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Online gaming addiction: Classification, prediction and associated risk factors

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Massively multiplayer online role-playing games (MMORPGs) have gained increased popularity over the last decade. Despite the many positives of gaming, alleged problems relating to MMORPG playing have emerged, more specifically in relation to addiction to MMORPGs among a small minority of players. This study set out to establish the prevalence of MMORPG addiction using validated addiction criteria. Factors relating to online gaming were examined to establish whether they were linked to MMORPG addiction. A self-selected sample of 1420 gamers ranging in age from 12 years to 62 years (mean age 23 years) completed an online questionnaire. The results showed that 44.5% of gamers were classified as addicted according to the polythetic format and 3.6% according to the monothetic format. Ordered logistic regression analysis showed that the variable years of gaming, total time spent playing online per week and employment status can have a major impact on the probability of MMORPG addiction. The implications of these findings for the assessment of MMORPG addiction are discussed.

Keywords: *Addiction, online gaming, risk factors, MMORPGs*

INTRODUCTION

Massively multiplayer online role-playing games (MMORPGs) have gained increased popularity over the last decade. Approximately, 20 million people play MMORPGs worldwide (Hill, 2011), and this number is set to increase as online gaming becomes more popular. These virtual worlds are utilised by people from all racial backgrounds, age groups and educational levels that suggests the stereotype of the young gamer is no longer accurate (Williams, Yee, & Caplan, 2008). Research also indicates that approximately one in five MMORPG players are female (e.g. Griffiths, Davies, & Chappell, 2004a; Williams et al., 2008). The academic gaming literature has consistently shown that there are many positive benefits that players get from engaging in their chosen activity. For instance, research has consistently shown that online gaming can be educational (e.g. de Freitas & Griffiths, 2007; Griffiths, 2010a), social (e.g. Cole & Griffiths, 2007; Hussain & Griffiths, 2008) and/or therapeutic (e.g. Griffiths, 2005a).

There is also research focusing on class and race (i.e. the individual characteristics of a particular character within a game) selection in MMORPGs (see Appendix section for glossary of terms). For instance, Castronova (2003) reported that players of *EverQuest* chose human and elf races more than ogres and trolls. The ability of the race in the online world was an important factor as well as the looks of the character. As mentioned in relation to positive benefits, MMORPGs can be good places for people to make new friends and socialise. Research by Cole and Griffiths (2007) revealed that MMORPGs offer a place where people can express themselves in ways that they may not feel comfortable doing in real life. They also reported that gamers had made good friends within MMORPGs.

The motivations for playing MMORPGs provide interesting insights into playing behaviour. Taylor and Taylor's (2009) qualitative analysis of gamer motivations showed that social communication and group cohesion were the strongest motivators for game playing. The authors acknowledged that the study was a small-scale pilot study ($n = 21$) and that a larger study was needed. Research by Yee (2006) revealed a

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five-factor model of user motivations that included achievement, relationship, immersion, escapism and manipulation. Male players were significantly more likely to be driven by the factors of achievement and manipulation, whereas female players were significantly more likely to be driven by the relationship factor. Additionally, the reward systems within MMORPGs (e.g. reaching a high level in the game, obtaining new weapons) may also motivate gamers to play online (Choi, Lee, Choi, & Kim, 2007; Jang, 2007; Steinkuehler & Williams, 2006).

Despite the many positive benefits of online gaming, alleged problems relating to MMORPG playing have emerged, most specifically in relation to addiction to MMORPGs in a small minority of players. Addiction to interactive technologies such as MMORPGs have been termed 'technological addictions' (Griffiths, 1995, 1996) and have been operationally defined as non-chemical (behavioural) addictions that involve excessive human–machine interaction and feature the core components of addiction including salience, mood modification, tolerance, withdrawal symptoms, conflict and relapse (Griffiths, 2005b). Although there are many different definitions of addiction, most definitions mention compulsive and/or uncontrollable dependence on a psychoactive substance or behaviour to the degree that cessation causes severe emotional, mental or physiological reactions (e.g. K. Anderson, L. Anderson, & Glanze, 1998; Griffiths, 2005b).

Such definitions demonstrate that the concept of addiction has changed over time and due to the current research context this definition is all encompassing (referring to both chemical and non-chemical behaviours). The six core components of addiction (i.e. salience, mood modification, tolerance, withdrawal symptoms, conflict and relapse) were first outlined by Brown (1993) and later modified by Griffiths (1996, 2005a). These components were extracted from the *Diagnostic and Statistical Manual* (DSM) pathological gambling criteria (American Psychiatric Association, 1980, 1994, 2000). Under this model, it is argued that any behaviour that fulfils the six criteria can be operationally defined as an addiction (Griffiths, 1996).

Many studies have raised concern about the risk of addiction to MMORPGs. For instance, research by Kim, Namkoong, Ku, and Kim (2008) investigated the relationship between MMORPG addiction and personality traits. An online survey was used to gather data from 1471 gamers. The results indicated that certain psychological characteristics such as aggression, self-control and narcissistic personality traits may predispose some individuals to become addicted to MMORPGs. However, it is important to note that the online Game Addiction Scale (GAS) and the narcissistic personality disorder scale used in the study had not been psychometrically validated. Mehroof and Griffiths (2010) focused on the links between online gaming addiction and personality factors using an opportunity sample of 123 student gamers. Results indicated that the five traits they examined (neuroticism, sensation seeking, trait anxiety, state anxiety and aggression) all displayed significant associations with MMORPG addiction. These findings suggested that certain personality traits may be important in the acquisition, development and maintenance of online gaming addiction. However, the sample size was small and may not have been representative of all gamers.

Research by Smahel, Blinka, and Ledabyl (2008) investigated relationships between players ($n = 548$) and their game characters using an online questionnaire containing DSM-IV items. The results showed that younger players (aged 12–27) had a tendency towards intensive gaming and were more prone to addiction. Identification with a character was seen as a factor influencing addiction. This is because some gamers develop an emotional engagement with the MMORPG and may play for long periods of time, neglecting real-life. However, the authors acknowledged that the relationship between identifying with a character and addiction was weak. Identifying with a character is likely to be a sign of enjoying an MMORPG. Other limitations of the study were that it focused on gamers who played fantasy MMORPGs only. Gamers who played other types of MMORPGs were not examined and may have led to different findings.

In a qualitative study, Chappell, Eatough, Davies, and Griffiths (2006) examined the experiences of gamers who played *EverQuest* using Interpretative Phenomenological Analysis. Data were gathered from various online forums where gamers who perceived their playing to be excessive shared their experiences of playing *EverQuest*. The analysis revealed that the gamers appeared to be 'addicted' to *EverQuest*. Most of the gamers appeared to display the core components of addiction. However, no single account mentioned all the core components of addiction; therefore, it cannot be concluded that the gamers were genuinely addicted to MMORPGs.

Hsu, Wen, and Wu (2009) used an online survey and explored students' gaming experience and level of addiction. The sample comprised 418 Taiwanese gamers aged 18–25 years old. The results revealed five predictors of MMORPG addiction (i.e. curiosity, role-playing, belonging, obligation and reward). However, the researchers only recruited a small subset of gamers making cross-cultural and cross-age comparison unfeasible. Grüsser, Thalemann, and Griffiths (2007) conducted an online survey among 7069 gamers in order to investigate the addictive potential of online gaming. They reported that 11% of gamers fulfilled at least three diagnostic criteria of gaming addiction. These gamers played for significantly longer daily periods of time when compared to the remaining gamers. They were also significantly more likely to report withdrawal symptoms and craving. However, there were some problems with the addiction criteria used in this study. Participants who fulfilled at least three of six criteria

of addiction were operationally defined as pathological gamers. It can be argued that this led to an overestimation of 'pathological' gaming behaviour.

Research by Van Rooij, Schoenmakers, Vermulst, Van Den Eijnden, and Van De Mheen (2011) examined online video game addiction in a sample of Dutch school children (aged 13–16). The sample was surveyed at two points in time over a 2-year period. At stage 1, the sample consisted of 1572 participants. At stage 2, the sample consisted of 1476 participants. The researchers used the Compulsive Internet Use Scale that incorporated items from the DSM-IV. The results showed that 3% of participants were addicted to online video games. However, all the participants were Dutch and no cross-cultural comparisons can be made. Caplan, Williams, and Yee (2009) examined problematic internet use (PIU) among a sample of 4000 gamers. Online survey data and in-game data from the MMORPG *EverQuest 2* (*EQ2*) was used in the analysis. The results showed that the strongest predictors of PIU were age, patterns of internet use and psychosocial well-being. The authors noted that one of the chief limitations of the study was that the results did not say whether gamers with problematic tendencies played MMORPGs, or whether MMORPGs created problematic tendencies.

Lemmens, Valkenburg, and Peter (2011) investigated whether psychosocial well-being is a cause or consequence of pathological gaming. The researchers conducted a two-wave panel study among 851 Dutch adolescents. The analyses indicated that social competence, self-esteem and loneliness were significant predictors of pathological gaming. The analyses also indicated that loneliness was a consequence of pathological gaming. The researchers concluded that lower psychosocial well-being can be considered as an antecedent of pathological gaming among adolescent gamers. However, the findings only pertained to Dutch adolescents. Further research is needed to see whether similar findings can be found with a broader population. Morahan-Martin and Schumacher (2000) surveyed 277 internet users in order to assess incidence of PIU. The results showed that 8% of participants were classified as pathological internet users. Pathological users were more likely to be male and to use online games. Liu and Peng (2009) explored the cognitive and psychological predictors of negative consequences associated with playing MMORPGs. Participants ($N = 288$) completed an online questionnaire. The results indicated the important roles that psychological dependency and deficient self-regulation play in negative consequences associated with online gaming. The results also indicated that psychological dependency on MMORPGs was predicted by a cognitive preference for a virtual life.

Gentile et al. (2011) conducted a 2-year longitudinal study in order to investigate the prevalence of problem video game playing in children. The researchers asked 3034 school children in Singapore to complete a survey containing adapted DSM-IV items for addiction. The surveys were completed annually over the period of 2 years. The results revealed that 9% of participants were classified as pathological gamers. Greater amounts of gaming, lower social competence and greater impulsivity were found to act as risk factors for pathological gaming. Batthyany, Muller, Benker, and Wolfling (2009) investigated the prevalence of excessive computer game playing behaviour among Austrian adolescents ($n = 1068$) with psychopathological tendencies that resembled the symptoms of addiction. The ICD-10 was used to develop a questionnaire. Similar to the findings of Grüsser et al. (2007), the researchers reported that 12% of participants displayed symptoms of addictive behaviour.

The examination of brain activities of gamers has also revealed some potentially interesting findings. Ko et al. (2009) attempted to identify the neural substrates of online gaming addiction through the evaluation of brain areas associated with cue-induced gaming urge. Their sample comprised 10 online gaming addicts and 10 control online gamers. They were presented with gaming pictures and non-gaming pictures while undergoing functional magnetic resonance imaging. The results demonstrated that the brain regions associated with cue-induced gaming urge/craving in online gaming addiction was similar to that of the cue-induced craving for individuals with substance dependence. This finding suggests that gaming urge/craving in online gaming addiction and craving in substance dependence might share the same neurobiological mechanism. The use of a larger sample and examining brain activity while playing an MMORPG would provide a better insight into the neurobiology of online gaming.

Griffiths' (2010b) case studies outlined the importance of context in the life of a gamer and demonstrated that excessive playing does not necessarily mean that a gamer is addicted. For instance, two gamers in Griffiths' study claimed to be playing for up to 14 h a day (i.e. their gaming was behaviourally identical) but they were different in terms of psychological motivation and the meaning and experience of gaming within their lives. The key issue in the case studies was the extent to which excessive gaming impacted negatively on other areas of the gamers' lives. Griffiths applied the core components of addiction to each of the two case studies and found that only one of the two gamers was addicted using these criteria. One gamer displayed all the core components of addiction (e.g. online gaming was the most important thing in his life, he built up tolerance to gaming over time, he experienced conflict in his life as a result of playing online, etc.). In contrast to this, the other gamer did not suffer from any withdrawal symptoms, relapse when unable to play or conflict. This gamer played excessively due to having lots of free time (he did not have a job, partner or children). When other things came along in his life (i.e. a job, a girlfriend), his playing dramatically

decreased. These case studies showed that a person can excessively play without necessarily being addicted. This raises important questions about the links between excessive playing and addiction. Furthermore, gamers may experience 'flow', an altered state of awareness when absorbed in an activity (Csikszentmihalyi, 1990). Flow experience has been linked to a variety of mediums and activities such as MUDs (Voiskounsky, Mitina, & Avetisova, 2004), and general internet usage (Chen, Wigand, & Nilan, 2000).

Some of the most commonly occurring limitations of previous online gaming research are the (1) use of adolescent samples, (2) focus on one type of MMORPG and (3) use of gamers from only one country. More importantly, almost all researchers have failed to use standardised and validated addiction criteria, although several studies (e.g. Bioulac, Arfi, & Bouvard, 2008; Griffiths & Hunt, 1995, 1998; Salguero, Moran, & Rosa, 2002) have adapted various DSM criteria for substance dependence or pathological gambling (American Psychiatric Association, 2000) in order to investigate addiction to offline video games. However, the criteria have not been psychometrically validated for the measurement of problem video game playing and so they may be overestimating or underestimating the true prevalence of gaming addiction. Recently, Lemmens, Valkenburg, and Peter (2009) psychometrically validated the GAS, and Griffiths (2010c) has recommended the use of this screening instrument. Charlton and Danforth (2007) argued that some early research studies in the area (e.g. Griffiths & Hunt, 1995, 1998) had overestimated the prevalence of addiction due to the use of a polythetic format to classify addiction. Polythetic formats require the endorsement of a number of items rather than all items (which is known as a monothetic format). Charlton and Danforth (2007) argued for the use of a monothetic format when investigating video game addiction. The type of classification system used will have an impact on the prevalence estimates of addiction in a given sample.

Addiction to MMORPGs is a serious social issue that may be as serious as addiction to alcohol, drugs and gambling (Hsu et al., 2009). This study set out to examine the impact of online gaming on the lives of online gamers and to establish the prevalence of MMORPG addiction using validated addiction criteria (Lemmens et al., 2009). The study also examined gamers playing styles (e.g. solo/group playing) and typical playing behaviour. Both monothetic and polythetic formats to addiction were also examined. The aim of the study was to measure MMORPG addiction using a sample of MMORPG players. It was hypothesised that the prevalence of MMORPG addiction would be small when classifying addiction to MMORPGs using a monothetic format.

Certain factors relating to online gaming were examined to establish whether they were linked to MMORPG addiction. These factors were the age of gamers, the number of years a gamer had been playing, the amount of time gamers devoted to playing, employment status of gamers and the type of server the gamer played on. It was hypothesised that the more years a gamer had been playing, the more likely their chances of being addicted to MMORPGs. This may be because some aspects of MMORPGs may appeal to them more over time. It was also hypothesised that the more time gamers devoted to playing MMORPGs the more likely they would be addicted. It was also hypothesised that being unemployed or retired would lead to a higher likelihood of addiction. Finally, it was hypothesised that playing on a PvP server would increase the likelihood of addiction to MMORPGs. These hypotheses were in need of examination because they focused on the behaviour of gamers and certain features of MMORPGs that have been linked to MMORPG addiction (Chappell et al., 2006; Hsu et al., 2009; Hussain & Griffiths, 2009).

METHOD

Participants

A total of 1420 online gamers completed an online questionnaire. The sample comprised 1095 males (77.1%) and 325 females (22.9%). The gamers ranged in age from 12 years to 62 years ($M = 23.18$ years; $SD = 8.39$ years). Most of the gamers were living in the United States (46.4%), followed by the UK (14.8%), Canada (6.3%), Australia (4.2%) and Finland (2.9%). Many other countries were also represented in the remainder of the sample (13.2%), including those from New Zealand, Greece, Norway, the Netherlands, Germany, Poland, Sweden and Japan.

Design and materials

Online questionnaire software (i.e. *Survey Monkey*) was used to collect data for the survey in order to remain consistent with previous studies (e.g. Charlton & Danforth, 2007; Gentile et al., 2011) that had used similar methodology. The online questionnaire asked questions relating to basic demographics of the online gamers (e.g. age, country of residence, gender, etc.). It also contained questions relating to typical online game playing behaviour (e.g. amount of time spent playing online per week, etc.) and playing style (e.g. whether gamers preferred playing solo, with guild members or a PuG, etc.). The questionnaire also incorporated the seven-item GAS (Lemmens et al., 2009). This self-report measure includes seven items representing seven DSM-based criteria for game addiction that had been identified in earlier research (e.g. Griffiths & Hunt, 1998). Lemmens et al. (2009) developed and validated the GAS to measure video game addiction. The questions related to seven underlying addiction criteria (i.e. salience, tolerance, mood modification, relapse, withdrawal, conflict and problems). Two independent samples of gamers were used to investigate the dimensional structure of the scale.

The results showed that the GAS showed high reliability and good concurrent validity across samples. In this study, scale items were slightly adapted to relate to MMORPG playing. Gamers rated all game addiction items on a five-point Likert scale (where 1 = *never,* 2 = *rarely,* 3 = *sometimes,* 4 = *often* and 5 = *very often*).

Examples of the GAS items were as follows: 'Did you think about playing a game all day long?', 'Did you spend increasing amounts of time on games?' and 'Did you play games to forget about real life?'. Items such as these were adapted to relate to MMORPG playing by substituting the word 'games' for 'MMORPGs' (i.e. 'Did you think about playing a MMORPG all day long?', 'Did you spend increasing amounts of time on MMORPGs?' and 'Did you play MMORPGs to forget about real life?'. Responses were checked in order to detect multiple, exaggerated and inappropriate responses (e.g. gamers who claimed that they played more than 100 times a week and gamers who entered profanity in text boxes instead of useable data) were removed from the data. To avoid multiple responses, all IP addresses were checked and duplicates were removed. In total, 87 entries were removed due to duplicate IP addresses.

Procedure

Postings inviting gamers to take part in the study were placed in the off-topic and general discussion forums of various well-known online gaming websites (e.g. mmorpg.com, womengamers.com, mmosite.com and blizzplanet.com). Each gaming site had similar structural features (e.g. latest news, help guide, site map, forums, etc.). The online recruitment posting informed all gamers about the purpose of the study. The post contained a link to a participant information sheet and a link to the online questionnaire. Participants were informed that the study had been approved by the research team's University Ethics Committee. Once gamers visited the hyperlink address to the questionnaire, they were given clear instructions on how to fill in the questionnaire and were assured that the data they provided would remain anonymous and confidential. A debriefing statement at the end of the questionnaire reiterated the purpose of the study and informed gamers of their right to withdraw from the study.

RESULTS

Demographic information

The data showed that 704 gamers (50.0%) were students, 504 (35.8%) were in employed work, 55 (3.9%) were self-employed, 134 (9.5%) were unemployed and 12 (0.9%) were retired. The majority of gamers (61.8%) were single, 14.3% were married and 24% were in an intimate relationship. The mean number of years of formal education for gamers was 11.8 years ($SD = 4.6$). Female gamers had more years of formal education ($M = 12.6$ years, $SD = 5.4$) than male gamers ($M = 11.6$ years, $SD = 4.3$), a difference that was significant [$t\ (387.99) = -3.03$, $p < 0.05$; effect size, $r = 0.15$]. The mean number of years gamers had been playing MMORPGs was 4.5 years ($SD = 3.1$). Male gamers had been playing MMORPGs for significantly longer ($M = 4.7$ years; $SD = 3.2$) than female gamers ($M = 3.9$ years; $SD = 3.2$), [$t\ (1208) = 4.1$, $p < 0.05$; effect size, $r = 0.1$].

Typical game playing behaviour

Gamers were asked about the number of times per week they played MMORPGs. The mean number of times gamers played online was 6.8 times per week ($SD = 6.7$; Median = 6.00). Gamers were also asked about the average length of each gaming session. The mean length of gaming sessions was 179 min ($SD = 121.9$; Median = 170.00). Females played longer per playing session ($M = 182.2$ min; $SD = 97.0$) than males ($M = 178.8$ min; $SD = 128.6$). However, this difference was not significant [$t\ (590.81) = -0.451$; $p > 0.05$; effect size, $r = 0.02$].[1]

Females played online more times per week ($M = 7.33$; $SD = 6.9$) than males ($M = 6.6$; $SD = 6.6$), but this difference was not significant [$t\ (1268) = -1.583$; $p > 0.05$; effect size, $r = 0.04$]. There was a significant positive relationship between the number of times gamers played online per week and the length of game playing session [$r_s\ (1083) = 0.25$, $p < 0.01$]. There was a significant positive relationship between the number of times gamers played per week and the logarithm of total time[2] [$r_s\ (1070) = 0.77$, $p < 0.01$]. Furthermore, there was a significant positive relationship between length of game playing session and logarithm of total time [$r_s\ (1070) = 0.76$, $p < 0.01$]. There was also a significant negative relationship between the age of gamers and the number of times gamers played MMORPGs per week [$r_s\ (1264) = -0.06$, $p < 0.05$]. The analysis also revealed a significant positive relationship between the age of gamers and the length of game playing session [$r_s\ (1059) = 0.08$, $p < 0.01$].

Number of MMORPGs played

Gamers were subscribed to an average of 1.3 MMORPGs ($SD = 1.2$). Females subscribed to more MMORPGs ($M = 1.4$; $SD = 1.1$) than males ($M = 1.3$, $SD = 1.1$), but this difference was not significant [$t(1388) = -1.940$; $p > 0.05$; effect size, $r = 0.05$]. *World of Warcraft* was the most common MMORPG played by the gamers (42.5%) followed by *Guild Wars* (7.9%), *RuneScape* (4.9%) and *EverQuest 1* and *2* (2.9%).

Level of avatar, gamers' in-game choices and character/avatar information

The mean level of gamers' main avatar was 64.7 ($SD = 29.7$).[3] Females had higher-level characters (M level = 67.2; $SD = 22.7$) than males (M level = 63.9; $SD = 31.6$), but this difference was

not significant [$t = (650.06) = -1.877$; $p > 0.05$; effect size, $r = 0.07$]. The mean number of avatars that gamers had in their main MMORPG was 6.5 ($SD = 6.99$). Gamers were asked about the class and race of their avatar. The results revealed that 13.3% of gamers played the *Warrior* class of avatar, 10.6% played the *Mage* class, 7.5% played the *Priest* class and 5.8% played the *Hunter* class. In regards to the race of avatar chosen by gamers, 30.6% of gamers chose the human race of avatar, 15.5% chose elves and 6.8% chose the undead race.

Gamers were asked about the type of realm/server they chose to play on. The results showed that 47.7% of gamers played on PvE servers and 37.3% of gamers played on PvP servers. The results also showed that 8.3% of gamers played on the 'Role-playing' (R-P) servers and 6.7% of gamers played on 'Role-playing–Player *versus* Player' (RP–PvP) servers.

Gamers preferred playing styles

Gamers were asked questions about their in-game playing styles. The results showed that 37.8% of gamers liked to play 'solo' in-game, whereas 35.5% of gamers did not like playing solo. The results also showed that 76.4% of gamers enjoyed playing with guild members, whereas 7.3% did not enjoy playing with guild members. The results also showed that 22.7% of gamers liked playing with a PuG, whereas 43% did not like playing with a PuG.

Addiction

Taking into consideration the arguments of Charlton and Danforth (2007), both monothetic and polythetic formats were used to determine whether a person was addicted to online gaming. This allowed for a comparison between the different addiction formats and would show how they differed when reporting the prevalence of MMORPG addiction. When using a monothetic format, all the criteria for MMORPG addiction have to be endorsed to be classified as an addict. The polythetic format required endorsement of at least half of the criteria for someone to be classified as 'addicted'. In this study, an item was considered to be endorsed when a gamer answered four *often* responses on the five-point addiction scale items. The polythetic format resulted in 44.5% of gamers who met at least four of the items in the seven-item scale. The monothetic format resulted in 3.6% of gamers who endorsed all seven items in the seven-item scale.

Monothetic and polythetic distinctions

In terms of the monothetic criteria, addicted gamers played longer per session ($M = 251.3$ min; $SD = 146.7$ min) than non-addicted gamers ($M = 182.5$ min; $SD = 122.5$ min). This difference was significant [t $(992) = -2.861$; $p < 0.05$; effect size, $r = 0.09$]. In terms of the polythetic criteria, addicted gamers played longer per session ($M = 213.3$ min; $SD = 144.9$ min) than non-addicted gamers ($M = 161.9$ min; $SD = 98.7$ min). This difference was also significant [t $(729.697) = -6.3$, $p < 0.05$; effect size, $r = 0.2$].

MMORPG addiction predictors

Further exploratory analysis was to predict which factors may explain addiction to MMORPGs. An ordered logistic regression analysis was carried out using the predictors of employment status, server played on by gamers, age, how long gamers had been playing MMORPGs and the logarithm of total time. The logarithm of total time was used because the variable was skewed and because it produced a model in which the time effect was considered proportional rather than additive. The dependent variable was derived from the continuous seven-item MMORPG addiction scale score from gamers. This score was used to derive an ordinal measure of addiction scored as '0' for gamers classified as not addicted, '1' for gamers classified as addicted according to the polythetic criteria and '2' for gamers classified as addicted according to the monothetic criteria. Modelling addiction in this way was seen to be a valid method as shown in the research findings of Lemmens et al. (2009). Past research (e.g. Chappell et al., 2006; Hsu et al., 2009; Hussain & Griffiths, 2009) have shown that the predictors included in the model are indicative of causing addiction to MMORPGs.

The analysis revealed a statistically significant overall model ($\chi^2(10,\ N = 553) = 818.3,\ p < 0.001$, Cox and Snell $R^2 = 0.087$). The test of parallel lines, $\chi^2(10) = 8.05;\ p > 0.05$, was consistent with the model meeting the proportional odds assumption of ordered logistic regression (with predictors having similar effects at each threshold). Results showed that significant predictors included the logarithm of total game time ($p < 0.001$), and employment status ($p < 0.01$). However, a large number of cases had missing data, and this can lead to biased parameter estimates and tests. For this reason, it was decided that the detailed interpretation of the analysis was best left until after data imputation. Further analysis involved the use of multiple imputation prior to regression to incorporate information from all cases (including those with missing values).

Multiple imputation was used as there was a high proportion of missing values for some important variables within the data set. The following variables had missing values; age (eight missing values), years of gaming (648 missing values) and total time spent playing (350 missing values). The common practice of deleting cases with missing values reduces the effective sample size. More importantly, it biases the results because important information implicit in the excluded cases would be lost, but almost certainly not at random (Peugh & Enders, 2004).

In this analysis, the missing data were imputed 10 times to generate 50 complete imputed data sets. An inclusive strategy was used during the imputation where the specific predictors were used to impute

Table I. Ordered logistic regression results for the seven-item MMORPG addiction scale using multiple imputation.

				Odds ratio 95% CI	
	b	SE	Odds ratios	CI Lower	CI Upper
Intercept					
Addicted *versus* not-addicted	1.69	0.55	5.44	1.86	15.93
Monothetic *versus* not monothetic	4.97	0.57	109.84	36.16	333.95
Parameters					
Age	−0.01	0.01	0.99	0.97	1.00
Years of gaming	0.04	0.02	1.04	1.00	1.08
Total gaming time (logarithm)	0.33	0.09	1.39	1.18	1.65
Employment status					
Student	0.72	0.36	2.05	1.02	4.12
Self-employed	0.47	0.35	1.60	0.80	3.17
Unemployed	1.09	0.39	2.96	1.38	6.33
Retired	0.96	0.70	2.61	0.66	10.32
Employed	–	–	–	–	–
PvE	−0.05	0.25	0.95	0.58	1.56
PvP	0.23	0.25	1.25	0.76	2.06
RP	0.32	0.32	1.34	0.72	2.48
RP–PvP	–	–	–	–	–

Note: PvE, Player *versus* Environment; PvP, Player *versus* Player combat; RP, Role-Playing; and RP-PvP, Role-Playing–Player *versus* Player.

missing values. The predictors included age, the number of times gamers played MMORPGs per week, the length of playing session (in minutes), how long gamers had been playing MMORPGs (in years/months), raw scores on the MMORPG addiction scale, employment status and the server played on by gamers. Using as many predictors as possible for imputation – even if not used in the final analysis – is known to produce better results.

Ordered logistic regression analyses were then performed on each data set using the same dependent variable and predictors as described above in the first regression analysis. The results from the 50 data sets were then combined to produce the final regression model. Table I gives this model with the predictive potential of the variables predicting MMORPG addiction after imputation.

Table I confirms that employment status ($p < 0.01$), years of playing MMORPGs ($p < 0.05$) and total gaming time per week ($p < 0.001$) were statistically significant predictors of addiction – influencing the probability of polythetic and monothetic addictions. Age ($p = 0.126$) and type of server ($p = 0.64$) were non-significant predictors of addiction classification. The test of parallel lines was also non-significant ($\chi^2(10) = 17.88$; $p > 0.05$). For employment status, being a student and being unemployed are associated with a significantly higher addiction classification. Being retired may also present increased risk, but the smaller number of participants in this category leads to low power to detect an effect. Being self-employed has an effect somewhere between that of being employed and the other categories, though this is not significantly different from that of the employed participants. Years of gaming and total time spent gaming both significantly increase the risk of polythetic or monothetic classifications, though the effect is more substantial for time spent gaming. Figure 1 shows the probability of non-addicted, polythetic or monothetic classification as a function of the two most influential predictors – time spent gaming and employment status (employed *versus* unemployed) for a 25-year-old gamer who has played for 5 years on a *PvE* server.

The impact of these predictors is most obvious for the polythetic classification, but the effect on the stricter monothetic classification is also pronounced. The chance of monthetic classification is negligible for infrequent gaming but approaches 20% for unemployed gamers gaming 60 or 70 h per week.

DISCUSSION

This study set out to examine the impact of MMORPGs on the lives of gamers. Results showed that there was a significant positive relationship between the number of times gamers played online per week and the length of game playing session. This suggested that the more times a gamer plays online, the longer the playing session will be. Past research has found similar findings (e.g. Chan & Rabinowitz, 2006; Griffiths, Davies, & Chappell, 2004b). The results also showed that the average length of gaming session was 179 min (almost 3 h). Here, the appeal of MMORPGs may have led to the increase in playing session. Research by Wood, Griffiths, Chappell, and Davies (2004) suggested that the structural characteristics of character development,

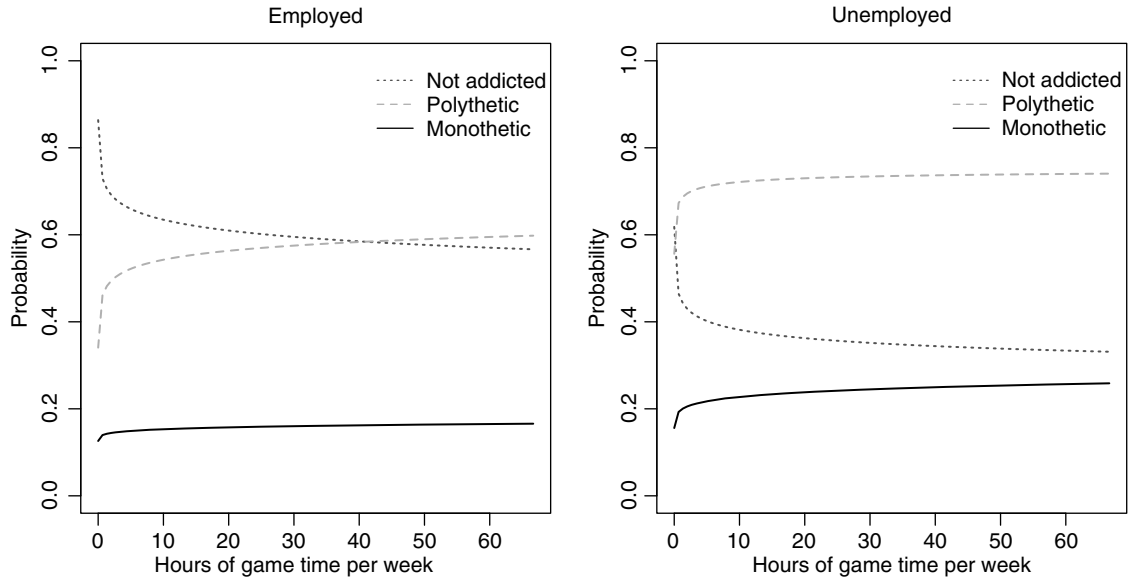

Figure 1. Predicted probability of non-addicted, polythetic or monothetic classification as a function of employment status (employed or unemployed) and hours of game time per week. All predicted probabilities are calculated for a 25-year-old gamer with 5 years MMORPG gaming experience on a PvE server.

rapid absorption rate, and multi-player features are characteristics that may induce playing or can be an inducement to continue playing. All these structural characteristics (in addition to others such as skill development and online chat features) can be found in MMORPGs. Therefore, it could perhaps be speculated that these characteristics induce longer game playing sessions as gamers might enjoy engaging in the social and competitive aspects of MMORPGs.

There was a significant negative relationship between the age of gamers and the number of times they played MMORPGs per week. This suggested that as gamers get older, play frequency decreases. This finding was similar to the findings of Griffiths et al. (2004b) who found that the younger the gamer the more hours per week they played. There are a number of reasons that could account for this. Adolescents tend to have more leisure time, fewer responsibilities and more flexibility in their weekly schedules than adults (Griffiths et al., 2004b). Consequently, adolescent gamers are likely to dedicate more hours per week to play MMORPGs than older ones. However, older gamers who may be retired could also dedicate more hours to play MMORPGs.

The analysis also revealed a significant positive relationship between the age of gamers and the length of game playing session. This suggests that as gamers get older, the length of playing session increases. These were interesting findings and suggest that MMORPGs were being played by gamers who play fewer times per week as they got older, but when they did play, the playing session would be considerably longer in length. One of the reasons for this could be that gamers might play once or twice on weekday evenings or on weekends when they are not working. They may attempt to accomplish as much as they can before returning to work, so the playing session would be extended in order to accomplish more in-game tasks.

Considering the time investment needed to play MMORPGs and the general life commitments of people as they grow older, these findings are understandable. A MMORPG can be played a few times per week but the playing session can be very long as one quest can take a few hours to complete. Many gamers use MMORPGs to socialise (Hussain & Griffiths, 2008) and keep in contact with friends (Cole & Griffiths, 2007), so the length of playing session can sometimes be very long. However, it must be noted that the correlations reported here do not prove causality. There may be many other unexamined variables that can explain why playing session time increases and the number of times played per week decreases. For instance, playing more than one MMORPG every week, gamers' commitment to a guild, their role within that guild, or gamers may be sharing computers so that they have less time to play. A qualitative study or a longitudinal study may provide further insight to such changes in playing behaviour. Further research is needed to explain prolonged playing session lengths as this would provide information about excessive play and possible health implications.

In relation to gamers' playing styles, the study showed that over three-quarters of gamers played with guild members, and just over one-third of gamers did not like playing solo. MMORPGs encourage gamers to group with other players in order to advance in the game. According to previous research, this type of playing style encourages interaction and teamwork (Griffiths et al., 2004a, 2004b; Hussain & Griffiths, 2008) as gamers enjoy the social and cooperative

aspects of MMORPGs (Chen, Duh, Phuah, & Lam, 2006). It may be speculated that the interaction involved in playing with others can be more stimulating than playing solo, although further empirical research is needed to confirm this.

It was also found that 43% of gamers did not like playing with a PuG. Playing with a PuG also involved group work but was usually restricted to the time it takes to complete a quest or one playing session. This finding suggests that gamers have the desire to develop networks of friends' in-game who they can group up with on more than one occasion. There may be other reasons why gamers do not like PuGs, therefore further research could examine this issue. The wider implications of these findings about playing styles are that many of the social norms of meeting people and making friends that can be found in real life can also be found in virtual worlds.

The results examining gender differences revealed that female gamers played longer per session (a finding similar to that reported by Hussain and Griffiths (2008)) and played more times per week. They also had higher level characters than male gamers. Although these findings were not statistically significant, they suggest that female gamers are playing MMORPGs at least as much as male gamers. Female gamers may prefer the socialising and entertainment aspects of MMORPGs (Hussain & Griffiths, 2008). There are also many other diverse activities within virtual environments that could be more appealing to males or females. For instance, the acquisition of virtual property, buying and selling virtual items, managing guilds, adventuring and helping gamers with in-game tasks or quests. Future research could examine male and female preferences for different in-game activities.

The results clearly demonstrate that there are different percentages of addicted gamers depending on the classification being used to determine addiction to MMORPGs. The analysis revealed that 44.3% of gamers were classified as addicted according to the polythetic format, whereas only 3.6% were classified as addicted according to the monothetic format. The former statistic was a very high percentage. These findings show that endorsement of just over half of the addiction criteria (polythetic format) leads to much higher levels of gamers being classed as addicted when compared to the endorsement of all the addiction criteria (monothetic format). The polythetic format findings were much higher than previous research findings that have experimented with the polythetic criteria. For instance, Griffiths and Hunt (1998) found that 16% of gamers were classified as addicted, while Charlton and Danforth (2007) classified 38.7% as addicted. When using the monothetic format, Charlton and Danforth (2007) found that 1.8% of gamers in their sample would have been classified as addicted. This shows that the polythetic criteria appear to lead to overestimations of addiction that can lead to unnecessary concerns among social scientists and policy makers.

The logistic regression analysis revealed the strength of various predictors that may explain why some gamers experience dependence to MMORPGs. The results showed that certain variables notably employment status (e.g. being a student or unemployed), years spent gaming and total gaming time may have a major impact on the probability of MMORPG addiction. These variables can increase the odds of either shifting from 'non-addiction' to 'polythetic addiction' or from 'polythetic addiction' to 'monothetic addiction' to a considerable degree. For instance, being unemployed increases the odds of shifting one classification by around 3 to 1 relative to being in employment. For continuous predictors such as total gaming time, the impact depends on the range of values that may arise. Here, the gaming time variable is highly skewed and the logarithm of minutes per week of gaming was used in the analysis and for practical purposes ranges from about 0 to 3.6 (representing around 70 h a week). Thus, the odds ratio of shifting classification would be around 2.3 for 5 h game time a week or 3.2 for 50 h game time a week. Figure 1 illustrates how the shift in odds can have a substantial impact on the probability of being classified as addicted by polythetic or monothetic criteria.

All the variables mentioned above (i.e. employment status, years of gaming and total time spent playing online) may be viewed as risk factors for MMORPG addiction. The longer a person has been playing an MMORPG, the more likely they are to be at risk of developing an addiction to MMORPGs. Furthermore, these risk factors are potentially cumulative. For instance, a gamer who has been playing for many years and becomes unemployed would – all other things being equal – have a greater risk of MMORPG addiction. One can see that being unemployed or retired can increase the likelihood of addiction as a gamer will have free time to play MMORPGs.

The more hours a gamer devotes to playing online also appears to increase the chances of becoming addicted. This may be because the reward systems within MMORPGs keep the gamer playing for longer periods of time and thus sustain gamer motivation (King & Delfabbro, 2009). The variable ratio reinforcement schedules within MMORPGs may shape future behaviour as well as maintain behaviour. Those gamers who are unemployed or retired tend to have more free time and are thus more likely to devote their time to play MMORPGs, perhaps making themselves vulnerable to addiction. Past research (e.g. Kim et al., 2008) suggests that employment status (which was one of the predictors in this analysis) explains some of the variance in online gaming addiction. Furthermore, the type of server that a gamer chooses to play on may be linked to addiction. For instance, a PvP server may be related to addiction due to the competitive aspect of playing against other gamers. In gambling, competition

has been shown to have an association with problem gambling (Parke, Griffiths, & Irwing, 2004).

Brown's (1997) Hedonic Management Model of Addiction may be useful when attempting to explain the mechanisms underlying MMORPG addiction. The model attaches importance to the role of conscious subjective experiences, beliefs and decisions of the addicted person. This model suggests that particular activities (such as MMORPG playing) can provide a strong stimulus to make people feel good or sustain a good hedonic tone (i.e. states of relative pleasure and euphoria). These activities disrupt the normal functions of planning for long-term goals. This is because the person attempts to sustain long periods of hedonic tone by engaging in the activity that for some will subsequently lead to addiction. Recovery is possible through improved self-awareness, vigilance, better decision-making, and reduction or extinction of the addictive activity (Brown, 1997).

Gamers may be manipulating their hedonic tone to sustain long periods of euphoria (or other mood modifying states) as they spend increasing amounts of time online. MMORPGs have the potential to provide long periods of euphoria through quests and undiscovered content that can be appealing to many gamers as it can provide an escape from reality (Hsu et al., 2009; Wood, Griffiths, & Parke, 2007). It is speculated that hedonic tone may also be sustained through the immersion of being in another world, social interaction, being part of an online community, gaining recognition and power in-game, character advancement, completing instances and acquiring new gear. The reward systems within MMORPGs (e.g. new gear, weapons, levelling up, etc.) provide schedules of reinforcement that require gamers to keep playing, and this supports Brown's (1997) model. Future research could apply Brown's model to the investigation of MMORPG playing behaviour and its possible links to hedonic tone (Charlton & Danforth, 2007).

It is also important to recognise the limitations of the study. The results relating to addiction do not prove causality and many other factors relating to MMORPG addiction were not examined. Therefore, caution must be taken about the moderating and/or mediating variables underlying the relationship when interpreting the results of the study. Some of the potential risk factors that were not investigated include individual differences among gamers, gamer motivations, personal life circumstances, perceptions, meanings that people attach to MMORPGs and the experiences of playing MMORPGs. These are all potentially important risk factors that may influence whether an individual's playing will be problematic. Previous research suggests that the community aspects of online gaming (such as belonging to a guild, participating in guild activities, developing social relationships with gamers) may help explain addiction to MMORPGs (Ducheneaut, Yee, Nickell, & Moore, 2006; Hsu et al., 2009; Seay, Jerome, Lee, & Kraut, 2004). This is a risk factor that was not investigated in this study. It is also important to note that it is not possible to imply that gamers with some signs associated with addiction suffer from problems, and that all MMORPGs are addictive. Further research is needed to identify other factors that contribute to problematic gaming behaviour. Researchers need to verify the results of this study by further investigating MMORPG addiction. Another issue to consider is whether gamers overestimate their game playing time. This is difficult to investigate unless researchers use in-depth qualitative methods such as the diary method and/or interviews. However, most research tends to suggest that players underestimate the time they spend online playing games (Wood, Griffiths, & Parke, 2007). In regards to determining the extent of addiction, longitudinal research that makes use of both quantitative and qualitative methods will most likely reveal the true nature and prevalence of addiction to MMORPGs.

The online data collection methodology used in this study was helpful in obtaining a relatively large and diverse sample of online gamers from around the world. The phenomenon being examined warranted an online questionnaire to be used to gather data. There is the issue regarding truthfulness of responses but this issue is not limited to online studies as it affects all types of self-report research in general (Wood, Griffiths, & Eatough, 2004). In this study, exaggerated responses were removed from the data, and IP addresses were checked to prevent multiple responses. One of the distinctive aspects of this study was that it did not focus on players of a particular MMORPG but rather it was interested in people who played all types of MMORPGs and so gamers were recruited from many different MMORPG fan sites and forums. However, it is not possible to make generalisations about all gamers from the study's findings as there are issues in regard to using a self-selected sampling strategy and not including gamers from many countries, and players of all MMORPGs. This study is one of the first studies of MMORPG addiction to make use of a validated gaming addiction scale. Further research could replicate this study or adapt the measurement instrument to examine potential addiction to other online media such as social networking sites, online dating sites and online gambling sites.

MMORPGs are complex graphical environments with enormous potential to attract millions of players worldwide. This study revealed that while many gamers show characteristics that are associated with MMORPG addiction, using monothetic criteria a relatively small percentage of gamers could be considered addicted. However, some risk factors appear to dramatically increase the likelihood of being addicted. The polythetic classification led to larger numbers of gamers being classified as addicted; therefore, it can be speculated that these gamers are likely to be more vulnerable to shift to the monothetic classification. This is because they possess some of the core

components of addiction and may possibly end up possessing the other addiction consequences with the passage of time. Video game developers should think about implementing safeguards to prevent excessive play as they are responsible for the games they develop (Van Rooij et al., 2010). For instance, the use of in-game time monitoring systems that forces gamers to log-out if they have been playing for excessive amounts of time may help to prevent excessive gaming behaviour. Making avatars experience fatigue and lose points due to excessive play may also prevent excessive gaming (Hsu et al., 2009). Understanding the difference between addiction, excess and non-addiction is important in deciding what types of prevention programmes can help those who are in need (Griffiths, 2010c; Griffiths & Meredith, 2009). Thoughtful evaluation surrounding the complex mechanisms of MMORPGs may be the way forward as this will help provide the knowledge needed to advise those people who experience gaming problems.

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NOTES

1. The Welch–Satterthwaite *t*-test was reported throughout the analysis because of unequal group sizes.
2. The logarithm of total time was used because the variable was skewed. The logarithmic transformation produces a model in which the time effect has a proportional rather than additive effect.
3. Many gamers have more than one avatar/character in a MMORPG. The highest level in the majority of MMORPGs is usually 80.

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APPENDIX

Glossary of terms

First-person game: Games in which the player 'sees' through the eyes of the character – typically associated with First Person Shooters such as Counter Strike, though also possible with most MMORPGs.

Elves: A race of character within many MMORPGs endowed with special powers.

Gear: Equipment or items that are gained by characters.

Guild: A guild is a collection of players who share a common principle or outlook, it can be a specialized group or simply a loose affiliation of players. Guilds are popular among the variety of MMORPGs available.

Instance/Instance Dungeon system: A specific part of the game environment that requires the co-operation of multiple players, involving tougher mobs and better rewards.

Levelling: Completing tasks/quests, fighting monsters or other gamers with the purpose of gaining a level.

Mages: A class that uses spells and long range attacks.

MUD: Multi-User Dungeon or Multi-User Domain. These were the first textual online worlds.

PvP: Player *versus* Player combat.

PvE: Player *versus* Environment. In this case, environment equates to all quests and monsters (mobs) in the virtual world.

PuG: Abbreviation for Pick-up-Group. Temporary groups assembled on the spot for various tasks.

Quest/questing: The process of completing tasks set by NPCs, in the process gaining experience and thereby levelling up.

Race/Class: The individual characteristics of a particular character within a game, e.g. Race – Night Elf, Class – Mage.

Realm: An online world within a game, several realms can exist on one real world server.

Realm versus Realm: Player *versus* Player events in game environments in which players of different realms (worlds) can fight each other.

Server: In computing, this term refers to a computer program that delivers a service to clients.

Undead: A race of character that is deceased but behaves as if alive.