:

> "somewhat marginalized socially, perhaps experiencing high levels of emotional loneliness and/or difficulty with real life social interactions. Current theory is that these individuals achieve more control of their social relationships and more success in social relationships in the virtual reality realm than in real relationships." (American Medical Association, 2007).

A recent meta-analysis investigated the connections between mental, social and academic functioning and video game addiction (Ferguson et al., 2011). The authors concluded that social variables showed the strongest connections to video game addiction, higher than mental health and academic functioning. After amalgamating 30 published articles and three doctoral theses, the pooled and corrected correlation coefficient of social variables and video game addiction

was .25, or roughly 6% of shared variance; an effect size generally considered small to moderate (J. Cohen, 1994).

The theory that video game play may have negative social impacts first arose in the 1980s, and has compelled a string of related studies. Generally the underlying mechanism is thought to be displacement or substitution of socialisation, a mechanism thought to also be present in earlier media effects research, such as on television viewing (Rich, Pecora, Murray, & Wartella, 2007).

Social problems have been highlighted in other addictive disorders as well. Blaszczynski and Nower's (2002) pathways model indicates the presence of an anti-social problem gambler as one subset of problem gamblers. Social problems are exacerbated by the excessive time spent pursuing a substance or a behaviour, as well as the conflict caused by prioritizing that activity over other more pro-social activities or the maintenance of existing social ties (Pietrzak & Petry, 2006; Sommers, Baskin, & Baskin-Sommers, 2006).

Negative social consequences, including diminishing one's social circle, is thought to be a direct consequence of video game addiction, with family conflict and social avoidance being included in many video game addiction scales (King, Haagsma, et al., 2013). Diminishing social well-being has also been connected to other media use, including television addiction (Chory & Banfield, 2009). However, studies investigating connections between video game addiction and social health have produced conflicting results, and very few have yet explored these beyond correlation (Lemmens et al., 2011). This section summarises the literature connecting social well-being to video gaming and video game addiction.

Structural aspects associated with social functioning.

There is some evidence suggesting certain structural aspects of video games that facilitate social communication will be particularly attractive or compelling to those with social difficulties. Research into computer-mediated communication indicates online communication can be hyper-personal and intense compared to in-person communication (Bartle, 1996; Campbell, Cumming, & Hughes, 2006; Parks & Roberts, 1998; Sum, Mathews, Hughes, & Campbell, 2008). It is thought that online communication, largely due to its anonymous nature, becomes hyper-personal as people are more likely to disclose personal information that they would not disclose to people in-person (Parks & Roberts, 1998; Suler, 2004). This disclosure is also likely

to be reciprocated, creating a positive loop in which people share highly personal information accompanied by increasing feelings of closeness, more rapidly than with offline counterparts (Nguyen, Bin, & Campbell, 2012). Further, it is thought that due to the greater control of the timing of communication in online messaging, as well as a redirection of communication cues from the non-verbal to the verbal (or textual), that people are able to focus more on the message content, feel more in-control and experience it as more intense (Campbell et al., 2006). These characteristics will be even more appealing to those with social anxiety or social difficulty, as the anxiety-provoking non-verbal cues that exist in face-to-face communication are circumvented (Chory & Banfield, 2009). It is expected that these dynamics will also be present in games which capacitate socialisation. However, social aspects of play were not specifically highlighted as important in the problem gamers identified by King, Delfabbro and Griffiths (2011).

Electronic friend theory, self-esteem and friendship network size.

Several studies have investigated the connections between video game play (as distinct from video game addiction) and social development and functioning. Selnow (1984) first articulated the theory of how video games may be displacing social development. He described the possibility that interactive media, as opposed to passive media like television, may pose more of a threat to social development as the player will spend more time interacting with the game and they may use this play to substitute social interaction with other people. He termed this the 'Electronic Friend Theory' (Selnow, 1984). Taking a gratification of needs approach, Selnow tested his hypothesis using a scale adapted from television watching to video game play, He found that gamers who commit more play time and money were more likely to perceive games fulfilling needs akin to socialization, including companionship and learning about others. However, considering video game arcades are highly social spaces, and this sample were drawn only from arcade parlours, it is reasonable to assume that people may be perceiving social needs to be fulfilled via this type of play, or at the very least it presents an unmeasured confounding variable in this study. While Selnow's study did not in itself provide strong evidence of social dysfunction being associated with play, the concept was germane and further studies have explored the topic; some using Selnow's scale.

A later study utilizing Selnow's needs scale did find strong inverse correlations between factors in the scale and the Rosenberg self esteem scale in females (ranging from r=-.33 to -.44, n = 52, p<.05), but not males (Colwell, Grady, & Rhaiti, 1995). This needs scale was again revisited

by Colwell and Pain (2000), who found two factors rather than the original five reported by Selnow (1984), one of which they described as a need to be alone, and the other they referred to as 'prefer to friends'. Neither factor correlated with participants' reported number of friends in 'real life', across both genders. However, amount of game play, rather than Selnow's factors, displayed an inverse correlation with reported number of friends in boys only (r=-.22, n=95, p<.05).

Using relatively strict criteria to define video game addiction, including endorsement of 2 out of 3 preoccupation/salience criteria and 3 out of 7 negative outcome criteria, Porter, Starcevic, Berle and Fenech (2010) also found video game addicts had significantly fewer offline friends than non-addicts and more often reported finding it easier to meet people online than offline.

Personality and social well-being.

A further study using a similar gratification of needs scale to Selnow also included measures of personality (Barnett et al., 1997), and found that introversion was associated with the factors 'preferring videogames over friends' (r = .22, N = 229, p < .001), a desire to 'play video games to fantasise' (r = .24, N = 229, p < .001), and to 'escape from daily concerns' (r = .31, N = 229, p < .001). Furthermore, self-esteem was negatively correlated with tendency to perceive video games as companions (r = -.26, N = 229, p < .001), and conscientiousness was negatively related to the importance/compulsiveness of play (r = -.24, N = 229, p < .001). This finding is in line with the inverse association between problematic role playing gaming and introversion described earlier (Caplan, Williams & Yee, 2009).

Peters and Malesky (2008) described similar personality findings with a sample of MMORPG players, with video game addiction correlating inversely with agreeableness (r =-.304, N = 145, p= 0.001), extraversion (r=-0.235, N=145, p=< 0.05) and conscientiousness (r=-.289, N= 145, p=< 0.001), and positively with neuroticism (r=0.381, N=145, p= < 0.001).

Loneliness and social competence.

Another recent study utilising two separate samples of Dutch adolescents found that loneliness was positively related (N = 352 and 369, r = .337 and .192, p<.001 for both) and social competence inversely related (N = 352 and 369, r = -.194 and -184, p<.001 for both) to scores

on a video game addiction scale (Lemmens et al., 2011). King and Delfabbro (2009) found that, when compared to Australian norms, heavy players scored lower on the subscale of Social Functioning on the SF-36 health index, which has well-established norms (heavy players *M*=78.3, *SD*=22.9, Australian norms *M*=89.3, *SD*=19.1, *d*=.51).

Relational maintenance.

Video game addiction has also been shown to negatively predict measures of relational maintenance, important skills related to establishing and maintaining satisfying social relationships. Chory & Banfield (2009) found that scores on 5 out of 7 subscales measuring relational maintenance strategies significantly predicted video game addiction scores in a multiple regression analysis, specifically assurances (β=-.24, *p*<.05), openness (β=-.25, *p*<.05), conflict management (β=-.24, *p*<.05), shared task (β=-.30, *p*<.05), advice (β=-.23, *p*<.05); but did not significantly predict the subscales positivity and social networks.

Social anxiety.

Studies originating in Taiwan have presented evidence of a relationship between video game play and social dysfunction that is more alarming. Lo, Wang and Fang (Lo, Wang, & Fang, 2005) found that 'heavy' video game users in a Taiwanese sample displayed lower mean scores on the Garthoeffner, Henry and Robinson's Interpersonal Relationship Scale compared to 'light' and non users (heavy users *M*=182.90, *SD*=10.40, *n*=32; light users *M*=205.10, *SD*=6.60, *n*=22; non-users *M*=219.20, *SD*=10.20, *n*=120) as well as higher mean scores on the Inderbitzen and Walters Social Anxiety Scale for Adolescents (heavy users *M*=79.30, *SD*=8.320, *n*=32; light users *M*=63.10, *SD*=8.65, *n*=22; non users *M*=67.30, *SD*=13.10, *n*=120). The groups were not identified using criteria of the components model of addiction, however, but instead by time investment only. These results indicate that quality of interpersonal relationships deteriorate while social anxiety increases with more online play time. Noteworthy is that the non-playing group scored a marginally higher social anxiety mean than the casual playing group, although this difference was not subjected to null-hypothesis significance testing, or assessment of effect size.

A further study with a sample of 1228 Taiwanese high schools students found video game addicts had significantly lower family closeness, coupled with higher sensation seeking, boredom inclination and animosity (Chiu, Lee, & Huang, 2004). Kim, Namkoong, Ku & Kim (2008) found narcissistic personality traits to be significantly related to a measure of video game addiction (r^2 = 0.36, p < .01), and inversely related to a brief measure of interpersonal relationship quality (r^2 = 0.16, p < .01).

Qualitative reports.

Some qualitative and case studies have provided partial triangulation of the relationship between video game addiction and social well-being, with studies describing excessive game players as socially withdrawn and anxious, experiencing great difficulty socializing offline and compensating for this with their online-identity (Allison, von Wahlde, Shockley, & Gabbard, 2006; Hussain & Griffiths, 2009). Although the subject of the Allison, von Wahlde, Shockley and Gabbard (2006) case study had mental illness dual-diagnoses and a problematic family history, there was a large amount of discussion revolving around the role of video games in the adolescent boys' life. It appears that in this case gaming provided a safe means by which the person could engage with others without fear provoking face-to-face communication; as well as a mechanism for dealing with anxiety, largely through escapism. The treating therapists argued against abstinence from games altogether as this would take away a crucial coping mechanism.

Contrary evidence.

In contrast to these findings, some studies have found only very small connections between video game addiction and social functioning. Loton (2007) examined the cross-sectional relationships between a measure of video game addiction and a diverse measure of the skills important in forming meaningful social relationships in a sample of 632 adult gamers. Despite the social skills measure being diverse, targeting verbal and non-verbal sending, receiving and appropriateness skills, and having extensive validity predicting measures of emotional intelligence and future career success in past studies, social skills were only predictive of a marginal amount of video game addiction variance. Specifically, when the six subscales measuring different aspects of socialisation were entered in a multiple regression model, only Social Sensitivity emerged as significant (β=-.17, p<.01), explaining 3% of variance in video

game addiction scores. Self-esteem was also inversely related to addiction, with similarly small magnitude (β=-.09, *p*<.01). A measure of balance between all dimensions of social skills was also tested for a relationships to video game addiction, as this measure has been related to psychopathology in past studies, but no significant relationship emerged (*p*>.05). Other recent studies have found similar results, finding small inverse relationships between online game play and the same social skills, albeit with different subscales (Kowert & Oldmeadow, 2013).

These results suggest that long-term stunted social development and social skill deficits are not substantial risk factors for video game addiction. Instead, connections between video game addiction and social difficulties may be more related to other difficulties in initiating and maintaining relationships, rather than an underlying deficiency in social capacity.

Longitudinal studies of social health and video game addiction.

There have been very few studies investigating the longitudinal fluctuations of social wellbeing and video game addiction, and of two notable studies, results are contradictory with regards to whether social wellbeing represents a risk factor, consequence, or both. In a two wave longitudinal sample across six months, 543 Dutch teens aged 11-17 years (*M*=13.9, *SD*=1.4), 70% male, who played video games completed several scales (Lemmens et al., 2011). Measures included the 20 item UCLA Loneliness scale, a social competence scale formed with items from other well-established social competence scales and the Rosenberg 6 item self-esteem scale, and the Satisfaction With Life Scale (SWLS). Using a longitudinal structural-equation model with auto-regressive paths controlling for effect of earlier waves, the authors were able to test whether the psychosocial variables represented a cause, consequence or reciprocal relationship with video game addiction.

The authors concluded that loneliness is bidirectional, finding loneliness at time 1 predicted video game addiction at time 2 (β = .12, *SE* = .035, *p* < .01), as well as video game addiction at time 1 predicting loneliness at time 2 (β = .12, *SE* = .061, *p* < .01). Social competence inversely predicted video game addiction at time 2 (β = -.15, *SE* = .035, *p* < .001), but video game addiction at time 1 did not predict social competence at time 2. Self-esteem at time 1 was also inversely predictive of video game addiction at time 2 (β = .10, *SE* = .066, *p* < .05), but the reverse was not predictive. Also, a bootstrapping procedure indicated self-esteem was not significantly predictive in one of the calculated samples and therefore may not be important.

Contrasting other cross-sectional studies, life satisfaction was not significantly predictive of video game addiction, or vice-versa, at either time point. As only loneliness was deemed to worsen as a result of video game addiction (and only to a very small degree), the authors concluded that video game addiction may be more symptomatic of underlying psychosocial vulnerabilities rather than a primary disorder.

Gentile et al. (2011) surveyed 3034 Singaporeans teens across grades 3, 4, 7 and 8, taking measures of social competence, emotional regulation, empathy, identification with game characters, parent-child relationships, goal-setting, relationally aggressive behaviours, relational victimization, ADHD symptoms and social phobia. Results indicated that lower social competence, empathy, emotional regulation skills and higher impulsivity and identification with game characters are risk factors for developing video game addiction. In terms of consequences, social phobia appeared to be an outcome of video game addiction as it was a prominent in the group whose addiction scores increased over the study, compared with those who remained stable. Likewise, gamers who were addicted but stopped showed significantly decreased social phobia. It was also found that parental relationships deteriorated after becoming an addicted gamer. The authors indicated that these relationships are mostly likely bidirectional and mutually reinforcing, and that more longitudinal studies are needed.

Summary of social health and video game addiction.

Together, results suggest video game addicts may have lower self-esteem, are lonelier, less socially competent, agreeable and conscientious, more introverted, neurotic, socially anxious and aggressive, feel more of a sense of community and find it easier meeting people online than offline, with fewer offline friends. Few longitudinal studies are unable to identify whether relationships represent antecedents or consequences. Of those that can, only loneliness and social phobia have longitudinal evidence suggesting a worsening after video game addiction (Gentile et al., 2011; Lemmens et al, 2011). Effect size between video game addiction and social variables is small to moderate, but stronger than mental health variables, according to one meta analysis (Ferguson et al., 2011). Most of these associations suggest that people exhibiting video game addiction are likely to be predisposed to social difficulties prior to the condition developing, as many variables develop early and are stable over the lifespan, such as personality traits. As such, associations with many of these factors already suggest a

mechanism linking the negative consequence and video game addiction. Other underlying mechanisms are suggested to be displacement of existing social ties, or opportunities to develop them (Chory & Banfield, 2009). This cluster of relationships may represent evidence of a socially problematic subgroup of gamers that use games as a means of escape and substitution for in-person socialization, which may represent a proportion of their video game addiction.

In seeming contrast to these findings, several studies have reported relationships between video game play and positive social functioning; but these studies do not always attempt to delineate a heavy playing group or include a measure of addiction. As some have suggested, for people who may have low social well-being or may be experiencing co-morbid conditions which impede the development of social relationships, such as autism or social anxiety disorder, or even being located in a geographically remote location, it is possible that the less challenging social avenues and communication provided by video games may provide a stepping stone to promote or sustain social development (Campbell et al., 2006; Tanaka et al., 2010). Some studies have even found positive connections between general video game playing and friendship network size (Colwell et al., 1995; Sakamoto, 2005). These contrasting findings may be one indicator of the difference between high engagement and addiction.

How large or unique this sub-sample experiencing social difficulties may be amongst a cohort of gamers who may be considered addicted, such as in the distinct classes of problem gamblers described by Blashinsky's pathway theory (Blaszczynski & Nower, 2002), is currently unknown. Similarly, due to the paucity of longitudinal studies and conflicting results in the few that have been conducted, the importance of social wellbeing amongst a host of other contributors is largely unknown. As is the degree to which it represents a risk factor, consequence or bi-directional and mutually reinforcing relationship. If the latter explanation is correct, video game addiction and diminishing social well-being should represent a downward spiral. Measures of video game addiction have also been connected to mental health and well-being.

Mental Health and Video Game Addiction

Several studies have now investigated the potential link between video game addiction and mental health and well-being, including psychological distress, psychopathology and diminished

functioning. These studies date back to the 1980s (R. F. McClure & Mears, 1984; R. Z. McClure & Mears, 1986). Few significant relationships were found between general video game play and psychopathology at that time (Mclure & Mears, 1986), but the strength of relationships appears to be increasing (Starcevic, Berle, Porter & Fenech, 2010). This may be due to advances in the technology and changes in the way people use videogames. Studies have also investigated connections with psychological characteristics which are strongly related to mental well-being, but would not be considered direct indicators. Studies have now tied video game addiction and extensive video game play to lower mental and physical health (King & Delfabbro, 2009), life satisfaction (Lemmens, Valkenburg & Peter, 2009), higher life trauma (Yang, 2005), a desire to escape from problems (Yee, 2006b), psychopathology (Starcevic, Berle, Porter, & Fenech, 2011), and health related quality of life (Mathers et al., 2009). Most studies are cross-sectional surveys that attempt to identify correlates between video game play and/or addiction and indicators of mental health and well-being. Very few studies investigate these connections over time or include mediating or moderating variables, but those that do are better able to speak to the importance of video game addiction in bringing about negative consequences, amongst other pathogenic contributors.

Psychological distress and psychopathology.

King and Delfabbro (2009) conducted surveys with Australian video game players in order to compare their general health with Australian norms, including a measure of video game addiction. Analyses included correlations between paying time and the Short Form 36 General Health Questionnaire and the Kessler Psychological Distress Scale (K10). Only a low correlation between addiction and the mental health dimension of the SF-36 emerged (r=-.10, p<.01). However, when a 'heavy' group was defined based on the criteria of playing at least 30 hours per week, four days per week and a minimum 3 hour mean playing time per session, some greater differences between Australian norms emerged. The heavy players (n=45) scored significantly lower on the mental health indicator than Australian norms (heavy players M=72.3, SD=18, Australian norm M=77.7, SD=17.7, Cohen's d=.30). The magnitude of difference in scores on the SF-36 between the heavy group and Australian norms was described as small to moderate. With regards to the K10, 55% of the heavy group scored in the 'low risk' range, and 23% scored in the 'moderate risk' range. While this analysis does indicate mildly lower health scores for heavy players compared to Australian norms on the SF-36, the degree of difference

is small. Further, scores on the K10 indicate that the heavy group was not experiencing clinically high levels of psychological distress.

One of the few longitudinal cohort studies found a similar result with regard to depression. Primack, Swanier, Georgiopoulos, Land and Fine (2009) investigated relationships between media use, including video games, and depression in 4142 (47.5% female) adolescents from the U.S. over a seven year period. It was found that while television and total media use correlated with later depressive symptoms, video game play was unrelated. This study asked participants for their average hours of exposure to different kinds of media, thus allowing a high playing sub-group to emerge. A video game addiction scale was not included. Yet most video game addiction measures report a very high relationship with hours of play, so it is reasonable to hypothesise that some relationship would have emerged between depression and video game playing time in this study, if it existed in the population. All participants had never received a diagnosis of depression at wave one, and the wave three sample was weighted to control for co-variates, including demographic factors. This study suggests television, and overall media usage, may be more important than exposure to video game playing in subsequent mental health outcomes. King, Delfabbro and Zajac (2011) investigated the relationships between a measure of video game addiction and mental health in another study. In this case, significant positive correlations were found between video game addiction and symptoms of depression (r=.18, p<.01), anxiety (r=.29, p<.01) and stress (r=.22, p<.01), as measured by the depression anxiety stress scale (DASS). These correlations were described as small.

Other studies have focussed on cognitive testing to investigate whether video game addiction is related to delayed response to video gaming stimuli. Using a polythetic cut-off of 5 out of 10 items from the original 13 item scale, it was demonstrated in a small sample of adults (N=40, n=20 addicted and n=20 engaged) that video game addicts had significantly delayed reactions to gaming-related words than engaged gamers, in a cognitive task (Metcalf & Pammer, 2011). This delay correlated significantly with total addiction scores, but did not correlate significantly with scores on the Depression Anxiety Stress 21 item version scale (DASS21). The finding that more highly engaged and possibly addicted gamers show delays to game-related words compared to less engaged and possibly not addicted gamers is unsurprising, especially if they are conceptualised as on a continuum. But addiction scores did also correlate positively with total scores on the Depression Anxiety and Stress scale (r=.36, p<.01), while engagement scores did not reach significance (r=.21, p>.05); although magnitude is similar. These results

provide some preliminary validity for the differentiation of addiction and engagement, in that the concentration of addicts on the task at hand was interfered with by addiction-related words, and this interference was not evident in engaged gamers. However, the results also suggest that this interference is not a good indicator of the problematic nature of possible behavioural addictions, as it failed to correlate with symptoms of psychological distress.

Porter, Starcevic, Berle and Fenech (2010) found significant and large magnitude relationships between video game addiction, and even video game playing time, and all dimensions of psychopathology in the Symptom Checklist 90 (SCL90). The SCL90 facilitated a comparison between video game addicts and non-clinical population US norms on symptoms of psychopathology. It was found that all dimensions of the SCL90 were significantly higher for video game addicts than the non-clinical norms. Further, the proportion of participants falling into the pathological range of the scale (over 1.96 *SD* above the norm mean) was compared from video game addiction to those without addiction. Results revealed the proportion to be significantly higher in the addicted group on all dimensions of psychopathology χ^2 (1, n = 11 to 30) = 29.4 to 370, p <.01, with proportions in the pathological region ranging from 12.8% to 34.9% across dimensions. The dimensions with the largest proportion falling into the pathological range were depression (34.9%), followed by interpersonal sensitivity (33.4%) and obsessive compulsive (31.4%). Noteworthy is that interpersonal sensitivity is often used as a substitute for social anxiety, therefore this finding is similar to qualitative and cross-sectional findings related to social well-being. Interestingly, the sample of male video game players (i.e. the non-addicts) also showed significantly higher psychopathology than the non-clinical normative U.S. sample on all dimensions, but with fewer proportion of the sample falling into the pathological range than the addicted group. Overall the results suggest that those with video game addiction show a more severe pattern of psychopathology than gamers without addiction; while non-addicted gamers still displayed higher psychopathology than the scale norms. Given the popularity of video games, this finding related to non-addicted gamers is unusual, and perhaps points to the need for further normative validation of the SCL90, or a very substantial bias in the sample or the sampling technique used. Yet, sampling did not target addicted or problematic gamers specifically and does not differ greatly from the several other studies on video game addiction and mental health which recruited online samples.

Dovetailing the above results were the findings from a large longitudinal epidemiological study of media use and health on adolescents in Victoria, Australia. Drawing from the Health of Young

Victorians Study, Mathers et al. (2009), found that Australian adolescents between the ages of 13-18 who reported playing a high amount of video games (defined as the upper quartile, or > 27 minutes per day) reported significantly more high and very high levels of psychological distress on the K10 than kids who reported playing no video games (*OR* 1.79, 95% *CI*, 1.17 to 2.73; p <.01). What explains this pronounced connection between video game playing time and decreased health is unclear. A measure of video game addiction was not included.

In a sample of Norwegian teens and using latent class analysis to identify a group in which addiction scores increased disproportionately to time spent playing, comparisons of psychosocial indicators were undertaken between addicted and non-addicted gamers (Van Rooij et al., 2011). Measures included the Rosenberg Self-Esteem Scale, the UCLA Loneliness Scale, the Depressive Mood list and the Revised Social Anxiety Scale for Children. The addicted group only showed significantly higher depression scores to the next highest playing group (p<.05), perhaps highlighting the centrality of depression. This study also looked at relationships between a cut-off of high time commitment and these variables, and found similar results, putting into question the validity of the addiction cut-off point as it was not more predictive of negative consequences than time commitment. Further, the number of participants in the addicted group was very small (n=12), likely influencing to the significance testing employed. However, the high playing and addicted groups did show significantly more problems (p<.05) on all four psychosocial measures than lower playing and less addicted groups; which is a significant finding even if it is accounted for primarily by time spent playing and not addiction scores.

Some studies utilising more powerful sampling methods have also investigated the connections between mental well-being and video game addiction. Mentzoni et al. (2011) measured relationships between video game addiction and mental health variables. Using a Norwegian national registry, 2500 people were randomly selected and sent a survey battery including the Hospital Anxiety and Depression Scale (HADS). After 816 participants aged 15-40 responded, MANOVAs were conducted comparing addicts based on the stricter and rarely used monothetic cut-off with non-addicts. Results indicated addicted gamers scored significantly higher on anxiety and depression (F(2,792)=9.87, p<.01), although the effect size was small and the mean scores for the addicted group falling within the normal range for the HADS.

Rehbein et al. (2010) investigated relationships between video game addiction and psychological stress and suicidal thoughts in a sample of 4727 German teens with a mean age

of 15.3 (*SD*=0.69). Gamers were classified as addicted using a monothetic cut-off and 'at-risk' using a polythetic cut-off (+2 *SD*). Alarmingly, addicted gamers showed significantly more suicidal thoughts, with 12.3% endorsing this item compared to only 2.4% of the main group. Addicted gamers also reported significantly higher mental stress, but the degree of difference is not reported. In a logistical regression predicting video game addiction scores, it was found school-related anxieties (β=.54, *p*<.01) was a significant predictor, however diagnostic history of depression, anxiety or ADHD were not. Nor was parental abuse, parental educational level (a proxy for socio-economic status) or low juvenile education. The way this study distinguished between what may be risk factors and outcomes is unclear. Finally, a study of Norwegian adults (*n*=3405) found that gaming over 4 hours daily was related to increased depression, suicidal ideation, anxiety, obsessions/compulsions and even alcohol/substance abuse (Wenzel, Bakken, Johansson, Götestam, & Øren, 2009). A limitation of the study is that it did not include a measure of video game addiction.

Longitudinal studies.

Longitudinal studies are particularly important in further understanding relationships between video game addiction and mental well-being as they have the potential to explore the temporal order of events. Establishing this 'temporal precedence' is a step toward identifying whether video game addiction is causal in any associated problems (Hoyle, 1995) . Such findings have implications for the notion of video game addiction as a primary illness, and its' role amongst a host of other health contributors. At present there are few studies investigating the connections between mental health and video game addiction over time.

Gentile et al. (2011), collected data from 3034 Singaporean youth across a two-year period, with three data-capture points. This study included measures of mental wellbeing. As described above, participants were grouped according to longitudinal video game addiction trajectories, and then compared to distinguish risk factors from outcomes. Results indicated that poorer emotional regulation was a risk factor for developing video game addiction. Similarly, participants who became addicted throughout the study worsened in measures of depression and anxiety. However, only 1.3% of the longitudinal sample who were not addicted at time 1, became addicted in the next two years; it is a small group on which to draw conclusions (*n*=35). Yet a group of participants who were deemed addicted at baseline recovered by the final wave (*n*=36) and showed a similar decrease in symptoms of depression and anxiety. Cut-off points for severity, which may equate to likely diagnoses of depression or anxiety, were not included in the

analysis. As in some other studies, there may have been a relationship between video game addiction and mental health, but overall the addicted group still falls within healthy norms (King & Delfabbro, 2009). Nonetheless, the overall results suggest that higher depression and anxiety are, at least partially, negative consequences of video game addiction, not just risk factors.

A more recent study investigated the longitudinal trajectories of Australian adult gamers, including two intervals over an 18 month period (King, Delfabbro, et al., 2013). This study utilised a well-validated video game addiction scale, and indicated that over an 18 month period, video game addiction symptoms abated with no intervention. This result suggests video game addiction may be a short-term phase for most adult gamers, which abates with no intervention. However, further studies are needed to ensure this finding was not the consequence of sampling method or other aspects of study design.

Another longitudinal study, using resource-intensive participant interviews of over 4000 youth, attempted to identify the effect of media exposure on development of depression (Primack et al, 2009). 4142 Teenagers from a nationally representative American sample completed measures of media exposure and mental health in 1994, and were then interviewed in their home seven years later. Results indicated a strong relationship between television consumption and overall media consumption and the development of subsequent depression. A sub-analysis of video game playing found no relationship.

Summary of mental health and video game addiction.

Associations of varying strength have been found between video game addiction and several mental health variables, including: different measures of psychological distress (K10, SF36), life trauma, depression, anxiety and school-related anxiety, stress, substance abuse, interpersonal sensitivity, obsessive compulsive tendencies and suicidal ideation. Most studies have found links between mental health and video game addiction, when measured, but some found addicted gamers fell into the normal range of mental illness symptomatology, or reported no significant connection with the same variables in different analyses. Further studies are required to clarify these mixed results.

Physical Health and Video Game Addiction

A number of studies, including large scale epidemiological surveys, have investigated the possible connections between video game playing and physical health and well-being, including physical inactivity, body-mass index and sleep health (King & Delfabbro, 2009; Mathers et al., 2009; Mentzoni et al., 2011; Rehbein et al., 2010). Fewer studies have investigated the connections between video game addiction, rather than playing time, and physical health and well-being. It is logical to assume that video game addiction is related to physical health, particularly sleep health as sleep deprivation is included as a specific negative consequence in video game addiction scales (King, Haagsma, et al., 2013). However, the results pertaining to the relationship between both video game playing, and video game addiction, and physical well-being are mixed.

General health, exercise and BMI.

Mathers et al. (2009) found that high video game use (>27 minutes per day) was associated with poorer health status as measured by the well-validated Pediatric Quality of Life Inventory 4.0 (r = -2.40, 95% *CI*, -4.20 to -.60; p=.009), and Health Related Quality of Life KIDSCREEN index (r = -1.19, 95% *CI*, -2.35 to -.03, p=.04). This decrease in health with video game play was said to account for the majority of the variance in the negative relationship found between all media use and health, which after the removal of video game play, was no longer significantly associated with lower health outcomes. The sample for this study was large and randomly selected.

Mentzoni et al. (2011) found that video game addicts did not have significantly poorer self-reported health status or exercise frequency than non-addicted gamers; but the non-addicted gamers scored significantly lower on both measures than those who did not play video games at all. They also measured exercise frequency and found no significant difference across these groups. By contrast, when heavy Australian gamers were compared to well-established norms, King and Delfabbro (2009) found they differed in the areas of ‘Physical Functioning’ (heavy players M=91.7, SD=12.6, Australian norm M=94.7, SD=9.7, d=.27) and ‘Vitality’ (heavy players M=61, SD=17.8, Australian norms M=67.7, SD=19.2, d=.36), or ‘General Health’ (heavy players M=67.5, SD=19.4, Australian norms M=75.8, SD=18.6, d=.44). Further research is required investigating connections between video game playing, video game addiction and physical activity.

Sleep health.

Some video game addiction scales include a specific item asking about sacrificing sleep to play, with some ramping this together with other negative consequences such as skipping meals or time with family (Tejeiro Salguero & Morán, 2002). However, a review of all scales measuring video game addiction indicated that only four scales out of 19 included items asking about negative consequences to sleeping habits (King, Haagsma, et al., 2013). Sleep deprivation can have severe impacts on health and functioning, and as such it is important to understand its' role, if any, in video game addiction (Grandi & Coppola, 2013).

In a large sample of 15168 German ninth graders (Rehbein et al., 2010), it was found gamers deemed as dependent had significantly lower amount of sleep. They slept for 6.9 hours per night on average compared with 7.5 hours for the group playing <2.5 hours per day. The dependent group also reported far higher sleep disturbance (15.1%) compared to the control (4.1%). In a study of 540 Everquest players, 18.1% indicated they regularly sacrifice sleep to play (Griffiths et al., 2004). In a sample of 100 University students, MMORPG players self-reported significantly worse sleep quality using a single item measure than arcade gamers, console gamers and PC gamers (Smyth, 2007).

Some studies have investigated whether video game playing, as opposed to other forms of media consumption, is particularly hazardous to sleep. One experiment, conducted in a sleep laboratory and taking measures of physiological and cognitive arousal, found gamers were more cognitively aroused than a control group who watched a DVD, but that indicators of sleep quality, including rapid eye movement and slow wave sleep were no different (Weaver, Gradisar, Dohnt, Lovato, & Douglas, 2010). While sleep onset latency was increased and gamers reported subjectively poorer sleep quality, the differences were small, in contrast to expectations. However, this study related to moderate video game playing. Further studies are needed to determine the influence of video game addiction on sleeping habits and subsequent effects on other health indicators.

Academic and Work Functioning

The DSM-V definition of 'Internet Gaming Disorder' includes the diagnostic criteria:

Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of participation in internet games. (American Psychiatric Association, 2013, p. 795).

It is also hypothesized that video game addiction is related to deterioration in functioning in different, but important, areas of life. How these areas of importance are identified as the most critical for successful functioning is not discussed. Suffice to say, functioning or performance in these areas are thought to be necessary for well-being and the ability to meet one's needs in society. That said, the importance of these domains is likely to vary from person to person, and some measure of the importance of these life domains would be useful when investigating the impact of factors, including proposed behavioural addictions, upon them. In studies of video game addiction, impact on these domains is often measured using single-item 'negative consequences' components of video game addiction scales, which asks people whether video games have negatively affected their functioning at work or school, or spending less time with friends or family (King, Haagsma, et al., 2013).

Whether a single-item measure is sufficient for understanding the connections between video game addiction and functioning in life domains is uncertain. Some anecdotal accounts and qualitative studies have described gamers who have difficulty maintaining work due to gaming habits (Chappell et al., 2006; Hussain & Griffiths, 2009). There is quite a long history of studies investigating relationships between aspects of video game playing, such as time spent playing, violent games and ADHD symptoms, and academic functioning (Anderson & Dill, 2000; Chan & Rabinowitz, 2006; Creasey & Myers, 1986; Gentile, Lynch, Linder, & Walsh, 2004; Harris & Williams, 1985). Some studies have now found connections between video game addiction and academic performance. In a sample of 333 Singaporean elementary school students, Skoric et al. (2009) found that video game addiction tendencies explained a small to moderate amount of variance in grade average across the subjects of english (β=-.33, p<.01), maths (β=-.20, p<01) and science (β=-.23, p<.01). In another sample from that region, 1422 fifth graders (674 females and 748 males, *M* age = 11.88) from Seoul, South Korea, completed a battery of scales measuring video game addiction and academic self-efficacy. Small to moderate inverse relationships were found in 8th graders (r=-.27, p<.01) and 5th graders (r=-.15, p<.01).

In a sample of 15168 German teens, boys who gamed extensively showed slightly worse grades in German, history, and sports (Rehbein et al., 2010). Further, youth deemed addicted

were more often classified as multiple truants with more than 5 days absent from school (p<.01). Addicts more often listed video gaming as the reason for their truancy (p<.01). A similarly mild effect was found in another adolescent sample by Gentile et al. (2009). In a sample of adults, it was found that addiction was inversely related to academic achievement whereas video game engagement was not (Skoric et al., 2009). Most studies have focussed on teenagers and few studies have yet investigated the predictive validity of video game addiction on functioning in paid work, or job seeking for those who are seeking work. Likewise, no studies have yet asked participants to set their own goals and measured the importance of video game addiction in meeting or not meeting these goals, which would ensure the area of functioning under investigation is assessed as relevant to participants.

Brain Studies

New methods of observing brain activity are providing glimpses into the biology of hitherto primarily psychological phenomena. Studies have examined the anatomy as well as electrical and chemical brain activity of video game players and video game addicts in response to relevant cues, using Electro-Encephalograph (EEG) and functional Magnetic Resonance Imaging (fMRI). Some of these studies explore the degree to which neurological activity and anatomy are able to distinguish groups with different levels of problem play, and to compare these differences with those identified as important in more established addictive disorders, as well as to explore possible underlying contributing processes.

Thalemann, Wölfing and Grüsser (2007) found that EEG results were able to distinguish between addicted and non-addicted video gamer groups with respect to their reaction to game-related cues. They found that video game addicts showed significantly more extended late productivity evoked potential at the parietal region electrode Pz (F (1, 28) = 7.84, p = .009), compared to casual players. Additionally, EEG via the late positive complex (LPC) is able to distinguish between affective and emotion-irrelevant cues, and according to this differentiation the reactions observed in excessive computer game players was of an emotional nature and significantly more arousing (Schupp et al., 2000). Based on the similarity of this heightened electrical activity to that observed in similar psychophysiological studies of substance abusers, the authors concluded that video game addicts are conditioned according to the mesolimbic dopaminergic system, coupled with incentive salience of specific computer game related cues.

fMRI studies directly observing the chemical activity within the brain may be able to provide more evidence for the role of dopamine in conditioning compulsive video game play. Brain studies represent a unique method of establishing validity for behavioural addiction in that they provide the opportunity to compare, in a quantitative manner, the extent and ways in which video game addicts' and substance abusers' brains respond to addiction relevant stimuli. Another line of investigation will be how similar brain reactions may be on withdrawal of chemical compared to behavioural addictions; although monitoring participants in such a study would be difficult in order to guarantee abstinence.

However, brain studies are not without limitations. They are not yet easily able to control for individual differences in brain activity, which can be quite unique in response to similar functions or cues and may limit ability of brain imaging to identify certain primarily behavioural and psychosocial conditions. It is also difficult to control for familiarity with the cue content, which is a confounding variable in cue-reactivity studies (Locke & Braver, 2008; Logothetis, 2008). This is particularly true in the case of possible behavioural addictions, for which the distinguishing line between high engagement and addiction is not yet clear. Early cognitive tests indicate conflicting results with regards to cue-reactivity of video games, with some highly engaged gamers showing faster reactions to game-related cues, while others showing the opposite (Han, Kim, Lee, Min, & Renshaw, 2010; Thalemann et al., 2007). These primed reactions do not necessarily relate to mental well-being, although they have been shown to differ across designated addicted and non-addicted groups (Metcalf & Pammer, 2011).

Although studies have identified several brain regions and functions of interest, there is no definitive neuro anatomical, electrical or chemical signature of addiction that can identify the construct accurately across substances, behaviours or individuals, as yet (Harding et al., 2012; Lorenzetti, Lubman, Whittle, Solowij, & Yücel, 2010; Nestler & Malenka, 2004). In fact, the degree to which the neurochemical signatures differ across individuals for even simple thoughts, feelings or stimuli is still uncertain, leaving open the possibility that there is no such signature of either specific or general addiction identifiable across different brains (Locke & Braver, 2008).

The majority of brain imaging studies focus on neurological characteristics related to substance misuse and tend to classify relationships found as consequences of the substance use, related to attention attenuation and cognitive impairment. This is partly due to the paucity of longitudinal

studies which may distinguish risk factors from outcomes (Lorenzetti et al., 2010). In the case of possible behavioural addictions, while theorists are looking for bio-behavioural validation (Shaffer, 2007), neurological results do not necessarily provide opportunities for identifying those at risk, nor avenues for intervention at the present time. Further studies may be able to address these limitations and the full significance of neurological results may become more apparent in future. Until then, qualitative inquiry via interview or quantitative scales which invite self-reflection, ideally with validation from third parties, may be a more useful means of capturing information on people's emotions, cognitions and behaviours, and should always accompany brain imaging studies.

Possible Confounds between Video Game Addiction and Well-Being

A common limitation of quantitative studies investigating cross-sectional associations between variables is causal inference, in that any associations found may actually be the product of a variable not included in that model. These are commonly called co-symptomatic, or confounding variables, or simply, the 'third variable problem' (Kenny, 1975). They may also take the form of mediators or moderators, which are then commonly tested in models to determine process (Preacher & Hayes, 2004).

Studies investigating the possible impacts of video game addiction are also vulnerable to this problem in inference. Many studies which investigate associations between video game addiction and deleterious factors hesitate to theorise exactly which direction these effects occur in, or the underlying mechanisms that may be operating. Difficulties in constructing accurate models are compounded in such studies as the variables of interest are often not directly, or highly accurately, measurable. Further, they usually occur in dynamic settings with a high degree of interconnectivity. Treatment non-specificity has been raised in support of general models of addiction, yet this same non-specificity could also serve as evidence of the lack of importance of the proposed cause of the problems – the addictive condition, in that the condition is surrounded by many other contributing factors which also produce the same negative outcomes, and the negative outcomes react similarly to treatment used successfully for many other conditions (Shaffer et al., 2004). Therefore, it is important for studies to investigate whether video game addiction is predictive of harm, even after accounting for other pathogenic contributors. Considerable advancements have been made in techniques which test models comprised of quasi-scientific social science variables, including advanced mediation and

moderation models which can test the nature of these connections even at the cross-sectional level (Hayes, 2009; Lomax & Schumacker, 2012; Preacher & Hayes, 2004). In line with this reasoning, some studies have begun to explore confounding factors by investigating possible mediators or moderators in any observed outcomes, including coping, basic needs fulfilment, satisfaction, addictive personality and self-regulation.

Coping.

Many researchers describe video game addiction as a coping mechanism for other problems, albeit a maladaptive one (Gentile et al., 2011; Grüsser, Thalemann, & Griffiths, 2006; Rehbein et al., 2010; Wan & Chiou, 2006). Other additive conditions, such as pathological gambling, have also been explained as resulting from maladaptive coping (Wood & Griffiths, 2007). Coping can be defined as "constantly changing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person" (Lazarus & Folkman, 1984, p. 141). Studies tend to discuss coping either in relation to a specific situation, or describe patterns in coping preferences. The latter studies often describe coping styles in terms of either problem or emotion focussed coping (Lazarus & Folkman, 1984).

Quantitative and qualitative investigations of playing motivations both with moderate gamers, and with gamers who identify as addicted, have highlighted gaming as an escape from stress and way of coping (Przybylski et al., 2009; Wan & Chiou, 2006; Yee, 2006b). Despite these many explanations of video game play as a coping mechanism for other problems, very few quantitative studies have directly investigated the role of coping style in video game addiction. The results already described above by Caplan, Williams and Yee (2009) are pertinent, as they found the play motivation of immersion significantly predicted PIU scores, after accounting for a host of other factors (β=.08, p<.01). The authors concluded gamers who play to escape from other problems are more likely to exhibit PIU.

Rehbein et al. (2010) surveyed 15168 German teenagers, including a video game addiction scale. The study included a single item measure of coping style, namely the question "I usually play video games when my life is not going well", alongside self-efficacy, measured using the single item question "How relevant is it for you to feel powerful and in control when playing action games?". It was found that agreement with both items was significantly higher (p<.05) in

an addicted group, suggesting video game addicts may perceive their gaming as a means of coping.

Other studies have investigated coping and video gaming. In a detailed model, Reinecke (2009a) investigated whether video game play can aid the experience of recovery from work-related fatigue and daily hassles, which included the specific recovery dimensions of psychological detachment, relaxation, mastery and control. Also included in the model were coping styles and moderating variable of social support. It was found that gaming for recovery was highly related to more positive recovery experiences (β=.60, p<.01), and people experiencing more work-related fatigue (β=.18, p<.01) and daily hassles (β=.09, p<.01) played games for recovery more. Interestingly, both problem and emotion focussed coping were significantly and positively related to using video games to recuperate, but emotion coping (β=.51, p<.01) was more strongly related than problem coping (β=.22, p<.01). An SEM approach confirmed social support as a moderator, with path strength between work-related fatigue and gaming for recovery increasing in a low social support subsample (β = .25, p < .01, n=775). Hierarchical multiple regression provided further support, with the product of social support and work related fatigue marginally adding to a model (β=-.04, ΔR^2=.01, both p<.05), after controlling for social support and work related fatigue in the first step (however the large sample size will have contributed to the significance level). This study indicates that people do perceive gaming to meet needs of stress recovery, and suggests that people who perceive gaming as such play more when experiencing stressors, particularly people with low social support.

Other coping style scales which measure different coping dimensions shown to be important in health may help to pinpoint the role of coping in video game addiction and negative outcomes (Finset, Steine, Haugli, Steen, & Laerum, 2002). Further studies are needed investigating coping as a possible mediator or moderator between video game addiction and associated problems.

Basic needs fulfilment.

Another proposed confounding factor is basic needs fulfilment. Using the dualistic model of passion and Self-Determination Theory (SDT), Przybylski, Weinstein, Ryan and Rigby (2009) investigated one conceptualisation of the difference between ‘wanting’, or ‘having’, to play; a

distinction akin to addiction and high engagement. Unlike many studies on the topic, the authors couched the concept of video game addiction in broader theories of psychological motivation. SDT posits that if a person has competency (or agency), autonomy and relatedness (adaptive interpersonal relationships), their basic psychological needs will be met and they will have high well-being. The theory utilised in defining this distinction is the dualistic model of passion. This theory posits that passion, defined as a strong inclination toward an interesting and important activity, can either be freely chosen and in harmony with other areas of life (i.e. harmonious passion), or may not be easily controlled and may cause conflict with other life domains (i.e. unharmonious passion). The researchers hypothesised that if basic psychological needs are being met a person will 'want' to play, characterised by unproblematic engagement with video games which is harmonious with other life activities. On the other hand people whose basic psychological needs are poorly met will feel compelled to play, which will be unharmonious with other life domains.

A sample of 1324, mostly male gamers aged 18-43 (*M*= 24.01, *SD*=4.01), recruited online, completed a battery of scales including the trait need satisfaction scale, the harmonious and obsessive passion for gambling scale adapted to video games, a game enjoyment scale adapted from the intrinsic motivation inventory, post-play energy and tension via an adapted activation-deactivation adjective checklist, the five item version of the satisfaction with life scale (SWLS) and medical outcomes study (or MOS36), which produces a measure of psychological well-being. Satisfaction with life was defined as a subjective self-assessment of general well-being.

Although obsessive play is not a direct proxy measure of video game addiction as it does not include as many specific negative consequences as video game addiction scales, it is very similar and was much more strongly correlated with weekly play time (r=38, p<.001) than harmonious play (r=.14, p<.01), providing a point of similarity with many video game addiction scales. After a series of simultaneous hierarchical regressions, overall results supported the hypothesis that obsessive passion was more likely to co-occur with low basic psychological needs satisfaction; and in turn to be related to higher tension and lower energy post-play, lower game enjoyment, lower mental health and lower life satisfaction (see page. 489 for a breakdown of the many models that were run). Similarly, correlational analyses found obsessive play was weakly related to mental health (r=.19, p<.001), and harmonious play (r=.07, p<.05). However, when proportion of variance explained in the multiple regression models was analysed, overall

motivations of play (including the obsessive subscale) accounted for only 1% of well-being, whereas trait need satisfaction accounted for a 40%. The authors concluded that “the moderation models examining overall well-being levels were no longer significant once accounting for variability in basic need satisfactions“ (pg. 490).

These results suggest that deficits in more basic needs satisfaction are far more important in well-being outcomes than a measure of obsessive game playing motivations or time spent playing. Obsessive video game playing does seem to mediate the link between basic needs satisfaction and well-being, but the variance explained is relatively low. This analysis demonstrates how the inclusion of a possible mediating variable can drastically alter interpretations of the relationships of underlying constructs. If, for example, the authors did not test for the mediating effect of SDT but instead calculated the direct relationships between obsessive play and well-being, they may have concluded that obsessive play is pathogenic. However, the inclusion of SDT explained almost all of this variance and downgraded the importance of obsessive play on well-being. The authors called for further longitudinal studies on the topic in order to determine the effect of time on the variables shown to be connected.

In a study using very similar measures but also including video game addiction rather than a measure of obsessive play, 165 Chinese adults (91 women) aged 18-30 (*M*=22.70, *SD*=2.73) completed the purpose in life, sense of autonomy, sense of competence and sense of relatedness scales (Wu, Lei, & Ku, 2012). The authors also couched human behaviour in SDT. They conceptualised the relationships between factors slightly differently, with autonomy, competence and relatedness determining video game addiction, with purpose in life as a mediator. It was found the three SDT measures were inversely related to video game addiction, explaining 38% of variance in the measure. Further, multiple mediation with a 10000 bootstrap and path analysis supported the proposition that purpose in life mediates this connection, accounting for 4% of this variance. Little was said of the size of this mediation effect in the interpretation of results. The stronger relationships between SDT factors and video game addiction in this study, compared with the relationship found with a measure of obsessive play, may reflect the more problematic nature of video game addiction, which includes explicit negative consequences within scale items.

Life satisfaction.

Several other studies have also found connections between video game addiction and life satisfaction. A study with two samples of Dutch adolescents (Lemmens, Valkenburg & Peter, 2009) found a negative correlation between video game addiction scores and the satisfaction with life scale (SWLS) (r = -.31 and -.15). Mentzoni et al. (2011), also using the SWLS, found that Norwegian gamers meeting a polythetic cut-off for video game addiction had significantly lower satisfaction with life than non-gamers or no-problem gamers (addicts M=4.13, SD=0.90, non-gamers M=5.34, SD=1.23). Both studies measured satisfaction with life using well validated scales with acceptable psychometrics. Further, a study with a Chinese cohort of children found significant life trauma history predicted video game addiction, leading the authors to conclude addicted gamers were escaping from emotional problems (Yang, 2005).

Media addiction, addictive personality and self-regulation.

Some theorists have put forward the notion of 'media' addiction. (Chory & Banfield, 2009). While the prime focus of this study was the impact on relational maintenance strategies, the authors also adapted Young's Internet Addiction Scale to measure video games and also television, and participants completed both measures. Participants were 138 undergraduate University students from the U.S. Video game addiction scores were positively correlated with television dependence to the degree of r=.53 (p<.05), indicating 28% of variance is shared between the two; a generally larger magnitude relationship than found in many other cross-sectional video game addiction studies. This alludes to the possibility of a media dependent subgroup which have difficulties controlling and managing their media use. Whether other forms of media use in addition to video game playing and internet use, such as reading or listening to radio, will show similar endorsement of addiction scales is yet to be investigated.

These findings also may be interpreted as evidence of an addictive personality trait. Some studies have found evidence that the tendency to become addicted to one behaviour or substance is related to the tendency to become addicted to others (Davis & Loxton, 2013; Takao, Takahashi, & Kitamura, 2009). Some studies point to underlying genetic and neurobiological idiosyncrasies to this personality trait (Davis & Loxton, 2013). Others have explained addictive personality as a deficiency of self-regulation. Self-regulation can also be seen as a personality trait, as it is likely persistent over time (Vohs & Baumeister, 2011). People regulate their behaviours, thoughts and emotions in many ways, but in this instance self-

regulation refers to an underlying skill, or tendency, in knowing when to switch activities and balance priorities (Vohs & Baumeister, 2011). One very large sample size study on MMORPG addiction, which included measures of possible negative consequences, highlighted self-regulation as the most important predictor of video game addiction scores (Seay & Kraut, 2007). However, the results of this study have not been published in detail. Once again, these results highlight importance of exploring mediating or moderating factors between video game addiction and negative consequences. Other studies have also highlighted personality traits related to video game addiction. Charlton and Danforth (2010) reported correlations between negativity in personality traits and their conceptualisation of addiction, with the same traits largely unrelated to their measure of engagement.

Together these studies highlight the multiple interpretations possible from varied cross-sectional model conceptualisations, based on different theorisations of the how the underlying variables relate to each other. One study suggests a very similar measure to video game addiction is not very important in well-being (Przybylski, Weinstein, Ryan & Rigby, 2009), relative to more basic psychological needs satisfaction. The other suggests that satisfaction with life is a mediating factor, and basic needs satisfaction explains a very large portion of variance in a video game addiction measure (Wu, Lei & Ku, 2012). Further studies are needed in order to determine the importance and possible underlying mechanisms in any connection found between video game addiction and deleterious factors.

Positive Effects of Video Game Play

“Video games are bad for you? That's what they said about rock n’ roll.”

(Shigeru Miyamoto, creator of Nintendo’s Super Mario Brothers; in Paumgarten (2010, p. 6)).

Many media reports of video gaming studies tend to discuss the topic in terms of whether gaming is ‘good’ or ‘bad’ for people. While some studies do attempt to investigate whether what may be termed ‘general’ video gaming is healthy or unhealthy, most focus on a particular aspect such as violence or excessive play. Most of these studies do not attest to their findings being relevant to gaming in any context or amount. Even in studies which have focussed on a particular aspect, such as violence, where the culminating evidence of all studies on the topic have been scrutinised by the supreme court in the United States, a consensus among scientists

or policy makers on the issue has not emerged (Anderson & Bushman, 2001; Ferguson, 2013; Prot, Anderson, Gentile, Brown, & Swing, 2014) . One thing can be certain: it is not possible to conclude that games are either good or bad; in other words that they exert universal effects on players. Instead, studies suggest the outcomes of gaming are complex, ambiguous and varied, dependant on the context of the gaming and aspects of the player. A long history of studies into the effects of other media use, such as watching television, have produced similarly complex and ambiguous results (Bryant & Oliver, 2009). In an effort to address a need for balance and complexity in the consideration of possible effects of video gaming and video game addiction, this section will discuss research which has found positive connections with video game play and consider how these findings may inform studies of video game addiction. Several studies indicate that video gaming, in common contexts or when used to achieve a particular purpose, have been associated with positive outcomes for gamers.

Therapy.

Video games have been successfully used as a therapeutic tool to improve mental health. Amon and Campbell (2008) demonstrated the usefulness of a biofeedback video game in helping children with attention deficit hyperactivity disorder (ADHD) to relax. In a clinical trial-like study, the playing/experimental group showed significant reductions in ADHD symptoms and improvements in emotional, behavioural and social functioning compared to a non-playing control group. These improvements were not only self-reported, buy triangulated via measures completed by the children's parents. Video games have been used to facilitate systematic desensitization in the treatment of phobias, as they are able to simulate fearful content in great detail while still providing control for the gamer over how, and the intensity, with which they experience their phobias (Walshe, Lewis, Kim, O'Sullivan, & Wiederhold, 2003). Video games have also been used to develop social skills for children and teenagers with autism spectrum disorder, finding that video games are able to encourage the development of facial recognition and speech skills (Rahman, Ferdous, & Ahmed, 2010; Tanaka et al., 2010). Video games with kinetic feedback controllers have been used to reliably predict older adults who are at greater risk of falls, allowing earlier intervention; and gaming was also shown to significantly improve balance and reduce future fall risk (Agmon, Perry, Phelan, Demiris, & Nguyen, 2011; Schoene, Lord, Verhoef, & Smith, 2011). Similar 'active' games, which require physical exertion, have also been shown to be effective as exercise tools (Taylor et al., 2012). Video games have been demonstrated to improve physical co-ordination training after stroke or acquired brain injury, and

with people suffering cerebral palsy (Acosta, Dewald, & Dewald, 2011; Levac, Miller, & Missiuna, 2012). Overall, many studies now suggest video games have great potential for aiding a range of therapies and improving health. However, these studies are preliminary in nature. Although many followed a clinical trial-like methodology, most did not include a follow up and were not blinded and therefore require further investigation (for a review see Primack et al (2012)).

Social benefits.

Aside from people experiencing an illness or condition, moderate video game play has also been associated with some positive effects in the general population. In samples of both American and Japanese adolescents, video game play has been significantly correlated with friendship network size, an indirect measure of social functioning (Colwell et al., 1995; Gentile et al., 2009; Sakamoto, 2005). Some of these studies categorised video games as pro-social, and use this as a unit of analysis (Gentile et al., 2009). However, other studies which analysed relationships between friendship network size and video game playing without distinguishing pro-social games still showed a similar relationship (Colwell, Grady & Rhaiti, 1995; Sakamoto, 2005). Other studies have found positive associations between group socialisation, social bonds, mutual support, self-esteem and active games (Lieberman et al., 2011). Through content analysis, some scholars have concluded that MMORPGs provide spaces of informal sociability, and may help to diversify world views, possibly challenging understandings of gender, race and increasing sociability (Steinkuehler & Williams, 2006). One study tested whether the online social support derived from the MMORPG World of Warcraft is able to buffer against negative emotional responses. This aspect is an important component of social support and its' relationship to morbidity and mortality rates is thought to result from a buffering effect against stress (Sheldon Cohen & Wills, 1985). However, the authors reported that after controlling for in-person social support no relationship between World of Warcraft derived social support was present (Longman, O'Connor, & Obst, 2009).

Skill development: education, intelligence and cognition.

Video games, particularly active video games, have also been associated with the development of problem solving and cognitive skills, including greater school readiness, verbal fluency, word

knowledge, attention, motivation, dual-attention tasks, visual-spatial skills and reaction speed (Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Graf, Pratt, Hester, & Short, 2009). A raft of educational video game based applications are now emerging, with hand held devices such as Apple Ipads proliferating among schools, with the support of administrators, in order to support learning (W. Clark & Luckin, 2013; DEECD, 2011). Early studies indicate some video games are able to promote problem solving skills, language-rich spaces, scaffold learning and be an effective educational tool when combined with quality teaching, particularly in encouraging student engagement (Graf et al., 2009; M. F. Young et al., 2012). It is even claimed active video games help to reduce negative classroom behaviours, tardiness and absenteeism, perhaps because of higher engagement (Lieberman et al., 2011). Gamification of educational curriculum is developing as an extensive theory, and discusses at length the possible educational benefits of the defined reward structures of gaming in developing difficult skills.

Exercise.

Video gaming has also been shown not to be as sedentary as comparable activities, such as television viewing. Studies indicate that metabolic rates are significantly higher when playing a video game, even those that do not involve physical activity, than watching television, thought to be due to a higher cognitive demand (Wang & Perry, 2006). In light of this potential, researchers are considering how best to develop video games which promote positive health behaviours (Primack et al., 2012). How specific these benefits are to active video games which involve exercise and the factors mediating these effects is only beginning to be investigated.

Longitudinal results indicating positive outcomes of general video gaming.

Interestingly, some studies indicate moderate video game playing may be part of a healthy adolescence. In one of the few longitudinal studies on video game playing and development, 1304 high school students completed questionnaires from 1983 to 1988 that included measures of psychosocial health and game play behaviour (Durkin & Barber, 2002). Archived academic school records were also incorporated. Players were divided into no play, low play and high play groups for comparison. It was found self-concepts of intelligence, mechanical skills and computer skills, self-esteem, family closeness, attachment to school, academic friendship group size, grade point average and club membership were all significantly higher in playing groups than non players, some of which being significantly higher in the high playing group, such as family closeness. Non players on the other hand had significantly higher scores on measures of

disobedience, substance abuse and risky friendship network size than the playing groups. However, high players had significantly higher depressed mood scores (*M* = 4.18, *SD* = 1.21) than low players (*M* = 3.95, *SD* = 1.17), which came close to the non-playing group mean (*M* = 4.16, *SD* = 1.30). Overall, these results suggest moderate video gaming may be a staple of a healthy, normal adolescence. While it is unlikely video game play is directly causing these increased indicators, it may be a contributor. However, it is also likely that lower indications of psychosocial health for the non-playing group may be an expression of lower socio-economic status, particularly in the early 1980s with lower proliferation of video games. This represents a possible confounding variable that was not measured in the study; but should be a consideration in other similar studies.

Similar findings are emerging indicating either some benefits or largely benign effects of video game play, through the secondary analysis of large scale data sets (Adachi & Willoughby, 2013). An analysis of youth and computer use included video game playing as well as indicators of academic achievement and behaviour (Hofferth & Moon, 2012). The authors concluded that for most students no relationship existed between computer game play and these factors; and that some groups benefitted, showing positive relationships between reading and problem solving achievement and video game play for girls and minority groups. The availability of large scale data sets which include video game playing as a variable will likely contribute to this discussion of the general effects of video gaming more into the future.

Societal improvement.

Other researchers have taken an even broader approach to the question of whether video games may have positive or negative effects, by analysing indicators of overall societal functioning throughout the time of proliferation of video games. In fact, during the rise in popularity of video games rates of morbidity, mortality and crime in Western societies indicate improvement (Kutner & Olson, 2008), suggesting severe universal negative outcomes of playing video games are not apparent. However, very few studies have undertaken exploring relationships between overall societal development and video game play.

Summary of positive outcomes: absence of universal effects.

Combined with results of negative consequences of high or moderate amounts of video game play, the above results present a seeming contradiction. Studies have found alternatingly

problematic and adaptive relationships with video game play and indicators of general exposure, such as video gaming time commitment, in general populations. These seemingly conflicting results indicate that relationships between a general measure of video game play and deleterious outcomes is complex, and broad relationships or models which do not include the context of play may miss underlying complexities which mediate or moderate outcomes (Jacobs, 1986; Yee, 2006b).

A similar dynamic is also reflected in media effects research. Decades of uses and gratifications research now indicates that, rather than effects increasing with exposure for everyone, the context of the usage is highly important in subsequent outcomes (Bryant & Oliver, 2009). Basically, the same media will not affect everyone in the same ways, even when broad-scale relationships are found to be present. Rather, outcomes will be mediated or moderated by factors within the player and within the environment; and it is the task of research to identify and understand them (Coyne et al., 2013). How to account for these possible positive effects of video gaming alongside possible negative effects, and/or identifying the markers that predict negative outcomes, is not yet well established in research methodologies.

Overview

When compared to other addictive conditions, such as pathological gambling and substance dependence, severe negative outcomes have not been broadly apparent in Western samples that play video games heavily or endorse video game addiction criteria; and many of the more severe outcomes of these conditions are not applicable to video game playing. Nonetheless, a cluster of relationships has emerged linking video game addiction with declined social, psychological and physical well-being, as well as functioning in certain life domains, suggesting a possible problem requiring further investigation. Taken together, the literature on video game addiction suggests that:

- researchers have been investigating a possible new mental illness, described as a behavioural addiction to video games, which now has a proposed diagnosis termed ‘Internet Gaming Disorder’ in the DSM 5;
- based mostly on survey responses from teenagers and children, a small percentage of gamers’ playing habits show similarities to many of the diagnostic criteria for established

addictive conditions and/or general models of addiction, but whether many of these features represent ‘symptoms’ of an illness is debatable;

- most factor analyses indicate these features tend to occur together, supporting their description as a syndrome, but some studies suggest a two-factor solution reflecting the possible differentiation between high engagement and addiction;
- endorsement of some of these features is far more common than others and prevalence rates vary widely across different thresholds for the proposed condition, even in the same samples;
- delineating moderate or highly engaged gaming from addicted gaming is currently difficult and which individual addiction features are most important has not been thoroughly tested;
- efforts to define and validate addiction must take a harm-centric approach, analysing evidence for possible negative consequences;
- some candidate negative consequences have already been identified in cross-sectional associations with video game addiction and in endorsement of diagnostic items, including aspects of mental, social and physical well-being and functioning in life domains. However results are conflicting regarding severity of associated problems when compared to norms or clinical cut-off points. Most studies imply these deleterious correlates are negative consequences of video game addiction;
- the relative importance of video game addiction in causing these associated problems amongst other factors which also contribute to the same negative outcomes (i.e. moderators, mediators, extraneous confounds, etc.) is not well known. Some studies suggest video game addiction may be relatively unimportant once mediators are accounted for;
- pre-existing psychosocial risk factors, which may also represent possible mediators or moderates of negative consequences, are thought to include poor basic needs fulfilment, negative personality traits including impulsivity, deficient self-regulation, maladaptive coping styles, lower social competence and possibly a history of trauma and other co-morbid conditions, including mental illnesses. However, many possible confounds are yet to be formally tested in models exploring process or temporal precedence;
- little is understood of how video game addiction and associated problems fluctuate over time and the few longitudinal studies so far have produced conflicting results. Most researchers hypothesise bi-directional and mutually reinforcing relationships between video game addiction and associated problems, which should be evident in a downward

spiral over time. Currently, temporal precedence with associated problems and other possible mediators or moderators is largely not established and there are few studies are able to test directionality;

- aetiology and causal mechanisms are also not well understood, but theories of negative consequences generally revolve around a loss of control, expressed through a dramatic shift in behavioural preference and emotional and motivational profile, and displacement or erosion of other important and adaptive activities, with these mechanisms either being tacitly or explicitly stated in studies;
- due to these uncertainties, interpretations of the construct can range from a discreet, new, primary mental illness or syndrome which causes a decline in health and functioning, to a relatively superficial and even benign manifestation of other, more important underlying problems;
- these factors may also differ across distinct subgroups of addictive gamers, which are yet to be identified.

Given the current state of knowledge on the topic, it is imperative this PhD further investigates:

- the possible differentiation between video game addiction and high engagement, based on factor analysis and the differential predictive validity of a range of health and functioning indicators;
- the nature and severity of problems associated with video game addiction, utilising findings from similar studies or population norms to provide reference points;
- test for possible mediating or moderating variables between video game addiction and associated problems, in order to understand more about the processes and circumstances under which the condition is most problematic, and investigate its centrality amongst a host of other health contributors;
- intensively explore how any emergent relationships behave over time, in order to establish temporal precedence and predictive validity.

This Thesis

Engagement and addiction.

This PhD utilises the definition of engagement and addiction proposed by Charlton and Danforth (2007), and further explores the validity of this differentiation. These researchers are leading efforts to understand how best to differentiate and measure these two constructs. They suggest that the components of tolerance, euphoria and cognitive salience may represent high engagement; while conflict with other activities, inter-personal conflict, withdrawal, relapse and behavioural salience represent addiction. They have developed a 29 item scale in line with this conceptualisation, with 13 items tapping addiction and 16 items tapping engagement.

Some validity now exists for this distinction in the form of negative personality traits, attentional profiles, academic achievement, negative mood and depression, anxiety and stress symptomatology in varied and small samples (Charlton & Danforth, 2007, 2010; Metcalf & Pammer, 2011; Skoric et al., 2009). But few studies have investigated the predictive validity of addiction vs engagement in predicting a wide range of indicators of mental, physical and social health, as well as functioning across life domains.

Analyses have also been called for at the item level, in order to identify which individual scale items (and the associated component of behavioural addiction models they represent) are most important in bringing about associated problems (King, Haagsma, et al., 2013). Such analyses may help to further validate or refine the proposed differentiation, as well as diagnostic applications of video game addiction. This PhD will test relationships between individual scale items and measures of health and functioning, using linear modelling to investigate their relative contribution.

Further, it is known that certain items are far more commonly endorsed than others in populations engaged in gaming, and that these items are likely to highly influence prevalence rates. Different thresholds have been adopted in past studies, but few studies have tested the ability of different thresholds to differentiate a range of problems. If differences are apparent, past research results using group comparisons must be interpreted cautiously. This PhD will test three commonly used thresholds in the same population using the same diverse measures of health and functioning.

The factor structure of the Charlton and Danforth Computer Addiction Engagement Scale (or CAES) is also yet to undergo a confirmatory factor analysis. Finally, Charlton and Danforth described high engagement and addiction existing on a continuum, with the former likely preceding the latter, but no longitudinal studies are able to provide evidence for this as yet. Given the commonalities highlighted across addictive conditions, findings relating to this distinction in video gaming may have implications for the broader measurement of behavioural addiction.

Possible negative consequences: diminished health and functioning.

A harm-centric approach is warranted in the validation of video game addiction. As the strength and severity of associated problems have differed in past studies, and few studies have provided evidence for temporal precedence, further investigations are required which are able to provide an indication of which problems are most strongly connected with video game addiction, and how these associations fluctuate over time.

As meta analyses have suggested social and mental health factors are most highly connected (in that order), the possible negative consequences of interest in this PhD include measures of mental (psychological distress), social (structural and functional social networks, social support) and physical health (general health, body mass index, physical exercise frequency and sleep health). Also among the negative consequences thought to result from video game addiction is the interruption of important life domains. Therefore, indicators have been included measuring functioning at work (or job seeking if currently unemployed) and in studying, parenting and in romantic relationships.

These analyses must investigate the severity, importance amongst mediating or moderating variables, as well as establish temporal precedence for any problems found to be connected. Analyses of severity will be assisted by scales which provide normative comparisons or clinical cut-offs. Longitudinal data may help in the investigation of directionality, thereby disentangling risk factors from consequences. Further, most researchers assume associated problems are bi-directional and mutually reinforcing, but very few studies have yet modelled this downward spiral.

Functioning in life domains: work, school, parenting and romantic relationships.

Few studies have tested for possible confounds, and/or mediating or moderating variables, in problems connected with video game addiction. In those that have, such as basic needs fulfilment, analyses indicated the variance explained by video game addiction in associated problems almost completely dissipated. Other variables which are suspected to be important, such as coping style, await testing as mediators or moderators. As such, a rationale guiding the design of this study was to account for as many possible confounding factors as possible, and to facilitate testing of possible mediators or moderators. Specifically, measures were included of socio-economic status, global stressful events, treatment seeking, social support, coping style, and satisfaction with life domains.

The latter is important as deteriorated functioning at school or work is usually included as single self-report items in video game addiction scales. Yet only a few studies have investigated the association with functioning using more detailed measures. Studies which have found associations between video game addiction and poorer academic functioning, a measure of importance or satisfaction with study was not included. In this PhD, a measure of satisfaction in that life domain has been included alongside each measure of functioning. These include measures of satisfaction with romantic relationships, parenting, a persons' job and their studies. Analysing the relative importance of satisfaction and video game addiction on the functioning across life domains provides a means of studying the supposed impaired free will associated with video game addiction. If satisfaction remains high yet functioning decreases with increased video game addiction, this may provide a strong indication of a lack of control. However, if satisfaction decreases prior to a decrease in functioning, and video game addiction remains relatively stable, this may indicate that decreases in functioning result more from a lack of satisfaction rather than an impaired free-will which results from addiction.

Aims

The aims of this PhD are to:

1. Explore the definition, and measure, of addiction and engagement proposed by Charlton and Danforth (2007) by investigating:
   1.1. Whether the factor structure of the scale reflects the theoretical conceptualisation of addiction and engagement in a CFA;
   1.2. Which individual scale items are more commonly endorsed and more strongly related to health and functioning.

2. Investigate the differentiation of video game addiction from engagement by analysing:
   2.1. Relationships between video game addiction versus engagement with measures of social, physical and psychological health;
   2.2. Relationships between video game addiction versus engagement with functioning in specific life domains, including at work, in seeking work, at academic studies, parenting and in romantic relationships.
   2.3. Differences apparent across three diagnostic cut-off points proposed in past literature on prevalence rates, and ability to differentiate groups on measures of mental, social and physical health and functioning.

3. Identify possible confounding variables between video game addiction and associated problems, by measuring:
   3.1. The impact of including satisfaction with life domains, coping styles, stressful life events, socio-economic status and treatment seeking in models measuring relationships between video game addiction and mental, social and physical health and functioning in life domains.

4. Intensively explore how any emergent relationships behave over a period of time, in order to investigate:
   4.1. The directionality and temporal precedence of any associations found between video game addiction and problems.

Hypotheses are detailed throughout the chapters, at the end of the method sections for each specific analysis.

Chapter 2: Method

Procedure

Online surveys were the method by which participants completed the study. In order to minimise the burden on participants, surveys used step-logic to ensure they were presented only with relevant questions. This was the case for measures of functioning and satisfaction across life domains, as many were dependant on the participants' life circumstance. Further, the surveys were programmed to email an automatic invitation each month from the beginning of the study, inviting participants to complete eight follow-up waves – making nine waves in total. Ethical approval was obtained from the Victoria University Human Research Ethics Subcommittee prior to commencing recruitment.

Communications and recruitment strategy.

As high engagement and addiction has been conceptualised as a continuum, and exploring how the two may differ is an aim of this study, recruitment was geared towards adults who are intense gamers. As there is no consensus on what should define addiction, participants were asked to take part if they felt they "have some sort of problem with their playing habit", that they "play too much", or that they may be "addicted". Advertisements for the study also made clear the nature of the topic under investigation (video game addiction). Therefore, it is likely that the sample is biased towards intense and problematic video gamers, as intended. These statements were included on the webpage and participant information form, which all participants were directed to before taking part.

A website hosting information about the study was created in April 2011, directing participants to the surveys. A $500 raffle draw was offered as an incentive and gesture of thanks. Invitations to take part were posted on several video game forums, directing people to the website. By November 2011, and after receiving completed surveys from just over 100 participants, a media release was circulated describing the preliminary results. This media release resulted in significant coverage of the study and a surge in participation brought the sample size up to 535 within the next year.

Data preparation.

All data cleaning and preparation took place using the Statistical Package for the Social Sciences (or SPSS) version 20. All datasets were checked for validity, cleaned and prepared for analysis using the following steps.

Cleaning.

All non-complete surveys were removed from the datasets. Some items which allowed open text but asked for a numerical figure (such as time spent on a particular activity) participants put in a range instead of a single number. In these cases, a median of the two numbers was taken. In most cases, there was little difference between the numbers. Syntaxes were programmed to reverse-score relevant individual scale items in the first wave and follow-up waves, and to tally scale totals and sub-totals. A large amount of manual data cleaning and checking was also undertaken.

Validity checking.

The data was checked for validity in many ways, primarily by reading participants responses to ensure they made sense. Items which were open ended and asked for a numerical figure were checked for face validity. For example, participants were asked how many days they had been late to work in the past month, of which no participant listed more than 20 (which would be the expected maximum assuming participants work a 5-day week and late once-per-day). For mental illness diagnoses, some participants indicated diagnoses which are not technically mental illnesses (e.g. tinnitus). Other responses from this participant appeared valid so this mental illness was removed from history but the rest retained. Participants were also checked for repetition of the same response to items, particularly a string of the neutral response ‘neither agree nor disagree’. No total amount of repeated responses was set as a cut-off, but some participants did show an obvious repetition. However, these were the same participants who were removed for other spurious responses, so no additional removal of cases was required. Participants were also checked to ensure reverse scored items which asked about similar things were generally inversed, which on a reading by the research team, were deemed acceptable.

Time spent completing the survey ranged from 7.4 minutes to 804.47 minutes, the maximum is likely explained by a participant leaving the survey package open then finishing the survey later

(the survey package included ‘cookies’ which facilitated participants’ leaving the survey and completing it again from where they stopped previously, as long as it is within three days of the start time). Of the first wave sample, 91.3% completed the survey within an hour, 7% within two hours, with eight participants taking between 122 minutes and 804.47 minutes. Follow-up surveys were generally shorter. Part of the reason for this variability across participants is that certain participants received more questions than others. The maximum would have been received by a participant who was working, but also seeking work, studying, in a relationship and a parent.

As the survey asked participants a few non-numerical open-ended questions, including naming five goals they wished to achieve over the next nine month period, this provided a useful means of checking validity of responses. All goals were read for validity and this identified several participants who were not fluent in English or whose responses were spurious. Although it is not possible to be overly prescriptive in what is considered a valid goal, and as many participants appeared to struggle to think of five goals they wished to pursue, several of the last goals listed contained an aspect of humour or loftiness; but spurious responses were obvious. IP addresses were checked for duplicates within each wave, but there was no evidence of multiple responses from the same address.

Data matching.

Data matching was completed by matching the primary email address to the participants first and last name. Some participants changed email addressed across waves, which was captured by asking participants whether they would like the reminder sent to a different email address. Some participants also changed the spelling of their surname subtly, such as removal of a hyphen, which caused failed matches but was picked up in a check of all participants who completed the sixth wave and tracing each back through previous waves to identify failed matches manually.

Four participants returned to older follow-up emails and completed earlier waves again (*n*=4). Time lapsed between waves was checked and as all four participants had repeated the follow up approximately four to five weeks after the previous wave, so subsequent waves were shifted to the next wave dataset. These participants then received another follow-up email one month after, and continued with the longitudinal study, even though they will complete ten waves in total, due to the duplication. In preparation for analyses requiring univariate normality, each

measure was checked for range, normality, and reliability, with each reported below along with descriptive statistics.

Outlier checks.

In preparation for inferential analyses which are sensitive to outliers, checks for univariate and multivariate outliers were run. Total scores for the addiction-engagement scale, and total scores for all other health and functioning measures, were examined (Pallant, 2010). On the basis of visual inspection, some univariate outliers were identified. Seven participants played over 100 hours per week, with one reaching indicating the highest of 140. But, as the hours of play indicator was negatively skewed with a long tail of several participants who played for very high hours per week, with many approaching 100 hours, and as this high level of play is consistent with the sampling strategy, these participants were retained. Multivariate outliers were also examined, initially using several bivariate scatterplots. Three participants with an unusual combination of very high symptoms of depression, anxiety and stress, but very low levels of addiction were identified in scatterplots. Mahalanobis' distance was then calculated in SPSS between addiction and each of the health and functioning measures, and a Chi-Squared distribution applied, which identified the same 3 participants as significantly different from the centroid mean at a level of $p<.001$. An additional two participants met this significance level who, on further inspection, had high BMI and low addiction scores, but were opted to be retained. As such, $n=3$ participants were removed as multivariate outliers. Further outlier checks were also conducted as part of assumption checking for suitability for multiple linear regression, and are detailed in their respective chapters. The final sample is now described.

Sample

Wave 1 / cross-sectional.

The first wave yielded 669 participants of which 506 fully completed the scales (completion rate of 77.93%). Across all waves, incomplete surveys were discarded, so no data imputation or estimation was necessary. IP addresses revealed no substantial duplicates. However, a small number of participants were removed due to being outliers (detailed further below and in specific chapters), open-ended responses indicating a lack of fluency in English ($n=5$) and some spurious prank responses ($n=3$), resulting in the final first-wave sample of $N=497$.

In terms of geographical location, the sample was fairly widespread, with the majority in Australia (52.3%), with the rest divided among several European countries (33%), the USA (4.2%), Brazil (4.2%) and smaller cohorts from a number of other countries. The most frequent European countries were Poland, Germany, Hungary and France. Analyses by country were not undertaken as the sample size for many was too small and not of central interest to this thesis.

As in past studies on the topic, the gender balance was skewed, with 84.7% (*n*=421) male. The sample ranged in age from 18 to 59 years (*M*=25.25, *SD*=6.45). Most of the sample were young adults, with 85.9% of the sample between 18 and 30 years of age (22.4% < 20, 63.5% between 21-30, 9.2% between 31-40 and 3.5% aged between 41-54).

As mentioned, the survey only presented relevant items to participants depending on their life circumstances, which resulted in several distinct sub-samples or cohorts to be analysed separately. These cohorts also provide demographic information, and frequencies are as follows (alongside percentage as a total proportion of sample): those who worked (*n*=312; 62.8%), were seeking work (*n*=74; 14.9%), studying (*n*=275; 55.3%), were in romantic relationships (*n*=243; 48.9%), or were parents, or acting in a parenting role (*n*=47; 9.5%).

Longitudinal.

Participants were asked to return to complete follow-up surveys each month for nine months using an automated email reminder which was sent one month from completion of the previous survey. Participants were asked several identifiers for data matching, including first and last names, two email addresses and mobile phone number.

As in past studies, attrition rates were high and each wave showed decreased participation. Attrition rates were highest from wave 1 to 2. Participants were free to complete the follow-up surveys anytime after they received the reminder, with the great majority completing the follow-up surveys within 6 each weeks of the previous wave (with percentages across waves ranging from 89.8% to 98%). Some anomalies were present. One participant in each wave completed a follow-up wave just over two weeks after the previous wave. This should not have been possible as the survey software package generated a unique link to the follow-up for each participant exactly one month after completion of the previous wave. This may have been a system error which sent out the reminder and link too early. However, this only occurred with one participant at each wave (not the same participant). Also, some participants delayed completing the surveys for far longer than anticipated, up to a maximum of 21.5 weeks. The proportion of

participants that did this was very low (less than two per wave) and as such had little effect on analyses of longitudinal fluctuations. Table 4 below shows a breakdown of participant numbers, attrition, and timeframes between each wave.

By the sixth wave, approximately 77% of the baseline sample had not returned to complete the follow-up surveys. Average attrition rate across all nine waves is 20.74%, typical of many longitudinal studies. Due to this high attrition rate and the low number of participants remaining by the ninth wave, it was decided that for all longitudinal analyses, the sample at the sixth wave would be used. This sample size (*n*=111) is sufficient for most analyses involving multiple variables. Demographics for six waves are presented below (see Table 5).

Table 4

Longitudinal Participation Rates and Timeframes

Wave	*n*	% attrition	time between waves (weeks) *M* (*SD*)	% completed within 6 weeks of previous wave
2	266	46.6	4.89 (2.41)	89.8
3	197	24.1	4.40 (1.46)	96.4
4	152	22.8	4.55 (1.24)	94.0
5	133	12.5	4.39 (1.27)	97.7
6	111	17.29	4.34 (0.76)	96.2
7	98	11.7	4.52 (0.81)	98.2
8	80	18.4	4.41 (0.76)	98.0
9	70	12.5	4.32 (0.74)	97.8

Table 5

Demographic Characteristics of the Sample

Wave	*n*	age in years *M* (*SD*)	% male	% studying	% working	% seeking work	% parents	% in romantic relationship
1	497	25.25 (6.45)	84.7	55.3	62.8	14.9	9.5	48.9
2	266	25.59 (6.10)	82	55.6	63.9	15.4	7.9	51.1
3	197	25.65 (6.20)	81.5	52.3	64.1	12.3	6.7	50.3
4	152	25.54 (5.70)	80.8	50.3	67.5	10.6	6.6	49.7
5	133	25.54 (5.82)	80.5	51.9	66.2	9	6	50.4
6	111	25.75 (5.92)	79.3	49.5	68.5	10.8	4.5	52.3

Measures

An overall strategy when selecting measures was to utilise scales with established norms and severity ranges to facilitate a comparative investigation of the severity of problems associated with video game addiction. Another strategy involved the use of objective indicators where self-reports would too biased. Where self-report of functioning or performance in life roles may be biased due to desirability, objective indicators were also asked about. Several measures were also included as possible mediators/moderators of any emergent relationships.

This section details the validity and reliability of the measures used, and provides information about how the sample compared to norms or past studies using the same measures. The section is divided according to the broad analytical strategy each measure fits under. These include Video Game Playing Behaviour, Addiction and Engagement; Mental, Social and Physical Health; Functioning in Life Domains; and finally Possible Mediators/Moderators.

Video game playing behaviour.

Participants were asked about several aspects of their video gaming. Aside from a question asking participants when they first started playing video games, all questions were specified to refer to the past month. Table 6 below lists each question, its' topic and response scale. Based on wave 1, participants played for a mean weekly time of 24.72 hours per week (*SD*=19.56), ranging from 0-100, consistent with the recruitment strategy. Three participants reported no hours of play for that month, but all reported some hours of play in following months so were retained.

Table 6

Video Game Playing Information

Topic	Question(s).	Response Scale
Age began playing	At what age did you first start playing video games?	Open-ended
Time commitment	How many hours per week did you play video games?	Open-ended
Games played	Which video game have you played the most in the past month	Open-ended
Systems used	Which video game hardware have you used the most (i.e. playstation, personal computer, etc.)?	Open-ended
Gaming with friends in-person	On average, what percentage of your gaming time was spent playing with friends in-person (i.e. playing games in the physical presence of friends, not online). Please answer between 0-100 %, an estimation is fine.	Open-ended
Gaming with friends online	And what percentage of your gaming time was spent playing with friends online? Please answer between 0-100%, an estimation is fine.	Open-ended
Meeting friends	Have you made friends through playing video games?	Yes/No
	(If yes) How many friends have you made this way?	Open-ended

Topic	Question(s).	Response Scale
Current friendships involving video games	Would you say that any of your current friendships revolve around video games (i.e. that if it weren't for playing video games together, you would have little in common)? (If yes) How many friendships do you have that would fit this description?	Yes/No
Enjoyment	Currently, how much do you enjoy playing video games?	6 point: Not at all; a little; a fair amount; a lot; very much; I love it.
Need to reduce play	How much do you feel you need to reduce your video game playing?	6 point: 'Not at all' to 'I need to stop completely'
Exclusion check	Does your job require you to play video games for more than 8 hours per week?	Yes/No

Note. Aside from age first played, all other items specified a timeframe of the previous month.

Of total gaming time reported, an average of 12.4% was spent playing with friends in-person and 39.6% online with friends. A large proportion reported having met friends through video gaming (*n*=335, 67.4%), and a smaller proportion reported having current friendships that, if not for video gaming, they would have little in common (*n*=177, 35.6%), suggesting on-going friendships are made through video gaming. Regarding enjoyment of video games, 37.8% reported they 'love it', 27.2% 'very much', 17.7% 'A lot', 13.7% 'A fair amount', 32% 'A little' and only .4% 'not at all'. Regarding a need to cut back to quit playing, 36.6% reported 'not at all', 30.8% 'a little', 18.1% 'a fair amount', 9.3% 'a lot', 3.8% 'very much' and 1.4% 'I need to stop completely'.

Addiction-Engagement.

The full 29 item version of the Charlton and Danforth Addiction-Engagement scale was used to measure engagement and addiction (Charlton & Danforth, 2007, p. 1539). The scale was adapted from focussing on one specific video game to generic video games, by replacing all instances of 'Asheron's Call' with the term 'video games'. This scale was adapted by the authors

from general computer use to that specific video game, and similar factor structures were reported, hence the alteration to refer to video games is valid. Inclusive of Brown's components, this scale has 13 items thought to tap addiction and 16 measuring engagement. While some items were dropped from the scale in subsequent analyses, as an aim of this study is to explore the possible continuum or distinction between the two constructs, the full scale was retained to facilitate maximum detail.

A 5 point Likert-type response set was adopted denoting endorsement for each statement, specifically: 1. strongly disagree, 2. disagree, 3. neither agree nor disagree, 4. agree and 5. strongly agree. For the sake of being conservative with estimates of addiction 'neither agree nor disagree' was converted to a 'disagree' before tallying total scores. This meant converting the response scale to a 4 point from a 5 point, which involved converting all '3's to '2's, then '4's to '3's and '5's to '4's. In preparation for structural equation analysis (and others), histograms were generated of each individual item before and after this procedure, which clearly indicate that few people responded with 'neither agree nor disagree'. This produced a bi-modal distribution. However, engagement items were generally unimodally distributed. Scale factorial structure is explored in Chapter 2.

Consistent with the recruitment strategy, the proportion of the sample meeting the differing proposed cut-off points was much higher than previous studies. At wave 1, 39.8% met the 5 symptom criteria used by Gentile et al (2011), who found a rate of 9.9% in a nationally representative sample of Singaporean youth. In addition, this study used a more conservative method of dichotomising items, with 'neither agree nor disagree' being considered a 'disagree', rendering them a negative in the dichotomisation process. This compares with Gentile et al (2011) who assigned the response 'sometimes' as a half-yes, or scoring it a .5, making it more likely for participants to meet the cut-off point. A closer prevalence of 38.7% was found by Charlton and Danforth (2007) in relation to avid players of the game 'Asheron's Call'. For comparative purposes, calculation of how many participants endorsed 'half of the total' of the addiction sub-scale was undertaken, finding a prevalence of 31.4% at wave 1, and steadily decreasing to 12.6% by wave 6. The proportion meeting the cut-off proposed by Charlton and Danforth (2007) was also calculated, which includes agreement of at least one behavioural salience item, at least one conflict item, and the withdrawal and relapse items. This was found to be 8.7% in wave 1, higher than the 1.8% reported by Charlton and Danforth (2007). The

differential validity of these varied cut-off points on determining diminished health and functioning is explored in chapter 2.

After conversion to a 4 point response scale, the addiction subscale ranged from 13-52. The complete scale is presented in Table 7. For different sections of the PhD, the entire scale is referred to and items numbered from 1-29. For other sections, the sub-scales for addiction and engagement are referred to separately, and item numbering reflects this, with the addiction sub-scale having items 1-13 and engagement 1-16, as detailed in table 7 below.

Table 7

Computer Engagement-Addiction Scale Adapted to General Video Game Playing

Item # sub-scales	Item # whole scale	Item text
Addiction 1	1	I sometimes neglect important things because of an interest in video games
Addiction 2	2	My social life has sometimes suffered because of me playing video games
Addiction 3	3	Playing video games has sometimes interfered with my work
Addiction 4	4	When I am not playing video games I often feel agitated
Addiction 5	5	I have made unsuccessful attempts to reduce the time I spend playing video games
Addiction 6	6	I am sometimes late for engagements because I am playing video games
Addiction 7	7	Arguments have sometimes arisen at home because of the time I spend on video games
Addiction 8	8	I think that I am addicted to video games
Addiction 9	9	I often fail to get enough sleep because of playing video games
Addiction 10	10	I never miss meals because of playing video games (R)
Addiction 11	11	I have never used video games as an escape from socialising (R)
Addiction 12	12	I feel a sense of power when I am playing video games

Item # sub-scales	Item # whole scale	Item text
Addiction 13	13	I often feel that I spend more money than I can afford on video games
Engagement 1	14	It would not matter to me if I never played video games again (R)
Engagement 2	15	I feel happy at the thought of playing video games
Engagement 3	16	The less I have to do with video games, the better (R)
Engagement 4	17	Video games are unimportant in my life (R)
Engagement 5	18	I would hate to go without playing video games for more than a few days
Engagement 6	19	I spend little of my spare time playing video games (R)
Engagement 7	20	When I see video games, I feel drawn towards them
Engagement 8	21	I rarely think about playing video games when I am not using a computer (R)
Engagement 9	22	I pay little attention when people talk about video games
Engagement 10	23	I tend to want to spend increasing amounts of time playing video games
Engagement 11	24	It is important to me to be good at video games
Engagement 12	25	I often experience a buzz of excitement while playing video games
Engagement 13	26	I like the challenge that learning to play video games presents
Engagement 14	27	I try to make video game play sessions last as long as possible
Engagement 15	28	Video game jargon sounds stupid to me (R)
Engagement 16	29	I can't understand why people like video games (R)

Note. (R) denotes a reverse-scored item.

Mean scores, reliability, normality and proportions meeting cut-off points for addiction were calculated for each wave and are detailed in Table 8 below.

Table 8

Descriptive, Normality, Reliability and Diagnostic Threshold Statistics for the Video Game Addiction Sub-Scale across Six Waves

Wave	*n*	total score *M* (*SD*)	Test-retest (*r*)	α	Skewness (*e*)	Kurtosis (*e*)	% meeting 5/10 cut off	% meeting 7/13 cut off	% meeting 4/7 cut off
1	497	29.21 (6.91)	-	.84	.12 (.10)	-.10 (.22)	39.8	31.4	8.7
2	266	26.63 (6.73)	.76**	.85	-.02 (.15)	-.62 (.30)	28.9	19.9	3
3	197	26.37 (6.65)	.82**	.86	-.09 (.16)	-.59 (.33)	26.2	18.5	4.6
4	152	25.56 (6.21)	.86**	.83	.30 (.20)	.04 (.38)	21.9	13.9	2
5	133	25.42 (6.32)	.83**	.84	.15 (.21)	-.26 (.42)	22.4	13.4	3.1
6	111	25.58 (6.30)	.87**	.83	.02 (.23)	-.21 (.44)	24.3	12.6	0

Note. Meeting a cut-off denotes a diagnosis of addiction, as discussed in Chapter 9. ***p*<.01.

For consistency the engagement sub-scale was also converted to 4 point in the same fashion as the addiction subscale, ranging from 16-64. Mean score, reliability and normality for each wave is detailed in Table 9 below.

Table 9

Descriptive, Normality and Reliability Statistics for the Video Game Engagement Sub-Scale across Six Waves

Wave	*n*	Total Score *M* (*SD*)	Test-retest (*r*)	α	Skewness (*e*)	Kurtosis (*e*)
1	497	45.33 (6.91)	-	.83	-.01 (.10)	.23 (.22)
2	266	45.49 (6.68)	.75**	.82	-.55 (.15)	.53 (.30)
3	197	46.05 (6.45)	.82**	.81	-.14 (.16)	.30 (.33)
4	152	45.36 (6.93)	.87**	.84	-.02 (.20)	.06 (.38)
5	133	45.65 (6.90)	.81**	.84	-.25 (.21)	-.41 (.42)
6	111	46.19 (6.77)	.85**	.86	-.21 (.21)	-.43 (.44)

Note. ***p*<.01.

Mental Health

Depression, anxiety and stress.

Mental health was measured using the 21 item Depression Anxiety Stress (DASS21) scale (Lovibond & Lovibond, 1995). The DASS21 measures symptoms of psychological distress, anxiety and depression. It is a well-established measure with norms and severity ratings available for the Australian population, as well as extensive validity and reliability. Divergent validity for the differential underlying factors is well explored, with sub-scales conforming to the Rasch model. Convergent validity is also extensive, with DASS21 scores predicting several measures of mental health, psychopathology and clinical practitioner assessments (Crawford, Cayley, Lovibond, Wilson, & Hartley, 2011; Lovibond & Lovibond, 1995). It has been used in epidemiological studies of population mental health, as well as studies of video game addiction (King, Delfabbro, & Zajac, 2011; Metcalf & Pammer, 2011). The scale uses a 4-point response set of 0-3, with 7 items for each of the three sub-scales, and ranges including categories of normal, mild, moderate, severe and extremely severe.

Given the well-established validity and reliability for the DASS21, and the adequate sample size in this study for most parametric statistical analyses, for the sake of brevity skewness and kurtosis for each sub-scale is not presented. In terms of symptoms of depression, anxiety and stress, the present sample rated slightly higher than available norms. In a sample of 497 Australian adults, claimed to be broadly representative of average Australians on the basis of age, gender, education and utilising a range of recruitment locations, Crawford et al. (2011) reported DASS21 mean scores of 2.57 (*SD*=3.86) for depression, 1.74 (*SD*=2.78) for anxiety, 3.99 (*SD*=4.24) for stress and a total score (subscales summed) of 8.30 (*SD*=9.83). Single sample, two-tailed t-tests between the wave 1 sample confirm these differences (depression $t(496)=15.60$, $p<.001$; anxiety $t(496)=12.51$, $p<.001$; stress $t(496)=11.83$, $p<.001$; and the total score $t(496)=15.25$, $p<.001$). Single sample t-tests at wave 6 ($n=111$) further confirmed that in all subscales and total score, the sample were significantly higher in comparison to norms (all $p<.05$). Given the recruitment strategy which targeted gamers who perceive a problem with their play or label themselves as possible addicts, this increase in negative mental symptomatology was expected. At first appearance, a downward trend seems evident in the mean symptoms of depression, anxiety and stress, over the study time period. This is relevant to the longitudinal analysis undertaken in chapter ten, and further preliminary tests of sample bias are detailed

there. A breakdown of the mean scores and proportion in the severity ranges is provided in tables 10-13 below.

Table 10

DASS21 Depression, Anxiety and Stress Sub-scale Descriptive Statistics across Six Waves

Wave	*n*	Depression *M* (*SD*)	Anxiety *M* (*SD*)	Stress *M* (*SD*)	Total *M* (*SD*)
1	497	6.58 (5.71)	3.95 (3.92)	6.39 (4.55)	16.94 (12.60)
2	266	6.17 (5.51)	3.63 (3.75)	5.76 (4.49)	15.55 (12.16)
3	197	5.51 (5.24)	3.34 (3.74)	5.57 (4.32)	14.45 (11.63)
4	152	5.58 (5.51)	3.15 (3.71)	5.18 (4.42)	13.92 (12.15)
5	133	5.21 (5.39)	2.80 (3.33)	5.25 (4.35)	13.27 (11.48)
6	111	4.99 (5.40)	2.46 (3.06)	4.89 (4.28)	12.35 (11.56)

Table 11

DASS21 Depression Subscale Severity Proportion across Six Waves

Wave	*n*	% normal (0-4)	% mild (5-6)	% moderate (7-10)	% severe (11-13)	% extreme (14+)
1	497	48.9	8.4	17.5	10.5	14.7
2	266	50.4	9	19.2	7.5	13.9
3	197	54.8	10.7	14.2	7.6	12.7
4	152	55.3	9.2	15.8	7.9	11.8
5	133	56	8.9	16.4	5.3	13.4
6	111	58.6	9	12.6	10.8	9

Note. The number in parentheses is the scale score range falling into that severity category.

Table 12

DASS21 Anxiety Subscale Severity Proportion across Six Waves

Wave	*n*	% normal (0-3)	% mild (4-5)	% moderate (6-7)	% severe (8-9)	% extreme (10+)
1	497	57.7	13.7	11.7	6.2	10.7
2	266	60.9	13.9	8.7	7.1	9.4
3	197	61.4	18.3	8.1	5.1	7.1
4	152	65.8	12.5	7.9	5.2	8.6
5	133	66.4	12.7	9.7	5.2	6
6	111	71.2	12.6	9	3.6	3.6

Note. The number in parentheses is the scale score range falling into that severity category.

Table 13

DASS21 Stress Subscale Severity Proportion Across Six Waves

Wave	*n*	% normal (0-7)	% mild (8-9)	% moderate (10-12)	% Severe (13-16)	% Extreme (17+)
1	497	63.6	11.9	13.8	8.3	2.4
2	266	70.3	11.7	8.2	7.5	2.3
3	197	72.1	8.6	10.2	8.1	1
4	152	72.4	8.5	11.2	5.9	2
5	133	73.1	9.7	11.2	4.5	1.5
6	111	75.7	8.1	10.8	4.5	0.9

Note. The number in parentheses is the scale score range falling into that severity category.

Mental illness history.

Participants were also asked whether they had been diagnosed with a mental illness(es), to list these and the date of diagnosis. These are presented in Table 14 below, with very similar conditions reported grouped for brevity. In each follow-up month, participants were also asked whether they had been diagnosed with a mental illness within the previous month. Of the sample at wave 1, 17.3% (*n*=86) had been diagnosed with a mental illness in the past, with the majority being diagnoses of depression and anxiety, and 45.3% (*n*=39) of these having had dual

diagnoses. While these diagnoses ranged back to 1970, the great majority occurred in the past four years, with most in the past two. This compares to the population prevalence of 13.6% for mental illness in Australians (Australian Bureau of Statistics, 2012b). This supports the DASS21 scores which were above norms, confirming the sample show slightly elevated levels of mental illness than the broader population. As past mental illness is a strong predictor of future mental illness, participants who had received a diagnosis in the past were compared to those who had not, on scores on the DASS21 subscales. Participants with a previous mental illness history had significantly higher symptoms of depression ($t(114.30)=4.44$, $p<.001$), anxiety ($t(109.76)=3.63$, $p<.001$) and stress ($t(495)=5.63$, $p<001$) at baseline.

Table 14

History of Mental Illness at Wave 1

Mental illness reported	Number
Depression	56
Anxiety	29
Bipolar	10
Aspergers, autism and low-spectrum autism	8
Attention Deficit Hyperactivity Disorder	6
Obsessive Compulsive Disorder	7
Post-traumatic Stress Disorder	5
Social Phobia	3
Agoraphobia	2
Schizophrenia	2
Neurosis	1
Hyperkinetic Disorder	1
Insomnia	1
Nervous breakdown	1
Dysthymia	1

Note. Anxiety included one case of generalised anxiety disorder and one of panic disorder.

As a likely mediating variable in observed outcomes, treatment seeking was also measured, by asking participants whether they are receiving treatment for a mental health problem and how many hours they have spent in the past month with mental health professionals. The first wave mean was 2.97 hours ($SD=2.17$); scores for other waves are reported in Table 15 below.

Table 15

Mental Illness Diagnosis and Treatment Seeking in Subsequent Waves

Wave	*n*	% diagnosed with a mental illness	% seeking treatment	hours spent with mental health professionals *M* (*SD*)
2	266	2.6	12.4	2.02 (2.61)
3	197	3.6	12.2	2.12 (2.46)
4	152	0	11.2	2.15 (3.07)
5	133	.7	13.4	2.43 (2.92)
6	111	0	12.6	3.07 (4.75)

Note. Diagnosis of a mental illness in this table relates to receiving a diagnosis in the previous month (not receiving a diagnosis in all prior years, as discussed above).

Social Health

As results regarding the role of video gaming in social well-being are contradictory, including the possibility that positive social support may be garnered via gaming and internet use, it was important to choose scales which are shown to be important by some objective outcome. As such, social support measures shown to be important in predicting mortality were chosen. Recent longitudinal meta-analyses suggest complex social support measures, which contain both structural and functional aspects, are the most predictive of mortality (Holt-Lunstad et al., 2010). Structural aspects refer to quantitative indicators of friendship network size and shape. Functional measures, on the other hand, refer to a subjective self-rating of the quality of these networks, usually in meeting important needs. In most measures, these functional indicators span a range of domains, each reflecting important functions of social support networks.

Functional social support.

To measure self-ratings of the quality of social support, a scale was created using three items from the Berkman and Syme Social Support Index (1979), measuring companionship, emotional and informational support. Also, two items based on tangible social support measures were included, covering both the provision of money and shelter (Heitzmann & Kaplan, 1988). Each

question asked participants how often that type of support was available to them. The scale utilised a response range of 1-7, with 1 denoting ‘none of the time’ and 7 denoting ‘all of the time’, with scores ranging from 5-35. Social health items and response style are detailed in Table 16 below.

Structural social support.

To explore whether video game addiction alters friendship networks over time, which has been mentioned as a possible consequence (Gentile et al., 2011), participants were asked about their structural social support networks. Participants were asked how many different friends they had seen, in-person (i.e. not online), in the past month, and how many social events they had attended (including outings to friends’ houses or vice-versa). These were tallied to provide a measure of social activity. This structural measure may seem biased towards ‘outings’, but it was specified that visiting friends’ houses or vice-versa was included. The definition of ‘friend’ was not provided, under the rationale that if a participant considered someone a friend, this was more important than meeting an external definition.

To further investigate how structural social networks are influenced via gaming, participants were asked whether they had met any friends through playing video games, and how many friendships they had that would likely not continue without the shared interest of video game play. Together, these measures provide a brief but complex social health measure, inclusive of aspects shown to be predictive of mortality in longitudinal studies.

Table 16

Social Health Items

Item	Category	Dimension	Response style
Is there someone available whom you can count on to listen to you when you need to talk?	Functional	Companionship	7 point
Can you count on anyone to provide you with emotional support (talking over problem or helping you make a difficult decision)?	Functional	Emotional	7 point
Is there someone available to give you good advice about a problem?	Functional	Informational	7 point
Is there someone available to lend you a large amount of money if you needed it?	Functional	Tangible	7 point
Is there someone available who would let you stay with them if you needed a place to stay?	Functional	Tangible	7 point
Thinking about the last month, how many different friends have you met with socially? An estimation is fine	Structural	Social network size	Open-ended
In the last month how many social events have you been part of? This can include going to friend's homes or friends visiting you. Don't include playing games online together unless you're physically in the same place. An estimation is fine.	Structural	Social events attended	Open-ended
Have you made friends through playing video games? (If yes) How many friends have you made through playing video games?	Structural	Video game playing centrality	Open-ended
Would you say that any of your current friendships revolve around video games (i.e. if it weren't for playing video games together, you would have little in common)? (If yes) How many friendships do you have that would fit this description?	Structural	Video game playing centrality	Open-ended

Note. The 7 point response range was from ‘None of the time’ to ‘All of the time’.

Descriptive and normality statistics were explored and are detailed in Table 17 below. As some people listed large numbers of friends and outings, these variables were capped at 30 (approximately one per day), creating a range of 0-60 for the social activity index. Social support total ranged from 5-35. Skewness and kurtosis indicated that the social support measure was significantly negatively skewed, and the social activity index significantly positively skewed, both of which make theoretical sense given the scale ranges. The social support scale showed strong internal consistency of α=.85 and test-retest of r=.77 (p<.001). The social activity index had α=.65 and test-retest of r=.69 (p<.001). Some validity for the measure was provided in the correlations between the structural and functional aspects of social support, along with SES.

Table 17

Descriptive, Normality and Reliability Statistics for the Social Health Measures

Wave	Social support measure *M* (*SD*)	Social support skewness (*e*)	Social support kurtosis (*e*)	Social activity index *M* (*SD*)	Social activity skewness (*e*)	Social activity kurtosis (*e*)
1	26.03 (6.95)	-.74 (.10)	-.01 (.22)	16.39 (12.72)	.10 (.10)	.54 (.22)
2	26.06 (7.20)	-.73 (.15)	-.11 (.30)	14.57 (11.78)	1.05 (.15)	.73 (.30)
3	26.37 (7.16)	-.80 (.16)	.01 (.35)	14.49 (12.71)	1.23 (.16)	1.28 (.33)
4	25.45 (7.15)	-.95 (.20)	.49 (.38)	13.72 (11.85)	1.26 (.20)	1.24 (.38)
5	26.46 (7.53)	-.86 (.20)	-.01 (.41)	15.25 (12.58)	1.10 (.21)	1.14 (.42)
6	26.96 (7.04)	-.71 (.23)	-.36 (.44)	14.94 (13.25)	1.20 (.23)	.97 (.44)

Table 18

Correlation Matrix Showing Some Validity for the Multidimensional Social Support Measures

Wave 1 (n=497)	Emotional	Tangible	Friendship network size
Tangible	.52***	-	
Friendship network size	.22***	.30***	-
Social events attended	.23***	.22***	.50***

Note. ***p<.001

Functioning in Life Domains

Many video games addiction studies identify diminished functioning in life domains as a possible negative consequence of the condition. The primary mechanism is thought to be displacement of other activities due to time spent playing and behavioural prioritisation of gaming. To investigate possible impacts on functioning in different life domains, several established scales and objective indicators were included. These domains covered romantic relationship conflict, working, studying, parenting performance, and job seeking behaviours. As such, these measures only applied to sub-samples, or cohorts, within the overall sample.

Parental performance scale.

The possible impact on parenting of video game addiction was investigated. Participants were first asked whether they were parents or acting in a parenting role, and if they answered yes they were invited to complete the 'Performance' and 'Satisfaction' sub-scales of the Guidubaldi-Cleminshaw Parent Satisfaction Scale (Guidubaldi & Cleminshaw, 1985). These factorially derived 10-item subscales were developed by quizzing parents on the most important aspects of parenting. The scale has shown a consistent factor structure and convergent, construct and predictive validity, showing relationships with the Dyadic Adjustment Scale, Lee's Marital Satisfaction Scale and several life satisfaction scales (Guidubaldi & Cleminshaw, 1985, 1989).

The performance factor includes aspects of becoming impatient with children, yelling, being consistent, child-rearing skills, giving individual attention, and being satisfied with time spent. Participants were also asked how many hours, in quality time, they have spent with their children in the previous month. This question was repeated each month. The scale used a 4-point Likert scale ranging from strongly disagree to strongly agree, resulting in a range of 10-40. Descriptive, normality and reliability statistics for the Parental Performance Scale are listed in Table 19 for six waves, even though by wave 3, the number of parents is so low as to not be worth analysing with inferential statistics.

Table 19

Descriptive, Normality and Reliability Statistics for the Parental Performance Scale

Wave	*n* parents	*M* (*SD*)	skewness (*e*)	kurtosis (*e*)	α	test-retest *r*
1	47	30.86 (6.26)	-.07 (.35)	-.23 (.67)	.84	-
2	21	31.75 (5.60)	.10 (.49)	-.45 (.96)	.90	.88***
3	13	29.91 (7.92)	.55 (.62)	-.20 (1.18)	.93	.77***
4	10	30.00 (7.29)	.82 (.69)	-.68 (1.32)	.91	.85***
5	8	30.24 (9.68)	.24 (.74)	-.44 (1.47)	.96	.78**
6	6	27.00 (5.15)	.87 (.90)	1.62 (2.00)	.85	.89**

Note. **p<.01, ***p<.001.

Romantic relationship conflict.

Participants were asked whether they were in a romantic relationship and then asked to complete the interactional reactivity subscale of the Romantic Partner Conflict Scale (Zacchilli, Hendrick & Hendrick, 2009). This six item subscale is suitable for married and unmarried romantic couples, has shown convergent validity in past studies and had a high reliability at baseline (α= .88). Table 20 below reports the descriptive, normality and reliability statistics for the relationship conflict scale across six waves.

At each follow-up, participants were asked whether they were still in a relationship, whether they had broken up from a relationship in the past month, and if so, whether they had wanted the relationship to continue (yes or no) and how much they believed their video game playing habits contributed to the break-up (1-5; from ‘not at all’ to ‘all of the reason’). All up, 65 participants experienced a break-up during the study period. 58% (*n*=38) of these participants reported wanting the relationship to continue. The largest number of reported break-ups was in wave 1 (40 participants). Low mean scores for the single item rating connecting video game play to the break-ups suggest most participants did not perceive their video gaming to be a contributor (*M*=1.41), but with high variability (*SD*=2.83).

Table 20

Descriptive, Normality and Reliability Statistics for the Relationship Conflict Scale

Wave	*n* in relationships	*M* (*SD*)	skewness (*e*)	kurtosis (*e*)	α	test-retest *r*
1	243	10.14 (3.28)	.31 (.16)	-.78 (.30)	.80	-
2	136	9.74 (3.38)	.63 (.21)	-.44 (.40)	.84	.73***
3	99	9.89 (3.40)	.91 (.23)	1.62 (.47)	.85	.58***
4	78	10.36 (4.37)	1.93 (.26)	6.38 (.54)	.82	.68***
5	67	10.30 (3.98)	1.39 (.28)	2.87 (.58)	.84	.80***
6	59	9.78 (3.88)	1.81 (.30)	5.54 (.60)	.86	.68***

Note. ***p<.001.

Work functioning/ interruption.

As video game addiction is assumed to negatively impact on work (which is specifically included as a negative consequence in video game addiction scales), indicators of functioning at work were included. After reviewing literature, it became clear that validity is difficult to establish in self-report measures due to desirability response bias. People usually perceive themselves performing above the rankings provided by their peers or managers (Donaldson & Grant-Vallone, 2002). As such, it was elected to focus on objective indicators of work functioning. Participants were asked how many times, over the past month they had arrived late to work, and received formal warnings from management for poor performance; and also whether they were dismissed/fired from their job. As such, higher scores on these indicators denote more work disruption, and poorer work functioning.

Arriving late was much more common than receiving warnings or being dismissed. Both continuous measures (times late and formal warnings) were significantly non-normal, with skewness and kurtosis figures far exceeding their standard error. Warnings received were so uncommon, only proportion is reported. Results for each wave are summarised in Table 21 below (note that all participants were asked whether they had been dismissed from a job in the past month, but only working participants were asked about times late and warnings received).

Table 21

Descriptive, Normality and Reliability Statistics for Functioning at Work Measures

Wave	*n* working	Late arrivals *M* (*SD*)	% received a warning	% dismissed
1	313	1.61 (3.47)	3.2	3.2
2	170	1.39 (3.11)	1.8	1.1
3	127	1.17 (2.59)	0	1
4	103	1.24 (2.93)	1.9	.7
5	89	1.03 (2.38)	2.2	.7
6	76	1.05 (2.86)	0	.9

All participants who were dismissed were also asked, in an open ended question, to provide a brief reason for their dismissal. Many provided reasons unrelated to video game playing or difficulty functioning, such as their employer going out of business or receiving a redundancy package. Across all waves, only one participant indicated their dismissal was related to video game playing, indicating they "would rather play Modern Warfare 3", one because of "poor performance" and one for "laziness".

Job seeking.

Of all participants in wave one, 14.9% (*n*=74) were seeking work. Participants who indicated they were unemployed and were not seeking work were asked why in a free-response item, and the great majority indicated it was because they were studying. On further analysis, only 14 participants in wave 1 were not working, studying or seeking work, and most attributed their situation to illness (many being mental ill). However, two reported gaming was more important than work as the reason. All participants seeking work were asked to indicate how often they had participated in a number of important job seeking behaviours, drawn from the behaviours used to validate the Job Seeking Self Efficacy Scale (Strauser & Berven, 2006). Commonly used in the field of social work and vocational rehabilitation, job seekers were asked how often they participated in a job interview, completed a job application, contacted an employer about a job, talked to a friend or relative about a job, described their skills to someone, prepared or updated a resume/curriculum vitae or searched for a job advertisement. Scores on each

individual item were capped at 60, allowing for two of each behaviour per day, and tallied. Three of the behaviours used in the original scale were deemed inapplicable or unnecessary and not included, namely whether participants had contacted an employer over the phone specifically, whether they had described accommodations or ADA to someone and whether they had described their limitations to someone. All total scores were non normal, except for wave 3 which had a skewness close to normal. Table 22 below details the descriptives and normality of these total scores below.

Table 22

Descriptive, Normality and Reliability Statistics for the Job Seeking Behaviours Scale

Wave	*n* seeking work	*M* (*SD*)	Skewness (*e*)	Kurtosis (*e*)	α	Test-retest *r*
1	75	24.75 (30.98)	3.45 (.28)	16.30 (.55)	.59	-
2	41	20.50 (20.88)	2.32 (.37)	6.43 (.71)	.73	.61***
3	24	15.24 (9.76)	.49 (.46)	-.15 (.92)	.57	.75***
4	16	23.24 (28.58)	2.33 (.55)	5.48 (1.08)	.80	.67***
5	12	30.74 (38.02)	2.57 (.64)	6.92 (1.22)	.79	.89***
6	12	26.17 (26.24)	1.76 (.64)	3.81 (1.22)	.72	.91***

Note. ***p<.001

Academic functioning.

Video game addiction scales also usually include an item asking about negative consequences in academic studies. At each wave, participants who were studying were asked for their grade average, the grade average they had been realistically aiming for and also how many subjects they had failed. Discrepancy was calculated by subtracting participants' desired from achieved grade averages. Discrepancy scores had both positive and negative values as some participants out-achieved their own goals and others did not reach their aim. The majority of participants did well in their studies, with mean scores in the distinction range (70-80% in Australian standards) and low discrepancy scores indicating most achieved close to their desired grade average. These measures were not normally distributed. Performance measures were not available for all participants who were studying at each round, as many had not received any grade averages to tally; or they had only been graded on a pass or fail basis. Table 23 below provides a breakdown of these scores each month.

Table 23

Descriptive Statistics for the Academic Performance Measures

Wave	*n* studying	*n* with assessment	Grade average *M* (*SD*)	Discrepancy score *M* (*SD*)	subjects failed *M* (*SD*)
1	269	212	73.60 (16.82)	4.09 (15.78)	.58 (1.29)
2	145	101	75.74 (15.47)	3.13 (11.73)	.30 (.87)
3	98	71	73.25 (19.13)	4.74 (14.54)	.24 (1.05)
4	75	49	74.28 (11.66)	2.55 (11.99)	.28 (.80)
5	68	48	74.01 (15.77)	4.83 (13.65)	.24 (.74)
6	55	39	73.23 (14.42)	4.08 (11.43)	.20 (.64)

Physical Health

In order to measure possible impacts on physical health, participants were asked about their general physical health, physical exercise frequency and sleep health. Participants were asked for their height and weight, from which their body mass index (BMI) was calculated. BMI, despite some limitations, is commonly used as a general indicator of physical health (Kuskowska-Wolk, Karlsson, Stolt, & Rössner, 1989; Nyholm et al., 2007). Further, participants were asked how many days in the past week they had engaged in moderate physical activity for at least one hour, and also to complete the single item general health measure from the Short Form 36 (Australian Bureau of Statistics, 2012b). Often referred to as the SF-1, this item provides an overall rating of general health on a 5 point scale ranging from poor to excellent. Both the exercise frequency item and SF-1 are commonly used in epidemiological health research and as such, norms are available.

General health rating normative comparison.

Normative data for the SF-1 from adult South Australian residents (Australian Bureau of Statistics, 2012b) collected in 2005 are provided in proportions, indicating 19.8% responded excellent, 36.5% very good, 27.9% good, 12% fair and 3.8% poor. Proportions in this study

indicate lower levels of general health, namely 7.8% reporting excellent, 22.9% very good, 37.4% good, 22.9% fair and 8.9% poor. A Chi-Squared goodness of fit test confirmed the observed distribution is significantly different to the South Australian norms $\chi^2(4) = 160.01$, $p < .001$.

Body mass index (BMI).

Normative data on BMI is also provided by the Australian Health Survey, the largest survey ever conducted on the health of Australians with 33500 participants (Australian Bureau of Statistics, 2012b). This study indicates the normal range of BMI for adults is 18.50-24.99 and that 33.3% of 25-34 year olds fall in the normal range, with the great majority of the remaining falling above that category, and therefore deemed overweight. However, just slightly down the age range to 18-24 years old, and 55.1% fall in the normal range. Using this banding of 18.5-24.99, 44.2% of the first wave sample in this study were normal, 53.6% were overweight and 2.2% underweight. As the majority of this sample fall across the two age bands reported in the Australian Health Survey, the midpoint of 33.3 and 55.1 was used (i.e. 44.2%) for comparison. The proportion in the first wave sample in the normal range fell exactly on this number (44.2%), suggesting the sample matches the normal BMI for the Australian adult population. Probability based inferential statistical tests were deemed unnecessary to compare the sample BMI to norms.

Sleep health / disturbance.

Participants were also asked to complete the 12 item Medical Outcomes Study Sleep Scale, or MOS-SS (Essink-Bot, Krabbe, Bonsel, & Aaronson, 1997). The MOS-SS is based on the areas of common agreement in sleep literature on the most important aspects of sleep health. It includes measures of sleep onset latency, average sleep quantity, adequacy of sleep, sleep disturbances and daytime sleepiness (or somnolence). The scale has shown extensive validity and reliability in predicting and measuring sleep disturbance across several populations with conditions that affect sleep (Cappelleri et al., 2009). Aside from sleep quantity, which is open-ended, and latency, which uses a 5 point scale denoting 0-15, 16-30, 31-45, 40-60 and 60+ minutes before falling asleep, the remaining ten items are scored on a 6 point Likert scale. While the original scale instructions involve converting the 6-point response scale to represent equal percentages out of 100, in this study items 2 and 10 were reversed (as they are reverse-worded), and higher total scores indicate better sleep health.

In this study, the total score for sleep health ranged from 10-60. In the MOS-SS norms (Allen, Kosinski, Hill-Zabala, & Calloway, 2009), it was reported that between 7-8 hours of sleep each night is ideal, and this sample demonstrated a mean score within that range. Average onset latency was also normal, with the mean score indicating between 16-30 minutes. Total sleep disturbance scores are reported below but are not comparable to past studies without conversion. The ten items showed strong internal consistency throughout: wave 1 α= .78, wave 2 α=.80, wave 3 α=.79, wave 4 α=.81, wave 5 α=.83 and wave 6 α=.85. Average BMI, exercise frequency, physical health and sleep health rating are reported in Table 24 below.

Table 24

Average BMI, Exercise Frequency, Sleep Quantity, Latency and Health Across All Waves.

Wave	BMI *M* (*SD*)	% BMI in normal range	Exercise frequency *M* (*SD*)	Average sleep quantity hours *M* (*SD*)	Sleep health total score *M* (*SD*)
1	25.66 (6.51)	50.4	3.64 (2.03)	7.16 (1.59)	42.84 (8.54)
2	26.71 (8.79)	44	3.53 (1.90)	7.23 (1.46)	44.09 (8.47)
3	25.87 (6.16)	46.7	3.60 (1.94)	7.11 (1.21)	44.27 (8.16)
4	25.10 (6.02)	48.7	3.63 (1.20)	7.25 (1.44)	44.83 (8.39)
5	24.40 (6.42)	50.7	3.69 (1.96)	7.10 (1.36)	44.50 (9.70)
6	24.87 (5.01)	52.3	3.69 (1.90)	7.22 (1.23)	46.21 (8.09)

Possible Confounds / Mediators or Moderators

An important rationale behind the design of this study was the attempt to rule out as many alternative explanations as possible for any emergent relationships. Specifically, in order to assess the importance of video game addiction as a cause of negative consequences, analyses must also take into account other known and possible causes of the same negative outcomes. By including such variables, research will be able to explore the relative importance of video game addiction in any emergent relationships and the context in which it is most problematic.

Measures of several possible confounding factors have been included in this study. These confounding factors could be conceived of as mediators or moderators. Some of these possible confounding factors are specific to certain life domains, such as the satisfaction measures, while others were completed by all participants. Where possible, norms are compared in order to further situate the sample within the broader population.

It must be noted that the precise meaning of the term ‘confounding variable’ fluctuates. Often it is used to refer only to variables which are not included in a study, either by a fault of design, or due to impossibility, that may alter the observed relationships and therefore inferences that can be made from the analysis. In this instance, the term is used knowing that, had these variables been omitted, they posed the potential to cause spurious inferences with regards to the degree of association between video game addiction and lower health and well-being. So, while these variables are actually included in this study design, they are still sometimes referred to as confounds.

It is also acknowledged that there were other potential confounding variables which were not included in the study. While completeness is encouraged when building models, it is difficult to achieve when modelling human behaviour particularly given the statistical requirements of large models, such as sample size. A complete model is beyond the scope of this PhD, and instead much of these analyses may be described as exploratory.

Socio-economic status.

Socio-economic status (SES) has long been known to be associated with health. SES was assessed by asking participants their current annual income (open ended), the combined income of their parents/guardians (open ended) and highest educational level of their parents/guardians from a choice of: primary/elementary school, high/secondary school, technical or trade qualification (e.g. plumber), bachelors/undergraduate degree or post-graduate degree. Own income, parental income and parents’ highest educational attainment are established measures of SES (Australian Bureau of Statistics, 2011; G. Marks, 2000). Own income was the only measure taken each wave. Multiple measures were preferred as SES indicators vary in predictive validity, with different indicators presenting different strengths and weaknesses. SES is one of the most consistent predictors of health in past studies and was conceptualised as such as in the present study. It was also considered a possible mediator of negative consequences of video game addiction, with higher SES buffering negative outcomes.

Due to the geographic spread of participants, income levels would have required extensive preparation for analysis including conversion from differing currencies into a standardised banding reflecting the position of that income relative to the national mean income or similar. Due to time constraints, analyses comparing the importance of participant and parental combined income to the other SES indicators collected were not undertaken, aside from a preliminary demographic check for all Australian participants (*n*=259). Of these, 3.9% declined to provide their own income, and 25.1% either declined or reported to not know their parents' combined income. The mean income of Australian participants was $39,823.42 (*SD*=34328.89). This mean income does not reveal significant differences captured by participants' life circumstances. As would be expected, independent samples t-tests indicated participants who were studying earned significantly less than participants who were not (*t*(205)=-8.935, *p*<.001), with students earning an average of $22,907.29 (*SD*=22731.80). Non-students mean earning was $57,016.87 (*SD*=35631.20). The mean income of non-students is slightly above the seasonally adjusted mean income of Australian adults in 2011 of $56175.6 (Australian Bureau of Statistics, 2012c). Similarly, the income of students' was close to, but below, the average income of Australian adults working part time as at November 2012, which was $29,120 (Australian Bureau of Statistics, 2012c). Mean combined parental income was $125,808.48 (*n*=193, *SD*=19.70).

Participants were also asked if they were experiencing financial hardship at each wave. At wave 1, 27.8% (*n*=138) reported experiencing financial hardship. Follow up waves indicated a drop in this proportion until wave 3 where rates stay consistently around 18%: wave 2 = 22.6% (*n*=60), wave 3 = 19.8% (*n*=39), wave 4 = 17.8% (*n*=27), wave 5 = 17.2% (*n*=23) and wave 6 = 18% (*n*=20). Parental highest education levels were also comparable to adult population average, with 4.6% reporting primary school, 26.2% high school, 19.5% technical/trade qualification, 27.2% bachelor's degree and 22.5% post-graduate degree.

In the Australian sub-sample, there was a small positive correlation between personal income and combined parental income (*r*=.22, *p*<.001, *n*=188), and parental income with highest education level (*r*=.19, *p*<.001, *n*=193), but personal income was not correlated with highest parental education level (*r*=-.01, *p*=.707, *n*=246). Comparatively, 25% of Australian adults reported having a tertiary degree (bachelor level or above) in 2011, compared with 49.7% of this sample's parents, suggesting a slightly higher SES than average. Overall, the SES of the

sample differed depending on life circumstance, but all indicators show a fairly close proximity to the population norms for Australian adults.

Coping styles.

As a possible important mediating variable between video game addiction and associated problems, a measure of coping styles was included. Participants were asked to complete the Brief Approach/Avoidance Coping Questionnaire (BACQ). This 12 item scale covers the coping domains present in the literature, including cognitive, socio-emotional and action-oriented, and presented a theoretically consistent factor structure with convergent validity by predicting scores on the COPE scale, Multidimensional Health Locus of Control Scale and General Health Questionnaire (Finset et al., 2002). The authors reported good internal consistency (α=.68) and test-retest of r=.61 (p<.01). Each item is scored on a 5 point Likert scale, which can be summed to produce three sub-scale totals representing approach coping (ranges from 6-30), diversion coping (ranges from 3-15) and withdrawal/resignation coping (ranges from 3-15). The BACQ was only included in wave 1. Internal consistency for the approach sub-scale was high (α=.71), similar to the diversion (α=.63) and the withdrawal/resignation (α=.68) sub-scales. Mean scores for approach was 20.33 (*SD*=4.33), diversion 9.38 (*SD*=2.60) and withdrawal/resignation 8.35 (*SD*=3.29). These can be compared with the student sample mean scores reported in the article detailing the study, namely 266 adult Norwegian students studying Psychology and Medicine, who scored a mean of 24 for approach, 8.3 for avoidance and 6.6 for resignation/withdrawal. However, these are not highly representative norms so a detailed comparison is not meaningful.

Global stressful events.

In an attempt to capture possible extraneous explanations for any decline in health observed, a measure of global stressful events was included. The PERI Life Events Scale (Dohrenwend, Askenasy, Krasnoff, & Dohrenwend, 1978) asks participants whether they had experienced any stressful events in their life that are out of the ordinary, and to briefly describe the event(s). Participants were also asked to rate events on a seven-point range from ‘Not very stressful’ to ‘Unbearably stressful’. This scale has extensive normative reference points for the different life events listed, for example moving house or death of a spouse. In this sample, 28.2% (n=140) of participants said they had experienced a stressful event at wave 1, with many relating to either

break-up of a relationship, of death of a loved one or pet. Of those that said yes, the mean stressfulness rating was 4.30 (*SD*=1.53). Proportions were similar in subsequent waves, with 21.4% in wave 2, 15.2% in wave 3, 14.5% in wave 4, 20.1% in wave 5 and 15.3% in wave 6. As the stressfulness rating stretches across a 7 point Likert scale, parametric statistics were produced and stable mean scores for stressfulness were obtained across all waves (all between 4 and 4.30).

Satisfaction with life domains.

One possible mediating or moderating effect between video game addiction and detrimental functioning is satisfaction. It is possible to theoretically construe the directionality of relationships between satisfaction, video game addiction and functioning in several ways. Firstly, decreased satisfaction may be a direct negative consequence of video game addiction, in that the increasing salience and tolerance of video game play may cause a decrease in satisfaction with other areas in life. Tied with a decrease in functioning that may be caused by video games displacing other activities, a negative spiral may ensue. This would fit with the general models of addiction described by Brown (1997) and Shaffer et al (2004), and would paint a picture of lack of control over gaming. Alternately, as gaming is an activity that usually takes place at home and is therefore easily accessible with little effort, is an immersive and enjoyable hobby for many, and may be used as an escape-based coping strategy, it is also possible that video game addiction may increase after a drop in satisfaction with a particular domain, caused by events unrelated to gaming. A decrease in satisfaction with a particular life domain may lead a person to increase their engagement and reliance on gaming, which may lead to greater endorsement of some video game addiction criteria. Due to time constraints, models for mediation or moderation are not tested using measures of satisfaction with life domains in this PhD. Instead, satisfaction is conceptualised as a confounding factor and included in cross-sectional models to determine if video game addiction still contributes to declined functioning, after controlling for the variance explained by satisfaction. The satisfaction scales utilised are detailed below.

Parenting satisfaction.

Participants were asked to complete the Satisfaction subscale of the Guidubaldi-Cleminshaw Parent Satisfaction Scale (Guidubaldi & Cleminshaw, 1985). The validity for this scale was

detailed earlier. Descriptive, normality and reliability statistics are now provided in Table 25 for the Parental Satisfaction sub-scale.

Table 25

Descriptive, Normality and Reliability Statistics for the Parental Satisfaction Scale

Wave	*n* parents	*M* (*SD*)	Skewness (*e*)	Kurtosis (*e*)	α	Test-retest *r*
1	47	36.00 (5.09)	-1.46 (.35)	4.13 (.67)	.77	-
2	21	34.94 (6.25)	-1.76 (.49)	3.40 (.96)	.86	.93***
3	13	31.00 (11.18)	-1.13 (.57)	-.25 (1.11)	.90	.93***
4	10	32.50 (7.95)	-1.22 (.69)	1.57 (1.32)	.93	.95***
5	8	26.30 (14.76)	-.38 (.69)	-1.94 (1.32)	.95	.99***
6	5	27.00 (5.15)	-2.03 (.90)	4.22 (2.00)	.74	.67

Note. ***p<.001

Relationship needs fulfilled and relationship satisfaction.

Satisfaction with romantic relationships was measured with the subscale tapping needs fulfilment from the Investment Model Scale (Rusbult, Martz & Agnew, 1998). This scale has demonstrated convergent validity, showing positive relationships with dyadic adjustment, trust level, inclusion of the other in the self and predicting relationship status over time. Divergent validity was demonstrated through a lack of relationships to several personal dispositional measures. Good internal consistency was present, judging by the results of a factor analysis. The subscale contains one item each covering needs for intimacy, companionship, sexuality, security and emotional involvement. Responses range from 1-4 and total scores from 5-20. Total scores showed non-normal skewness and kurtosis, but fairly strong reliability. Table 26 below reports the descriptive, normality and reliability statistics of the relationship needs fulfilment scale.

Table 26

Descriptive, Normality and Reliability Statistics for the Relationship Needs Scale

Wave	*n* in relationships	*M* (*SD*)	Skewness (*e*)	Kurtosis (*e*)	α	Test-retest *r*
1	243	25.10 (2.78)	-1.123 (.156)	1.253 (.311)	.83	-
2	136	21.90 (2.72)	-.794 (.208)	.304 (.413)	.83	.63***
3	99	21.42 (3.01)	-.447 (.243)	-.791 (.481)	.88	.76***
4	78	21.05 (3.47)	-1.035 (.276)	1.276 (.545)	.90	.71***
5	67	21.58 (3.76)	.027 (.295)	3.481 (.582)	.91	.21 (*p*=.08)
6	59	21.54 (2.83)	-.339 (.314)	-.824 (.618)	.87	.66***

Note. ***p<.001

Satisfaction with social activity.

As a possible confounding factor for diminishing social health, a single item measure of social satisfaction was included. Satisfaction with social activity was assessed with the single item "How satisfied are you with your social life?". This item had a 7 point Likert type response scale, starting at "Very dissatisfied" to "Very satisfied". Mean score at wave 1 was 4.40 (*SD*=1.69) and the item was not normally distributed.

Job satisfaction.

To determine the impact of satisfaction with work on functioning, the job satisfaction subscale of the Michigan Organizational Assessment Questionnaire (Bowling & Hammond, 2008) was included. All working participants completed three questions about satisfaction with each job they listed:

- All in all, I am satisfied with my job;
- In general, I don't like my job (reverse scored); and
- In general, I like working in my job.

Responses ranged from 1-5 on a Likert scale from strongly disagree to strongly agree. The middle item was reverse-scored and all items tallied. This scale has extensive validity in

samples of over thirty thousand participants, showing positive relationships with job complexity, skill variety, task identity, task significance, autonomy and feedback; and negative relationships with role ambiguity, role conflict, organisational constraints, interpersonal conflict and work-family conflict. It also has strong reliability and internal consistency (α=.84). Fortunately, some normative data is also available, although the authors chose to reported it as the average score for each item on a 5-point scale, rather than the total score average. They achieved this by dividing the mean reported in past studies by 3, arriving at an average of 3.93 (*SD*=.83). When the same treatment was given to the wave 1 total score, the resultant mean is 3.78 (*SD*=.95), only marginally lower. Further descriptive, normality and reliability is provided for the scale total score in Table 27 below.

Table 27

Descriptive, Normality and Reliability Statistics for Job Satisfaction Scale

Wave	*n* working	Total score *M* (*SD*)	skewness (*e*)	kurtosis (*e*)	α	Test-retest *r*
1	312	11.32 (2.85)	-.75 (.14)	.10 (.26)	.90	-
2	170	11.23 (2.88)	-.91 (.19)	.45 (.36)	.88	.77***
3	127	11.19 (2.82)	-.78 (.20)	.30 (.43)	.91	.78***
4	103	11.08 (2.83)	-.96 (.24)	.70 (.46)	.91	.81***
5	89	11.38 (2.69)	-.79 (.24)	.48 (.51)	.91	.67***
6	76	11.54 (2.43)	-.61 (.28)	-.03 (.54)	.91	.84***

Note. ***p<.001

Summary of the Sample Characteristics

In summary, the sample in the study are mostly male, about half are studying, slightly more than half are working, ten percent are parents and about half are in romantic relationships; and the great majority are avid gamers. They have marginally lower social, mental and physical health than available norms but with normal sleep health and BMI, and good overall academic and work functioning. These slightly lower health measures are tentatively assumed to be due to the recruitment method which targeted self-identified problem gamers, as intended. The elevated scores compared with norms may already suggest some variables which coincide with

heavy video game play or video game addiction. While these normative comparisons indicate some limited generalizability, they also suggest the recruitment strategy was effective.

Chapter 3: Factor Structure of the Addiction-Engagement Scale

One approach to investigating the differentiation of addiction and engagement in relation to video games, or other potential behavioural addictions, is to analyse scale factorial structure. Psychometric analyses are able to give an indication of how likely items within scales are to 'hang together' or co-occur, which is to be expected if the condition represents a 'syndrome' of interconnected parts. These interconnected parts are theorised to represent latent variables, which can be modelled and tested according to observed data. There is mixed evidence regarding the latent structure of many similar video game addiction scales, with most reporting unifactorial or second-order structures, and others finding a two factor solution representing one possible differentiation between measures of addiction and the close but unproblematic construct of high engagement.

Unifactorial or second-order factor structure scales.

Many video game addiction scales show a unitary or second-order factor structure, providing some supportive evidence that the various symptoms of the syndrome or components models tend to occur together. Some video game addiction scales included detailed analyses of their internal structure. The Problem Video Game Playing Scale (or PVP) is a nine item measure which adapts some DSM-IV-TR criteria for substance abuse and pathological gambling to video game playing. This scale was first tested with a sample of 223 Spanish adolescents ranging in age from 13 to 18 (Tejeiro Salguero & Morán, 2002). The authors reported the scale has acceptable internal consistency (α=.69), and that removal of any of the nine items reduced the alpha score. A principle components analysis of the tetrachoric items-correlation matrix revealed one factor explained 39.1% of the variance across the items, which was accepted as evidence of a unifactoral structure. However, two items, one relating to using video games to alter mood and another asking about lying or deception to conceal video game playing from others showed low item-total correlations (*r*=<.30). Later the PVP was again tested with a sample of 204 American adolescents, and a principle components analysis using a indicated only one factor present, and an identical Chronbach's alpha coefficient (Hart et al., 2009).

The Problem Video Game Playing Test (PVGT), a 20 item scale adapted from Young's Internet Addiction Test, demonstrated even higher internal consistency (α=.93) in a sample of 416 adult Australian gamers (King, Delfabbro, & Zajac, 2011). All items showed moderate correlations

with the item total (at least *r*=>.54), unlike some items in the PVP. Further, the authors conducted both an exploratory factor analysis (EFA) and a confirmatory factor analysis (CFA) to assess factor structures. The EFA suggested a single factor but the possibility of two factors. However, the results of a CFA indicated that a single factor model showed a better fit than a two-factor solution. With all items constrained to a single factor, Chi Square (χ^2), Tucker Lewis Index (TLI) and the Standardized Root Mean Square Residual (SRMSR) all indicated a good model fit (χ^2 (63)=368.67, *p*<.001; TLI=.98; SRMR=.06). Lemmens, Valkenburg and Peter (2009) developed a 21 item scale and also used CFA to test its' factor structure in two samples of Norwegian adolescents (*N*=352 and *N*=369). Using a model reflecting a second order factor structure, with 7 first order factors reflecting Brown's components, each measured using three individual items, the model showed a good fit (χ^2 (182)=594.20, *p*<.001; CFI=.903, RMSEA=.07), and this fit was replicated in the second sample. However, other similar video game addiction scales have not reported factorial structure (Choo et al., 2010; D. Gentile, 2009; Gentile et al., 2011; Porter et al., 2010).

Two-factor addiction and engagement scale.

On the contrary, Charlton and Danforth (2007) reported a two-factor structure with tolerance, mood modification and cognitive salience grouping not with addiction, but with the theoretically separate construct of engagement. An initial Principle Components Analysis produced a Scree plot suggesting two factors. The two factors accounted for 32% of item variance, with the first showing 25% and the second 7%, with an inverse correlation (*r*=-.33), justifying oblique rotation. On careful analysis of the item factor loadings after this solution, the authors concluded that items tapping conflict with other activities, inter-personal conflict, withdrawal symptoms, relapse and behavioural salience represented a clear addiction factor; whereas items tapping tolerance, euphoria (also called mood modification) and cognitive salience represented engagement. This factor structure closely resembled that found in a previous study which applied this scale to general computer use, rather than to a specific video game (Charlton, 2002).

The two factors have been termed 'peripheral' and 'core', with core referring to the pathological addiction factor. Analysis of frequency of individual item endorsement revealed that these engagement items were also amongst the most commonly endorsed, far more so than items in the core factor. The most commonly endorsed item related to often thinking about video games (cognitive salience) and the second most endorsed related to feeling a buzz of excitement when

playing video games (mood modification). The least endorsed item related to often feeling agitated when not playing video games (withdrawal), and the second least related to failures to reduce time spent playing (relapse).

Focus of this Chapter

The Charlton and Danforth (2007) scale is yet to undergo a confirmatory factor analysis (CFA), which arguably has different, arguably more stringent, requirements for model fit than an exploratory factor analysis. CFA is also often used to assess whether observed data fits a theorised model. The Charlton and Danforth (2007) scale factor structure has only been explored twice, once in relation to general computer use and another in relation to a specific online game (Charlton, 2002), both utilising exploratory factor analysis. The next step in testing this factor structure is to conduct a CFA in a sample of highly engaged gamers. This chapter will therefore test the Charlton and Danforth Addiction-Engagement scale using CFA, as well as test the discriminant validity of the latent constructs in the scale, using traditional and structural equation modelling based tests. As Charlton and Danforth (2007) discussed engagement as playing a peripheral role to addiction, with high engagement likely a precursor, a model was constructed with engagement and addiction as two co-varied latent constructs.

Aims and Hypotheses

Aim:

1. Explore the definition, and measure, of addiction and engagement proposed by Charlton and Danforth (2007) by investigating:

    1.1 Whether the factor structure of the scale reflects the theoretical conceptualisation of addiction and engagement in a CFA;

Hypotheses:

1. That the Addiction-Engagement Scale will show acceptable model fit according to conventional fit statistics
2. That the two latent constructs will show discriminant validity

Method

AMOS version 20 was used to conduct a CFA on the Charlton and Danforth (2007) addiction-engagement scale, using the cross-sectional sample at wave 1 (*n*=497). The 29 item version of the scale, published in Charlton and Danforth (2007) was adopted. Histograms of all 29 items revealed the addictions items were not normally but bi-modally distributed, with very few participants selecting 'neither agree nor disagree'. This bimodality would adversely affect the CFA and other SEM-based analyses as each item is less approximated to an asymptotic distribution. In order to address this, and for the sake of being conservative in classifying addiction, responses were converted from a 5 point Likert scale to a 4 point, by converting the response 'neither agree nor disagree' (equating to a '3' in the numerical score) to a 'disagree' (equating to a '2'). Following this treatment, addiction items were unimodally distributed and negatively skewed. For consistency, all analyses in this PhD utilising scores from the Addiction-Engagement scale use the converted 4-point response scale, including total scores (see Method section for further detail on the scale). Bartlett's test for sphericity indicated the items were suitable for analysis ($\chi^2(406)=4489.35$, $p<.001$) and a Kaiser-Meyer-Olkin measure of sampling adequacy was high (at .90). A model was created with the 13 addiction items feeding into a latent construct representing addiction and the remaining 16 engagement items feeding into an engagement construct. The two latent variables were co-varied and are presented in the format of the statistical program used to test the model (AMOS) in Figure 1.

Model fit.

Model fit indices included both fit statistics and incremental (or comparative) fit indices. Fit statistics assess the differences between the implied variances and co-variance matrix in a suggested model to the sample variances and co-variances, to determine if the differences are statistically significant (Lomax & Schumacker, 2012, pp. 119-136). Comparative fit indices assess how much better fitting the model is from a baseline model, by comparing the two (Bentler, 1990). Fit statistics utilised included the Chi Square Goodness of Fit test and the Root Mean-Square Error of Approximation (RMSEA). Comparative tests used included the Tucker-Lewis Index or TLI (Tucker & Lewis, 1973) and the Comparative Fit Index or CFI (Bentler, 1990). Each fit statistic takes into account slightly different characteristics of model fit, and is sensitive to different statistical features within the data. For example, the Chi Square Goodness of Fit test is sensitive to sample size, with larger samples decreasing the likelihood of an acceptable model fit. Likewise, the Chi Square test has more stringent fit requirements as it

assumes that the distributions are from a population in which the model may be exist perfectly as hypothesised, rather than a sample which will inevitably include misspecifications (Lomax & Schumacker, 2012). The RMSEA applies less stringent assumptions regarding the estimation of population parameters by which model fit is assessed (Steiger, 1990). A spread of fit indices was chosen as this study is exploratory, and to test for differences across diverse fit requirements.

Discriminant validity.

Discriminant validity is also a focus of this analysis. That is, determining whether the engagement and addiction factors, while co-varied, can be said to measure separate constructs and be statistically distinct. In the case where there is likely to be some shared variance between theoretically distinct latent variables, some SEM-based techniques are available to investigate discriminant validity. Fornell and Larcker (1981), while not strictly SEM-based, suggested that discriminant validity holds if the average variance extracted (AVE) for two latent factors exceeds the square of the correlation between them. This method takes into account the average variance explained by the factor in the scale items, including the error in this approximation, and compares it to the strength of the relationships between the constructs. Alternately, Bagozzi et al. (1981) suggested an SEM-based discriminant validity analysis approach using nested models. Bagozzi et al. (1981) suggest that the model can first be run unconstrained, then run a second time with the correlation between the latent constructs constrained to ‘1’, and if this does not significantly worsen the Chi Square test for model fit, then the constructs are deemed not be discriminant. If the model does significantly worsen after constraining the relationship between the constructs, one can conclude the constructs are discriminant from each other. In addition to model fit, these two discriminant validity indicators will also be calculated.

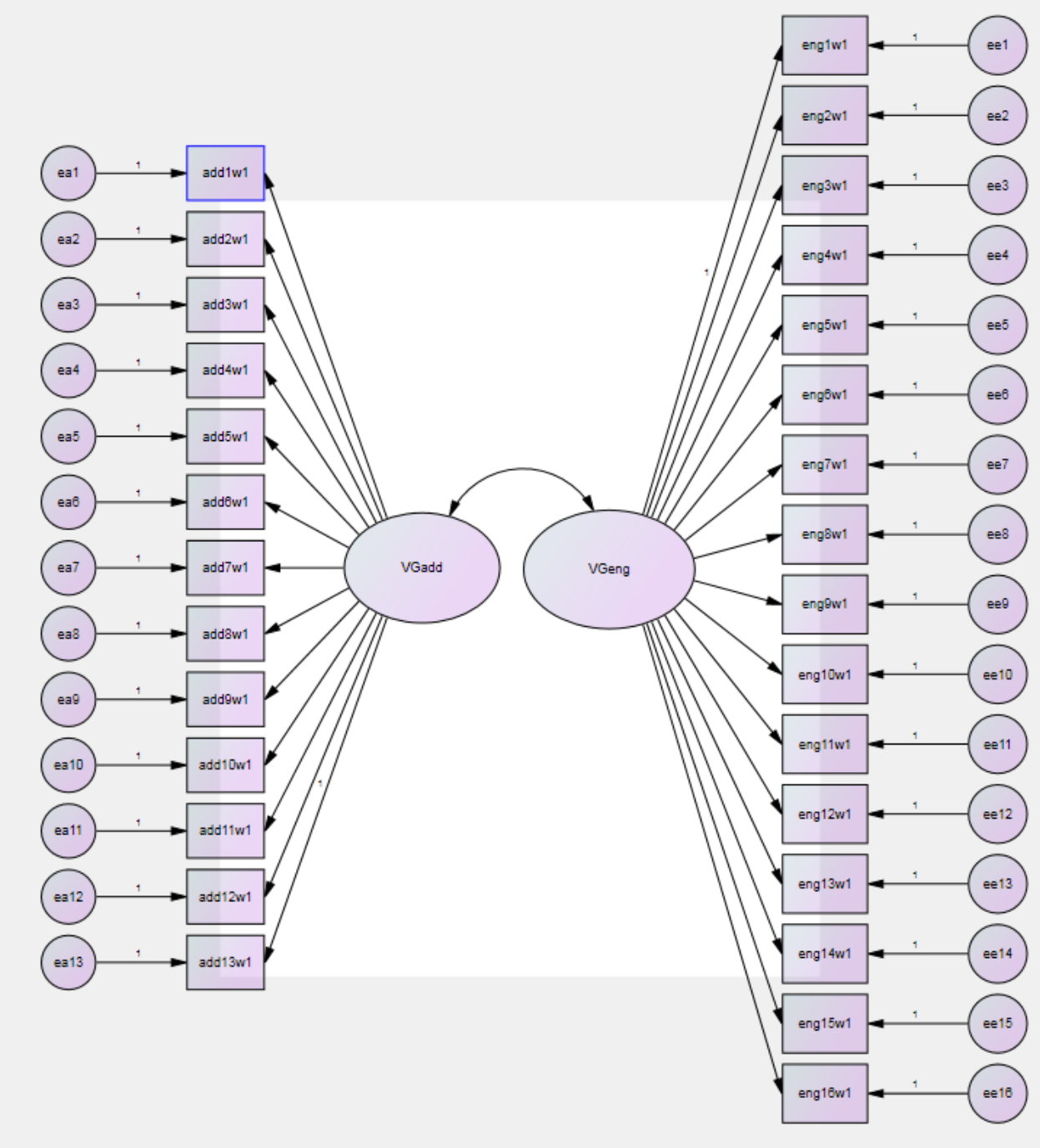

Figure 1. Model Demonstrating Proposed Factor Structure Between Engagement ('VGeng') and Addiction ('VGadd').

Note. Model is depicted in the format of AMOS software and readers are encouraged to consult the User Guide for further explanation of graphical conventions (Arbuckle, 2012).

Results

Model fit.

Initially, the model was run without the two latent constructs covaried. This resulted in a poor fit, indicating the observed model was different to the proposed model ($\chi^2(377)=1414.261$, $p<.001$). The two latent constructs were then covaried which resulted in a slightly better, but still poor, model fit ($\chi^2(376)=1247.09$, $p<.001$; RMSEA .06; TLI .77 and CFI .79). Model re-specification was considered in order to explore what changes may be required to improve fit. Modification indices were computed and changes were undertaken in an exploratory manner. The biggest improvement that could be made was to covary engagement item 3 with the video game addiction latent construct, suggesting that this item is highly correlated with video game addiction scores (and inconsistent with the theoretical conception of the scale). The other largest modification indices involved covarying the error terms of several engagement items, namely items 1 and 3; 1 and 4; 3 and 4; 6 and 9; 9 and 10; 2 and 16; and 12 and 13. After these modifications were made, the model still demonstrated a poor fit by most standards ($\chi^2(368)=878.17$, $p<.001$; TLI .85; CFI .88); however the RMSEA suggests the model may be tenable as a close fit (rather than exact fit), with RMSEA=.053, or .04 if rounded to two decimal places; and PCLOSE greater than .05 (PCLOSE=.13).

Discriminant validity.

Fornell and Larcker's (1981) AVE method was calculated by dividing the sum of the squared standardised regression weights (as it is termed in the AMOS output) by the sum of the squared standardised regression weights and the error variance. This produced an AVE of .391 for the addiction factor, and .336 for engagement. The average of these two figures is .362. The correlation between the two factors is .48. Table 28 below provides a summary of the AVE calculations.

Table 28

Output of Fornell and Larcker AVE Method for Assessing Discriminant Validity in Interrelated Latent Constructs

Factor	Items	standardised factor loadings	l^2	Error variance	Variance extracted
Addiction	Add1	.722	.520	.334	
	Add2	.700	.490	.417	
	Add3	.562	.316	.553	
	Add4	.683	.465	.312	
	Add5	.637	.406	.421	
	Add6	.565	.318	.481	
	Add7	.579	.334	.607	
	Add8	.696	.483	.453	
	Add9	.651	.424	.480	
	Add10	.268	.072	.830	
	Add11	.396	.157	.760	
	Add12	.452	.203	.541	
	Add13	.381	.144	.566	
	Sum		4.332	6.755	.391

Factor	Items	standardised factor loadings	l^2	Error variance	Variance extracted
	Eng1	.458	.210	.593	
	Eng2	.535	.285	.328	
	Eng3	.279	.078	.628	
	Eng4	.460	.212	.512	
	Eng5	.657	.432	.386	
	Eng6	.501	.250	.474	
	Eng7	.601	.360	.419	
	Eng8	.375	.141	.470	
	Eng9	.408	.165	.561	
	Eng10	.653	.425	.336	
Engagement	Eng11	.521	.270	.507	
	Eng12	.557	.300	.433	
	Eng13	.365	.132	.436	
	Eng14	.662	.437	.380	
	Eng15	.286	.082	.735	
	Eng16	.249	.061	.442	
	Sum		3.860	7.640	.336

Ave variance extracted	0.362
Correlation between factors	0.491
Correlation squared	0.240

As the Fornell and Larcker method gives the average of the variance in each item explained by the factor, taking into account error, this figure is likely to be lower if certain items load weakly onto the factor. As this was the case with quite a few items in both scales, particularly addiction item 10 and engagement items 3, 15 and 16, the Bagozzi et al. (1981) nested models method was also used.

The nested model approach to assessing discriminant validity was tested with the final model, after modification indices were applied. Covariance between addiction and engagement was constrained to equal '1'. In this second model, the fit statistic became poorer ($\chi^2(369)=1213.6$, $p<.001$; compared with $\chi^2(368)=878.17$), with model comparison demonstrating this difference was statistically significant ($\chi^2(1)=335.43$, $p<.001$), suggesting independence of the constructs.

Discussion

Model fit.

The first hypothesis for this analysis was only partially met. Most fit statistics indicated a relatively poor model fit for the conceptualisation of the latent constructs of engagement and addiction as measured by this scale, except for the RMSEA, and only after a number of modifications. The model was improved by following the modification indices which suggested the most significant improvements. Altering models to improve fit on this basis has been cautioned against by psychometricians (Bagozzi & Yi, 1988). Any alternations made must be considered in light of the theoretical conceptualisation of the constructs. Most involved co-varying error terms of items within the engagement subscale. Jöreskog and Sörbom (1996: p306) suggest that when error term covariations can substantially improve the model fit, correlations exist between those items in greater magnitude than the correlations with their latent construct.

The largest improvement involved covarying the error term of engagement item 3 with the video game addiction latent construct. This item is ‘The less I have to do with video games, the better’. It may be that participants who self-identify as problem video gamers interpret this item to indicate the problematic nature of their gaming habits, rather than a more straightforward interest in video games. As such, the item was more highly correlated with the addiction construct than represented in the model, and covarying the error term improved model fit. This suggests that this item is likely ambiguous when presented alongside addiction items, and should either be removed or possibly relocated to the addiction sub-scale.

The next best changes involved covarying the error terms of several engagement items. These covariances suggest engagement is likely a more complex structure made up of several sub-factors. This would be consistent given the varying motivations of play identified in past literature investigating why people play video games (Yee, 2006). In this case, given that the engagement subscale has 16 items, it is unsurprising that some smaller factors are represented within that. That said, most sub-factors (or systematic statistical correlations) are theoretically sensible and logical on a reading of face-validity. Modification indices indicated improved fit by covarying error terms for the following engagement items:

- 1 (‘It would not matter to me if I never played video games again’; reverse scored) and 4 (‘Video games are unimportant in my life’; reverse scored);
- 6 (‘I spend little of my spare time playing video games’; reverse scored) and 9 (‘I pay little attention when people talk about video games’; reverse scored);
- 9 and 10 (‘I tend to want to spend increasing amounts of time playing video games’);
- 2 (‘I feel happy at the thought of playing video games’) and 16 (‘I can’t understand why people like video games’; reverse scored);
- and 12 (‘I often experience a buzz of excitement while playing video games’) and 13 (‘I like the challenge that learning to play video games presents’).

On a reading of theoretical sensibility, it is not clear why these items would converge beyond the contribution of their latent construct. That said, the engagement scale is relatively long, with 16 items. Other studies of motivations for playing video games suggest a diversity of reasons, which can be conceptualised under multiple domains, such as those described by Yee (2006). Others investigating interest or motivation to play video games in the context of consumer satisfaction or user design have reported several sub-factors (Wiebe, Lamb, Hardy, & Sharek,

2014). With 16 engagement items, it is therefore not surprising that smaller sub-domains are represented within the overall scale. While further work may be needed to psychometrically target a measure of unproblematic engagement, the presence of these sub-factors was not considered to invalidate the overall engagement measure. Further chapters explore other aspects of how addiction may be distinct from engagement, based largely on measures of health and functioning.

However, despite covarying these engagement error terms, the model still demonstrated misfit according to most conventions. Specifically, the Chi Square, the TLI and CFI. Browne and Cudeck (1993) suggest that if RMSEA scores are below .05, which when rounded to two decimal points this RMSEA score is, and PCLOSE is greater than .05 (in this case .144), researchers are able to accept the hypothesis that the model is a close fit to the data and therefore tenable. RMSEA is able to take into consideration the differences between the population and sample distributions. Given these model fit indices are much closer to acceptable standards than the Chi-squared, CFI or TLI, this may be another indicator that a sample of very highly engaged and self-identified problematic gamers are not representative of the average gamer and may not contain enough variance for most model fit indices.

In conclusion, these CFA results do not provide unequivocal support for the conception of the latent constructs addiction and engagement as measured by the Charlton and Danforth Addiction-Engagement scale. The RMSEA suggests a model which is very close to the data and acceptable by some conventions. According to the modification indices, the sub-factors between engagement items are not necessarily detrimental to the separation between addiction and engagement, except for engagement item 3. The largest modification was actually covarying engagement item 3 with the addiction factor, clearly indicating that this item belongs more in the addiction factor, or is ambiguous and should be discarded. Further studies must explore the factor structure of engagement-addiction scales further with a population more representative of the average gamer.

Discriminant validity.

The second hypothesis for this chapter was confirmed. Most factor analyses favour factor purity indicated by a lack of relationships to other factors. However, in the social sciences it is reasonable to expect that many latent variables of interest will be interrelated. Such is the case with video game addiction and engagement. Distinguishing the two latent constructs was explored through analysis of factorial discriminant validity.

Two methods of assessing discriminant validity for interrelated latent variables were employed. The first utilised AVE. This analysis indicated the average variance explained in the items by the latent constructs, taking into account error/residual, was greater than the squared correlation of the latent constructs. This suggests that the latent constructs explain more variance in their respective items than they do of the variance in each other, confirming discriminant validity. The second discriminant validity analysis produced a similar conclusion. When the relationship between the two latent constructs was constrained to a perfect correlation, overall model fit statistics became significantly poorer, indicating a substantial increase in residual.

These two checks for discriminant validity, one comparing average variance explained and the other using structural equation modelling fit statistics, both confirmed that the two latent constructs are discriminant. Results for this chapter indicate that the data is better explained when the two latent constructs are co-varied, but discriminant. The findings for discriminant validity are arguably more compelling given the sampling strategy targeted people on the higher end of addiction scales. While the overall model only met requirements of a close fit, results for the chapter generally provide support for Charlton and Danforth's conceptualisation of engagement and addiction as related, but theoretically distinct. As a harm-centric approach must be adopted when defining video game addiction and distinguishing it from engagement, the next chapter investigates which items in the scale are most related to detrimental health and functioning.

Chapter 4: Item-Level Analysis of the Addiction-Engagement Scale; Prevalence and Relationships with Health and Functioning.

Researchers have detailed general models of addiction, reviewing the evidence in favour of a common underlying etiology not specific to any particular behaviour or activity. Across different addiction or addiction-like conditions, researchers have described similar or same risk factors and vulnerabilities, natural histories, expressions and outcomes; as well as response to treatment (Brown, 1997; Shaffer et al., 2004). While there is variation across general addiction models, most include the following components: tolerance, withdrawal, salience, mood modification, conflict and loss of control.

Different models place different levels of importance on these components. Brown (1997) argued that tolerance and withdrawal are less central to behavioural addiction. Whereas Shaffer et al (2004) suggest that tolerance and withdrawal are key indicators. Likewise the authors of the DSM-V tentative diagnosis of 'internet gaming disorder' have stressed the disorder is not yet official partly because of the current lack of evidence in favour of the presence of tolerance and withdrawal in video game playing (APA, 2013). This indicates the DSM-V working party also believed in the centrality and importance of tolerance and withdrawal.

Features which are idiosyncratic to the particular behaviour or activity of interest are also expected to be present, but how to identify and deal with them is not well elucidated in general models currently. Proponents have noted that greater understandings may be attained by studying the application of addiction to as-yet dissociated disciplines or topics. For example, Brown's (1997) components model was described in the chapter of a book exploring the application of addiction theory to criminality. Debates continue over the existence, usefulness and definition of internet and video game addiction, (Petry, 2013; Starcevic, 2013a), with one essential question being whether the concept of addiction can be meaningfully applied to *any* behaviour or activity, as suggested by general models.

There is no clear consensus on the evidence required to validate general addiction, but it is widely accepted that the condition must cause negative consequences (Griffiths & Davies, 2005). Validation should take a harm-centric approach, identifying the components which are most associated with negative consequences. General addiction must also be distinguished

from other close concepts. These include habits, obsessions, compulsions, attachments and dependencies; as well as, particularly in the case of demonstrating negative consequences, other mental illnesses (Brown, 1997). In sum, criticisms of general addiction models include the current lack of evidence for causality with associated problems, reduced severity in identified negative consequences compared with substance abuse and pathological gambling, lack of understanding in identifying and assessing importance of idiosyncratic aspects, reductionism as common aspects are given priority over idiosyncratic ones and failure to conclusively demonstrate tolerance and withdrawal for non-substance behaviours (Brown, 1997; Hellman et al., 2012; Petry, 2006, 2011, 2013; Shaffer, 1996, 1999; Shaffer et al., 2000; Shaffer et al., 2004).

Aside from the uncertainty around which general addiction components are most important or problematic, researchers have also noted that some of the components, such as tolerance, salience and mood modification, are likely to be ubiquitous in many adaptive or benign hobbies or activities (Charlton, 2002; Charlton & Danforth, 2007, 2010). Determining the intensity at which these components should be considered indicative of an addiction is complex. Theorists of general addiction talk of hedonic gaps, restructuring of motivation and behavioural hierarchy choices, as well as ratios of risk and reward (Brown, 1997; Shaffer et al., 2004): all of which are likely to be multidimensional and relative to an individual's history and context. Yet, when general addiction components are applied and measured in possibly new non-substance addictions, such as video game addiction, intensity has not been studied in such a way that allows detailed exploration of these ratios over time. Instead, intensity of features is usually measured with simple response ranges and at a single time point, or even discarded in favour of dichotomous responses. Analyses have also focussed heavily on scale total scores, rather than individual addiction components, or combinations of components.

Measuring video game addiction and the importance of individual addiction components.

Different video game addiction scales prioritise slightly different aspects. This occurs by wording items differently, ramping multiple consequences together or devoting more or less items to different aspects, such as conflict across life domains (King, Haagsma, et al., 2013). After conducting an extensive comparison of video game addiction scales, King, Haagsma, Delfabbro, Gradisar and Griffiths (2013) noted the importance of analysis at the item level,

stating: “Given the range of addiction indicators employed across instruments, it may be worthwhile for studies to … identify test items most indicative of levels of severity” (p. 340). It is currently unknown whether certain general addiction components, such as withdrawal or salience, are more important in bringing about negative consequences than others potential ‘symptoms’. It may be that certain items are related more strongly to declined health and functioning, especially across a spectrum of different aspects of health and functioning.

It is also unknown whether single survey items will show convergent validity with well-established scales measuring that domain of interest. For example, whether agreement to the statement ‘I often fail to get enough sleep because of playing video games’, will successfully predict sleep disturbance using a validated and multi-dimensional measure. This applies for other self-rated and subjective aspects of the scale as well, such as whether the item ‘My social life has sometimes suffered because of me playing video games’, will show inverse relationships with structural and functional measures of social health. Analyses of other scales used for screening depression have indicated that just two verbally asked questions show comparable sensitivity and specificity to the composite of the entire scale (Zimmerman et al., 2006). Therefore, single items can be highly valid measures in the context of health. Given the relative infancy of video game addiction, individual items in video game addiction scales deserve analysis.

Prevalence of individual video game addiction components is also largely unknown, with only a couple of studies reporting individual item prevalence. These suggest that some of the more serious addiction components, like withdrawal and loss of control, are also the least common, while items representing mood modification and tolerance are very common (Charlton & Danforth, 2007; Tejeiro Salguero & Morán, 2002). If left untested, these differences in prevalence of individual items may have implications for development of theory and addiction thresholds. Studies of video game addiction have thus far not reported relationships with individual scale items and measures of possible negative consequences, which may contribute knowledge about which possible components are the most problematic.

Differentiation between engagement and addiction.

Charlton and Danforth (2007) have highlighted that some components thought to constitute addiction may actually represent the benign or even adaptive intense interest in a hobby. They argued that tolerance, cognitive salience and mood modification are more reflective of high engagement with video games, while the remaining components indicate addiction. Their Addiction-Engagement scale reflects this conceptualisation. In addition to tolerance, cognitive salience and mood modification, their engagement subscale also includes elements of prioritisation of video games in life, enjoyment of video games, paying attention to and being drawn to video games. Inclusion of such a measure alongside addiction is a unique way to explore and validate how to separate addiction from similar constructs, such as hobbies; a consideration noted by theorists of general addiction (Brown, 1997).

Charlton and Danforth (2010) and others have tested this differentiation of engagement and addiction relating to video games by investigating relationships with scale total scores. So far, addiction was associated with negative personality subtypes, attentional profiles, poorer academic performance and decreased mental health in a small sample (Charlton & Danforth, 2010; Metcalf & Pammer, 2011; Skoric et al., 2009). In the same studies relationships were absent between these possible negative consequences and the engagement sub-scale. Yet, many other studies use similar video game addiction scales which classify tolerance, mood modification and cognitive salience as addiction, and these studies have shown similar relationships with detrimental well-being (Allen et al., 2009; Gentile et al., 2011; Lemmens et al., 2011; Mentzoni et al., 2011; Starcevic et al., 2011; Tejeiro Salguero & Morán, 2002). Validity for the conceptualisation of tolerance, cognitive salience and euphoria as engagement rather than addiction may be tested by investigating their relationships with a range of health and functioning indicators, at the item level. This chapter presents item-level analyses for the addiction-engagement scale.

Focus of this Chapter

This chapter will report analyses of the Charlton and Danforth (2007) Addiction-Engagement scale (CEAS) at the level of individual items, with a sample of highly engaged and possibly addicted gamers. Firstly, individual item prevalence will be reported. Secondly, relationships between individual items and a broad range of health and functioning measures will be

explored, across both engagement and addiction. Thirdly, the relative strength of addiction and engagement items in predicting health and functioning will be analysed using linear models which take into account the relative contribution in the presence of all other items.

Aims and Hypotheses

Aim:

1. Explore the definition, and measure, of addiction and engagement proposed by Charlton and Danforth (2007) by investigating:

    1.2 Which individual scale items are more commonly endorsed and more strongly related to health and functioning.

Hypotheses:

1. Some scale items will be more commonly endorsed than others, with addiction items generally less endorsed than engagement items;
2. Some scale items will show larger relationships with measures of health and functioning than others, and addiction items will generally show larger relationships with health and functioning than engagement items;
3. Some items will be more predictive of aspects of health and functioning than others in regression models.

Method

For ease of reading, this section divides the method, results and discussion sections into the sub-headings of ‘Prevalence’, ‘Relationships between individual items and health and functioning’ and ‘Modelling the relative importance of items as predictors of health and functioning’. Also for easier reading, when discussing the results the individual items of the addiction-engagement scale are numbered according to their position in their sub-scale rather than their position in the total 29 item scale. So, rather than numbering the scale items from 1-29, items are separated according to sub-scale, resulting in a 13 item addiction scale and 16

item engagement scale (see the Measures section in the Method Chapter for further detail and the complete wording of every scale item).

Prevalence.

Firstly, individual prevalence of the scale items were reported and analysed. Items were dichotomised by converting ‘disagree’ and ‘strongly ‘disagree’ to a ‘no’, and ‘agree’ or ‘strongly agree’ to a ‘yes’. As detailed in the method section (Chapter 2), all ‘neither agree nor disagree’ responses were converted to disagree, therefore these prevalence rates may be more conservative than past studies which either treated these as a ‘yes’, or a half yes (numerically a .5; see Gentile et al, 2011).

Relationships with health and functioning.

As the addiction-engagement scale items were converted to a 4-point response range after inspection of histograms revealed non-normality for addiction items, the type of data in this analysis can be said to be ordinal rather than interval. Limitations of ordinal data primarily relate to the inability to discern the distance between each measurement interval. This same criticism is generally considered to be overcome when several Likert-type items are summed to produce a total scale score, as this data begins to approximate an interval scale; or the data meet certain criteria of normality or sample size, and hence parametric inferential tests are then commonly employed (Tabachnick, Fidell, & Osterlind, 2001). Due to the Likert-type (as opposed to Likert-scale) data employed in this analysis, two-tailed Spearman’s Rho correlations (r^S) were calculated between health and functioning measures and individual scale items.

Correlations were calculated between individual items and symptoms of depression, anxiety and stress, social support, social activity, BMI, sleep health and physical activity; as well as those scales relating only to a sub-sample, including relationship conflict, work disturbance (times late and warnings received), academic functioning (number of subjects failed, grade average and discrepancy score) and job seeking behaviours.

Modelling items as predictors of health and functioning.

Enter-method linear regression models were generated to investigate the relative strength of relationships between individual scale items and measures of health and functioning, in the

presence of all other items. All 29 items of the addiction-engagement scale (which includes the 13 addiction sub-scale items and 16 engagement sub-scale items) were entered as predictors with measures of mental, social and physical health, as well as functioning in life domains, as outcomes. Although items are on an ordinal scale, for the purposes of this analysis they were considered interval, with the acknowledgement that distances between the intervals may not be consistent. As this analysis is exploratory, the lack of equi-interval data was not considered to greatly diminish interpretation of results, or overly bias parameter estimates. Scatterplots of residual versus predicted values were examined and revealed roughly rectangular shapes, clustered around the 0s with no discernible structure, suggesting linear and largely homoscedastic error terms. In each model, a few cases just made it over the 3.3 Z-score which can signify univariate outliers. But as there were only 3 cases, and the maximum score a participant could have for each item was 4, they were retained. King, Haagsma, Delfabbro, Gradisar and Griffiths (2013) suggested Rasch analysis for the purpose of exploring video game addiction scales at the item level. While the Rasch model is argued to overcome limitations associated with ordinal data and is often used to explore diagnostic thresholds, this exploratory analysis has employed correlations and regression as a starting point for investigating the importance of individual items.

Creating composites.

As these regression models are confined to only one outcome variable (the dependant variable), the different health and functioning indicators were composed as composites. Symptoms of stress, anxiety and depression were combined to produce a measure of overall mental health (with lower scores indicating better health). Social health consisted of the total score for the social support scale and social activity scale (with higher scores indicating better health). The range for social activity is larger (60) than the range for the social support scale (30), so this metric is biased towards a structural measure of social health rather than functional. Physical health consisted of the product of physical exercise frequency, the SF-1 general physical health rating, BMI and the sleep health scale (with higher scores indicating better physical health). The MOSS and BMI have larger ranges than the other composite measures, and as such bias this composite in their favour. In terms of functioning in life domains, a model predicting relationship conflict was run for those in relationships (higher scores equate to more conflict). Work disturbance consisted of sum of times late and warnings received (with higher scores indicating poorer functioning), which is skewed towards times arriving late as it was more

commonly reported and had a much larger range. Academic functioning consisted of number of subjects failed, grade average and discrepancy score (only negative discrepancy, removing participants who achieved better than they intended; see Method section). The job seeking behaviour scale total was the outcome variable in one additional model for job-seekers.

Results

Prevalence.

Table 29 reports the prevalence of individual addiction items within the wave 1 sample, and Table 30 reports the prevalence of individual engagement items, in order of most commonly endorsed. For reference, item text is included. Charlton and Danforth indicated which components of Brown's model each item tapped (see Charlton and Danforth, 2007, p. 1539). Some of these items obviously reflect aspects noted by general addiction theorists and other video game addiction scales, such as the attribution of addiction reflecting intra-personal conflict; other items are more ambiguous or not specific to one general addiction component. These tables give an indication of the prevalence of each of the individual Charlton and Danforth Addiction-Engagement scale items.

Table 29

Prevalence of Individual Addiction Items, in Order of Most Commonly Endorsed

Addiction Item	% endorse	Item text
1	61	I sometimes neglect important things because of an interest in video games
3	49.5	Playing video games has sometimes interfered with my work
12	48.1	I feel a sense of power when I am playing video games
11	47.5	I have never used video games as an escape from socialising (R)
2	45.1	My social life has sometimes suffered because of me playing video games
9	40.4	I often fail to get enough sleep because of playing video games
7	39.2	Arguments have sometimes arisen at home because of the time I spend on video games
8	36.4	I think that I am addicted to video games
10	32.2	I never miss meals because of playing video games (R)
5	25.6	I have made unsuccessful attempts to reduce the time I spend playing video games
6	23.9	I am sometimes late for engagements because I am playing video games
4	18.5	When I am not playing video games I often feel agitated
13	16.1	I often feel that I spend more money than I can afford on video games

Note. (R) denotes reverse-scored items.

Table 30

Prevalence of Individual Engagement Items in Order of Most Commonly Endorsed

Engagement Item	% endorse	Item text
16	90.3	I can't understand why people like video games (R)
13	83.3	I like the challenge that learning to play video games presents
2	82.7	I feel happy at the thought of playing video games
1	75.1	It would not matter to me if I never played video games again (R)
12	74.4	I often experience a buzz of excitement while playing video games
9	71.2	I pay little attention when people talk about video games
4	70.4	Video games are unimportant in my life (R)
3	69.6	The less I have to do with video games, the better (R)
6	63.2	I spend little of my spare time playing video games (R)
15	59.2	Video game jargon sounds stupid to me (R)
11	57.9	It is important to me to be good at video games
7	47.9	When I see video games, I feel drawn towards them
8	44.3	I rarely think about playing video games when I am not using a computer (R)
14	44.3	I try to make video game play sessions last as long as possible
10	34.4	I tend to want to spend increasing amounts of time playing video games
5	33.6	I would hate to go without playing video games for more than a few days

Note. (R) denotes reverse-scored items.

Relationships with health and functioning.

Tables 31 and 32 report the Spearman Rho Correlations (r_s) for measures of health, namely symptoms of depression, anxiety and stress, social support, social activity, BMI, physical exercise frequency and the single item general health rating from the SF-36. Tables 33 and 34 report r_s for indicators of functioning, which were only completed by relevant cohorts, namely relationship conflict, work disturbance (product of times late and warnings received), number of academic subjects failed, academic grade average, academic discrepancy score and job seeking behaviours.

Table 31

Spearman Correlations (r^S) between Addiction Sub-Scale Items and Measures of Health

Addiction item	Depression	Anxiety	Stress	Social support	Social activity	BMI	Exercise Frequency	General Health Rating	Sleep health
1	.33***	.24***	.31***	-.18***	-.10**	.07	-.17***	-.21***	-.27***
2	.29***	.29***	.33***	-.22***	-.20***	.07	-.11**	-.23***	-.21***
3	.23***	.18***	.24***	-.13***	-.08*	.03	-.11*	-.12*	-.20***
4	.42***	.46***	.46***	-.28***	-.24***	.07	-.16***	-.20***	-.37***
5	.23***	.22***	.28***	-.19***	-.24***	.05	-.08*	-.17***	-.27**
6	.19***	.24***	.27***	-.16***	-.09*	.10*	-.03	-.15***	-.28***
7	.26***	.27***	.25***	-.21***	-.16***	.01	-.06	-.10*	-.18***
8	.24***	.26***	.26***	-.16***	-.19***	.12**	-.15***	-.17***	-.22***
9	.26***	.28***	.28***	-.19***	-.10*	.15**	-.08*	-.19***	-.36***
10	.12**	.17***	.17***	-.05	-.06	.01	-.06	-.12**	-.14***
11	.31***	.15***	.22***	-.14**	-.17**	.01	-.05	-.11**	-.14***
12	.18***	.29***	.25***	-.11**	-.11*	.07	-.04	-.14***	-.18***
13	.21***	.16***	.20***	-.19***	-.18***	.15***	-.09*	-.19***	-.14***

Note. *p<.05. *p<.01. ***p<.001. N=497. Higher scores on depression, anxiety, stress and BMI equate to poorer health on these measures. In all other measures, higher scores equate to better health.

Table 32

Spearman Correlations (r_s) between Addiction Sub-Scale Items and Indicators of Functioning

Addiction item	Relationship conflict (n=243)	Late to work (n=313)	Performance Warnings (n=313)	Subjects failed (n=269)	Grade average (n=212)	Discrepancy score (n=212)	Job seeking (n=74)
1	.10	.14**	.07	.12*	-.07	.02	.10
2	.12*	.08	.12*	.04	-.03	.06	-.03
3	.16*	.10*	.09	.16**	-.23**	.13*	.00
4	.28**	.09	.09	.09	-.02	.13*	.21
5	.10	-.00	.01	.02	-.04	.04	.07
6	.24***	.19***	.03	.10	.03	-.01	-.05
7	.19***	.15**	.07	.03	-.05	.12	.11
8	.18**	.06	.18**	.12*	-.06	.10	.10
9	.16*	.06	.02	.05	-.04	-.04	.06
10	.10	.01	.03	-.01	-.07	.14*	.01
11	-.03	.11*	.03	.03	.02	.01	.10
12	.08	.00	.10	.05	.07	.04	-.03
13	.10	.00	-.03	.11	-.11	.07	-.15

Note. *p<.05. *p<.01. ***p<.001. Higher scores equate to poorer functioning on all domains, except grade average and job seeking behaviours, in which higher scores equate to better functioning.

Table 33

Spearman Correlations (r^S) between Individual Engagement Items and Measures of Health

Engagement item	Depression	Anxiety	Stress	Social support	Social activity	BMI	Exercise frequency	General health rating	Sleep health
1	.06	.06	.08	.04	-.00	.11**	-.07	-.13**	-.11*
2	.02	.00	.02	.02	-.04	.10*	-.03	-.01	.01
3	-.06	-.11*	-.11*	.04	-.04	.10*	-.04	-.04	.09*
4	.09*	.06	.06	-.02	-.05	.09*	-.13**	-.10*	-.05
5	.19***	.23***	.20***	-.05	-.20***	.18***	-.10**	-.19***	-.23***
6	.16***	.08*	.09*	-.00	-.11**	.11**	-.10*	-.12**	-.08
7	.16***	.23***	.20***	-.05	-.08	.04	-.09*	-.12**	-.15**
8	.13**	.13**	.10**	-.05	-.09**	.08	-.03	-.08	-.16***
9	.07	.02	.04	.05	-.07*	.07	-.03	-.03	-.04
10	.22***	.26***	.28***	-.16***	-.11**	.12**	-.03	-.12**	-.27***
11	.15***	.20***	.12**	-.12**	-.04	.08	.02	-.10*	-.16***
12	.00	.04	.06	.00	-.05	.07	.00	-.07*	-.05
13	-.02	.01	-.05	.09*	-.05	.10*	.05	.04	-.00
14	.19***	.19***	.17***	-.12***	-.13**	.09*	-.10**	-.15***	-.23***
15	.00	-.00	-.01	-.05	-.00	.10*	.01	-.07*	-.05
16	.02	-.02	.01	.09*	-.04	-.00	-.00	.03	-.00

Note. *p<.05. **p<.01. ***p<.001. All participants completed these health measures (N=497).

Table 34

Spearman Correlations (r^s) between Individual Engagement Items and Indicators of Functioning

Engagement item	Relationship conflict (n=243)	Late to work (n=313)	Performance warnings (n=313)	Subjects failed (n=269)	Grade average (n=212)	Discrepancy score (n=212)	Job seeking (n=74)
1	-.09	.14*	.00	.00	.07	.01	.01
2	-.00	-.00	.00	.06	.04	.00	.12
3	-.14*	.01	-.01	-.05	.18**	-.11	-.04
4	.06	.01	.01	.07	.05	-.02	-.01
5	.07	.00	-.00	-.01	.13*	.06	.08
6	-.06	-.02	-.02	.03	.01	.02	.03
7	.11	.02	.03	-.04	.14*	-.00	-.04
8	.05	.02	-.01	.01	.11	-.07	.01
9	-.13*	.07	.07	-.03	.01	02	-.07
10	.12	-.04	-.04	-.01	.08	.06	-.05
11	.11*	-.06	.11*	.04	.02	.14*	-.05
12	-.13*	-.07	.02	.06	-.05	.07	.06
13	-.09	-.05	.02	.06	.08	.05	-.05
14	.06	-.06	.07	.08	.02	.04	-.01
15	-.05	.00	-.04	-.06	.09	-.07	.04
16	-.02	-.05	.00	.00	.01	.06	.21

Note. $^{*}p<.05$. $^{*}p<.01$. $^{***}p<.001$. Higher scores equate to poorer functioning on all domains, except grade average and job seeking behaviours, in which higher scores equate to better functioning.

Modelling items as predictors of health and functioning.

Six enter method multiple regression models were run, each with all 29 survey items entered as predictors and a measure of health or functioning as the outcome. Variance Inflation Factor (VIF) statistics were requested and no predictor exceeded a VIF of 2.21, acceptable according to the <10 'rule of thumb' to indicate predictor independence (O'brien, 2007; Tabachnick et al., 2001).

All models were significant (p<.05) except for job seeking behaviour (p=.47) and academic functioning (p=.32). As such, further models were run using the other indicators of academic functioning that were collected. That is, grade average and the discrepancy score between what grade average participants were aiming for and what they achieved. The model predicting grade average was significant (F(29)=1.75, p=.02), but discrepancy score was not (p=.28). It is likely significance would not be reached in the job seeking model as only 73 people were seeking work, therefore violating one common rule of thumb for regression analyses of a minimum of 15-20 participants per predictor variable (Tabachnick et al., 2001).

The following models were significant: mental health (F(29)=7.30, p<.01), social health (F(29)=3.40, p<.01), relationship conflict (F(29)=1.96, p<.01, n=242), physical health (F(29)=2.87, p<.01), work functioning (F(29)=1.85, p<.01, n=312), and academic grade average (F(29)=1.75, p<.01, n=211). For brevity, only the significant (p<.05) standardised beta coefficients (β) are reported in summary tables 35 – 40 below. For ease of reference, the addiction and engagement items are numbered respective to the order in their sub-scale (i.e. addiction items from 1-13 and engagement items from 1-16).

Table 35

Enter Method Multiple Regression Predicting Mental Health with all Addiction-Engagement Scale Items

Item	β
Addiction item 4	.29***
Addiction item 11	.09*
Addiction item 12	.10*
Engagement item 12	-.10*

Notes. *p<.05. *p<.01. ***p<.001. Adjusted R^2=.26. Higher scores on the dependant variable equate to poorer mental health.

Table 36

Enter Method Multiple Regression Predicting Social Health with all Addiction-Engagement Scale Items

Item	β
Addiction item 2	-.12*
Addiction item 4	-.15***
Addiction item 5	-.11*
Addiction item 11	-.11**
Addiction item 13	-.11**
Engagement item 1	.11*
Engagement item 3	-.14**

Notes. *p<.05. *p<.01. ***p<.001. Adjusted R^2=.11. Lower scores on the dependant variable equate to poorer social health.

Table 37

Enter Method Multiple Regression Predicting Physical Health with all Addiction-Engagement Scale Items

Item	β
Addiction item 1	-.14*
Addiction item 4	-.16**
Addiction item 9	-.13*
Engagement item 12	.09*
Engagement item 14	-.13**

Note: *p<.05. *p<.01. ***p<.001. Adjusted R^2=.09. Higher scores on the dependant variable equate to better physical health.

Table 38

Enter Method Multiple Regression Predicting Relationship Conflict with all Addiction-Engagement Scale Items

Item	β
Addiction item 4	.23***
Engagement item 11	.15*
Engagement item 12	-.16*

Notes. *p<.05. *p<.01. ***p<.001. Adjusted R^2=.01. Higher scores on the dependant variable equate to more relationship conflict.

Table 39

Enter Method Multiple Regression Predicting Work Functioning with all Addiction-Engagement Scale Items

Item	β
Addiction item 1	.15*
Addiction item 5	-.15*
Addiction item 6	.24**
Addiction item 7	.16*
Engagement item 1	.17*
Engagement item 14	-.15*

Notes. *p<.05. *p<.01. ***p<.001. Adjusted R^2=.07. Higher scores on the dependant variable equate to poorer work functioning.

Table 40

Multiple Regression Predicting Academic Grade Average with all Addiction-Engagement Scale Items

Item	β
Addiction item 3	-.26**
Engagement item 7	.24*

Notes. *p<.05. *p<.01. ***p<.001. Adjusted R^2=.09. Higher scores on the dependant variable indicate a higher grade average.

Discussion

Prevalence.

Researchers have specifically called for item-level analysis of video game addiction scales (King, Haagsma, et al., 2013). Prevalence of item endorsement provides a basic but often unreported and important means of exploring measures of proposed behavioural addictions, including video game addiction, particularly at this early stage of research. The first analysis in this chapter investigated prevalence of agreement to items tapping engagement and addiction in the sample at wave one (*N*=497). The first hypothesis, which is exploratory and broad, was that certain scale items will be more commonly endorsed than others, with engagement items being generally more common than addiction items. Implied in this hypothesis is that the items Charlton and Danforth considered reflective of engagement (which many others consider indicative of addiction) will be more commonly endorsed than addiction items. Specifically, these items reflect tolerance (engagement item 10), cognitive salience (engagement item 8) and euphoria (engagement item 12), also called mood modification.

The first hypothesis was confirmed. Tables 29 and 30 indicate that prevalence differs greatly across individual addiction items. Specifically, items reflecting a neglect of important activities, playing interfering with work, feeling a sense of power while playing and playing to avoid socialising are far more common than feeling a sense of general agitation when not playing, failures to reduce or stop play and spending more money than one can afford on gaming. Some addiction features were endorsed by around 40-60% of participants, and others less than 20%, with a large difference between the most commonly (addiction item 1) and least commonly endorsed item (addiction item 13) of 44.9%. Some of the most commonly endorsed addiction items were possible negative consequences, including interference between video game play and important activities, such as unspecified important activities (addiction item 1), and work (addiction item 3). The least commonly endorsed relate to spending too much money on gaming, withdrawal symptoms and being late for engagements. This suggests more people in this sample allow gaming to interfere with their work than with their engagements.

Overall, engagement items were more commonly endorsed than addiction items. Some engagement items were extremely common, with 90.3% of participants reporting they can't

understand how others could dislike video games (engagement item 16), and 83.3% enjoying the challenge (engagement item 13). This compares to the most endorsed addiction item, eliciting agreement from 61% of participants. Hating to go without video gaming for a few days (engagement item 5) was the least common engagement item, with 33.6% of the sample agreeing. This is again contrasted by the least endorsed addiction item which only found agreement from 16.1% of the sample. There was a greater range of variance in endorsement from the most common to the least commonly endorsed engagement items (56.7%) than in the addiction scale, largely owing to the high level of agreement for certain items.

Results partially support the second part of the hypothesis: that euphoria, cognitive salience and tolerance will be more ubiquitous than addiction items (Charlton and Danforth, 2007). In this sample of highly engaged and possibly addicted gamers, euphoria was more commonly endorsed than even the most prevalent addiction item, with 74.4% of the sample agreeing. However, cognitive salience was less common, being agreed to by 44.3% of the sample, and tolerance was the least common of these with 34.4% of participants agreeing. These latter two items were actually less commonly endorsed than about half of the addiction items. But these features were also more common than other addiction items, namely loss of control (addiction item 5) and being late for engagements (addiction item 6) showing just over 20% of agreement, followed by withdrawal at 18.5% and spending more money than one can afford at 16.1%.

All features were expected to be more common in this sample than a random sample of the population, and the proportions of endorsement for Brown's components reflect very closely those reported by Charlton and Danforth (2007, p. 1540). It is noteworthy that even in this sample of self-identified avid gamers, there is still substantial variance in agreement across different items, suggesting that diagnostic prevalence will vary greatly depending on item selection and weighting in thresholds. These diagnostic thresholds are subsequently explored in chapter four. This analysis also confirms that video game addiction scales which specifically include euphoria, tolerance and cognitive salience as features of addiction and incorporate them into diagnosis may inflate prevalence rates, as these items were more commonly endorsed than many addiction items. This is particularly the case for euphoria, agreed to by 74.4% of participants in this sample. The following section will now examine the relationships between these individual scale items and measures of possible negative consequences.

Individual item correlations with health and functioning.

There is a need to differentiate video game addiction, and other potentially new behavioural addictions, from close constructs, including what may be described as passion, high engagement, or prioritisation of a hobby (Brown, 1997; Charlton & Danforth, 2007; Shaffer et al., 2004). This differentiation is particularly important in populations who have a keen interest in the activity in question. A number of video game addiction measures have now been detailed in the literature which share many similarities but also have slight differences in the representation or prioritisation of addiction components (King, Haagsma, et al., 2013).

Based on a reading of face validity, some researchers have classified some components as aspects of engagement, while others construe these same aspects as symptoms of addiction (Charlton & Danforth, 2007). This is underpinned by debate and uncertainty over how addiction should be defined, especially in relation to substance free activities (Brown, 1997; Shaffer et al., 2004). After a review of video game addiction measures, researchers have explicitly called for analyses which can identify test items most indicative of severity (King, Haagsma, Delfabbro, Gradisar and Griffiths, 2013). Taking a harm-centric approach to validity, poorer health and functioning are construed here as possible negative consequences of video game addiction, and items which co-incide with lower health and functioning are considered more valid and indicative of greater severity of the condition.

This analysis explored which individual scale items, in a measure of both engagement and addiction, were most strongly associated with a broad range of health and functioning indicators. Namely, tolerance (engagement item 10), cognitive salience (engagement item 8) and euphoria (engagement item 12).

A broad, exploratory hypothesis was put forward - that certain scale items will more strongly co-occur with health and functioning than others, with addiction items showing generally stronger relationships than engagement items, supporting the differentiation in this scale. This hypothesis implies that Charlton and Danforth's conceptualisation of tolerance, euphoria and cognitive salience (as they fall under the engagement sub-scale) will be validated by these items being either unrelated, or less strongly related, to diminished health and functioning than addiction items. It also implies that items which show stronger associations with diminished health and functioning may be better at targeting a greater level of severity of video game addiction.

The broad hypothesis was confirmed. Items differed in co-occurrences with health and functioning indicators. Tables 31 and 32 demonstrate that all addiction items co-occurred with at least one health or functioning indicator, at a significant level (p<.05). However, tables 33 and 34 show that some engagement items were significantly related to diminished health and functioning, but fewer items and with generally smaller magnitudes. Some health measures were associated with all addiction items, such as the mental and sleep health measures, while others were only associated with some addiction items, possibly indicative of varying degrees of severity measured by those particular items. Similarly, diminished functioning was related to fewer scale items, and with smaller relationship magnitudes when significant, than measures of mental, social and physical health.

Addiction items and decreased health and functioning.

All addiction items showed significant and small-to-moderate sized associations with increased symptoms of depression, anxiety and stress, poorer sleep health and poorer general physical health; with lower social support and activity being related to all but one addiction item (item 10, or 'I never miss meals because of playing video games'). In contrast, lower physical exercise frequency was only significant related to addiction items 1-5, 8 & 9, and 13. Of the health measures, BMI showed significant relationships with the fewest number of addiction items, with only items 6, 8, 9 and 13 reaching significance. Even when in the significance range, relationship with both exercise frequency and BMI showed generally lower magnitudes than addiction items with other aspects of health.

Indicators of functioning in life domains showed fewer significant associations with the video game addiction items than health. Relationship conflict co-occurred with seven of the addiction items (2, 3, 4, 6, 7, 8 and 9) to a small degree. Five of the addiction items co-incided with arriving late to work more often, but only two items (and neither of these two were related to late arrivals) were associated with formal warnings received (addiction items 2 and 8). Three addiction items (1, 3 and 8) were related to a higher number of subjects failed, and only addiction item 3 was associated with poorer grade average. Addiction items 3, 4 and 10 showed a higher negative discrepancy between the desired grade and grade achieved. Correlations with job seeking behaviour did not reach significance, perhaps due to the smaller sample size.

Overall, these relationships demonstrate validity for the items in measuring their intended domain, including the inverse relationships between sleep health and addiction item 9, work

and addiction item 7 and academic functioning and item 3. Yet significant relationships were present among many health indicators and addiction items not specifically tapping that domain, particularly in the measure of sleep disturbance. Overall, this analysis indicates that addiction items were consistently more related to measures of possible negative consequences than engagement items, and that single items do show substantial relationships with more detailed and established measures.

Addiction items most indicative of severity.

This analysis also facilitates exploration of which items may be most indicative of severity. Looking at the addiction sub-scale, certain items showed consistently stronger associations across the range of indicators present than other addiction items. These relationships may be reflective of a higher degree of severity of addiction, as discussed by King, Haagsma, Delfabbro, Gradisar and Griffiths (2013). The largest relationships were between addiction item 4 and symptoms of stress and anxiety (both relationships r=.46, p<.001). This indicates 20% of the variance between these items was shared; a substantial relationship, considered medium to large (J. Cohen, 1988). This item also showed consistently large and significant relationships with the other health and functioning indicators. Addiction item 4 is worded 'When I am not playing video games I often feel agitated'. As this item asks about a general agitation when not playing video games, which is supposed to align with the concept of withdrawal, associations with diminished health is theoretically consistent with the item. This item is worded slightly differently to other video game addiction scales intending to tap withdrawal. Examples of other video game addiction scale items tapping withdrawal are "Have you become restless or irritable when trying to cut down or stop playing computer- or video games?" (scale used in Gentile et al 2011, see Choo et al, 2010, p. 826), "Do you feel depressed, moody, or nervous when you are not playing video games, which goes away when you are back playing video games?" (King, Delfabbro & Zajac, 2009, p. 7), or Salguero and Moran who used the item "When I can't use the video games I get restless or irritable" (p. 1606). King, Delfabbro and Zajac's scale is the most explicit about indicating video games are what bring about a reliable relief of negative affect. Given this item appears the most important in associated problems, the Charlton and Danforth scale would benefit from an additional follow-up question to those endorsing this item, asking participant to list the activities that reliably relieve negative feelings, and to rate each activity in how strongly each provides relief. Data generated by such an approach may facilitate an empirical investigation of the narrowing of hedonic management avenues available, considered a hallmark of addiction by some theorists.

Engagement items and decreased health and functioning.

In contrast to addiction items, fewer of the engagement items showed significant connections with the same aspects of health, and were generally weaker in magnitude when present. Nonetheless, certain engagement items were still associated with poorer health. Items 4-8, 10, 11 and 14 were fairly consistent in associations with increased symptoms of depression, anxiety and stress. Only three engagement items were connected with poorer social support (items 10, 11 and 14); and six items were connected with poorer social activity (5, 6, 8-10, and 14). Interestingly, a greater number of engagement items were significantly related to higher BMI than in the addiction scale. Engagement items 1-6, 10 and 13-15 were all associated with increased BMI. Five of the engagement items (4-7 and 13) were related to poorer physical exercise frequency, and ten of the items to poorer general physical health rating (1, 4-7, 10-12, 14 and 15). Seven of the items were also related to poorer sleep health (1, 5, 7 and 8, 10 and 11, and 14). Generally, relationships that reached significance were smaller in magnitude, ranging from r=.28 with symptoms of stress and engagement item 10, to r=-.07 between engagement item 12 and the general health rating. In contrast, many addiction items showed relationships with declined health that were larger in magnitude.

Engagement items and increased health and functioning.

Interestingly, other engagement items actually showed significant associations with improved health and functioning, although they were small in magnitude. Engagement item 3 showed several adaptive associations, including fewer symptoms of anxiety and depression (both r=-.11, p<.05), better sleep health (r=.09, p<.05), less relationship conflict (r=-.14, p<.05), and higher grade average (r=.18, p<.01). This item is worded 'The less I have to do with video games, the better' and reverse-scored. Given the wording, this item may be an artefact of the sampling method, which targeted self-identified problematic gamers. Participants in this sample are likely to have already partially attributed declined health and functioning to past video gaming, or perceived a link in some form between these factors, and as such identify that they are healthier with less gaming. Therefore, studies with more general populations are required to confirm these relationships.

Engagement item 16 ('I can't understand why people like video games', reverse scored), and 13 ('I like the challenge that learning to play video games presents'), which were the first and second most endorsed items in the sample, had a relationship with greater social support

(*r*=.09, *p*<.05). Engagement items 5 ('I would hate to go without playing video games for more than a few days') and 7 ('When I see video games, I feel drawn towards them') were both related to higher grade average (*r*=.13 and .14, respectively, both *p*<.05). This relationship is unusual as item 5 also showed relationships with declined health across many measures, but grade average was positively correlated, and no other functioning indicator was significantly related. Item 5 is close in content, but distinct, from the item tapping tolerance (engagement item 10). The difference being that tolerance relates to a need to increase play to get the same enjoyment, whereas item 5 specifies hating to go without gaming for more than a few days. Overall these relationships with certain engagement items and positive health and functioning are supportive of the scale measuring a close, but distinct, construct to addiction.

Tolerance, euphoria and cognitive salience.

Findings are mixed, but generally supportive, of Charlton and Danforth's (2007) conceptualisation of tolerance, euphoria and cognitive salience as engagement rather than addiction. The hypothesis that tolerance, euphoria and cognitive salience will not show associations with problems was partially confirmed. Charlton and Danforth argued that euphoria, alternately called 'buzz' or 'mood modification', tolerance, and cognitive salience are indicative of engagement and prioritisation of a hobby, rather than addiction. They also noted these items are likely play a peripheral role in addiction. These items correspond in this analysis to engagement items 12 (buzz), 10 (tolerance) and 8 (salience) (see Charlton and Danforth, 2007, p. 1539-1540). The correlation matrix indicates that tolerance and salience both show significant relationships with associated declined health and functioning, but euphoria did not.

These relationships suggest a possible reconsideration of these items in future conceptualisations of engagement, but confirm the role of euphoria as unimportant in health and functioning, suggesting it should not be given consideration in diagnostic thresholds. Charlton and Danforth (2007) did indicate that there is a relationship between high engagement and addiction, and that they are likely to precede addiction or compound the negative effects of addiction when they are also present. The present sample may increase the likelihood of finding relationships with peripheral aspects of addiction, as the sample is skewed towards the most highly engaged and possibly addicted adult gamers. That said, testing for the differentiating of addiction from engagement is also arguably most important in such a sample. In future, longitudinal studies exploring developmental trajectories between

individual components and associated problems may help to further pinpoint their importance.

Modelling items as predictors of health and functioning.

Another means of identifying items most indicative of severity is to use regression analyses modelling the predictive power of all addiction and engagement items. Enter method multiple regression models estimate the prediction of each predictor variable in the dependant variable, after converting the predictors into a linear composite variable. This conversion facilitates some diagnosis of the relative importance of each predictor. As these regression models were confined to a single dependant variable, each considered the impact of scale items separately on measures of mental, social and physical health; and functioning in relationships, work and academic pursuits. Separating models as such facilitated comparisons of which aspects are most strongly related to addiction and engagement, independent of the other health and functioning indicators.

Across all the models, some scale items significantly predicted more variance in health and functioning than others; and only a few items emerged as significant in each model. As in the correlations between individual items and health and functioning, some engagement scale items actually showed beneficial relationships when entered as predictors. Other engagement items were associated with declined health and functioning. When items which are significantly associated with declined health and functioning are considered, certain items clearly stand out as more problematic than others. In all models, no more than 7 of the 29 scale items emerged as significant. In many of the models, only a few items emerged as significant predictors. This suggests that when modelled in the presence of all other items, a handful of items appear more important than others in predicting different aspects of health and functioning.

In particular, addiction item 4 was consistently significant in all health-related measures, and was often the strongest predictor. It was also very strongly related to relationship conflict, emerging as the highest magnitude predictor. As discussed previously, this item is supposed to represent withdrawal symptoms; however another item triangulating the meaning would have been beneficial. Nonetheless, results of these regression analyses support the correlation matrix, and suggest that a general sense of agitation, which is relieved when playing video games, is a potentially important marker of the differentiation between a hobby and behavioural addiction. However, this item did not predict work functioning or academic grade average, which may be expected as other items in the scale focus on life interruption

and may have accounted for the variance. Addiction item 11 also appeared important in measures of mental and social health, indicating gamers who use video gaming as an escape from socialising tend to have poorer mental and social health. Addiction items 2, 5 and 13 also emerged as significant in predicting social health. Addiction item 2 is particularly relevant to social health, asking people if they feel their social life has suffered due to video gaming. Addiction item 5 represents repeated failures to reduce or cease gaming, and addiction item 13 asks about spending more than one can afford on gaming. Relationships between these items and measures of structural and functional social health provide strong validity. Items tapping physical health also showed validity by emerging as significant predictors. Addiction items 1 and 9 were related to physical health, suggesting neglecting important things to play video gaming may relate to exercise, and providing validity for item 9 which asks about sleep suffering due to gaming.

Other items did not predict their targeted domain of health or functioning. Severe life interruption may be expected to coincide with behavioural addiction, including inability to function at work. The item specifically relating to video gaming interrupting work (addiction item 3), did not significantly predict the work functioning indicator in this study, while the item asking about being late for engagements (item 6) did. This is likely the result of the composite work functioning measure being biased towards times late to work, rather than other indicators of poor or interrupted functioning, such as warnings received from management (the other indicator). Along with the low number of participants who reported receiving warnings from management, this result also suggests that people agreeing to this addiction item are not receiving many formal warnings from managers/supervisors for poor performance, at least that the time of completing the survey.

Some engagement items also emerged in these models, suggesting they may play a peripheral role as suggested by Charlton and Danforth (2007). In order of the presentation of relationships, engagement item 3 predicted poorer social health, engagement item 11 predicted higher relationship conflict, engagement item 14 predicted lower physical health and engagement item 1 predicted poorer work functioning. These items relate to the importance placed on video game playing in life and the desire to play for long periods of time and to improve at game play. In general, addiction items were more related to harm than engagement, however many addiction items did not reach the significance threshold ($p<.05$) and some engagement items emerged as related to harm. These relationships suggest that these engagement items, while at face value are not inherently pathological and may relate to any hobby, could be problematic in the context of addiction items.

Interestingly some items emerged as inversely related to indicators of harm. These items include engagement item 12 (mental health and relationships conflict), engagement item 1 (social health), addiction item 5 and engagement item 14 (work functioning) and engagement item 7 (academic functioning). These results indicate that in the presence of addiction certain aspects of the hobby may prove to be beneficial to health. These aspects may represent buffers for the negative effects of video game addiction or may represent features of the hobby which are adaptive to other areas of life. Item 12 indicates a buzz of excitement when playing, which may be akin to beneficial enjoyment of the hobby. Item 1 indicates the importance of video games in life, which while related to better social health was also associated with poorer work functioning. This may hint at the social nature of gaming. Addiction item 5 and engagement item 14 were related to better work functioning and both relate to a discipline in cutting back or controlling the length of playing sessions. Finally, engagement item 7 was quite strongly related, relative to the present models, to academic functioning. This item involves being drawn to video games, tapping into a basic interest in the activity. The reason this is related to grade average is unclear, perhaps it indicates an unproblematic, more basic engagement with the activity.

Overall the results of this chapter affirm the separation between addiction and engagement. The measure shows promise in measuring varied aspects of health and functioning. However, not all items were equally related to health and functioning indicators. Instead, some items were consistently and strongly related, and others did not reach the significance threshold. Results clearly indicate that certain items may be more important than others, and that future studies should further explore video game addiction scales at the item level in order to understand more about the proposed ‘symptoms’ and to form diagnostic thresholds. The importance of individual items in associated harms is further explored in chapter 9, where the different effects in the cut-off points proposed in the literature on measures of harm are contrasted.

Future researchers may consider Rasch analysis to provide further validation for scale reduction or alteration by indicating whether the likelihood of endorsement remains stable across individuals, sub-groups and samples; as well as testing the item response range. The models in this chapter are likely limited in interpretation of the relative importance of items, due to their multicollinearity and the way items are converted into a linear composite. Statistical simulations indicate it is possible that only marginally larger correlations between a predictor and outcome variable can result in much larger relative standardised regression coefficients when predictors are intercorrelated (Tonidandel & LeBreton, 2011). In this analysis, this may have translated into suggesting that certain items account for more

variance in health and functioning than is actually the case. Future studies could consider more advanced regression diagnostic techniques to explore relative importance of items further, such as relative weights analysis or dominance analysis (Tonidandel & LeBreton, 2011). Nonetheless, this analysis provides a first step and confirmation that different items, equivalent to different ‘symptoms’ of the general model of addiction applied to gaming, can produce vastly different relationships with health and functioning indicators.

Chapter 5: Addiction Versus Engagement on Relationships with Mental, Social and Physical Health

While the previous chapter explored the prevalence of individual items in the addiction and engagement scale, and their validity in the form of associations with health and functioning, video game addiction is greater than the sum of its parts. In other words, video game addiction is a disease model which suggests an emergence arising from the combination and interaction of several of these features, rather than the presence of only individual features. Generally, it is expected that the greater the number and strength of these 'symptoms', the greater the decline in health and functioning. In statistical terms, that there will be a roughly linear relationship between addiction symptoms and declined health and functioning. Similarly, if addiction is to be successfully differentiated from close constructs, the same relationships with declined health and functioning will not be present with a measure of engagement. Therefore, this chapter investigates relationships across the scale total scores for addiction and engagement with a diverse range of health and functioning indicators.

Few studies have explored differential predictive validity of video game addiction and engagement measures across a span of diverse measures of health and functioning, particularly in a sample of adults who fall at the more intense end of video gaming. So far, studies have found that addiction, but not engagement, was associated with poorer academic performance, negative personality traits, attentional profile, and mental health in a small sample of participants (Charlton & Danforth, 2010; Metcalf & Pammer, 2011; Skoric et al., 2009). However, most studies of video game addiction have not attempted to test the differentiation between addiction and close but non-pathological constructs.

In terms of mental health, video game addiction has shown correlations with increased psychological distress, a range of psychopathologies, suicidal ideation, life trauma and health-related quality of life (Gentile et al., 2011; King & Delfabbro, 2009; King, Delfabbro, & Zajac, 2011; Mathers et al., 2009; Mentzoni et al., 2011; Primack et al., 2009; Rehbein et al., 2010; Starcevic et al., 2011; Van Rooij et al., 2011; Yang, 2005). Regarding social health, results suggest video game addicts have lower self-esteem, are less agreeable and conscientious, more neurotic and socially anxious, have poorer relational maintenance skills, with less offline friends and are more comfortable meeting people online than offline (American Medical Association, 2007; Chiu et al., 2004; Colwell et al., 1995; Ferguson et al., 2011; E. J. Kim et al., 2008; King & Delfabbro, 2009; King, Haagsma, et al., 2013; Kowert &

Oldmeadow, 2013; Lemmens et al., 2009, 2011; Lo et al., 2005; Peters & Malesky Jr, 2008; Starcevic et al., 2011). Some studies have also connected poorer physical health with video game addiction, including poorer health status, exercise frequency, physical functioning, vitality, general health, and sleep health (Griffiths et al., 2004; King & Delfabbro, 2009; Mathers et al., 2009; Mentzoni et al., 2011; Rehbein et al., 2010; Smyth, 2007; Tejeiro et al., 2012; Tejeiro Salguero & Morán, 2002). A meta-analysis investigating the average effect size of a range of problems connected with video game addiction concluded that connections with social well-being showed the strongest effect size of r^{+}=.25 (pooled correlation coefficient), or roughly 6% of shared variance, compared with mental (r^{+}=.19) and physical health (r^{+}=.12) (Ferguson et al., 2011).

Yet in all instances, there is contrary evidence. Studies which included measures of the same or very similar variables have found an absence of relationships with video game play or addiction, or differences in the strength of the associations. These include mental health (King & Delfabbro, 2009; R. F. McClure & Mears, 1984; R. Z. McClure & Mears, 1986; Primack et al., 2009), social health (Colwell et al., 1995; King, Delfabbro, & Griffiths, 2011; Kowert & Oldmeadow, 2013; Loton, 2007; Sakamoto, 2005) and physical health (Mentzoni et al., 2011). Many deleterious correlates are what can be described as small in magnitude. Other studies included possible confounding variables, such as basic needs satisfaction, which in some instances explained almost all of the connections measured between video game addiction and health (Przybylski et al., 2009; Seay & Kraut, 2007). Further studies are needed comparing relationships to addiction versus engagement, and investigating the importance of video game addiction across a spread of well-established measures of health and indicators of functioning.

Focus of this Chapter

This chapter will investigate relationships between total scores for engagement, addiction and a range of health measures in a sample of adult, highly engaged and self-identified problematic gamers. The chapter will explore whether video game addiction is more predictive of mental, social and physical health indicators, than engagement. Which aspects of health are most important will be investigated by including them as predictors in regression models. Where possible, the size of relationships will be compared to other factors related to health, in order to contextualise the severity of associated problems with video game addiction.

Aims and Hypotheses

Aim:

2. Investigate the differentiation of video game addiction from engagement by analysing:

    2.1. Relationships between video game addiction versus engagement with levels of social, physical and psychological health;

Hypotheses:

1. That video game addiction will be predicted by lower levels of mental, social and physical health;
2. That video game engagement will show no association with the same measures of health.

Method

Correlation matrix.

As a first step, a correlation matrix was produced reporting correlations between total scores for addiction, engagement and all health and functioning measures.

Predicting addiction versus engagement with health and functioning indicators.

Two enter method multiple regression models were run. One model predicted total score for the addiction subscale and the other the engagement subscale, using the following predictors: total scores for anxiety, stress and depression subscales, social activity index, total score for the social support scale, BMI, the physical exercise frequency item and total score for the sleep health scale.

Theoretical and statistical directionality of these models was thoroughly considered. Statistical directionality and model specification should usually follow lines of plausibility,

based on theory (Pallant, 2010). An exception is when the goal is to maximise the variance explained using statistical techniques, which may produce models which are inconsistent with theory when applied to variables. However, in the instance of video game addiction and health aspects, it is possible to construe these relationships in either direction, or in both directions. Video gaming can be a relaxing, enjoyable and distracting activity, which is easily accessible in the home environment. It is possible that in response to declined health, particularly mental health, which can cause people to feel unable to deal with even simple daily tasks, gamers may intensify their hobby, which may include increasing some aspects of addiction. Studies have shown that people experiencing poorer mental health, particularly depressive illnesses, often increase time spent at home (Dickerson, Gorlin, & Stankovic, 2011). This explanation characterises video game addiction as predominantly a response rather than cause of decreased health, at least in the initial stages. Alternatively, it is also plausible that a person experiencing stable health may develop video game addiction, which incurs negative consequences directly resulting from displacement of other activities and components of dependence, which then leads to poorer mental health. This explanation suggests the decrease in health would otherwise not have occurred, if not for the addiction. Likewise, it is theoretically plausible that any of these relationships are bi-directional and mutually reinforcing; i.e. a downward spiral (Gentile et al., 2011). This uncertainty regarding directionality is important to take into consideration when interpreting the results of cross-sectional analyses. While it was conducted subsequently, the longitudinal analysis in chapter 10 actually supports the statistical directionality of the models in this chapter, with detrimental health predicting addiction.

Similarly, the connection between social support and video game addiction can be conceptualised in many ways. It could be considered a moderator, buffering negative outcomes of video game addiction. Alternatively, deficient social support could be a cause, with video games offering a substitute in the absence of fulfilling social relationships, as concluded by the literature review on the topic by the American Medical Association's Council on Science and Public Health (American Medical Association, 2007). Yet another interpretation is that reduced social support could be an outcome of video game addiction, with play displacing relational maintenance strategies. A cross-sectional relationship supports the latter interpretation in a study measuring media dependence (Chory & Banfield, 2009). As there is no clear rationale for controlling for social support, low support was considered a possible cause of video game addiction and included, along with all other health measures, as a predictor in the two enter-method multiple regressions. As in the past models, scatterplots were produced displaying the standardised predicted versus actual values, which showed clear linearity, normality and quite highly homoscedastic errors. Once

again, in each model, a few cases were identified as univariate outliers on some measures based on standardised Z scores, and twelve cases were identified as multivariate outliers utilising Mahalanobis' distance, with a Chi-Squared probability distribution applied. Given the sample size, all were retained and are not believed to contribute a large amount of bias to the final models.

Results

Correlation matrix.

Results of the correlation matrix are presented in Table 41. Correlations indicated significant relationships between the scale total scores and psychological, social and physical health indicators.

Table 41

Correlation Matrix (Pearson) Reporting Relationships Between Engagement, Addiction and Health at Wave 1

	Eng	Dep	Anx	Str	Soc supp	Soc act	Phy exer	BMI	Sleep Health
Addiction	.48**	.42**	.40**	.44**	-.27**	-.24**	-.15**	.13**	-.37**
Engagement	-	.17**	.17**	.15**	-.04	-.12**	-.06	.19**	-.18**
Depression		-	.64**	.68**	-.49**	-.25**	-.16**	.07	-.51**
Anxiety			-	.71**	-.34**	-.16**	-.13**	-.00	-.52**
Stress				-	-.31**	-.19**	-.17**	.08	-.55**
Social Support					-	.33**	.13**	-.05	.33**
Social Activity						-	.17**	-.08	.14**
Physical Exercise							-	-.05	.12**
BMI								-	-.15**

Note *p<.05, **p<.01. Title of measures in top column abbreviated for formatting.

Predicting addiction versus engagement with health and functioning indicators.

The model predicting addiction was significantly different from a null model ($F(8)=23.30$, $p<.001$), with adjusted R^2 indicating 26.5% of addiction variance was explained, as detailed in Table 42. The same predictors explained substantially less variance of engagement scores, with adjusted R^2 indicating 7.8% of variance was shared, but the model was still significant ($F(8)=6.24$, $p<.001$). This is reported in Table 43.

Multicollinearity diagnostics were run alongside the model. While there is no consensus on the multicollinearity indicators required to denote independence of predictor variables, variance inflation factors (VIF) under 10 is one rule of thumb (O'brien, 2007). As no predictor variable exceeded a VIF of 10, this suggests variables may be considered independent, and multicollinearity would not explain the lack of significance for depression. As receiving a mental illness diagnosis prior to the study ($n=86$) was associated with significantly higher scores on the DASS subscales (see Chapter 3, Method: Measures: Mental Health), a further hierarchical regression was run with prior mental illness as a dummy variable in the first step. Controlling for past mental illness made no substantial difference in the results, only changing the standardised beta coefficients at the third decimal point in two of the predictors. As such, this analysis is not reported here.

Table 42

Enter Method Multiple Regression Predicting Addiction with Measures of Social, Physical and Psychological Health.

Predictor	*b*	SE *b*	β	*p*	VIF
Social support	-.06 (-.21, .06)	.07	-.04	.26	1.44
Social activity	-.09 (-.17, -.04)	.02	-.13	.002**	1.15
Exercise frequency	-.23 (-.63, .13)	.20	-.05	.20	1.05
BMI	.09 (-.02, .21)	.05	.07	.08	1.04
Sleep health	-.14 (-.24, -.02)	.02	-.12	.02*	1.64
Stress	.41 (.14, .70)	.13	.18	.002**	2.67
Anxiety	.31 (.01, .60)	.14	.11	.02*	2.31
Depression	.11 (-.09, .32)	.11	.06	.24	2.50

Note. Adjusted $R^2=.265$. 95% confidence intervals for *b* reported in parentheses.

Table 43

Enter Method Multiple Regression Predicting Engagement with Measures of Social, Physical and Psychological Health.

Predictor	b	SE b	β	p
Social support	.12 (.01, .25)	.07	.09	.05*
Social activity	-.08 (-.13, -.001)	.02	-.11	.01**
Physical exercise frequency	-.17 (-.54, .22)	.20	-.04	.38
BMI	.22 (.08, .34)	.05	.16	.001***
Sleep health	-.12 (-.22, -.005)	.06	-.10	.03*
Stress	-.11 (-.37, .17)	.14	-04	.44
Anxiety	.28 (-.004, .57)	.14	.13	.04*
Depression	.11 (-.09, .32)	.11	.08	.25

Note. Adjusted R^2=.078. 95% confidence intervals for *b* reported in parentheses. Refer to previous table for VIF.

Discussion

Few studies have thus far investigated the differential connections between video game addiction versus engagement on a range of health indicators. As cut-off points are problematic and can artificially or inappropriately divide samples and mask relationships, relationship-based statistics are still preferable when investigating validity in this instance. As expected, many significant correlations were present between the total scores of addiction and engagement, and measures of health. As such, multiple regression analyses were conducted. These provide an indication of overall variance explained in addiction versus engagement by the combined measures of social, physical and psychological health, including which indicators were most predictive while taking into account the contribution of the other indicators. These models differ from the previous chapter as they consider scale total score, rather than item-level analyses, and they also assess the importance of all of the health measures simultaneously; unlike the previous chapter which separated models according to the specific health domain.

Addiction versus engagement.

The first and second hypotheses were partially confirmed. As noted, a key distinguishing feature of addiction is that it has demonstrable negative consequences. Both models were significant, indicating that a linear relationship is present between both addiction and engagement and measures of health. However, the difference in the variance explained provides some validity for the separation between addiction and engagement as designated by Charlton and Danforth (2007). A comparison of the overall adjusted R^2 figures indicates that much less variance is explained by health indicators in the model predicting engagement (7.8%) than the model predicting addiction (26.4%). Addiction predicted over three times the overall variance. However, significant relationships also emerged between engagement and detrimental health. In order to gain a greater understanding of the specific health indicators related to addiction and engagement, standardised beta coefficients are considered.

Video game addiction and mental health.

The multiple regression models give an indication of the relative importance of video game addiction on this spread of health indicators, taking into account the influence of the other health indicators. The results confirm the second hypothesis. Different indicators of health were clearly more important in predicting addiction, and engagement, when considered in the presence of all other health indicators. A review of the standardised beta coefficients reveal some interesting features, and facilitate a further exploration of the differences between engagement and addiction.

When accounting for all health indicators present, addiction was not predicted by social support, physical exercise frequency and, surprisingly, depression. Instead, stress arose as the most substantial predictor, followed by anxiety, which was equal to social activity and sleep disturbance, and finally BMI. The direction of all predicted variables is as expected. Relationships indicate that as video game addiction scores increase, it is generally accompanied by increases in stress, anxiety and BMI; and decreases in social activity and sleep health.

The absence of relationship with depression contrasts past studies, which have consistently found significant relationships between depression and video game addiction, even in the presence of other mental health features (King, Delfabbro, & Zajac, 2011; Mentzoni et al.,

2011; Metcalf & Pammer, 2011; Rehbein et al., 2010; Starcevic et al., 2011). Interpretation of this result must take into account the nature of the sampling strategy, which targeted self-identified problematic adult gamers who were already above norms for these symptoms. This finding may indicate that in the presence of already elevated levels of mental illness symptomatology, increases in video game addiction is accompanied mostly by stress, and less-so anxiety – but not necessarily depression. This interpretation has some theoretical merit, as stress, in this case, refers to a general psychological distress. As addiction is thought to include increasing displacement of other activities, whereby important responsibilities fail to be met, this may cause mounting pressure and subsequent distress and anxiety. However, it is equally plausible to conclude the opposite, that with increased psychological distress and anxiety brought about by other factors, some people become increasingly dependent on video gaming as an escape-based coping strategy, which posits video gaming as a response rather than the central cause, of declined. This result is difficult to interpret without further studies, especially longitudinal studies investigating temporal precedence. It must be noted that the DASS measures symptoms of these mental health conditions, rather than providing an actual diagnosis. Ideally, if resources permitted, an individual clinical assessment would help to confirm the relationship and provide accurate diagnosis.

Video game addiction and social health.

Further differences were apparent with regards to social health. Video game addiction was predicted by social activity, which is a structural measure, being a count of friendship network size and social outings; but showed no significant relationship with social support, a functional measure. Social support is central to health as it taps subjective ratings of the quality of critical social support available, including informational, emotional and tangible support. This suggests that with increasing video game addiction, social relationships may be displaced, but not necessarily with those people who provide key forms of support, suggesting close and important relationships may be less affected. Alternatively, it may also be reflective of the provision of social support through video gaming. Many participants reported having made friends through video gaming, and a smaller proportion reported having current friendships that, if not for video gaming, they would have little in common (*n*=177, 35.6%). This finding may also point to a tendency for people who endorse video game addiction criteria to require comparatively less friends and social outings to satisfy their social needs. In this instance, introversion, which has been associated with internet and video game addiction in past studies (Charlton & Danforth, 2010; Gibb, Bailey, Lambirth, &

Wilson, 1983; R. F. McClure & Mears, 1984), may present a confounding variable that could be tested in future modelling exercises. This may explain why higher addiction scores were predicted by lower structural social support, but not by functional social support. Longitudinal studies may help to determine whether these more critical functional social connections erode with prolonged video game addiction.

Video game engagement and health.

Engagement also demonstrated some significant connections with measures of health, including one positive indicator – social support. Participants' ratings of the quality of their own social support actually tended to increase with higher engagement. This may be in line with other research which described video gaming capacitating online communication and socialisation, and ultimately the provision of some forms of social support (Lieberman et al., 2011; Steinkuehler & Williams, 2006). This result also confirms the lack of a significant inverse prediction of social support in the model predicting addiction. In contrast to addiction, this analysis suggests social support is actually higher in those more engaged with video games, which may hint at the greater support provided by online social networks. It is also possible that some of this social support is derived by playing games with friends in-person. However, at baseline, only 12.4% of gaming time was spent with friends in-person, compared with 39.6% online, suggesting that most of this additional social support garnered through engagement with games is derived online. Further, a large proportion of the sample reported having made friends through video gaming (n=335, 67.4%), and a smaller proportion reported having current friendships that, if not for video gaming, they would have little in common (n=177, 35.6%), suggesting on-going friendships are made through video gaming. The differences between offline and online socialisation, including in terms of impacts on health, are still being established (Steinkuehler & Williams, 2006).

Yet higher engagement was also related to lower health on some indicators, including less social activity, higher BMI and higher anxiety. BMI was actually more highly predictive of engagement than addiction. The finding regarding anxiety may relate to an increased use of relaxing activities when anxiety is heightened or the avoidance of other social activities. Magnitudes of standardised beta coefficients give an indication of the effect size for each predictor, and indicate some aspects of health are moderate, particularly for mental health and sleep health/disturbance. Magnitudes are smaller for social support, social activity, physical exercise and BMI.

This analysis helped to pinpoint which aspects of health are most predictive of video game addiction versus engagement, including taking into account a broad range of measures simultaneously. This facilitated an assessment of the relative importance of these predictors, and then contrasted them in a model predicting engagement. Results indicated lower health coincided with a substantial amount more variance in the addiction model than the engagement model, as expected. Yet, engagement was still related to lower health on some measures, including a larger relationship with BMI. It may be expected that both addiction and engagement coincide with higher BMI, as video gaming is usually a sedentary activity, even if it does involve higher metabolic activity than other, more passive forms of media consumption (Wang & Perry, 2006). This chapter presented many generic limitations which are discussed in the epilogue. The following chapter focusses on identifying confounding factors between addiction and associated health aspects.

Chapter 6: Confounds Between Video Game Addiction and Health

Demonstration of negative consequences for possible new non-substance addictions is difficult. This is partly because outcomes are the result of multiple, dynamic, inter-related, and unobservable (with the exception of behaviour) factors. This poses challenges to contemporary research methods, which often attempt to measure and model such processes but have difficulty disentangling interrelated factors and cause from effect. For example, some of the evidence put forward in favour of a general model of addiction, including common risk factors like problematic family environment or past trauma, is likely to manifest a host of similar psychological conditions with associated negative outcomes; all with a high degree of treatment non-specificity. This is already evident in the high rates of co-morbidity in pathological gambling, and the attempts to separate distinct sub-types of pathological gamblers (Petry, 2005). Establishing accurate theorisations of how these indirectly measured and interrelated variables influence each other in relation to video game addiction will likely require extensive resourcing of longitudinal and mixed-methods studies. It is also important for any early cross-sectional studies to attempt to identify, and assess the importance, of possible mediators or moderators. Assessing the relative importance and contextual factors which alter the associations with video game addiction will have implications for how the condition is assessed, including whether it is considered a primary disorder requiring an official diagnosis.

Several measures were collected in this study in order to test for possible mediators or moderators between video game addiction and negative consequences, which, if left unmeasured, may have posed confounding effects on observed relationships. These indicators were also included in an attempt to rule out as many extraneous variables as possible. Selection of these variables was guided by other factors known to impact lower health and functioning. Some are likely to pre-date video game addiction, including socio-economic status and coping styles. Others reflect situations or factors which are more dynamic (i.e. do not develop over the lifespan) but may account for an observed decline in health and functioning over the study period; including global stressful events, treatment seeking and satisfaction with life domains. Measures of satisfaction and indicators of functional impairment were specific to context and only completed by relevant sub-samples. These are explored in subsequent chapters.

Most studies investigating connections with video game addiction and associated problems have not undertaken mediation or moderation analyses. In those that have, some have found substantial variance in relationships between video game addiction and a possible

negative consequence was explained by another factor. Basic needs fulfilment, for example, explained almost all of the variance between a measure akin to video game addiction and well-being in one study (Przybylski et al., 2009). After basic needs fulfilment was accounted for, the obsessive video game playing subscale (akin to a video game addiction measure) accounted for only 1% of well-being, whereas trait need satisfaction accounted for 40%. Other studies investigating basic needs satisfaction and video game addiction have found smaller mediation effect sizes (Wu et al., 2012). These results may suggest that video game addiction is associated with declined health and functioning, but to a smaller degree than other contributors.

Focus of this Chapter

This chapter introduces confounds (i.e. possible moderators or moderators) into the models from the previous chapter, which attempt to predict addiction using health and functioning variables. Possible confounds which were completed by all participants included socio-economic status, coping style, global stressful events and treatment seeking. All of these variables are potential mediator or moderator candidates, which have demonstrated relationships with health and well-being in past studies. Social support has also been demonstrated to be a mediator in past studies, with greater social support buffering stress, a central explanation as to why people with greater social support tend to live longer (Sheldon Cohen & Wills, 1985). However, lower social support has also been classified as a possible outcome of video game addiction, which is thought to interrupt and deteriorate social networks. In the absence of directional certainty in this instance, social support is here tested as a possible moderator.

Aims and Hypotheses

Aim:

3. Identify possible confounding variables between video game addiction and associated problems, by measuring:

    3.1 The impact of including coping styles, stressful life events, social support and treatment seeking in models measuring relationships between video game addiction and mental, social and physical health;

Hypothesis:

1. that the proposed confounding variables will alter relationships between video game addiction and health.

Method

Preliminary tests of mediation and moderation.

First, preliminary checks were run to determine that proposed confounds are related to measures of health and addiction. T-tests were conducted to determine whether participants reporting seeking treatment or experiencing a global stressful even at wave 1 showed significant differences on addiction and health scores. To facilitate easy comparisons with the remainder of the PhD results, effect size of these tests is also provided in Pearson's *r*. Correlations were conducted for all other possible confounds as they were continuous variables. To verify the relationship with global stressful events, the single item rating of stressfulness of any events reported was correlated with addiction and all health measures. Participants were also asked how many hours they had spent with mental health professionals in the past month, and how long they had been receiving mental health treatment, and a correlation was run between these indicators.

Hierarchical multiple regression between addiction and health after controlling for confounds.

Following the preliminary check of the mediators' relationships with health and addiction, a multiple regression was run using depression, anxiety, stress, social activity, sleep health and BMI to predict addiction, with coping styles, stressful event rating, treatment seeking and social support entered in the first step as control variables. This analysis will determine whether the relationships between addiction and health indicators vary substantially after controlling for several other important contributors to health. VIF scores were checked to rule out problematic multicollinearity, and scatterplots of predicted versus actual values produced and examined for the final model to check that assumptions of linearity and homoscedasticity are sufficiently met.

Results

Preliminary tests of confounding effects.

Table 44 below indicates that those receiving treatment (n=51) showed significantly lower health on all measures (p<.05), except for social activity. But as shown in table 45, those reporting an unusual stressful event (n=140) did not show lower health aside from more

global psychological distress as measured by the stress sub-scale of the DASS21, and higher sleep disturbance (both $p<.05$).

Correlations were conducted for all other possible confounds as they were continuous variables, and are reported in Table 46 below. Significant correlations were found between the global stressful event rating and stress ($r=.21$, $p<.01$), depression ($r=.21$, $p<.05$) and the sleep health scale ($r=-.20$, $p<.01$); all other correlations were non-significant ($p>.05$). As this continuous measure showed stronger correlations than the group differences when treated as dichotomous, it was decided to include this continuous indicator of global stressful events rather than enter it as a dummy variable. No significant relationships emerged between time spent with mental health professionals in the past month and health measures (all $p>.05$). Length of treatment, on the other hand, was significantly related to social support ($r=.35$, $p<.01$), but no other health measure ($p>.05$). As all possible confounds mentioned above produced either a significant difference or demonstrated a relationship with most measures of health, all were included.

Table 44

T-tests on Differences in Health Measures and Addiction for Participants Reporting Treatment Seeking

	t	*df*	*p*	M_{diff} (*SE*)
Depression	4.72	495	.000	3.91 (.83)
Anxiety	4.16	56.84	.000	2.92 (.69)
Stress	5.78	495	.000	3.75 (.64)
Social activity	-1.88	495	.06	-3.56 (1.88)
Social support	-.54	495	.581	-.57 (1.02)
BMI	1.30	53.99	.20	1.88 (1.42)
Sleep health	-3.60	495	.000	-4.50 (1.25)
Addiction	3.05	495	.002	4.53 (1.46)

Note. n=51 participants were seeking treatment. All variables aside from anxiety and BMI had equal variances according to Levene ($p>05$).

Table 45

T-tests on Differences in Health Measures and Addiction for Participants Reporting a Global Stressful Event (n=140)

	t	*p*	M_{diff} and (*SE*)
Depression	.99	.30	.58 (.56)
Anxiety	.23	.82	.09 (.38)
Stress	2.37	.01	1.04 (.44)
Social activity	-.73	.46	-.94 (1.26)
Social support	-1.17	.24	-.81 (.68)
BMI	.88	.36	.58 (.65)
Sleep health	-2.33	.02	-2.02 (.85)
Addiction	.83	.39	.85 (.99)

Note. n=140 participants reported a global stressful event. All variables had equal variances according to Levene (*p*>05), as such *df*=495 for all.

Table 46

Correlation Matrix of Proposed Mediators/Moderators between Addiction and Health

	Approach coping	Diversion coping	Withdrawal coping	Stressful event rating	Depression	Anxiety	Stress	Social activity	Social support	Sleep health	BMI
Addiction	-.28***	.19***	.43***	.11	.42***	.40***	.44***	-.24***	-.27***	-.36***	.13***
Approach coping	-	-.07	-.48***	-.07	-.56***	-.37***	-.33***	.30***	.41***	.33***	-.00
Diversion coping		-	.28***	-.00	.18***	.18***	.18***	-.09*	-.11***	-.15***	.08
Withdrawal coping			-	.01	.64***	.49***	.49***	-.29***	-.34***	-.38***	.13***
Stressful event rating				-	.21*	.10	.21***	-.11	-.06	-.20*	-.01
Depression					-	.64**	.68***	-.25***	-.49*	-.51***	.08
Anxiety						-	.71***	-.16***	-.36***	-.52***	-.00
Stress							-	-.17***	-.31***	-.55***	.08*
Social activity								-	.33***	.14***	-.08
Social support									-	.33***	-.05
Sleep health										-	-.15***

Note. *p<.05, **p<.001

Hierarchical multiple regression between addiction and health after controlling for confounds.

The results indicated the step 1 of the model was significantly different to a null model (F(6, 134)=6.85, p<.001), as was step 2 (F(12, 128)=4.68, p<.001). Adjusted R^2 indicates the first model explained 20% of variance in video game addiction scores, and the second model explained 24%. The R square change statistic (ΔR^2) for model two was .06, which was significant (F(6, 128)=2.18, p<.05). VIF scores indicate no problematic multicollinearity. Analysis of the beta coefficients revealed that only withdrawal coping was a significant predictor. This was true of both models. Table 47 below presents a summary of results.

Table 47

Hierarchical Multiple Regression Predicting Video Game Addiction with Mental, Social and Physical Health after Controlling for Possible Confounding Factors

Predictor	Adjusted R^2	β
Step 1	.20**	
Stressful events rating		.08
Treatment seeking		-.04
Social support		-.11
Approach coping		-.05
Diversion coping		.06
Withdrawal coping		.33**
Step 2	.24*	
Stressful events rating		.04
Treatment seeking		.00
Social support		-.04
Approach coping		-.02
Diversion coping		.05
Withdrawal coping		.22*
Depression		-.05
Anxiety		.08
Stress		.20
Social activity		-.09
Sleep health		-.11
BMI		.07

Note. *** p<.001, ** p<.01, * p<.05.

Discussion

The purpose of this analysis was to explore several possible mediators or moderators of relationships between video game addiction and health. Demonstrating negative consequences is central to the validity for video game addiction. Therefore, when a cross-sectional relationship that presents a candidate negative consequence, it is important to test the influence of other factors which may also contribute to the same outcome. If mediators or moderators can be identified, then the relative importance and context within which video game addiction is most problematic may be better understood. Identifying which factors are most important may also provide a means of explaining mechanisms within the relationship, and possible portals to intervention. While it was not feasible to include all factors known to predict health, or addiction, in this thesis, few studies have so far investigated factors which may confound problematic correlates with video game addiction. This analysis investigated the strength of connections after accounting for global stressful events, treatment seeking, social support and coping styles.

Initial preliminary checks confirmed moderate relationships between the proposed confounding factors and video game addiction and/or health. Then, a hierarchical multiple regression tested the relationships between health indicators and video game addiction score, after controlling for these confounding factors by entering them into the model in the first step. The results suggest that health has only very small connections with video game addiction, after controlling for the confounding variables. The great majority of variance explained in video game addiction was accounted for the confounding factors, particularly withdrawal coping style, with only a small but significant increase attributed to the further health variables. This result is similar to other studies which found basic needs fulfilment explained almost all of the variance between obsessive video game play and well-being (Przybylski et al., 2009). The reasons for this result are unclear. The importance of coping styles suggests that video game addiction may be primarily a response to, rather than a catalyst, of declined health, in gamers with poor coping styles.

Most researchers cautiously assume bi-directional relationships between video game addiction and associated problems at this early stage of research. Yet, bi-directionality still suggests at least a partially causative relationship between video game addiction and health. As such, some connection should be present, even after controlling for other contributors to health. Yet in this model connections were weak, with not one health indicator reaching significance in the presence of mediators, and the second model only increasing the amount of variance explained by 4% and no other predictors reaching significance. Instead, this

analysis seems to suggest video game addiction is not highly related to health in addition to coping styles, particularly withdrawal coping. As the effect of coping styles was so strong, their mediating effects are investigated in more depth in chapter 8, using a multiple mediation analysis.

Limitations

This chapter presented the specific limitations of utilising indicators for treatment seeking (time spent with mental health professionals) for which validity is not yet established, and the lack of more advanced statistical regression diagnostics techniques. The differential effect sizes of the dichotomous compared with the continuous indicator of mental health treatment seeking (time spent with mental health professionals) was compared, with the continuous showing more promise as a moderator, the use of time spent with mental health professionals as an indicator of treatment seeking has not yet been empirically established. The validity of this indicator could have been tested by including further indicators of different aspects of treatment seeking, such as prescription of medication, adherence to treatment protocols, and possible satisfaction or a self-rating of how much treatment is helping. However, the survey was already large and time-consuming for participants, and introduction of additional scales would have increased this burden. When finalising the survey battery, balancing meaningful data with brevity was always a concern. Another limitation was the regression approach. The individual contribution of each predictor may have been further explored with more advanced statistical regression diagnostic procedures, such as dominance or relative weights analysis, or analysis of part and partial correlations. Structural Equation Modelling (SEM) based techniques may also prove useful in exploring directionality of relationships, even in cross sectional models. Nonetheless, these preliminary results provide a starting point for further studies, which may include more detailed indicators of mental health treatment seeking and more varied statistical techniques.

Chapter 7: Video Game Addiction and Functioning, Including Confounds

Difficulty in maintaining expected life roles such as working or studying, sometimes referred to as ‘life interruption’, is often considered a component of addiction. Video game addiction measures include some items covering aspects of life interruption, generally with a single item each asking participants whether video game playing has had a detrimental effect ‘at work’, ‘at study’, or ‘at home’. The latter may refer to romantic/marital, parental or other familial relationships. The recently introduced DSM-V proposed diagnosis includes specific mention of gaming having jeopardized or lost a significant relationship, job, or educational or career opportunity because of participation in internet games. However, few studies have explored relationships between video game addiction scales and a wide variety of functioning indicators, especially in the presence of possible mediators or moderators.

This study collected indicators of functioning at work, study, job seeking, parenting and in romantic relationships. The study also collected measures of satisfaction with these domains. The role of satisfaction is uncertain in this dynamic, but it is theoretically possible to conceptualise it as a risk factor, consequence or bi-directional relationship with video game addiction. Satisfaction may provide a means of investigating the difficulty in controlling one’s activities, thought to be a component of video game addiction and reflected in many of the common measures of the construct, and proposed diagnostic criteria (King, Haagsma, et al., 2013). This component suggests that even if a person intends to maintain successful functioning in certain areas of life, functioning suffers as a direct result of the addiction, either through displacement by activities required to upkeep the addiction, or by the addiction diminishing the ability to function well (e.g. the effect of drugs). Alongside this diminished functioning, the person will usually report difficulty in controlling or regulating their own behaviour, which was too difficult to direct away from maintenance or growth of the addictive condition. If this difficulty in controlling one’s activities is present, then it is reasonable to expect that people who have high satisfaction with a particular life domain will still diminish in their functioning due to video game addiction. This would provide strong evidence demonstrating the difficulty in controlling one’s activities with high video game addiction.

However, it is equally plausible to hypothesise that lower satisfaction with life domains would pose a risk factor for developing video game addiction, particularly in the absence of adaptive coping styles. Bi-directionality is also plausible, in which case lower satisfaction

may exacerbate existing video game addiction, leading to diminished functioning, characterising a downward spiral. Ideally, longitudinal analyses may help to provide some greater understanding of the directionality between these factors. However, as yet no studies have investigated the role of satisfaction in the connection between video game addiction and functioning. Chapter 5 reported several relationships between video game addiction and lower functioning at work and study, and higher relationship conflict. This chapter will now test whether the inclusion of satisfaction will alter these results.

Focus of this Chapter

The previous chapter introduced possible confounding factors in relationships between video game addiction and health. This chapter now introduces satisfaction in life domains as a possible confounding factor in relationships between video game addiction and functioning. Parental functioning, which was not included in analyses thus far, is now included.

Aims and Hypotheses

This chapter addresses aim number three and its' second sub-aim:

3. Identify possible confounding factors in relationships between video game addiction and associated problems, by measuring:
    3.2 The impact of including satisfaction with life domains in models measuring relationships between video game addiction and functioning in life domains.

Hypotheses:

1. That inclusion of satisfaction with life domains will not alter the relationships between video game addiction and functioning in that domain.

Method

Preliminary check for confounding effects.

Firstly, Pearson product-moment correlation matrices were calculated for indicators of functioning across life domains, satisfaction and video game addiction. Additionally, a correlation was run between job seeking and video game addiction, which was not found to be significant (r=.01, p=.55). For the purposes of this analysis, all academic discrepancy

scores which were negative (i.e. the participant performed better than the grade they had been aiming for) were removed. One outlier was also corrected to the maximum grade discrepancy of 50, which guarantees an overall fail by the grade reporting standard participants were asked to complete.

Hierarchical multiple regression analysis.

Hierarchical multiple regression analyses were conducted to determine whether video game addiction predicted functioning, after controlling for the variance explained by satisfaction, in each life domain investigated. Hierarchical multiple regressions have the advantage of exploring relationships between satisfaction in that life domain, and outcomes, in the first step. Then, the unique contribution of video game addiction can be explored in addition to the effect explained by satisfaction in the second model. Multicollinearity was checked for all models by producing VIF statistics and this indicated no unreasonably high VIF scores.

Results

Preliminary check for mediation.

All functioning domains indicated significant correlations between satisfaction, functioning and video game addiction, indicating possible confounding effects. Parenting satisfaction showed no relationship with parenting performance, but video game addiction was highly and significantly correlated. Correlation matrices are reported in tables 48-51 below.

Table 48

Correlation Matrix for Indicators of Functioning and Satisfaction at Work and Video Game Addiction.

	Times late to work	Warnings received from management	Satisfaction with work
Video game addiction	.14**	.11*	-.21**
Times late to work		.21**	-.19**
Warnings received from management			-.08

Note. *p<.05, **p<.001, n=312.

Table 49

Correlation Matrix for Indicators of Academic Functioning, Satisfaction and Video Game Addiction

	Grade average (*n*=212)	Number of subjects failed (*n*=275)	Discrepancy score (*n*=158)	Satisfaction with study (*n*=275)
Video game addiction	-.06	.12	.16*	-.14*
Grade average		-.38**	-.45**	.14*
Number of subjects failed			.51**	-.16*
Discrepancy score				-.15

Note. *p<.05, **p<.01. A correlation was also produced between video game addiction and all participants in the inverse range of the discrepancy score and no significant relationship was found (r=-.15, p=.14).

Table 50

Correlation Matrix for Relationship Conflict, Relationship Needs Satisfied and Video Game Addiction

	Relationship needs fulfilled	Relationship conflict
Video game addiction	-.14*	.20**
Relationship needs fulfilled		-.39**

Note. *p<.05, **p<.01.

Table 51

Correlation Matrix for Indicators of Functioning and Satisfaction with Parenting and Video Game Addiction.

	Parental performance	Parental satisfaction
Video game addiction	.-.59**	.09
Parental performance		-.09

Note. *p<.05, **p<.001, n=47.

Hierarchical multiple regressions.

Work functioning.

With regards to work, the first model was significant ($F(1, 310)=13.73$, $p<.001$), however the adjusted R^2 indicates satisfaction only predicted 4% of functioning (the sum of times late to work and warnings received). The ANOVA for the second model was also significant ($F(2, 308)=6.27$, $p<.001$), indicating addiction did significantly contribute to the model, however the R^2 change figure was only .01 and did not reach significance ($F(1, 308)=2.38$, $p=.08$).Standardised beta coefficients for addiction came close, but did not reach the significance threshold of $p<.05$. Table 52 below reports the standardised beta coefficients of each variable.

Table 52

Hierarchical Multiple Regression Predicting Work Functioning with Video Game Addiction after Controlling for Job Satisfaction

Predictor	Adjusted R^2	β	F for ΔR^2
Step 1	.04**		
Job satisfaction		-.21**	
Step 2	.05		2.38
Job satisfaction		-.19**	
Video game addiction		.10 (p=.07)	

Note. *$p<.05$, **$p<.01$, ***$p<.001$.

Academic functioning.

Regarding academic functioning, only some participants had received assessment which was not pass or fail in the previous month; this also affected the academic discrepancy score. As such, two separate hierarchical regression models were run, one including the number of subjects failed in the past month as a dependant variable (n=269), and another including the grade average (n=212).

In the model predicting number of subjects failed, step 1 was significant (F(1, 267)=8.02, p<.05), with adjusted R^2 of .026, indicating academic satisfaction explained a very small 2.6% of subject failure variance. Step 2 was also significant (F(2, 266)=5.22, p<.05), increasing the adjusted R^2 to .031, or 3.1% variance shared. However, at .01 the R^2 change statistic did not reach significance (F(1, 266), p=.11). These figures are summarised in Table 53.

For the model using grade average as the dependant variable, the first step just reached the significance threshold (F(1, 210)=4.03, p=.05), with higher satisfaction predicting higher grade average, although the effect size was smaller than in the model predicting number of subjects failed (β=.14, p<.05). However, inclusion of video game addiction in the second step increased error into the null hypothesis rejection threshold (F(2, 209)=1.73, p=.13). As such, the standardised beta coefficients are not reported.

Table 53

Hierarchical Multiple Regression Predicting Number of Subjects Failed with Video Game Addiction after Controlling for Satisfaction with Study

Predictor	Adjusted R^2	β	F for ΔR^2
Step 1	.03*		
Satisfaction with Study		-.16*	
Step 2	.02.*		.01
Satisfaction with Study		-.16**	
Video game addiction		.08	

Note. *p<.05, **p<.01, ***p<.001.

Relationship conflict.

In the case of romantic relationships, relationship needs fulfilment was used as a proxy of satisfaction and was entered in at the first step. This first model was significant (F(1, 241)=46.43, p<.001), with adjusted R^2 of .16. The second step was also significant (F(2, 240)=28.47, p<.001), with adjusted R^2 increasing to .18. The F statistic for the R^2 change was significant (F(1, 240)=8.98, p<.001). Examination of the standardised beta coefficients

suggests conflict increases with higher video game addiction in addition to lower needs satisfaction, but to a smaller degree. A model summary is presented in Table 54 below.

Table 54

Hierarchical Multiple Regression Predicting Relationship Conflict with Video Game Addiction after Controlling for Relationship Needs Fulfilled

Predictor	Adjusted R^2	β	F for ΔR^2
Step 1	.16*		
Needs fulfilled		-.39***	
Step 2	.18*		8.98***
Needs fulfilled		-.38***	
Video game addiction		.18***	

Note. *p<.05, **p<.01, ***p<.001.

Parental performance.

The first model indicated satisfaction was not a significant predictor of parental performance (F(1, 45)=.35, p=.54). However, the second model, which included video game addiction, was significant (F(2, 45)=11.74, p<.001). As shown in Table 55, video game addiction explained a large amount of variance in parental performance (adjusted R^2 =31.9), with a significant standardised beta coefficient for addiction (β = -.57, p<.001).

Table 55

Hierarchical Multiple Regression Predicting Parental Performance with Video Game Addiction after Controlling for Parental Satisfaction

Predictor	Adjusted R^2	β	F for ΔR^2
Step 1	.01		
Parental satisfaction		-.08	
Step 2	.32**		23.50***
Parental satisfaction		-.06	
Video game addiction		-.59***	

Note. *p<.05, **p<.01, ***p<.001.

Discussion

Overall, these results provide mixed validity for the video game addiction scale in predicting declined functioning across life domains, over and above satisfaction with those domains; except in the case of parental performance, for which video game addiction was strongly predictive. Functioning at work, at studies and relationship conflict were not substantially predicted by video game addiction, after controlling for satisfaction. Where results met statistical significance, the magnitude of variance explained was small. This was the case even though the scale included items which were designed specifically to tap into the component of addiction sometimes called 'life interruption', as video game addiction scores increased in these models, indicators of functioning did not even moderately decrease.

The scale asking participants to endorse whether gaming has caused them to "neglect important things" (addiction item 1), their "social life to suffer" (addiction item 2), "Interfered with my work" (addiction item 3), made them "sometimes late for engagements" (addiction item 6), "arguments have sometimes arisen at home" (addiction item 7) and to "escape from socialising" (addiction item 11). Yet connections with indicators of functioning at work, study and in relationships were small or did not meet statistical significance, after accounting for satisfaction with those domains. These results differ from studies which concluded, tacitly if not explicitly, that addiction causes a decrease in academic functioning (Skoric et al., 2009).

This absence of associations occurred in a sample of highly engaged and self-identified problematic gamers. A sample in which, it can be argued, these relationships should be even more pronounced than in a broader population of gamers. This lack of predictive validity is confusing. It is contrasted by many anecdotal accounts of video games interfering with life roles. It is also contrasted by the moderate associations between video game addiction and mental, social and physical health. It may be that diminished functioning in these life domains occurs only after prolonged periods of addiction. A more limited variance in functioning is one possibility due to the sampling strategy of this study; yet descriptive statistics still showed a wide range of scores on the functioning indicators within the sample. Longitudinal studies which take a random sample from the population may help investigate these relationships further.

One indicator did emerge as highly related to video game addiction – parental performance. The parental performance subscale of the Guidubaldi-Cleminshaw Parental Satisfaction Scale (Guidubaldi & Cleminshaw, 1985) asks participants ten questions about their self-rated parenting performance. The scale includes item such as "I wish I did not become

impatient so quickly with my children", "I am upset with the amount of yelling I direct towards my children", "I wish I were a better parent and could do a better job parenting", and "I wish I gave my children more individual attention". The scale has shown convergent validity with similar measures: dyadic adjustment, parent-child relations and reduced child problem behaviours (Guidubaldi & Cleminshaw, 1988). The strong relationship that emerged between video game addiction and this measure was unexpected, especially as the parental satisfaction subscale seems to have little effect, either in isolation, or in models which include both. It may be that parenting, which presents significant demands on time and resources, is a domain of functioning which is more sensitive to interruption from a (potential) behavioural addiction such as video game addiction. The aspects of parenting which this scale targets, and the large magnitude in the relationship, suggests that impacts of video game addiction for both parents and their children may be severe. It must be noted that this explanation presents declined parenting performance as a negative consequence of video game addiction, rather than the reverse. It may also be possible to theorise the opposite, in that parents who decline in their performance (but seemingly not as a result of a drop in parental satisfaction), then uptake excessive video game playing as a compensatory activity. The sample of parents was small, and further investigations with larger sample sizes, and longitudinally, are required to gain a greater understanding.

Limitations

This chapter presented specific limitations of small sample sizes in some sub-groups, the use of indicators and composite score for which validity and reliability are not yet established and which present some bias, and a lack of other data collection methods which may help to triangulate results. This chapter utilised composite indicators for functioning at work and at study which, while objectively relevant to most people, lack prior empirical testing and are susceptible to bias. This is particularly true of the work functioning composite measure, which prioritised punctuality. Punctuality may be unimportant in many jobs, such as work with flexible hours. Outliers suggested this was likely the case with some participants as they reported a very high frequency of late arrivals yet no warnings from management for poor performance. This measure was capped in order to reduce the bias any extreme scores may have caused on analyses.

The more severe indicators, including receiving warnings from management, or the loss of a job, were relatively uncommon across the duration of the study, despite the sampling strategy; therefore the dataset does not allow thorough exploration of these possible

negative consequences. Why these were uncommon, given the sampling strategy and the high levels of video game addiction and engagement reported, is uncertain. On face value this result suggests that even within samples exhibiting enough signs to meet diagnostic thresholds for video game addiction, and identifying as potentials addicts, severe negative consequences at work is still uncommon. The academic functioning indicators, including grade average, discrepancy score between desired and achieved average, and number of subjects failed, are generally considered acceptable indicators of functioning and have been used in many past studies.

The measures of satisfaction were all scales for which some validity and reliability was available, but due to the need to reduce burden on participants were very short. More detailed, multi-dimensional scales may facilitate an investigation of which specific aspects of functioning, in each domain, are most related to video game addiction.

Another noteworthy limitation is the choice of functioning measures included. The life domains chosen have pragmatic value for most people. But, arguably, these life domains measured represent what can be considered a conventional approach to life. People's life priorities can differ immensely, and can change over the lifespan, and it is quite possible that some people consider the aspects of functioning included in this study unimportant. Including subjective measures of importance of each life domain, or constructing a measure flexible enough to respond to participants' own priorities, would be ideal.

Chapter 8: Mediating Role of Coping Style in Relationships between Addiction, Engagement and Mental Health

To date few studies have tested for mediating or moderating variables which may help to explain the relationship between video game addiction and poorer mental health. One study, using self-determination theory as their framework, showed that the lack of basic psychological needs satisfaction in gamers with obsessive passion was associated with lower mental health (Przybylski et al., 2009). Another potential mediator could be coping style. Maladaptive coping has been shown to result in numerous negative health consequences (A. A. Clark & Hovanitz, 1989; Folkman, Lazarus, Gruen, & DeLongis, 1986; Lazarus & Folkman, 1984) and video game addiction has been linked in qualitative studies with a lack of coping skills, or described as an escape-based coping strategy (Allison et al., 2006; Beranuy, Carbonell, & Griffiths, 2013; Wan & Chiou, 2006; Wood & Griffiths, 2007). Researchers and participants in video game addiction studies have also described video game addiction as an attempt at coping, and several studies have reported correlations between video game addiction and a desire to escape (Gentile et al., 2011; Tejeiro et al., 2012; Yee, 2006a). Coping skill training is also a major empirically supported component of many interventions for additive disorders (A. A. Clark & Hovanitz, 1989).

Coping refers to 'constantly changing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person' (Lazarus & Folkman, 1984, p. 141). Although there are many different coping strategies, they are often conceptualized under the higher order dimensions 'approach' (i.e., concentrated efforts to manage a stressful event, such as planning) and 'avoidance' coping. The latter includes activities or cognitive changes to avoid situations via diversion (cognitive distancing) or withdrawal (remove oneself from the situation) (Finset et al., 2002). Approach coping is associated with better mental health and avoidance coping with poorer mental health (A. A. Clark & Hovanitz, 1989; Folkman et al., 1986). As such, video game addicts with coping preferences characterized by distraction and/or or withdrawal, coupled with fewer approach coping strategies, may be more likely to develop or experience more severe mental health problems.

Chapter 6 suggested that coping style explained much of the connection between video game addiction and a range of health measures. This chapter investigates whether coping styles mediate the relationships between video game addiction versus engagement and mental health, in adult problem video gamers. Based on the distinction put forward by

Charlton (2007) we predicted that severity of video game addiction would be directly and inversely related to poorer mental health status (higher levels of stress, anxiety and depression) whereas engagement would not. Secondly, we predicted that individuals with higher levels of video game addiction would exhibit higher levels of depression, anxiety and stress, which would be mediated by greater use of avoidance coping strategies and fewer approach coping strategies. Engaged gamers on the other hand would be more likely to report lower depression, anxiety and stress levels which would be mediated by the use of more approach and less avoidance coping.

Focus of this Chapter

As chapter six suggested such a strong confounding influence of coping style between video game addiction and health, this chapter investigates this influence more thoroughly. A multiple mediation analysis, utilising bootstrapping, will be able to provide a robust indication of the mediating effect of coping style in the relationship between video game addiction and health. For this chapter, mental health will be the focus as stress and anxiety have shown the strongest connection with video game addiction in the multiple regression analysis in chapter five. Further, the same analysis will be conducted using video game engagement, in order to explore how connections with health and coping-style differ. This chapter investigated whether coping mediated the relationships between video game addiction or engagement and mental health in adult problem video gamers.

Aims and Hypotheses

Aim:

3. Identify possible mediating variables between video game addiction and associated problems, by measuring:

    3.1. The impact of including coping styles, stressful life events, socio-economic status and treatment seeking in models measuring relationships between video game addiction and mental, social and physical health;

Hypotheses:

1. That coping styles will mediate the relationships between video game addiction or engagement, and mental health; with greater use of avoidance and lower use of approach coping relating to higher video game addiction, and in-turn higher symptoms of stress, anxiety and depression.

Method

To further investigate the significant coping mediation apparent in the previous analyses, a multiple mediation method was conducted. A bootstrap (5000) resample procedure calculated the direct and indirect effects of video game addiction or engagement (independent factors) on mental health (dependent factors: stress, anxiety and depression). Six models in total were generated, examining whether approach, withdrawal and distraction coping fully or partially mediated the relationships between addiction or engagement and depression, anxiety and stress. All statistical analyses were conducted using SPSS V. 20 and a macro for SPSS, which facilitates multiple mediation analysis. This provided the direct, indirect, and total effects, and bias corrected and accelerated (BCa) confidence intervals (CI) (Preacher & Hayes, 2004, 2008).

Results

Addiction, coping style and mental health.

Table 56 provides the details of the mediation analysis for addiction and mental health. The mediation analysis showed that coping was a partial mediator between Addiction and Stress, Anxiety and Depression (See figures 2a, 2b and 2c). There was a significant total effect of Addiction on Stress, Anxiety and Depression (path c; $p < .05$) and a significant but smaller direct effect of coping on Stress, Anxiety and Depression adjusted for the mediators (path c'; $p < .01$). The significant effect of Addiction on the mental health outcomes adjusted for by the mediators was in all instances smaller than the significant effect of addiction on mental health indicating partial mediation. The total indirect effects had a BCa CI which was different from zero. Approach and Resignation and Withdrawal coping were significant partial mediators whereas Diversion coping did not contribute to the indirect effects above and beyond Approach and Resignation and Withdrawal coping. In all instances lower levels of addiction were associated with more use of Approach coping which in turn was associated

with lower levels of Stress, Anxiety and Depression. Higher levels of Addiction on the other hand were associated with more use of Resignation and Withdrawal coping and higher levels of Stress, Anxiety and Depression.

Table 56

Multiple Mediation Analysis of Video Game Addiction and DASS Subscales Mediated by Approach, Resignation & Withdrawal, and Diversion Coping

		Product of Coefficient		BCa 95% CI	
	Point estimate	SE	Z	Lower	Upper
Indirect effects – Addiction and Stress					
Approach	.33	.06	6.01**	-.01	.12
Resignation & Withdrawal	.27	.06	4.59**	.16	.40
Diversion	.03	.02	1.63	-.00	.07
Total	.33	.06	6.01**	.23	.47
Indirect effects – Addiction and Anxiety					
Approach	.04	.03	1.28	-.03	.13
Resignation & Withdrawal	.33	.07	5.03**	.21	.49
Diversion	.02	.02	1.66	.00	.08
Total	.42	.07	6.34**	.29	.56
Indirect effects – Addiction and Depression					
Approach	.02	.05	.65	-.06	.13
Resignation & Withdrawal	.30	.05	4.87**	.17	.45
Diversion	.03	.02	1.78	.00	.05
Total	.37	.06	5.10**	.21	.51

Note. BCa bias corrected and accelerated confidence intervals. *** $p<.001$. ** $p<.01$. * $p<.05$.

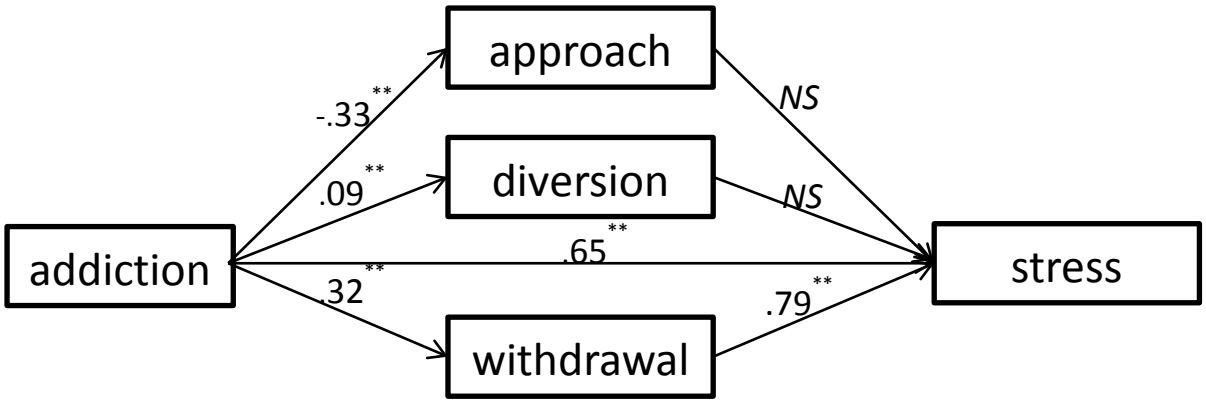

Figure 2a. Multiple Mediation Model of Video Game Addiction Predicting Stress Mediated by Approach, Resignation & Withdrawal, and Diversion Coping.
Note. ***p*<.001. **p*<.01. *p*<.05. *NS*=non-significant (*p*>05).

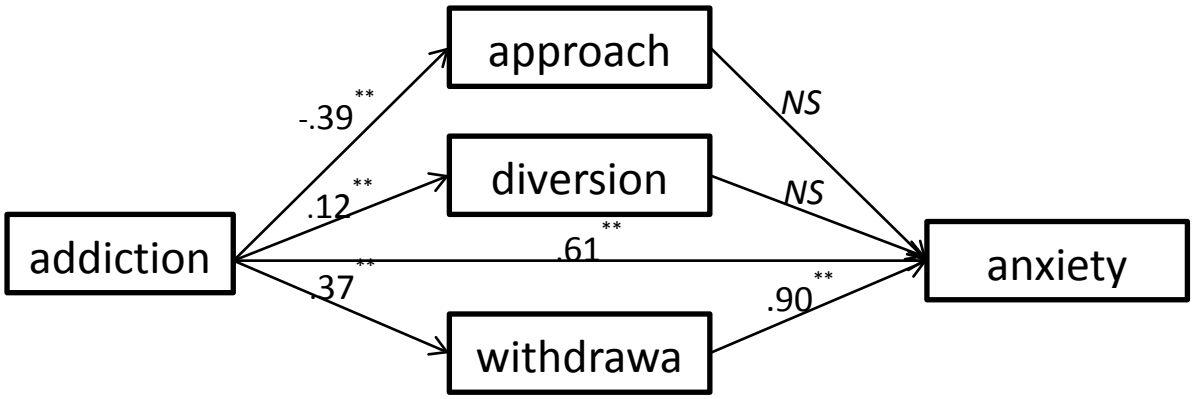

Figure 2b. Multiple Mediation Model of Video Game Addiction Predicting Anxiety Mediated by Approach, Resignation & Withdrawal, and Diversion Coping.
Note. ***p*<.001. **p*<.01. *p*<.05. *NS*=non-significant (*p*>05).

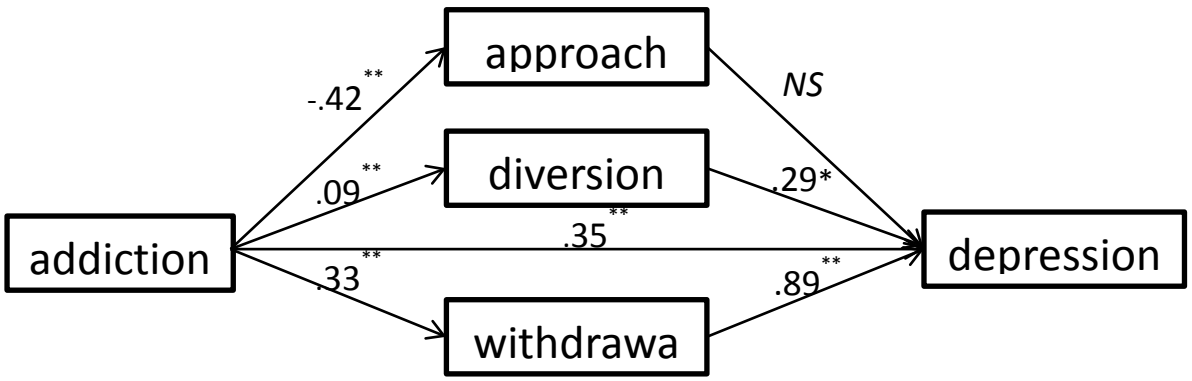

Figure 2c. Multiple Mediation Model of Video Game Addiction Predicting Depression Mediated by Approach, Resignation & Withdrawal, and Diversion Coping.
Note. ***p*<.001. **p*<.01. *p*<.05. *NS*=non-significant (*p*>05).

Engagement, coping style and mental health.

Coping was found to be a full mediator between Engagement and Stress, Anxiety and Depression (see Table 57 and Figures 2d, 2e, 2f). There was a significant total effect of Engagement on Stress, Anxiety and Depression adjusted for the mediators (path c; $p < .01$) but no direct effect (path c'; $p > .05$). The total indirect effects were all different from zero. All three coping dimensions were full mediators for Engagement and Stress and Depression. However, Resignation and Withdrawal coping was not a significant mediator for Anxiety. Lower levels of Engagement were associated with more Approach coping which in turn was associate with lower levels of Stress, Anxiety and Depression. Increased levels of Engagement were associated with more use of Diversion and Resignation and Withdrawal coping. Higher levels of Diversion coping were associated with higher levels of Stress, Anxiety and Depression whereas higher levels of Resignation and Withdrawal coping were associated with higher levels of Stress and Depression but not Anxiety.

Table 57

Multiple Mediation Analysis of Engagement and DASS Subscales Mediated by Approach, Resignation and Withdrawal, and Diversion Coping.

		Product of Coefficient		BCa 95% CI	
	Point estimate	SE	Z	Lower	Upper
Indirect effects – Engagement and Stress					
Approach	.11	.04	2.92**	.03	.17
Resignation & Withdrawal	.07	.04	1.17	-.03	.18
Diversion	.06	.01	2.66**	.01	.11
Total	.23	.06	4.07**	.13	.33
Indirect effects – Engagement and Anxiety					
Approach	.13	.03	2.86**	.04	.23
Resignation & Withdrawal	.05	.05	1.02	-.07	.18
Diversion	.07	.01	2.67**	.03	.13
Total	.26	.07	3.95**	.17	.39
Indirect effects – Engagement and Depression					
Approach	.15	.05	3.01**	.06	.24
Resignation & Withdrawal	.08	.05	1.49	-.06	.20
Diversion	.05	.02	2.80**	.02	.08
Total	.29	.06	4.05**	.12	.43

Note. BCa bias corrected and accelerated confidence intervals. ** $p<.01$. * $p<.05$.

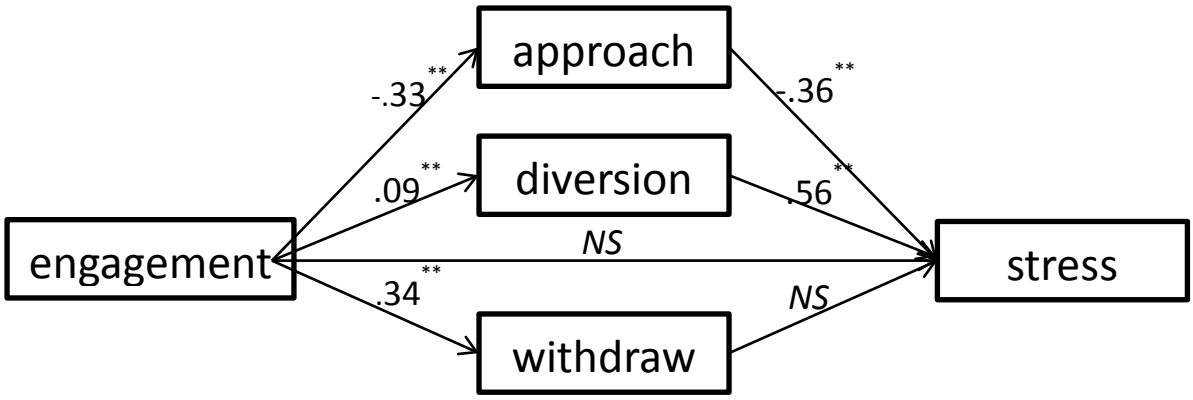

Figure 2d. Multiple Mediation Model of Video Game Engagement Predicting Stress Mediated by Approach, Resignation & Withdrawal, and Diversion Coping.

Note. *** = *p*<.001; ** *p* <.01; * *p*<.05; *NS*= non-significant (*p*>.05).

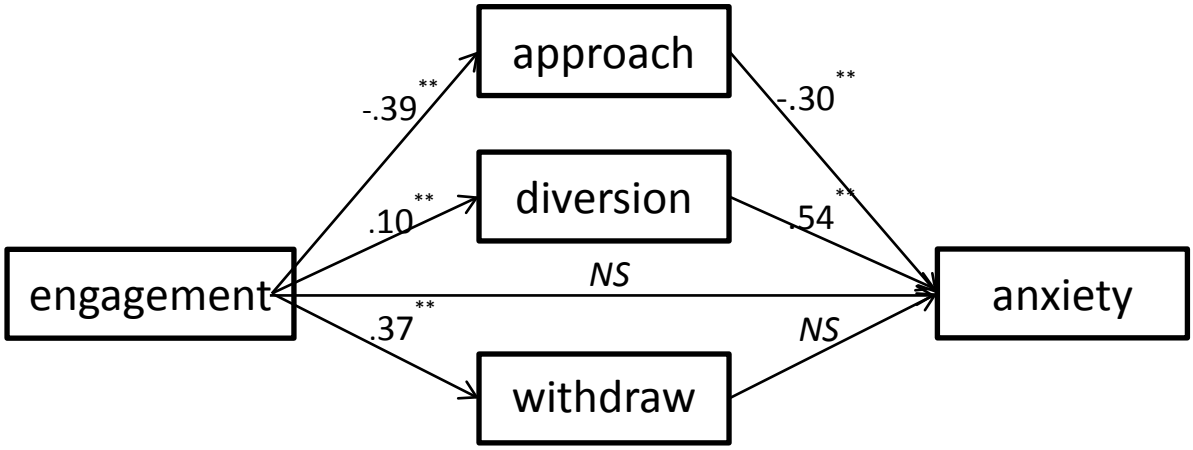

Figure 2e. Multiple Mediation Model of Video Game Engagement Predicting Anxiety Mediated by Approach, Resignation & Withdrawal, and Diversion Coping.

Note. *** = *p*<.001; ** *p* <.01; * *p*<.05; *NS*= non-significant (*p*>.05).

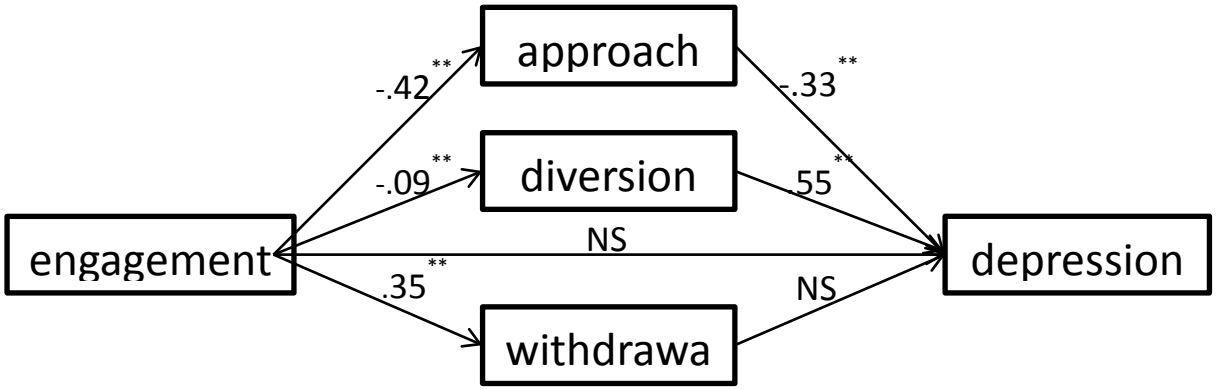

Figure 2f. Multiple Mediation Model of Video Game Engagement Predicting Depression Mediated by Approach, Resignation & Withdrawal, and Diversion Coping.

Note. *** = *p*<.001; ** *p* <.01; * *p*<.05; *NS*= non-significant (*p*>.05).

Discussion

This chapter investigated the potential mediating role of coping in understanding the relationship between video game addiction versus engagement and mental health. Consistent with the hypothesis, coping was found to be a mediator (albeit partial) between video game addiction and mental health, as well as between engagement and mental health (a full mediator in this instance). As predicted, approach coping was inversely related to video game addiction and was associated with lower levels of stress, anxiety and depression. However, individuals with higher levels of video game addiction reported greater use of avoidance oriented coping (particularly resignation and withdrawal), which was associated with higher levels of stress, anxiety and depression.

Resignation and withdrawal coping strategies are considered maladaptive and passive, comprising of acquiescence, withdrawal and disengagement (Finset et al., 2002). Uses of such strategies have been shown to result in increased levels of distress (A. A. Clark & Hovanitz, 1989; Nicholls, Polman, & Levy, 2012; Polman, Borkoles, & Nicholls, 2010), thwarted goal-attainment (Gaudreau & Antl, 2008), and negative emotions (Carver et al., 1993). Although avoidance coping strategies might provide temporary relief, they often involve deferring problem solving to the future, which can result in poorer health and well-being (Folkman et al., 1986; Polman et al., 2010). Diversion coping was not found to be a partial mediator between video game addiction and mental health. This suggests that addictive video game players are less likely to use distractive activities to deal with difficulties, including video game playing. The strong presence of withdrawal in the connection between video game addiction and mental health may suggest that, in addition to a baseline of poorer mental health, the addition of withdrawal and resignation coping exacerbates difficulties. However, longitudinal studies will be required to confirm this result.

This analysis found a direct effect between video game addiction and mental health, with anxiety showing the largest relationship followed by stress and depression. This is consistent with previous chapters, as well as several other studies which have found direct connections between video game addiction and poorer mental health (Gentile et al., 2011; King, Delfabbro, & Zajac, 2011; Mentzoni et al., 2011; Starcevic et al., 2011). As this relationship remained significant after accounting for the effect of coping, future studies must explore additional underlying mechanisms. In contrast to addiction, engagement was not directly related to mental health. However, increased levels of engagement were associated with less use of approach and increased use of avoidance or maladaptive coping strategies. This in turn was associated with poorer mental health. Diversion coping was found to be

associated with all three mental health measures, whereas resignation and withdrawal coping was only associated with stress and depression. Although, the magnitude in the path analyses between engagement and diversion was small, suggesting participants who use diversion coping may not necessarily be much more likely to use video games for this purpose; although those that do tend to report higher stress, anxiety and depression.

One possible explanation for this finding is that some gamers use increased video game playing as a distraction from difficulties. This is consistent with a German study that reported excessive child gamers were more likely to use electronic media, including video gaming, to regulate negative emotions and reduce stress. Through playing computer games, some individuals with a maladaptive coping repertoire may suppress negative emotions and stress, rather than actively solve the underlying cause(s) (Grüsser & Rosemeier, 2004). Such behaviour has the potential to act as a reward to the individual, while simultaneously suppressing the use of active coping strategies to deal with negative feelings and stress. The absence of a well-developed and effective coping repertoire can be a risk factor in the development of video game addiction (Grüsser & Rosemeier, 2004). Increased engagement paired with maladaptive coping may point towards individuals at risk of transitioning into video game addiction, however longitudinal studies are needed to further explore this relationship. Future studies should also explore the role of coping in the relationship between other hobbies (including various media consumption) and mental health. Our research identified subtle but significant differences between coping strategies employed by those who are engaged and video game addicts which contributes to previous discussions on when intense gaming may or may not become problematic for the person (Charlton & Danforth, 2007; Gentile et al., 2011; Mentzoni et al., 2011; Petry, 2013).

The current chapter confirms the co-occurrence of poorer mental health with video game addiction and maladaptive coping. This analysis also reaffirms the differentiation between addiction and engagement, with addiction retaining a direct relationship with mental health symptoms while engagement did not. Similarly, coping may also provide a portal to intervention. Future studies should examine whether coping interventions which increase the use of approach coping strategies and decreases avoidance coping strategies among excessive video gamers are able to improve mental health outcomes or prevent transition into addiction.

The generalizability of the results is limited given the targeting of self-identified problem gamers. The use of self-report measures is a further limitation. While poorer mental health was described as an outcome of video game addiction and maladaptive coping the study

was cross-sectional in nature, meaning we cannot determine causality. It is plausible that mental health problems and maladaptive coping pre-date video game addiction or engagement, and/or are bidirectional and mutually reinforcing. Longitudinal data will help to confirm the directionality of these relationships, and identify risk factors and outcomes.

In conclusion, coping is an important partial mediator between video game addiction and mental health. On the other hand video game engagement is not connected to mental health, except in the presence of maladaptive coping. The use of maladaptive coping strategies not only provides an explanation for the relationship but also a portal for intervention. Interventions that improve coping may have the potential to reduce or prevent declines in mental health that are thought to result from excessive video game playing.

Chapter 9: Cut-Off Point Comparison Based on Measures of Health and Functioning

Addictive disorders, and most disease models, contain multiple components. The individual components making up the condition combine to produce a unique effect, and it is the combination and interaction of multiple components that make up the condition. Diagnostic thresholds reflect this fact, requiring the presence of a certain minimum number of symptoms. Most disease models are necessary simplifications of complex real world phenomena. As stated by one leading researcher, in a caution to others considering disease models of addictive conditions, “the map is not the territory, the menu is not the meal, and the diagnosis is not the disorder” (D. Hanson, 2012, p. 3). The use of diagnostic thresholds has also been cautioned against at such an early stage of research into this proposed new behavioural addiction. If the bar is set too low, an epidemic may ensue, but if set too high, cases may never be identified (Starcevic, 2013a). Despite the uncertainty at this stage in where to draw the line, many researchers have used thresholds to investigate video game addiction and have highlighted their usefulness to the construct in applied settings (D. Gentile, 2009; Gentile et al., 2011; Griffiths, 2008a; Tejeiro Salguero & Morán, 2002).

The individual item analysis in chapter four, along with results from past research, confirmed that some features of video game addiction are far more common than others, even in a sample of self-identified problem adult gamers. Results also indicated that certain features are more strongly related to harm. Whether the varied features of video game addiction are included or weighted differently in thresholds will have a large impact on diagnosis or interpretation of research results.

Already different cut-off points have been proposed in past research for video game addiction scales, resulting in vastly different prevalence rates (Rehbein et al., 2010). Past studies utilising thresholds have usually taken endorsement of ‘half-out-of-the-total’ items to indicate a positive diagnosis of addiction. This, of course, varies with the length of the scale (i.e. in terms of total number of items), and also places equal importance on any of these items. Another factor that can have a major impact on diagnostic thresholds is the coding of agreement. To calculate cut-off points, items must first be dichotomised. Researchers have treated partial endorsement differently, for example Gentile et al. (2011) classified the response of ‘sometimes’ as a half-yes. Some studies have reported vast differences in prevalence rates in the same sample with slightly different operationalizations of the addiction threshold (Choo et al., 2010). Handling this coding is particularly difficult in the

case of potential behavioural addictions, which can have symptoms that are common in low intensities, like sometimes being late for engagements, or feeling euphoric at the thought of a (perhaps only previously) enjoyable activity. At what intensity, or in what combination with other features, does this cease to be an indicator of normal behaviour and become a sign of an addictive illness, is a question driving much of this PhD. A harm-centric approach to validity is required for any proposed thresholds, warranting investigation of which thresholds are able to distinguish participants' experiencing negative consequences.

In line with their conceptualisation of addiction and engagement, Charlton and Danforth (2007) proposed a tentative cut-off point which does not include tolerance, mood modification or cognitive salience at all in the diagnosis; features which are included in many other video game addiction scales. Instead, Charlton and Danforth's cut-off point requires endorsement of only four items, those representing withdrawal, loss of control (alternately called relapse and reinstatement), one of the three conflict items and one of the two items representing behavioural salience. This cut-off point resulted in a far lower prevalence in their sample of Asheron's Call players than the commonly adopted 'half-of-the-total' approach. Charlton and Danforth (2007) also compared hours of play across these thresholds, finding their cut-off showed greater time-commitment between addicts and non-addicts (p<05). This threshold was again tested and compared to gamers who endorsed only engagement criteria without endorsing any of the core addiction criteria (Charlton & Danforth, 2010). Findings confirmed past results, showing addicts had significantly higher hours of play than highly engaged gamers (p<.05); however sample size using these groupings were small (n=13 addicted and n=13 highly engaged). Aside from hours of play, negative consequences should be a key distinguishing feature of any potential behavioural addiction. Therefore, further studies are required comparing how varied thresholds for video game addiction can distinguish between participants experiencing declined health and functioning.

Focus of this Chapter

This chapter tests whether three different cut-off points, which are either identical or comparable to those used in past studies, are equally able to distinguish participants with lower mental, social and physical health, as well as poorer functioning in life domains. This analysis will help to determine which threshold results in the greatest differences between those deemed addicted and not addicted on measures of associated problems. The item-level analysis in chapter four suggested some of these more problematic items are also the

least commonly endorsed. This suggests that not all items are equally valid as a measure of video game addiction, and will be expressed in diagnostic thresholds. Comparing cut-off points in the same sample fulfils a similar purpose, but will also test the validity of the thresholds utilised in past studies. This analysis also serves the overall aim of exploring validity for video game addiction by investigating links with possible negative consequences. This chapter was difficult to fit into a logical progression in the thesis chapters. It would have been equally well placed after the individual item analysis (chapter four).

Aims and Hypotheses

Aim 2:

2. Investigate the validity of video game addiction and engagement by analysing:

    2.3 Differences apparent across three diagnostic cut-off points proposed in past literature on prevalence rates and measures of health and functioning.

Hypotheses:

1. That the different cut-off points proposed in past studies will produce different prevalence rates and measures of health and functioning between those deemed addicted and not addicted in this study;

2. That participants meeting the addiction criteria will show poorer mental, social and physical health, as well as functioning in life domains, than those classified as non-addicts.

Method

Three cut-off points will be used. Firstly, Charlton and Danforth's four-item cut-off point, which requires endorsement of withdrawal, loss of control, one of the three conflict items and one of the two items representing behavioural salience. This translates to 4-out-of-7 items in the scale, and is referred to as 'C&D 4 item'.

The second cut-off to be used is a 'half-of-the-total' of the items representing Brown's components model. Unlike Charlton and Danforth's 4 item cut-off, this threshold includes

tolerance, mood modification and cognitive salience, and translates to agreement with 5 out of 10 specific items in the Addiction-Engagement scale. Prevalence for this cut-off point was also reported by Charlton and Danforth (2007). This threshold is referred to as '5 out of 10'.

Finally, a 'half-of-the-total' of all 13 addiction items in the Charlton and Danforth scale will be adapted, which is how many researchers designated a cut-off point for addiction previously (D. A. Gentile, 2009; Starcevic et al., 2011; Tejeiro Salguero & Morán, 2002). These cut-off points will facilitate a comparison with past studies. This cut-off point is referred to as '7 out of 13'. All analyses in this chapter are undertaken on the first wave sample (*n*=497).

Demographic and circumstantial differences.

As explained in the overall method section, some measures taken relate only to a subsample, including those working, seeking work, in relationships or studying. These demographic features may also relate to video game addiction, and are therefore are also reported across the three cut-off points. Parental performance was not included in this analysis as the sample size deemed addicted was too small to warrant group comparisons. Instead, relationship statistics are used in a subsequent chapter.

Prevalence and differences on health and functioning indicators.

Two-tailed, independent samples t-tests were conducted comparing the measures of health and functioning across the cut-off points. In order to compare effect sizes across the cut-off points, the mean effect size for all significant health and functioning indicators, for each cut-off point, was calculated using the student's *t* statistic, Pearson's *r* (see Field, 2009 for formula to convert *t* to *r*) and unstandardized mean difference (M_{diff}). This analysis tested whether any cut-off point shows a greater difference in effect size in distinguishing a broad range of health and functioning indicators. Pearson's *r* was chosen as another means of representing effect size as it is often used throughout the PhD and allows easy comparison.

Severity analysis on DASS21 subscales.

As well established severity ratings are available for the DASS21, the different proportions falling into the severity ranges of the depression, anxiety and stress subscales was explored across the three cut-off points. Chi-squared Goodness of Fit tests were used to compare the distributions of these clinical severity ratings for participants deemed addicted according to that cut-off point, to Australian age-matched norms (Australian Bureau of Statistics, 2012b;

Crawford et al., 2011). This determined whether significantly more addicts fell into the severe ranges for depression, anxiety and stress than in non-addicts.

Results

Demographic and circumstantial differences.

Table 58 reports the demographic characteristics, including life circumstances, for those classified as addicted across the three cut-off points in participant number and as a proportion.

Table 58

Demographics for Participants Classified as Addicted across the Three Cut-Off Points

	7 out of 13	5 out of 10	C&D 4 item
M (*SD*) years of age	25.68 (6.46)	25.42 (6.28)	24.47 (5.07)
% (n) classified addicted at first wave	31.39 (156)	39.84 (198)	8.64 (43)
% (*n*) male	88.57 (140)	85.56 (173)	86.03 (37)
% (*n*) in relationship	46.14 (72)	49.48 (98)	53.49 (23)
% (*n*) working	57.04 (89)	58.07 (115)	51.15 (22)
% (*n*) studying	53.84 (84)	56.05 (111)	53.49 (23)
% (*n*) neither working nor studying	2.54 (5)	4.05 (8)	4.64 (2)
% (*n*) experiencing financial hardship	38.45 (60)	33.3 (66)	44.19 (19)

Prevalence and differences on health and functioning indicators.

Results of this study indicates that far fewer people meet the Charlton and Danforth 4 item cut-off point (*n*=43), even though it requires endorsement of only four items compared with five or seven. Results for the group comparisons testing differences across addicts and non addicts on measures of health and functioning, across the three cut-off points, are presented in Tables 59 to 61 below. Where the *p* figure is not less than .05, the exact figure is reported. The mean effect sizes were calculated for each cut-off point across all measures of health and functioning which reached significance ($p<.05$). Mean effect sizes are presented

in the form of the *t* statistic, Pearson's *r*, and the unstandardized differences (M_{diff}) in Table 62 below. Hours of play were excluded from this analysis as it is not a measure of health or functioning.

Table 59

Differences on Measures of Health and Functioning on Diagnosis using '7 out of 13 item' cut-off point

Measure of health or functioning	T statistic, degrees of freedom and significance	*n* addicted / *n* not addicted	Effect size in *r*	M_{diff}, and standard error of the mean difference
Depression	$t(256.01)=-7.79^{***}$	156 / 341	.44	-4.08 (.55)
Anxiety	$t(235.47)=-7.89^{***}$	156 / 341	.46	-2.83 (.39)
Stress	$t(253.10)=-8.30^{***}$	156 / 341	.46	-3.66 (.43)
Social support	$t(249.19)=5.96^{***}$	156 / 341	.35	3.89 (.71)
Social activity	$t(345.43)=3.99^{***}$	156 / 341	.21	4.85 (1.15)
BMI	$t(237.86)=-3.51^{***}$	156 / 341	.22	-2.17 (.68)
Physical exercise	$t(495)=2.16^{*}$	156 / 341	.10	.41 (.20)
Sleep disturbance	$t(495)=-7.54^{***}$	156 / 341	.32	-5.91 (.77)
Hours of play	$t(495)=-4.14^{***}$	156 / 341	.18	-7.73 (1.85)
Relationship conflict	$t(241)=-2.64^{**}$	72 / 171	.12	-1.21 (.44)
Work functioning	$t(310)=-1.70$, $p=.08$	89 / 223	.08	-.74 (.43)
Grade average	$t(210)=.82$, $p=.41$	62 / 150	.04	2.07 (2.53)
Grade discrepancy	$t(210)=-.75$, $p=.45$	62 / 150	.03	1.80 (-6.52)
Subjects failed	$t(267)=-.98$, $p=.31$	82 / 187	.04	.16 (-.50)
Job seeking	$t(70)=-1.21$, $p=.21$	37 / 35	.05	-10.92 (-28.72)

Note. $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$. Inverse *t* and M_{diff} scores denote higher scores for the addicted group. As certain measures relate only to sub-samples (e.g. those working, studying, in romantic relationships, etc.), separate sample sizes are reported. Levene's test indicated unequal variance across groups on measures of depression, anxiety, stress, social support, social activity and BMI.

Table 60

Differences on Measures of Health and Functioning on Diagnosis using ' 5 out of 10 item' cut-off point

Measure of health or functioning	T statistic, degrees of freedom and significance	*n* addicted / *n* not addicted	Effect size in *r*	M_{diff}, and standard error of the mean difference
Depression	*t* (363.69)=-7.50***	156 / 341	.37	-3.75 (.52)
Anxiety	*t* (333.84)=-6.81***	156 / 341	.35	-2.47 (.36)
Stress	*t* (365.51)=-7.24***	156 / 341	.35	-3.07 (.41)
Social support	*t* (390.59)=4.44***	156 / 341	.22	2.84 (.69)
Social activity	*t* (457.36)=4.33***	156 / 341	.20	4.84 (1.12)
BMI	*t* (341.44)=-2.03*	156 / 341	.11	-1.26 (.63)
Physical exercise	*t* (495)=2.14*	156 / 341	.10	.40 (.19)
Sleep disturbance	*t* (495)=-7.01***	156 / 341	.30	5.23 (.75)
Hours of play	*t* (495)=-4.88***	156 / 341	.21	-8.54 (1.74)
Relationship conflict	*t* (241)=-1.92*	98 / 145	.09	-.81 (.42)
Work functioning	*t* (310)=.53, *p*=.60	115 / 197	.02	.18 (.36)
Grade average	*t* (210)=-.49, *p*=.62	87 / 125	.02	1.17 (2.34)
Grade discrepancy	*t* (210)=-1.33, *p*=.17	87 / 125	.06	-2.91 (2.19)
Subjects failed	*t* (267)=-1.81, *p*=.06	108 / 161	.08	-.31 (.17)
Job seeking	*t* (70)=-.84, *p*= .40	41 / 31	.04	-5.74 (7.45)

Note. *p<.05, **p<.01, ***p<.001. Negative *t* and M_{diff} scores denote higher scores for the addicted group. As certain measures relate only to sub-samples (e.g. those working, studying, in romantic relationships, etc.), separate sample sizes are reported. Levene's test indicated unequal variance across groups on measures of depression, anxiety, stress, social support, social activity and BMI.

Table 61

Differences on Measures of Health and Functioning on Diagnosis using 'Charlton and Danforth 4 item' cut-off point

Measure of health or functioning	Charlton & Danforth 4 item (*n*=43 addicted)	*n* addicted / *n* not addicted	Effect size in r^2	Unstandardised effect size (M_{diff})
Depression	*t*(495)=-4.70***	43 / 454	.21	-4.19 (.88)
Anxiety	*t*(45.53)=-4.96***	43 / 454	.59	-4.16 (.83)
Stress	*t*(47.44)=-4.95***	43 / 454	.58	-4.10 (.82)
Social support	*t*(495)=4.39***	43 / 454	.19	4.79 (1.08)
Social activity	*t*(66.25)=5.74***	43 / 454	.58	7.68 (1.32)
BMI	*t*(44.92)=-1.42, p=.16	43 / 454	.21	2.22 (1.55)
Physical exercise	*t*(495)=1.78, *p*=.08	43 / 454	.08	.58 (.32)
Sleep disturbance	t(495)=6.30***	43 / 454	.27	8.28 (1.30)
Hours of play	t(46.10)=-4.21***	43 / 454	.53	16.94 (3.99)
Relationship conflict	t(241)=-1.72, *p*=.09	23 / 220	.11	-1.21 (.70)
Work functioning	t(310)=-.59, *p*=.55	22 / 247	.03	-.46 (.77)
Grade average	t(210)=1.56, *p*=.11	17 / 195	.11	6.59 (4.23)
Grade discrepancy	t(210)=-2.29*	17 / 195	.16	-9.08 (3.94)
Subjects failed	t(22.83)=-.93, *p*=.20	22 / 247	.19	-.35 (.38)
Job seeking	t(70)=-1.12, *p*=.16	41 / 31	.13	-9.98 (8.83)

Note. *p<.05, **p<.01, ***p<.001. Inverse *t* and M_{diff} scores denote higher scores for the addicted group. As certain measures relate only to sub-samples (e.g. those working, studying, in romantic relationships, etc.), separate sample sizes are reported. Levene's test indicated unequal variance across groups on measures of anxiety, stress, social activity, BMI, hours of play, number of subjects failed and job seeking behaviours.

Table 62

Mean Effect Size for All Significant (p<.05) Health and Functioning Indicators across all Cut-Off Points

Cut-off point	*M t* statistic (*SD*)	*M r* statistic (*SD*)	*M* M_{diff} (*SD*)
7 out of 13 items	5.52 (2.47)	.30 (.13)	3.21 (1.75)
5 out of 10 Brown's components	4.81 (2.39)	.21 (.10)	2.55 (1.98)
Charlton and Danforth 4 item	4.75 (1.28)	.37 (.19)	5.09 (2.21)

Comparison using DASS21 subscale severity range.

Chi-squared Goodness of Fit tests were conducted comparing the proportions falling into the clinical severity ranges of the DASS21 scale, across the three addiction cut-off points analysed. These clinical thresholds are based on Australian norms (Australian Bureau of Statistics, 2012b; Crawford et al., 2011). Descriptive statistics showing the proportion of the sample meeting the severity thresholds across each diagnostic cut-off point is presented in tables 63 to 65. Between the 7 out of 13 item and 5 out of 10 cut-offs, no significant differences were apparent in the proportions of participants falling into the severe range for depression ($\chi^2(4)=7.03$, $p=.14$), anxiety ($\chi^2(4)=.01$, $p=1$) and stress ($\chi^2(4)=7.97$, $p=.08$). Differences between the Charlton and Danforth 4 item and the Brown's components 5 item cut-offs (which showed the next-highest amount of participants in the upper severity ranges) were also compared, for depression ($\chi^2(4)=1.42$, $p=.84$), anxiety ($\chi^2(4)=4.99$, $p=.28$) and stress ($\chi^2(4)=5.32$, $p=.26$). No significant differences were again apparent according to null hypothesis significance testing using the Chi Square distribution.

Table 63

Percentage of Participants in Severity Ranges of DASS21 Depression Subscale across Three Cut-Off Points

Cut-off point	*n* addicted	Depression normal (0-4) %	Depression mild (5-6) %	Depression moderate (7-10) %	Depression severe (11-13) %	Depression extreme (14+) %
7 of 13	156	31.8	8.6	22.7	12.2	22.2
5 of 10	198	26.9	8.4	15.4	11.5	28.2
4 item	43	23.3	9.3	20.9	16.3	30.2

Table 64

Percentage of Participants in Severity Ranges of DASS21 Anxiety Subscale across Three Cut-Off Points

Cut-off point	*n* addicted	Anxiety normal (0-3) %	Anxiety mild (4-5) %	Anxiety moderate (6-7) %	Anxiety severe (8-9) %	Anxiety extreme (10+) %
7 of 13	156	39.9	16.2	14.6	9.6	19.7
5 of 10	198	34.6	16.7	16.6	10.3	21.8
4 item	43	23.3	11.6	20.9	11.6	32.6

Table 65

Percentage of Participants in Severity Ranges of DASS21 Stress Subscale in Those Meeting the Three Cut-Off Points

Cut-off point	*n* addicted	Stress normal (0-7) %	Stress mild (8-9) %	Stress moderate (10-12) %	Stress severe (13-16) %	Stress extreme (17+) %
7 of 13	156	46	15.1	18.7	15.7	4.5
5 of 10	198	40.4	15.4	21.1	17.3	14.7
4 item	43	37.2	11.6	14	27.9	9.3

Discussion

This exploratory analysis compared three cut-off points proposed in the literature in their ability to distinguish participants across a wide variety of health and functioning indicators. The analysis served two purposes:

1. to explore the validity for the video game addiction subscale in measuring indicators of associated problems using a diagnostic rubric; and
2. to determine whether, like prevalence rates, different cut-off points vary substantially from one another in distinguishing participants with lower levels of health and well-being.

Underlying this harm-centric comparison of cut-off points is the question of whether certain video game addiction items (or combinations thereof) are more problematic than others, and whether the varied cut-off points in past studies are equally valid.

Prevalence and differences on health and functioning indicators.

The hypothesis for this analysis was not supported. All cut-off points showed some validity in distinguishing those addicted/not addicted based on measures of health and functioning. Those deemed addicted across all three cut-off points fared significantly worse than non-addicts, showing more symptoms of depression, anxiety and stress, smaller structural social networks and lower ratings of social support, higher relationship conflict for those in relationships, and lower physical health, especially experiencing higher sleep disturbance. Addicts also played for significantly more hours per week. However, certain proposed associated problems were not distinguished by the cut-off points. Differences were not apparent in arriving late to work or receiving warnings for poor performance, academic grade average, number of subjects failed or academic discrepancy score. This last indicator was significantly different in the Charlton and Danforth 4-item cut-off point, with those classified as addicted using this threshold scoring significantly lower than they intended, by an average of 12.47 marks; however the sample size meeting this threshold and with grades enabling the discrepancy calculation was small (n=17). Why differences were not apparent in items relating to functioning at work and study is uncertain, given that in the chapter two results indicated video gaming interfering with work was one of the most commonly endorsed scale items. It may be that participants over-estimate the impact of their gaming habits on their functioning at work and study, or perhaps that the indicators chosen were inadequate.

In comparing the average differences between addicts and non-addicts across a wide range of health and functioning indicators, the average effect size varies according to the effect statistic used (t=4.75-5.52; r=.21-.37, M_{diff}=2.55-5.09). On initial reading, it appeared that the Charlton and Danforth cut-off point predicted substantially greater severity of associated problems than the other two cut-off points. This finding would have been consistent with the individual item analyses, which suggested greater problems associated with the items included in Charlton and Danforth's point, when entered simultaneously into regression models, especially item 4 (representing withdrawal). While scale score differences appeared greater across most measures on the Charlton and Danforth cut-off point, as did the r statistic, the mean t statistic across health and functioning indicators was actually smaller across those addicted and not addicted, in comparison to the other cut-off points. As the probability figure in these inferential tests are influenced by sample size, it may be that the smaller number of participants meeting this criteria adversely affected the results, increasing the risk of type 2 error. Further studies utilising a Rasch analysis may help to conduct a greater exploration of which items, or combinations of items, result in the greatest degree of problems. To put it another way, whether more endorsement of any addiction items lead fairly linearly to greater associated problems.

Comparison using DASS21 subscale severity range.

Comparison of the proportion of participants falling into the DASS21 severity ranges also failed to support the hypothesis. While at face value it appeared that far more participants meeting the Charlton and Danforth cut-off point fell into the severe ranges of the DASS21 subscales, except for stress, Chi-Squared Goodness of Fit tests indicated no significant difference across the different cut-off points. This may have resulted from the smaller sample size impacting the calculation of statistical significance.

By conducting this analysis, new knowledge was created on the differential validity of a few proposed cut-off points used across the video game addiction literature. Results suggest that studies need not prioritise one cut-off point over another. However, as this is only one study and there are substantial differences apparent in scale mean scores and prevalence rates, while not significant according to t-tests of Chi Square Goodness of Fit tests, it may still be beneficial to explore the differences posed by these cut-off points in other samples. Given the doubts and concerns around cut-off points, relationship statistics are more appropriate for exploring validity of video game addiction at this early stage. While the results have not revealed many differences between the proposed cut-off points, they indicate that a video

game addiction diagnosis does distinguish participants experiencing greater problems, across a range of well-established indicators.

However, the sample for this study is biased, with significantly higher mean scores than those reported in a normative sample of the Australian population and results must be interpreted with caution. Further, this analysis is cross-sectional and not longitudinal. It cannot inform temporal precedence or predictive validity over time, and therefore cannot distinguish between ‘associated problems’ or ‘negative consequences’. Likewise, cut-off points must be used tentatively at this early stage of research, and therefore relationships statistics are preferred, as is the inclusion of a measure of engagement in order to explore the dividing line.

Chapter 10: Short-term Longitudinal Study of Video Game Addiction and Mental Health

Longitudinal studies are critical in the investigation of video game addiction and associated problems. As stated, the term negative consequences implies causality, in that associated problems are the direct consequence of video game addiction. The DSM V definition for 'Internet Gaming Disorder' defines the condition as the persistent and recurrent use of internet gaming "leading to clinically significant impairment or distress". This term 'leading to' implies that video game addiction causes this distress – rather than results from it. It is also possible that video game addiction develops from predetermined vulnerabilities or risk factors, but then exacerbates (hence causing) associated problems. Either way, without demonstrating video game addiction is related to negative consequences, at least in part, validity for video game addiction is lacking. Video game addiction is likely to occur amongst a host of other contributing factors to negative outcomes, therefore research is presented with the challenge of determining its relative importance.

While experimental evidence demonstrating negative consequences would be ideal, in which the effect of video game addiction on health can be examined while each factor is manipulated by the researcher, such evidence is unlikely to surface without radical technological advancements, or perhaps, never. It would also be unethical to introduce addiction in any study. Such evidence is often not available when studying psycho-social variables which are impossible to manipulate, difficult to accurately measure, are the product of many inter-connected variables and can change dynamically. Also, experimental settings of video game playing or addiction, particularly over time, generally have low ecological validity, as they are unable to preserve or reproduce the settings in which people play video games normally; generally the home. Yet in the absence of experimental research, longitudinal analyses can provide an additional dimension – change over time. This information may help to determine whether video game addiction occurs primarily before, or after, co-morbid conditions, and the degree to which these connections reinforce each other over time, i.e. a downward spiral.

Longitudinal studies are not able to prove causality alone, but they can provide some further evidence by which to explore associated variables. For a factor to be considered pathogenic, changes in that factor will predict future detriment to health. By studying how inter-relationships fluctuate over time, longitudinal studies may help to better differentiate risk factors from consequences. Investigation of this order of events is often referred to as

establishing temporal precedence. Longitudinal analyses of video game addiction may also provide new knowledge on the persistence of video game addiction over time, and whether effects of persistent addiction result in cumulative detriment to health and functioning. Further, by controlling for certain mediating or moderating factors, longitudinal models may be able to illustrate the future effects of video game addiction, over and above other contributors to detrimental health.

Longitudinal studies are particularly relevant to the topic of video game addiction. Theorists of general models of addiction describe a downward spiral between addictive conditions and associated problems, underpinned by risk factors and vulnerabilities which precede development of the condition. Brown (1997) described a typical situation in which underlying risk factors, such as difficulties in childhood with the family environment, disengagement with the education system or employment, low social support or psychological maladaptation or illness, lead to development of an addiction. After development, an addiction progressively (further) interrupts functioning and causes health problems, which in-turn provides increasing reasons to ramp up the addictive activity in order to cope with these problems, on top of the already existing underlying vulnerabilities. This downward spiral eventually leads to a persistent state of crisis in which maintaining a minimum of mood and functioning is the only priority, managed primarily through the addictive activity. Theorists of the general models have specifically called for further testing of temporal fluctuations including with related variables and co-morbid conditions; addiction hopping from non-substance to substance behaviours, and treatment non-specificity (Shaffer et al., 2004). Such a downward spiral may very well characterise video game addiction, although this has not yet been demonstrated conclusively. In fact, there is still limited evidence establishing temporal precedence for associated problems, which are often described as negative consequences.

Mental health and video game addiction.

One meta analyses of problematic correlates with video game addiction suggest that the effect size for mental health measures across the sampled studies was estimated at .19, or 4% of shared variance; making mental health the largest amongst the health factors included (Ferguson et al., 2011). Some cross-sectional studies, however, have demonstrated much larger relationships with mental illnesses (Starcevic et al., 2011), including with more severe symptoms such as suicidal ideation (Rehbein et al., 2010). The previous chapters of this thesis repeatedly confirmed a relationship between video game addiction and poorer mental health. Mental health showed generally larger connections than social or physical health.

Longitudinal studies of video game addiction and associated problems.

Very few studies have so far investigated factors which are longitudinally connected to video game addiction. Those which have produced mixed results with regards to the persistence of video game addiction over time and the identification of risk factors versus consequences (Gentile et al., 2011; King, Delfabbro, et al., 2013; Lemmens et al., 2011). Most researchers, however, tentatively conclude that associated problems are likely bi-directional and mutually reinforcing, and represent a downward spiral (Gentile et al., 2011; King, Delfabbro, et al., 2013; Tejeiro et al., 2012).

After a six month, two wave study of 543 Dutch adolescents, Lemmens et al. (2011) concluded that loneliness was bi-directional, with video game addiction at time 1 predicting loneliness at time 2, and vice versa. However, social competence and self-esteem were both deemed to be risk factors, as they predicted the development of video game addiction at the same or subsequent wave, but increases in video game addiction did not predict consequential increases in either variable. Loneliness was deemed a possible negative consequence, although effect size was small. This study used a longitudinal structural equation model with auto-regressive paths controlling for effect of earlier waves, so that the authors were able to test whether the psychosocial variables represented a cause, consequence or reciprocal relationship with video game addiction. It may be that loneliness results from video game addiction as gaming displaces upkeep of social connections, which is indicated by cross-sectional studies finding declined relational maintenance strategies associated with media dependence (Chory & Banfield, 2009).

Gentile et al. (2011) reported results of a two-year, three wave longitudinal study of 3034 Singaporean youth. Measures included social competence, social phobia, emotional regulation, empathy, identification with game characters, parent-child relationships, goal-setting, relationally aggressive behaviours, relational victimization, ADHD symptoms, and mental health. In this study, a latent growth mixture modelling extracted groups of participants with similar trajectories of video game addiction. These groups were then compared on measures of health and functioning. Results indicated that lower social competence, empathy, emotional regulation skills and higher impulsivity and identification with game characters are risk factors for developing video game addiction. On the other hand, participants who became addicted throughout the study worsened in measures of depression and anxiety, and these were therefore considered outcomes. However, only 1.3% of the longitudinal sample who was not addicted at time 1 was deemed addicted in the next two years. This means it is a small group on which to draw conclusions (*n*=35). The

authors indicated that these relationships are mostly likely bidirectional and mutually reinforcing, and that more longitudinal studies are needed.

A more recent study investigated the longitudinal trajectories of Australian adult gamers, including two intervals over an 18 month period (King, Delfabbro, et al., 2013). This study utilised a well-validated video game addiction scale. Results indicated that video game addicts scored significantly lower on measures of psychosocial problems at all time points than non-addicts, but that video game addiction symptoms abated with no intervention over time. This result suggests video game addiction may be a short-term phase for most adult gamers, but further studies are needed.

Another longitudinal study used resource-intensive participant interviews, with a very large sample, to investigate the possible effect of media exposure on development of depression. 4142 teenagers from a nationally representative American sample completed measures of media exposure and mental health in 1994, and were then interviewed in their home seven years later (Primack et al., 2009). While more resource intensive, interviews have the potential to allow information to emerge in more detail than in surveys. Results indicated a strong relationship between television consumption, and overall media consumption, and development of subsequent depression. However, a sub-analysis of video game playing found no relationship.

Focus of this Chapter

This chapter will explore the longitudinal fluctuations between video game addiction and symptoms of depression, anxiety and stress, across six waves over a roughly seven month period. This aim was originally conceived to be broader reaching, investigating the temporal precedence of all aspects of health and functioning associated with video game addiction and mapping the hypothesised downward spiral. This larger model would have also included engagement to explore whether it does precede video game addiction, composite variables to make comparable functioning in life domains which are different for each participant, and all possible confounding factors identified in the previous chapter, including satisfaction with life domains to determine whether satisfaction tends to drop before, or after, video game addiction.

However, building and testing ever larger and complex models became beyond the reach of the PhD. Due to time restrictions, this longitudinal analysis had to be restricted in scope. It

was decided to focus on the relationships between video game addiction and symptoms of stress, anxiety and depression, as these showed the strongest relationships amongst a host of health and functioning indicators, across this PhD. This is also driven from theory of general models of addiction, with Shaffer et al. (2001, p. 372) calling for more testing on "temporal patterns of psychiatric comorbidity (e.g., sign, symptom, and disorder patterns)".

Aims and Hypotheses

Aim:

4. Explore how any emergent relationships behave over a period of time, in order to investigate:

    4.1. The directionality and temporal precedence of any associations found between video game addiction and problems.

However, as further longitudinal analyses became beyond the reach of the thesis, the sub-aim was condensed to:

> 4.1 Explore the temporal precedence of associations between video game addiction and symptoms of depression, anxiety and stress, across a six-month period.

Hypotheses:

1. That average video game addiction trajectories will remain stable over a six month period.

2. That video game addiction will show bi-directional and mutually reinforcing relationships with symptoms of stress, anxiety and depression.

Method

Preliminary check of longitudinal sample bias.

Firstly, a sample bias check was conducted to confirm that participants who dropped out of the study did not have significantly different characteristics to those who continued to subsequent waves. It may have been the case that participants whose video game addiction, or other aspects of health or functioning, were more problematic found the survey

too difficult to complete each month. A cursory look at the DASS21 descriptive statistics (see Method section) seems to indicate a downward trend in depression, anxiety and stress symptomatology over the time period, which may suggest that those with higher symptoms were not returning to subsequent waves. Yet both the wave 1 and 6 sample scored significantly higher than population norms on one-way t-tests (all $p<.05$). As a preliminary test of this sample bias, participants who completed wave 1 but did not return for wave 2 were extracted and put into a separate dataset ($n= 288$), then compared with participants who did return to complete wave 2 ($n=266$), on measures which were completed by all participants.

Consistency of video game addiction.

Then, mean scores for video game addiction were calculated across all six waves, for addicts and non-addicts, based on the 7-out-of-13 item cut-off point at wave 1. Mean score changes were visually analysed in a line graph.

Cross-lagged panel with autoregressive paths between video game addiction and mental health.

In planning the SEM analysis, the strengths and weaknesses of different longitudinal SEM techniques were considered, specifically cross-lagged panel designs and latent growth curve models; as well as models which combine the two approaches such as auto-regressive latent trajectory models (Bollen & Curran, 2004). Finally, one achievable analysis was settled on. This chapter details a longitudinal cross-lagged panel analysis, with 6 waves over a 7 month period (while waves were one month apart, most participants at most waves took about 1 week to return to complete the measure after the first reminder, totalling roughly 7 months by the 6th wave).

The cross-lagged model uses autoregressive paths which control for the effect of the same measure in the previous wave, allowing for the relationships between video game addiction and mental health symptoms at each month to be examined (i.e. the crossed paths). For example, the best predictor of mental health at any given wave is the same mental health measure from the previous wave. By including autoregressive paths, the model estimates the contribution of video game addiction in predicting future mental health, and vice-versa, over and above these autoregressive effects.

As the sample size was small by the sixth wave (111), partial least squares-based (PLS) estimation was utilised instead of the more common maximum likelihood (ML) method. By weighting indicators of latent variables according to maximise variance, PLS models are less sensitive to the small sample size, and therefore make it more likely for the overall model to fit. However, the overall model fit is not the key focus of the analysis. Instead, it is the strength and significance of the paths between video game addiction on mental health symptoms, after controlling for the effect of the same variable in the previous month. Further detail is provided in the results pertaining to the cross-lagged panel below.

Results

Preliminary check of longitudinal sample bias.

T-tests comparing participants who returned to complete the second wave, to participants who did not, are presented in Table 66 below. Only engagement showed a significant difference.

Table 66

Preliminary Check for Differences Between Participants Who Did, and Did Not, Return for Wave 2

Measure	Returners *M* (*SD*)	Non-returners *M* (*SD*)	*t*	*p*
VG addiction	28.91 (6.63)	29.54 (7.19)	.98	.31
VG engagement	46.22 (6.81)	44.33 (6.93)	-3.04	.01**
Social support	26.34 (6.85)	25.68 (7.08)	-1.08	.27
Social activity	16.64 (12.37)	16.11 (13.15)	-.461	.63
Sleep health	43.15 (8.49)	42.52 (8.62)	-.80	.40
Stress	13.26 (4.39)	13.56 (4.72)	.76	.43
Anxiety	10.79 (3.71)	11.12 (4.15)	.87	.38
Depression	13.38 (5.62)	13.80 (5.82)	.84	.40

Note. df=495 for all, all had equal variance according to Levene, ** *p*<.01.

Video game addiction consistency.

To explore the persistence of video game addiction across time, the sample of participants who completed all six waves were isolated (*n*=111) from the remainder. Then, Pearson's product-moment correlations were produced from the total video game addiction scores between each month. Table 67 reports this correlation matrix.

Table 67

Correlation Matrix Video Game Addiction Scores Across Six Waves

	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6
Wave 1	1	.74***	.75***	.72***	.69***	.70***
Wave 2		1	.82***	.83***	.82***	.84***
Wave 3			1	.87***	.85***	.83***
Wave 4				1	.86***	.80***
Wave 5					1	.87***
Wave 6						1

Note. *** $p<.001$

Another strategy for testing the rate of change over the study period is to chart the mean score for addiction and engagement for participants deemed addicted at first wave. As chapter three indicated relatively little difference across different addiction thresholds in distinguishing a range of health and functioning measures, the 7-out-of-13 item threshold was adopted. As stated in the method section, dichotomisation of items was more conservative than in past studies, with the mid-point in the response scale classified as non-endorsement (i.e. a 'disagree'). This resulted in 81 non-addicts and 30 addicts. Results are presented in Table 68.. A slight downward trend was evident, with mean scores for addicts at first wave dropping marginally from wave 1 to 2, but remaining fairly stable for the remainder, resulting in a total decrease of 4.58 (or 12.8%) by the final wave. The same was evident for non-addicts for the addiction measure, and the engagement measure was highly stable for both groups.

Table 68

Mean Scores for Video Game Addiction and Engagement Across Six Waves for Participants Deemed Addiction and Not-Addicted at First Wave.

	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6
Addiction score for those deemed addicted at first wave *M* (*SD*) (*n*=30)	35.70 (4.23)	32.42 (4.80)	32.40 (4.51)	31.72 (4.32)	31.47 (4.99)	31.12 (4.28)
Engagement score for those deemed addicted at first wave *M* (*SD*) (*n*=30)	48.60 (6.54)	48.40 (7.25)	48.10 (7.33)	48.03 (7.37)	47.90 (7.14)	48.12 (6.70)
Addiction score for those deemed not addicted at first wave *M* (*SD*) (*n*=81)	25.78 (4.23)	23.95 (4.61)	23.63 (5.78)	23.48 (5.11)	23.42 (5.68)	23.52 (5.68)
Engagement score for those deemed not addicted at first wave *M* (*SD*) (*n*=81)	45.22 (5.93)	44.73 (5.78)	45.36 (6.33)	44.83 (6.32)	45.25 (6.70)	45.48 (6.72)

Note. Participants were deemed addicted or not-addicted based on endorsing 7 out of 13 items on the addiction scale, with the neutral item counted as a non-endorsement.

Cross-lagged model with autoregressive paths analysis strategy.

The cross-lagged panel model seen in Figure 3a was tested using partial least squares structural equation modelling (PLS-SEM) with the WarpPLS version 3.0 software (Kock, 2012). PLS-SEM was established as a general algorithm for the estimation of structural models using latent variables represented by multiple indicators (Chin, 1998; Wold, 1985). PLS-SEM comprises two models: (1) a measurement model sometimes referred to as the outer model, which specifies the relationships between latent variables and their associated indicators and; (2) a structural model, sometimes referred to as the inner model, which stipulates relationships between the latent variables (Chin, 1998). Encompassing an iterative estimation procedure that minimises residual variance by providing successive approximations of indicator variable loading and path estimates, PLS-SEM affords latent variable scores that are derived from the best estimated indicator weights (Silva et al., 2010).

Importantly, whereas conventional covariance based modelling (e.g., AMOS) requires a large sample size to converge models with many parameters, PLS-SEM is ideally suited for

use with smaller sample sizes (Chin, 1998). This is because of the partial nature of the estimation procedure, with each aspect of the model estimated sequentially. The model in the current study consists of 12 latent variables with 96 indicators. Given the sample size available (111), covariance based modelling would have been impractical. The recommended minimum sample size for PLS-SEM is ten times the number of structural paths leading to the endogenous variable with the largest number of predictors (Chin & Newsted, 1999). In the current study, this necessitated a minimum sample size of 40 – easily reconciled with the sample. Taking heed of recommendations provided by Hulland (1999), then, the cross-lagged PLS-SEM model was tested in two-stages. The first was a test of the adequacy of the measurement model. The second was a test of the adequacy of the structural model.

Assessment of the measurement model involved first the estimation of indicator reliability. To do this, the standardised factor loading of an indicator on its manifest variable should be significant and > .40 (Hulland, 1999). Second, the reliability of the latent variables was examined via an inspection of the composite reliabilities. As composite reliability does not assume equal indicator weighting, it is considered superior to the conventional Cronbach alpha (Nunnally & Bernstein, 1991). Nunnally and Bernstein (1992) suggest a composite reliability above .70 is indicative of acceptably internal consistency. Following this, convergent and discriminant validity of the latent variables was examined by the average variance extracted (AVE). The AVE is the mean variance in a set of indicators explained by their manifest variable. It should exceed .40 for convergent validity, and be larger than the squared zero-order correlations between one latent variable and the other latent variables in the model (Fornell & Larcker, 1981).

Assessment of the structural model involved the estimation of path coefficients between latent variables and their significance. WarpPLS uses a bootstrapping procedure to estimate path coefficients and their standard errors. Bootstrapping produces an empirical representation of the sampling distribution of path coefficients and standard errors by treating the observed sample as a representation of the population in miniature, one that is repeatedly resampled as a means of reproducing the original sampling process (Hayes, 2009). In doing, the bootstrap procedure makes no distributional assumptions and as such does not require a normal distribution (MacKinnon, Lockwood, & Williams, 2004). In the current study, 999 bootstrap iterations were requested. The mean path coefficients and standard errors across these iterations are reported as the bootstrap estimates. A fundamental aim of cross-lagged analysis is to identify reciprocal causation. Thus, if the two cross-over pathways to and from latent variables (see Figure 3a) are significant then reciprocal causation is inferred. However, if only one of the two cross-over paths is

significant then the conclusion is that the relationship operates in the direction of the significant path.

Cross-Lagged Panel Results

The central focus of the current study was to test a cross-lagged model of psychological distress and video game addiction across 6 waves of data. The effective sample size at wave 6 was 111. T-tests comparing the valid data set with that of the missing dataset group revealed no significant differences. Complete demographics and descriptive statistics for the longitudinal dataset are presented in the method section.

Measurement model.

Initial measurement model analyses indicated that a number of video game addiction items had low factor loadings[1]. As such, these items were removed and the model re-estimated. Following re-estimation, all factor loadings exceeded .40 and were significant. Distress at time 1 had loadings between .87 and .89 (p <.001). Addiction at time 1 had factor loadings between .44 and .71 (p <.001). Distress at time 2 had factor loadings between .81 and .91 (p <.001). Addiction at time 2 had factor loadings between .44 and .79 (p <.001). Distress at time 3 had factor loadings between .87 and .90 (p <.001). Addiction at time 3 had factor loadings between .45 and .76 (p <.001). Distress at time 4 had factor loadings between .88 and .90 (p <.001). Addiction at time 4 had factor loadings between .40 and .84 (p <.001). Distress at time 5 had factor loadings between .86 and .91 (p <.001). Addiction at time 5 had factor loadings between .46 and .78 (p <.001). Distress at time 6 had factor loadings between .88 and .93 (p <.001). Addiction at time 6 had factor loadings between .42 and .75 (p <.001).

The composite reliabilities, AVE's and zero-order correlations among the latent variables are displayed in Table 69 (note that three decimal points are used in this table, unlike the remainder of the thesis, in order to convey a greater level of detail). Composite reliabilities exceeded .70 and AVE's exceeded .40 indicating acceptable convergent validity for the indicators. AVE's for each latent variable were larger than the squared zero-order correlations between distress and addiction factors thereby indicating acceptable discriminant validity. The zero-order correlations were all significant and in the expected

[1] Video game addiction items: 10 (.21), 12 (.27) and 13 (.35) at time 1; 10 (.25) and 11 (.36) at time 2; 12 (.31) and 11 (.23) at time 3; 10 (.31) and 12 (.35) at time 4; 11 (.31) and 12 (.19) at time 5 and; 12 (.11) at time 6.

directions affording initial support for the hypotheses. In all, these analyses support the adequacy of the measurement model.

Structural model.

The mean standardised parameter estimates across the 999 bootstrap iterations are reported in Figure 3b. As expected, all of the autoregressive paths were large and significant meaning each endogenous variable in the model adequately reflected residual or change variance. Addressing the central aim of the current study, 3 of the modelled cross-lagged effects were significant. First, wave 1 distress predicted wave 2 addiction controlling for wave 1 addiction ($\gamma = .18$, $p < .05$). Second, wave 3 distress predicted wave 4 addiction controlling for wave 3 addiction ($\beta = -.10$, $p < .10$). Third, wave 5 distress predicted wave 6 addiction controlling for wave 5 addiction ($\beta = .09$, $p < .05$). No paths from addiction to distress were found to be significant. In all, these effects speak to the temporal causality of addiction and stress with evidence attesting the antecedent role of distress in contributing to increases in video game addiction.

Table 69 *Composite reliability, average variance extracted and zero-order correlations of factors in the measurement model*

Factor	1	2	3	4	5	6	7	8	9	10	11	12
1.Distress W1	--											
2.Distress W2	0.805	--										
3.Distress W3	0.784	0.729	--									
4.Distress W4	0.850	0.770	0.821	--								
5.Distress W5	0.837	0.813	0.781	0.886	--							
6.Distress W6	0.801	0.737	0.799	0.858	0.880	--						
7.Addiction W1	0.299	0.326	0.275	0.282	0.313	0.258	--					
8.Addiction W2	0.317	0.415	0.334	0.354	0.334	0.319	0.701	--				
9.Addiciton W3	0.260	0.303	0.305	0.301	0.280	0.254	0.732	0.776	--			
10.Addiciton W4	0.334	0.346	0.335	0.343	0.324	0.318	0.708	0.790	0.859	--		
11.Addiciton W5	0.264	0.306	0.308	0.285	0.301	0.259	0.684	0.791	0.866	0.837	--	
12.Addiciton W6	0.274	0.356	0.278	0.317	0.355	0.309	0.700	0.814	0.838	0.783	0.876	--
Composite Reliability	0.910	0.905	0.914	0.918	0.911	0.931	0.870	0.891	0.905	0.883	0.892	0.890
AVE	0.770	0.760	0.780	0.790	0.774	0.818	0.404	0.433	0.470	0.419	0.435	0.411

Note: n = 111; all correlations significant at the $p < .01$ level.

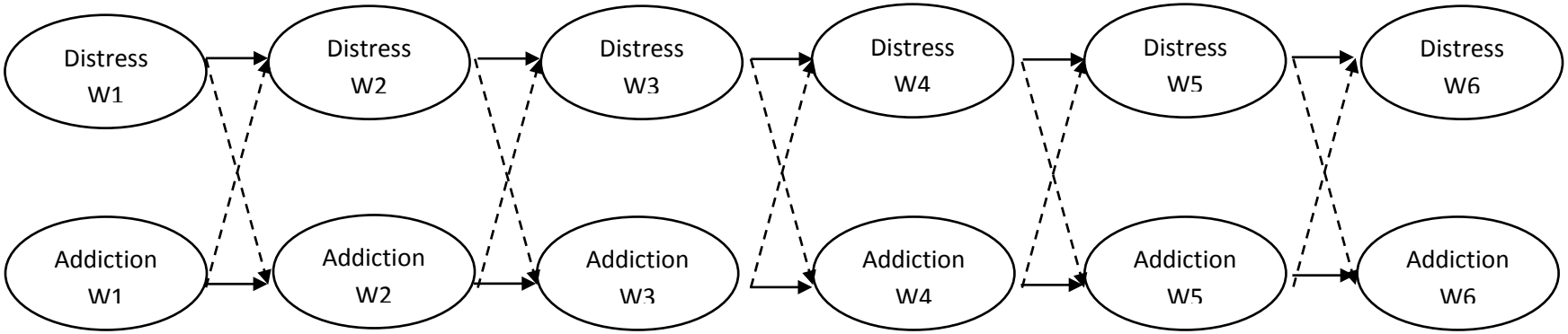

*Figure 3a***.** A Cross-Lagged Latent Panel Model of Distress and Video Game Addiction Across 6 Waves.
Note. The 10 sloped dotted lines represent the paths that test for possible cross-lagged effects between distress and addiction. The 10 solid parallel lines represent the autoregressive paths that test for stability over time; W = wave.

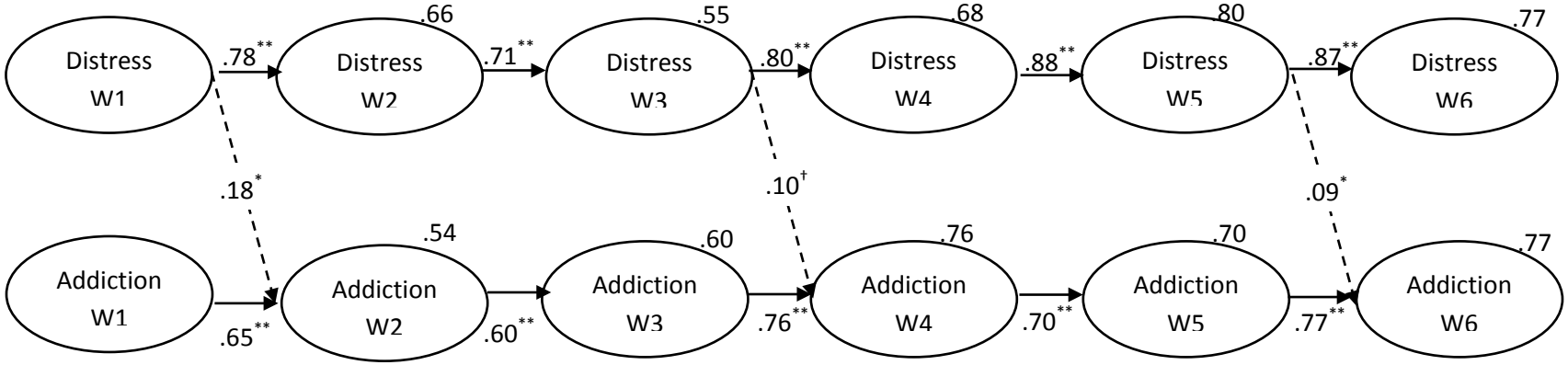

*Figure 3b***.** Bootstrapped Standardised Parameter Estimates and Variance Explained in the Endogenous Variables (R^2) in the Cross-Lagged Model. *Note:* W = wave. For clarity, only significant paths are presented. ** $p < .01$, * $p < .05$, † $p < .10$.

Discussion

This chapter analysed the longitudinal fluctuations of measures of video game addiction and symptoms of mental illness over six waves which were approximately five weeks apart, making a total of about seven months. This design has been described as a short duration, or intensive, longitudinal study and has been used to study causality between other psychological factors, including addictive conditions and the development of associated problems (Robert, Séguin, & O'Connor, 2010; Rose, Chassin, Presson, & Sherman, 2000). The sample utilised for this analysis is the six wave sample with 111 adults. As all incomplete cases were discarded, data imputation was not necessary. Preliminary comparisons between those who continued the study up to wave 6, and those who did not, revealed only one significant difference, on engagement. This suggests the 6 wave complete sample (*n*=111) is broadly representative of the complete first wave sample (*n*=497) on measures of health and addiction, and the results presented in this chapter do not reflect a unique sub-group of participants who continued to completion because they differed on the variables of interest.

Video game addiction consistency.

It was expected that video game addiction would decline over the study period, as in the case of King et al. (2013), who also studied video game addiction in adults, albeit over a longer period of time (18 months rather than 6). Where King et al. (2013) reported an inexplicable decline in video game addiction symptoms over that time period, this study revealed a much higher consistency in the sample in their video game addiction and engagement scores. In this sense, results are similar to that of Gentile et al. (2011), who reported a group of Singaporean youth whose endorsement of video game addiction criteria remained stable over a three year period. In this study, participants meeting one of the proposed thresholds for addiction (endorsing 7 out of 13 items) at wave 1 showed very stable addiction and engagement scores over the 6 waves, as did those participants who did not meet this threshold. The correlations between waves also indicated that scores at wave 1 explained 50% of the variance of scores at wave 6, with even higher correlation coefficients between adjacent waves. This consistency is further confirmed in the cross-lagged panel model, which produced very strong auto-regressive paths. The higher consistency found in this study could very well be explained by the sampling strategy, which targeted self-identified problematic and intense gamers. Advertisements for the study clearly sought people who identify themselves as video game addicts, or who play too much or feel

they have some sort of problem with their video game playing. As such, these participants may already be in a more stable pattern of gaming behaviour and associated health impacts.

Cross-lagged panel results.

The most central and important component of validity for video game addiction, and perhaps the application of addiction to any commonly unproblematic hobby, is that it causes, or in the words of the DSM V, 'leads to', negative consequences. Some debate around video game addiction questions whether it is a meaningful concept, or whether a new disorder is warranted (Petry, 2013; Starcevic, 2013a, 2013b). Concerns remain around differentiation of video game addiction and what may be termed high engagement, or high prioritisation, of a hobby. Some features included in measures of video game addiction may be ubiquitous in populations highly engaged in video gaming, and there are doubts about whether symptoms reflecting tolerance and withdrawal are truly representative of their substance-abuse equivalents (Starcevic, 2013a). While many studies have reported deleterious correlations with video game addiction, some studies have failed to replicate the same relationships with similar study designs, and effect sizes greatly vary, with most being described as small (Ferguson et al., 2011). Some studies have also reported confounding variables which, in cross-sectional analyses, remove the shared variance between video game addiction and proposed negative consequences (Przybylski et al., 2009). Therefore, researchers currently draw mixed conclusions around the negative consequences of video game addiction.

Many studies have reported co-occurrences between poorer mental health and higher video game addiction scores. However, few have investigated longitudinal fluctuations. In one of the few longitudinal studies, Gentile et al. (2011) concluded that emotional regulation was a risk factor, but anxiety and depression were both outcomes of the condition. This study was over a longer time period than the present study (2 years), but only three waves of data were collected, and a cross-lagged panel design was not used to investigate causality. Instead, participants were grouped according to similar video game addiction trajectories, based on several statistical indicators of similarity and theoretical sensibility. This design facilitated the comparison of participants who developed addiction, or ceased addiction, to those who never develop addiction or remained addicted over the time period, on a range of psychosocial health and functioning measures. Gender and race were controlled for, but mental health at the starting point, or the previous waves, was not controlled for in analysis of subsequent waves.

Studying the direction of relationships between video game addiction and symptoms of mental illness over a greater number of time periods, but a shorter duration of total time, may provide another means of investigating causality. While mental health often shows consistent patterns across the lifespan, and includes a genetic component, many studies and clinical treatments demonstrate that it can also substantially vary over the time period of this study, i.e. roughly seven months (Barlow & Durand, 2011). Less information is known about how video game addiction varies over this time period, but the preliminary check in this chapter indicates that it remains stable, contrary to one other study with a similar population. To this author's knowledge, this is the only study investigating the temporal precedence between video game addiction and psychological distress symptoms using a short duration longitudinal study with this many waves. The prime advantage of this analysis is that it is able to control for the effect of past mental health and video game addiction status, and investigate the direction and strength of any predictive effects that occur across the variables. Effectively, this provides one further line of evidence for investigating causality between these factors.

This chapter hypothesised that video game addiction would have bi-directional and mutually reinforcing effects on psychological distress, characterising a downward spiral. Contrary to the hypothesis, results indicate that video game addiction tended to increase in response to declined mental health. The results of this chapter therefore differ from earlier longitudinal studies on the topic (Gentile et al, 2011), and the conclusions drawn from many cross-sectional studies that poorer mental health is likely a 'negative consequence' of the condition (Ferguson et al., 2011; Lemmens et al., 2009; Mentzoni et al., 2011; Starcevic et al., 2011). This study included a well validated measure of psychological distress, comprised of depression, anxiety and stress symptoms. The sampling strategy targeted problematic adult gamers who agreed that their gaming had become excessive or problematic. Also, many individual items in the video game addiction scale request people to identify their video game playing as causing problems with different domains in life and aspects of health, including mental health. Yet, increases in this measure of addiction did not predict subsequent increases in psychological distress at any time point, after controlling for auto-regressive paths. Despite the very high consistency in auto-regressive paths across all waves, significant relationships did emerge in the reverse direction, on three out of the six waves studied. That is, increases in psychological distress predicted future increases in video game addiction. Other waves showed no relationship between video game addiction and mental health, which may suggest that at some waves too little change

occurred to reach significance, and this may have resulted from the waves being so close together.

These results suggest poorer mental health is an antecedent to increasing video game addiction. Evidence for the causality of video game addiction in bringing about decline in mental health was absent over the time period. This was the case with a sample of adults who fall on the severe range of video game addiction, both in relation to past studies utilising the CAES and in studies using similar scales that tap the same dimensions. Chapters 6, 7 and 8 highlighted the substantial variance between video game addiction and associated problems which was explained by possible confounding variables. Specifically, coping styles, stressful life events, socio-economic status, treatment seeking and satisfaction with life domains were all able to substantially reduce the variance explained by video game addiction in measures of health and functioning.

Interpreted in light of these findings from the previous chapters, the present results provide further evidence situating video game addiction primarily as a response to mental health difficulties, more than a cause. Theoretically, it is possible to conceive of the construct of video game addiction as a response rather than pathogenic cause of mental health decline. Video games are almost always now played in the home. In times of increased psychological distress, particularly in the case of depression and stress, many common activities are often described as far more difficult, including leaving the home (Barlow & Durand, 2011). Increased time spent in the home is used as an indicator of a possible mental health crisis in remote mental health monitoring systems (Dickerson et al., 2011). People who prioritise video gaming in their lives may increase their gaming behaviour when experiencing increased symptoms of mental illness, particularly as other activities become more difficult. It may be that with increased time spent at home, gaming provides an easily accessible activity that increases in response to declined mental health. This explanation posits video game addiction as primarily a response to other difficulties, contrasting the characterisation of video game addiction as a new illness, which would suggest that increases in the addiction would ‘lead to’ poorer mental health. In this study, increases in video game addiction did not predict subsequent increases in psychological distress at any wave.

However, one limitation was the lack of time-use data, including time spent in the home. Future studies incorporating time usage, including time spent in the home, may be able to confirm the

importance of this aspect. There are several other limitations to this study in addition to the absence of time use data. Participants were not a random sample of the population who were surveyed over the course of time in which they first developed video game addiction or mental health difficulties. Temporal data during this first-episode period may help to reveal whether development of video game addiction is more often rapid or slow, how it interacts with engagement, and whether the initial development of video game addiction is associated with negative consequences. The sample in this study already identified themselves as video game addicts and possible problematic video game players, although definitions for these concepts in the recruitment materials were not overly prescriptive. It may be that after some time of video game addiction, a consistent pattern between video game addiction and associated problems develops, and this pattern may be reflected in the results of this chapter. A different pattern may be evident, as in the study by Gentile et al. (2011), if the study had monitored participants over a longer time period which included first-episode. In this study, most participants who reported being diagnosed with a mental illness had received the diagnosis within a year of their taking part in the first wave, but further analyses of mental health history were beyond the time limits of the PhD. There is also the possibility, albeit unlikely, that taking part in surveys measuring these topics so many times over a short time period increased self-awareness and altered behaviour; a kind of bibliographic intervention.

The model in this chapter specifically investigated mental health difficulties rather than physical or social health, or aspects of functioning, and it did not control for possible mediators such as coping style. Variations of the model, such as substituting addiction with time spent playing, or engagement, could also be illuminating in further understanding video game addiction.

Epilogue

This PhD further investigated the definition and validity of video game addiction by studying how it differed from the close concept of engagement, and exploring connections with a wide range of health and functioning indicators, in a sample of adult problematic video gamers. The thesis adopted a harm-centric approach to validity, exploring several possible negative consequences of video game addiction, in the presence of confounding factors and longitudinally over a period of seven months.

Overview.

The first analysis in the thesis, chapter three, explored the underlying factor structure of the CAES. The CAES was applied to general video game playing (as opposed to the original which targeted one specific game), and a confirmatory factor analysis was conducted to determine whether the observed data fit the proposed theoretical model of addiction and engagement. Exogenous (observed) items were fed into the two endogenous constructs, which were co-varied. By most fit statistics, the data did not fit the theoretical model well, except for the RMSEA, which has been described as less sensitive to differences in the sample from the overall population. The poor fit on other indices may be due to the sample having limited variance across engagement and addiction compared with samples from the broader gamer population. Further, the largest improvement that could be made to the model was co-varying engagement item 3 with addiction, suggesting it is more highly correlated to addiction than engagement. Correlating errors between several engagement items also improved fit, suggesting engagement may be composed of more distinct sub-constructs. These error correlations were not inconsistent with the theoretical use of engagement in this study, however. On the other hand, discriminant validity was tested using the AVE and nested models methods, and was confirmed by both. The results of this chapter are equivocal. The model does not fit by many standards, but is acceptable as a close fit according to the RMSEA, which is not as sensitive to a normal distribution (Cudeck, 1993). This is consistent with study design, which may have resulted in limited variance across measures compared to a broader sample. Further, discriminant validity was confirmed with both methods. As such, investigation of the factor structure suggests some support for the current conceptualisation, and certainly of the distinction, but there is potential for future studies to find cleaner internal psychometric

structures with some alteration of the scale; and to re-test the model fit with broader populations.

Chapter four detailed an analysis of the CAES at the individual item level. At this early stage of investigation into the application of addiction to substance-free activities, analysis at this level may inform when and how behavioural or emotional aspects of leisure pursuits become symptoms of an addictive syndrome. Relationships between the individual CAES items and a range of health and functioning indicators were analysed. Addiction items were more often significant, and more strongly related, to health and functioning than engagement items. Some engagement items even showed small associations with improved health and functioning, but others were related to declines, suggesting they play a peripheral role. This peripheral role was discussed by the authors of the CAES. Items reflecting tolerance and cognitive salience did show relationships with decreased health, in contrast to their inclusion in the engagement rather than addiction scale, but euphoria did not. Scale items showed differential relationships with health and functioning, particularly when their impact is considered relative to each other in regression models. This suggests some items may be more indicative of severity. Removing or weighting according to these connections may provide a way of increasing internal psychometric validity, and improving diagnostic accuracy. These regression models highlighted a cluster of more strongly predictive items, particularly the item representing withdrawal. Yet this item asks participants if video gaming relieves a general sense of agitation, but it does not specify that video gaming is the *only*, or the *main*, activity to do so. Additional clarity in this item would help in comparisons to physiological withdrawal to substances. Therefore, it is recommended to include a follow up question, asking respondents to provide a list of activities that relieve this general sense of agitation, and the degree to which each is consistent and effective in this relief. This may provide empirical evidence of the narrowing of behavioural hierarchy discussed by addiction theorists and present in diagnostic criteria. In other words, how the activity comes to ‘dominate’ daily life. Qualitative investigations may be more suitable to gather this data, as hierarchies of behavioural priorities may be highly subjective, varied and detailed across individuals.

Chapter five tested the differentiation of addiction and engagement by analysing relationships with measures of mental, social and physical health. Rather than analyses taking place at the item level, this chapter investigated relationships between addiction and engagement total scores, with all health measures simultaneously included in models. As predicted, video game

addiction did show significantly stronger relationships with health, as well as functioning across life domains, than engagement. Health measures predicted more than three times the variance in addiction than engagement scores. These results are supportive of the differentiation of the two constructs. However, higher engagement was also significantly predicted, albeit weakly, by lower health, once again suggesting a peripheral role. This analysis also allowed the assessment of which aspects of health and functioning were most important in video game addiction, taking into account the range of measures included. Stress was the strongest predictor, followed by anxiety, sleep health and social activity which were equally strong predictors, and finally, BMI. Interestingly, depression was not a significant predictor after accounting for these other factors.

Chapter six introduced possible confounding factors between video game addiction and health. The rationale for this analysis was to attempt to rule out extraneous contributors to potential negative consequences. These analyses also have potential to gain a greater understanding of the context in which problems occur, as well as underlying mechanisms. Other studies utilising similar cross-sectional methods have already identified basic psychological needs satisfaction as possibly more important in well-being outcomes than a measure of obsessive play, akin to video game addiction (Przybylski et al., 2009). Similarly, the results of this chapter suggest that confounds are important. When coping styles, stressful life events, socio-economic status, social support and treatment seeking were introduced, the same health factors which predicted addiction in the previous chapter only increased the variance explained by 4%. Without inclusion of these confounding factors, the same health variables explained 26.4% of video game addiction. This result confirmed that health factors still made a unique contribution to predicting video game addiction, but that much more variance was explained by the confounding factors than by the health factors in models including both. As this analysis identified coping style, particularly withdrawal coping, as the most substantial contributor to video game addiction scores of all confounds, this relationship was explored further in chapter eight.

Chapter seven investigated the connections between video game addiction and impaired functioning in life domains, including satisfaction with different life domains as possible confounds. This analysis was designed to test whether video game addiction was able to predict declined functioning in life domains, beyond satisfaction with that domain. As video game addiction is described as having a component of loss of control, also called ‘life interruption’, it

was hypothesised that video game addiction would still predict decline in functioning, even after accounting for the effect of satisfaction. Results indicated video game addiction was a significant but small predictor of poorer academic and work functioning, and relationship conflict. However, it was a very strong predictor of parental performance, even after accounting for parental satisfaction, which was not a significant predictor of performance. This indicated that with increasing video game addiction, parental performance substantially declines. However, the number of parents in this sample was small, and this result requires further investigation with larger samples. Overall, indicators of functioning were less affected than health by video game addiction, with certain outcomes being very rare, such as loss of jobs or receiving warnings for poor performance.

In chapter eight, a more detailed mediation analysis was conducted investigating the role of coping styles in the connection between video game addiction, engagement and mental health. A bootstrapping approach was adopted to confirm these mediation effects independent of assumptions about population distribution. This analysis again supported the differentiation of video game addiction and engagement, showing engagement had no direct connection to symptoms of stress, anxiety and depression in mediation models, whereas addiction did. These models also highlighted the importance of coping style, showing that in combination with a reliance on avoidance coping and lack of approach coping, video game engagement can also coincide with increased mental illness symptoms. The importance of withdrawal and resignation emerged in models examining the same mediation effects with video game addiction instead of engagement. Video game addiction, in contrast to engagement, worsened when people felt as though they have given up trying to cope, and they are unable to make any difference (i.e. withdrawal coping). This is quite different from the displacement theories, which suggest video game addiction displaces other activities through an escape or distraction based coping, as in the three addiction models distraction coping was insignificant. This chapter suggests coping styles are a previously unidentified and potentially important portal to intervention.

Chapter nine compared cut-off points used in past studies on ability to discern participants experiencing declined health and functioning. This was an important and necessary test, as different cut-off points have produced vastly different prevalence rates, suggesting they may also have differential diagnostic validity. Results suggested little difference across the cut-off points investigated. As such, past studies which utilised these different cut-off points can be validly compared. Overall, results again suggest a tentative diagnosis of video game addiction is

related to poorer mental, social and physical health, but functioning was drastically impaired. Differences were not apparent in arriving late to work or receiving warnings for poor performance, academic grade average, number of subjects failed or academic discrepancy score. Very few participants diagnosed as addicted reported association between video game addiction and losing jobs, or in seeking work, or breakdown of romantic relationships. This may be reflective of the short time period of the study, with these consequences only occurring after more prolonged video game addiction, or these occurrences may be very rare.

As validity for video game addiction rests on demonstrable negative consequences, longitudinal studies which can examine the order of events in connected factors, as well as the relative importance of each, are crucial. A key priority of this study was to collect a useable longitudinal dataset, which was able to test the directionality of the interplay of these factors over a short period. There is no set time frame in which video game addiction is known to cause problems. Problems may emerge rapidly, or may take place over many years. Currently there are too few studies and mixed findings to make strong assertions about developmental timeframes, or to identify which associated problems are antecedents or consequences. As such, an intensive data collection regime, with the same measures taken each month for nine months, was initiated.

Chapter ten investigated the longitudinal fluctuations of video game addiction and mental health. Sample sizes were too small at the ninth wave at time of analysis (for example, during write-up of the thesis results, 73 people had fully completed all nine waves). Programming of the data collection software, and final collection, tracking, cleaning, merging and analysis of these datasets took substantial resources. Resources were further stretched as recruitment of the longitudinal sample took place over a long period of time, the cleaning and analysis was a rolling process, with new participants being incorporated into the final dataset, as every case was valuable. Finally, the longitudinal analysis was capped at six waves and a size of 111 participants. One detailed cross-lagged design was able to be undertaken specifically investigating the relationships between video game addiction and psychological distress, comprised of the sum of depression, anxiety and stress symptoms. Mental health was chosen as it showed the strongest prediction of video game addiction in earlier chapters.

This analysis revealed some interesting patterns. Firstly, addiction and engagement remained highly stable over the timeframe, unlike past studies. Also, instead of the expected bi-directional

and mutually reinforcing downward spiral, whereby video game addiction would predict future declines in mental health and vice-versa, results suggested video game addiction increased *only* as a response to mental health decline: an antecedent rather than consequence. This result provided no evidence that video game addiction leads to poorer mental health, and may theoretically support earlier chapters which identified the important mediators of low avoidance and high withdrawal coping styles. However, this pattern may be unique to a group of self-identified problematic gamers, who have already settled into a 'holding pattern' with regards to their gaming habits and mental health. Nonetheless, these findings suggest clinicians should be aware that people who are highly engaged with video games, and endorse video game addiction criteria, may increase gaming behaviour in response to worsening mental health. Clinicians must also be cautioned not to assume that increases in video game addiction-like features will lead to declined mental health, or to assume it is the central factor impacting on mental health outcomes.

Limitations

Studying video game addiction; or the measurement of video game addiction?

While the aim of the thesis was to explore the definition and validity of video game addiction, there is a conflation between the terms 'definition' and 'measurement'. It can be argued this thesis is concerned primarily with measurement, and simply investigates one measure of video game addiction and engagement, and can say little about the construct beyond the accuracy or inaccuracy of this particular scale. Yet the similarities in the underlying theory informing development of most video game addiction scales are clear, and the scales themselves are similar. Despite some small but important differences (King, Haagsma, et al., 2013), the great majority of video game addiction scales tap aspects of what are thought to constitute a general model of addiction (Brown, 1997; Shaffer et al., 2004). These scales are drawn either directly from these general models (Griffiths, 2005), or adaptation of substance abuse and pathological gambling diagnostic criteria (Tejeiro Salguero & Morán, 2002), both of which share many similarities. The influences of the general model are also reflected and acknowledged in the tentative proposed diagnosis of Internet Gaming Disorder in the DSM V. Furthermore, while measurement issues are important with any particular scale, quantitatively analysing factors

related to a measure of video game addiction and engagement can also generate knowledge that challenges or informs the definition of the broader construct.

Sample Bias

Sample bias is a consideration in all studies. This section considers the possible sample biases present in this study. But first, some points on the consideration of sample bias in general are made. If the important ethical principle of voluntary, informed consent is genuinely applied, the options available to researchers in understanding and minimising sample bias are limited. They generally consist of testing for, and then statistically controlling, or excluding and analysing separately, certain cases deemed to bias an analysis. In this sense the term ‘self-selected’, when used to refer to a limitation in study design leading to sample bias, is somewhat of a misnomer. Generally, all participants are asked to provide consent to take part in studies. Even in rare studies using ethically approved but limited forms of consent, such as the use of deception, participants can almost always request that their data be removed from the study if they so choose, after they have been informed that they have been participating. Ethical approval for such studies occurs under strict conditions, and only when there is minimum chance of harm to participants.

It is ultimately impossible to ascertain the exact effect of sample bias in studies with voluntary consent. The collection and use of detailed data from participants who did not consent (aside from simple information such as gender and approximate age, if non-consenting participants are observed) may not be possible to attain and/or may be ethically and even legally unacceptable. In certain countries, privacy laws also prevent such unconsented data collection. Therefore, it is not possible know the full extent of sample bias, but only to consider its possible effects, based on strong theoretical grounds and other studies specifically designed to test for these effects. Within empirical psychological research, much validity rests on the randomisation of participants. Yet if voluntary consent is present, the only randomisation that can occur is in the random allocation of participants (who have already provided consent) into different conditions or treatments. It is impossible to gather detailed data from people in the population of interest who choose not to consent in studies.

Considerations of sample bias in studies of video game addiction.

While limited disclosure of information or deception is sometimes ethically approved in research, this study was up-front about the focus on video game addiction. Notably, the authors cannot recall one study of video game addiction which has explicitly concealed the topic of the study from participants (although different terms are used in study advertisements, such as problematic, intemperate, or just video gaming). Yet even if advertisements for a study concealed the explicit focus on video game addiction, if the study was an observational self-report survey, like most studies on video game addiction thus far, participants are likely to quickly realise the study focus when completing the survey. At that point, participants who feel the topic is irrelevant to them may stop participating or show fatigue or skip items. Studies of sample bias, as well as studies of attentional profiles in general, suggest that participants are more likely to pay attention to, and take part in, studies which are salient or relevant to them (Hamill, Wilson, & Nisbett, 1980). Therefore, most samples of video game addiction which are drawn from recruitment materials that detail the nature of the study, even just general video gaming, are likely to be at least slightly skewed towards more highly engaged and/or addicted gamers.

In addition, effects of sample bias can be magnified in studies involving a negative association or social stigma towards the content, such as in studies of sexual behaviour (Catania, Gibson, Chitwood, & Coates, 1990). Some commentators and researchers have described a negative stigma associated with video game playing, including perceptions that gaming is somehow unhealthy, illegitimate or generally negative way to spend time compared with analogous leisure activities (Brenick, Henning, Killen, O'Connor, & Collins, 2007; Guy, Ratzki-Leewing, & Gwadry-Sridhar, 2011). A negative stigma deploring lengthy video gaming may have discouraged some participants from taking part, so that they do not perceive themselves in a negative light (similar to social desirability response bias, but in relation to the decision to participate, rather than how to respond to questions). Therefore, it is likely that participants in this study genuinely felt concern about their gaming habits being problematic, which overcame any desire to avoid association with this negative stigma. Certainly, video game addiction is a topic which is regularly discussed in the media, and the ideas that are held by many gamers on the topic may influence their decision to participate, or how they participate, in topical studies. Ultimately, it is impossible to know for certain the extent of sample bias arising from the attitudes or ideas held

in the broader population of gamers. Sample bias may indeed fluctuate in response to changing social attitudes and media messages about gaming and health.

Sample bias in this study: more involved male and cross-cultural gamers.

This study's sampling strategy targeted the most engaged and self-identified possible problematic gamers, but without being specific enough as to exclude participants who have a specific definition of video game addiction (e.g. at least 50 hours per week of gaming). This sampling strategy was consistent with the aim of investigating the differentiation of high engagement from addiction. In line with this rationale, the description of video game addiction was deliberately non-specific. Any gamer who felt they play too much, have some kind of problem with their gaming, or are addicted to video gaming, was invited to take part. No omission of information was undertaken in recruitment materials. It was made clear that the focus of the study was video game addiction, which is therefore likely to attract participants who feel this topic is relevant to them.

Survey responses supported this description of the sample, as in the first wave response to the question "Currently, how much do you enjoy video gaming?", 37.8% indicated "they love it", and 27.2% said "very much", with almost all the remainder indicating they enjoy video gaming to a lesser degree. Therefore, generalisation of the results to the broader population of gamers who may not be as engaged, or non-gamers in the case of the application of the syndrome model to other potential behavioural addictions, is limited. Likewise, this may have affected all statistical analyses. Variance in many of the measures taken is likely to increase across a wider spectrum of intense gamers to more casual or non-gamers, who were less prevalent in the current study.

The final sample was also gender biased, with a greater proportion of males than females. This was as expected, and is consistent with the majority of studies on the topic of video game addiction or general video game playing. The sample in this thesis was not stratified and an even gender balance was not sought. So, while this gender split is consistent with past studies, generalisation of results to female gamers must be made with caution. Separate comparative analyses across gender was not undertaken, but may provide interesting results.

The international nature of the sample was a further source of sample bias, as respondents resided in many diverse nations. Checks were conducted by analysing all open-ended

questions, many of which required substantial answers, thereby facilitating a detailed identification of participants' English fluency. This helped to determine whether any participants had a level of English that would have obviously impeded interpretation of the survey. However, this procedure could only identify extreme cases. More subtle misinterpretations are still possible. Ideally, translated and back-translated measures would have been made available to all participants, with differential item analyses providing some empirical evidence of cross-cultural stability. Yet translation of scales was beyond the resources of the PhD, as was further cross-cultural comparisons.

Cross-sectional nature.

Another limitation is the cross-sectional nature of most analyses. Aside from chapter eight, all others relied on cross-sectional analyses. This included several different modelling analyses, including hierarchical multiple regression and multiple mediation analyses, which attempt to extract and compare variance between different factors in models, in order to test theoretical conceptualisation of how the variables are connected. Yet, in many cases, it was not known or well-established whether connected factors are risk factors or causes, mediators or moderators, or outcomes; or some combination. Explicit theorisations had little evidence to back them. Ideally, longitudinal analyses were better suited to exploring such questions. These were planned and intended, but in the end, many were beyond the reach of both the sample size (in the case of cohorts such as parents, those in relationships, working, studying), and time available. The study collected much data that is planned for analyses after completion of the PhD. The cross sectional nature of many analyses, including mediation analyses, made decisions about statistical modelling particularly difficult, with the possibility that running the models is reverse may have altered the results.

There has been much debate about the use of common social-science statistical methods for exploratory purposes recently. Doubts have been cast over the use of common statistical conventions, including the validity of hypothesis testing, i.e. the *p* figure (at least at the .05 level), and difficulties have been reported in reproducing results of many social science studies (Ioannidis et al., 2014). With debate over the validity of many different approaches, some have suggested to use multiple statistical methods to determine whether results converge, and to trust intuition or a pre-determined theory over statistical results (Nuzzo, 2014). However, mastering many different and nuanced statistical approaches can dramatically increase

resources required to complete a study. Also, relying on intuition may make it more likely for statistics to reify existing beliefs, rather than test them against observations (i.e. empirically). Arguably these issues are intensified in the case of exploration of psychological factors, which can dynamically interact and are not accurately measureable. Without firm theoretical bases on which to make conclusions about model directionality (at the cross-sectional level), model specification was difficult.

Self-report and lack of data triangulation.

Further limitations included the use of self-report scales and indicators. Self-reports are often biased, due to reasons such as social desirability or incorrect recollection. This became evident when attempting to identify valid self-report measures of job performance in the psychological literature. Some of the indicators used in this study are not well established, such as time spent with mental health professionals as a proxy indicator for treatment seeking. Recollection may have also been a source of bias. Each wave asked participants to recollect and estimate their agreement to survey items based on the past month. This recollection was likely inaccurate to some degree. Other sources of data, such as clinical assessments, to assist in confirmation of findings would have been beneficial.

The study would have benefited from triangulation of data from other sources outside of self-report. Ideally, mental health could have been further gauged by a mental health professional using in-person clinical assessments, and in-depth interviews would have helped to explore the role of video game playing in further detail. Other studies have gathered game playing data, such as time spent playing, direct from online servers (Caplan et al., 2009). However, the resources required for such confirmation exceeded this PhD, and would clinical assessments would have added further burden to the already substantial time-commitment of participants.

Future Research Suggestions

Video game addiction is one manifestation of the burgeoning application of the concept of addiction to substance-free activities. Many such activities can be described as leisure pursuits or hobbies. Future researchers should continue to compare and contrast these different potential behavioural addictions, refining universal addiction models and detailing commonalities

and idiosyncrasies across each proposed condition. As these conditions are being put forward as possible mental illnesses, demonstration of negative consequences is central to their validity. Health, well-being and functioning are likely to remain key outcomes. Yet as health is the outcome of many factors, assessing the relative importance of any potential behavioural addiction amongst other contributors to health is also critical. Unfortunately, many statistical techniques, and the principles behind quantitative research, require very large samples in order to estimate models with many variables. One efficient way to gather the extensive longitudinal data able to make inferences on directionality and relative importance of video game addiction on health may be by requesting additional participation from sub-samples who are already involved in on-going longitudinal health studies.

Despite a large amount of anecdotal evidence, there remains a lack of qualitative studies on video game addiction. The field will benefit from additional rich, detailed qualitative analysis, alongside quantitative measures. These studies may explore the perceptions of participants about the wider role of video gaming in their lives, including the applicability of specific addiction components to gaming habits, and this perception changes over time and in response to other important aspects in life. Inclusion of input from those in close relationships with people who identify as video game addiction may also shed light on conflicting explanations and rationalisation of gaming behaviour.

While empirically oriented psychological research can contribute much to this field, researchers should also consider contributions of theory and methods from other disciplines. Sociological studies highlight the tendency for certain sub-groups, as well as new types of media, to be labelled as episodic ‘folk devils’ in the wider media. These movements in the public sphere are characterised as a moral panic, like a lightning rod focussing negative sentiment, including a general sense of societal decline, on the folk devil of the time (Stanley Cohen, 2002; Thurlow, 2006). Video game addiction is a topic often discussed in the media, and shared understandings and perceptions of the concept may influence survey studies in ways which are not yet clear. Sociological studies including media content and discourse analysis may begin to detail the evolution of the concept of video game addiction in the public sphere, and may eventually interface with survey studies in order to test whether changing public perceptions influence participant responses. Likewise, in the tradition of Latour (2000), science and technology studies may detail the official and unofficial development of a diagnosis for the condition, providing glimpses into how the contributing science is constructed and fits within broader social systems.

Overall the results of this study pointed to the importance of coping styles, particularly withdrawal coping, which involves a sense of having given up trying to cope. Future studies may attempt to understand how coping styles change over time in relation to video game addiction, exploring coping techniques and appraisals of success, rather than focussing on the domain of global coping styles. Coping interventions which build active coping strategies may be trailed to determine whether they improve mental health outcomes. Another key finding that requires further investigation from the present study is in the area of parental performance. While the sample of parents was small, the statistical result strongly indicated that the parent-child relationships suffer as video game addiction increases. Future studies may explore this link further, using mixed methods and longitudinally over time, the latter helping to identify whether these difficulties in parenting are risk factors or consequences of video game addiction.

Final Word

Overall, video game addiction is not yet a well-understood, primary illness, with demonstrable negative consequences. Substantial but mixed cross-sectional evidence exists regarding the ability of video game addiction scales to predict detrimental well-being, but according to effect size severity is generally low, even in samples which target the most problematic gamers. Of the few studies exploring mediating or moderating variables, or longitudinal fluctuations, results are at best mixed; with some suggesting video game addiction plays a minor role after accounting for other factors, such as basic needs fulfilment. In this study coping styles appeared more important in health than video game addiction. Longitudinal findings are similarly mixed as to whether video game addiction is a risk factor or outcome in many potential negative consequences. The longitudinal model tested in this thesis did not suggest a prolonged worsening of mental health with continued addiction, nor a downward spiral of mutually reinforcing relationships. However, it is still possible that people who have stable health would have remained stable, if not for the initial development of video game addiction. Longer term studies covering first-episode or earlier phases of health and functioning are required for confirmation. Currently, empirical evidence for video game addiction ‘leading to’ negative consequences is therefore not yet well established.

Caution should be taken with the expansion of the general model of addiction to ever-more activities, without requisite evidentiary checks to support each application. How unique features for each activity in question will be identified and incorporated is an open question. The tentative video game addiction diagnosis recently included in the DSM V makes easier the application of

the diagnostic criteria to other activities. Notably, there is nothing specific to video game playing included in the diagnostic criteria aside from the words ‘video game playing’; easily interchangeable for any desired activity. This lack of idiosyncrasy may be a detriment to building a better understanding of each proposed behavioural addiction.

Broadly, the results of this thesis also support caution in overestimating the centrality of video game addiction in outcomes, especially in the presence of comorbidities and other potential mediators or moderators. However, the results did support the distinction between engagement and addiction in the measure adopted, particularly in mental health, social activity and sleep health. However, indicators of life interruption were not as strongly associated with addiction, with the exception of parental performance which requires further research. Coping styles was also identified as an important mediator in the relationship between addiction and mental health, and higher engagement was also associated with poorer mental health in the presence of poor coping. Therefore, coping styles may be a key driver in excessive video gaming behaviour and may provide a portal for intervention. Future research may consider approaching the topic of video game addiction from the perspectives and methods of multiple disciplines. They may also seek data stretching over the lifespan in order to investigate temporal precedence, and, by taking into account as many other factors as possible which impact on health outcomes, the relative importance of video game addiction.

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