Video Game Addiction: Past, Present and Future

Mark D. Griffiths[a,*], Daria J. Kuss[a] and Daniel L. King[b]

[a]*International Gaming Research Unit, Psychology Division, Nottingham Trent University, Burton Street, Nottingham, NG1 4BU, UK;* [b]*School of Psychology, The University of Adelaide, South Australia, S.A., 5005, Australia*

Abstract: Gaming addiction has become a topic of increasing research interest. The last decade has witnessed a significant increase in the number of empirical studies examining various aspects of problematic video game play and video game addiction. This paper begins with a brief past history of how research into video game addiction has changed over the last three decades (i.e., the 1980s, 1990s and 2000s). It then examines more thoroughly the contemporary research literature by analyzing the (i) prevalence of problematic video game use and video game addiction, (ii) negative consequences of excessive video game use, (iii) factors associated with problematic video game use and video game addiction, and (iv) the treatment of problematic video game use and video game addiction. The paper concludes by looking at the trends in the field and a somewhat theoretical examination of what the future of video game addiction might be.

Keywords: Video games; Video game addiction; Gaming addiction; Problematic video game use; Excessive gaming; Gaming addiction treatment.

VIDEO GAME ADDICTION: PAST, PRESENT AND FUTURE

Introduction

Gaming addiction has become a topic of increasing research interest. Over the last decade there has been a significant increase in the number of empirical studies examining various aspects of video game addiction compared to the preceding decade. This has resulted in a wide-ranging selection of review papers focusing on different aspects of the topic. These include general literature reviews of video game addiction [1-5], reviews of online (as opposed to offline) gaming addiction [6-8], reviews of the main methodological issues in studying video game addiction [9,10], reviews of structural characteristics and their relationship with video game addiction [11,12], reviews of video game addiction treatment [13-16], reviews of video game addiction and co-morbidity/convergence with other addictions such as gambling addiction and Internet addiction [17-20], and miscellaneous review papers on very specific aspects of video game addictions such as social responsibility [21], screening instruments [22], or reviews refuting that video game addiction even exists [23].

It should also be noted that given the lack of consensus as to whether video game addiction exists and/or whether the term 'addiction' is the most appropriate to use, some researchers have instead used terminology such as 'excessive' or 'problematic' to denote the harmful use of video games [24]. Terminology for what appears to be the same disorder and/or its consequences include problem video game playing [25,26], problematic online game use [27], video game addiction [1,28], online gaming addiction [29,30], Internet gaming addiction [7], and compulsive Internet use [31]. This paper briefly examines a number of key areas in the study of problematic video game play and video game addiction. It begins with a brief past history of how research into video game addiction has changed over the last three decades. It then examines the present research by analyzing the (i) prevalence of problematic video game use and video game addiction, (ii) negative consequences of excessive video game use, (iii) factors associated with problematic video game use and video game addiction, and (iv) the treatment of problematic video game use and video game addiction. The paper concludes by looking at the trends in the field and a somewhat theoretical examination of what the future of video game addiction might be.

GAMING ADDICTION: THE PAST

Gaming Addiction in the 1980s

Following the release of the first commercial video games in the early 1970s, it took until the 1980s for the first reports of video game addiction to appear in the psychological and psychiatric literature. In the early 1980s, Ross, Finestone and Lavin [32] reported three cases of '*Space Invaders* obsession' and Nilles [33] described a similar phenomenon but called it 'computer catatonia'. Arguably the first reference to 'video game addiction' was in 1983 by Soper and Miller [34], who, based on their observations as school counselors, claimed the disorder was like any other behavioral addiction and consisted of a compulsive behavioral involvement, a lack of interest in other activities, association and friendship circles mainly with other video game addicts, and physical and mental

*Address correspondence to this author at the International Gaming Research Unit, Psychology Division, Nottingham Trent University, Burton Street, Nottingham, NG1 4BU, UK; Tel: +44-115-8482401; Fax: +44 (0)115 848 2390; E-mail: mark.griffiths@ntu.ac.uk

symptoms when attempting to stop the behavior (e.g., "the shakes"). Some credence was given to these claims that video game addiction existed following papers on the seemingly successful treatment of video game addiction using cognitive behavioral therapy [35,36]. However, all of these studies were somewhat observational, anecdotal, and/or case studies, primarily based on samples of teenage males, and all based on a particular type of video game using a particular medium (i.e., 'pay-to-play' arcade video games).

In 1989, Shotton [37] published the first empirical study specifically on gaming addiction on a relatively small sample of 127 people (almost all teenage or young adult males) who described themselves as ''hooked'' on home video games for at least five years. Shotton's conceptualization of game addiction was more positive than negative, and she reported that her 'addicts' were on the whole highly intelligent, motivated, and achieving people but often misunderstood by others in society. In relation to gaming addiction, the main problem with the study was that no standardized measure of addiction was actually used. The only criterion for being 'addicted' was the individual's own admission that they were 'hooked' on computer games. Despite this major shortcoming, recent research by Widyanto, Griffiths and Brunsden [38] reported that a person's self-diagnosis of whether they were addicted to the Internet or not correlated highly with more standardized measures of Internet addiction.

Gaming Addiction in the 1990s

The 1990s saw a small but significant increase of research into video game addiction with all of these studies being carried out in the UK and on adolescents typically surveying children in school settings [39-45]. In contrast to the early 1980s studies, these studies mainly examined non-arcade video game playing (i.e., home console games, handheld games, PC gaming). However, all of these studies were self-report surveys, relatively small scale and the main problem was that all of them assessed video game addiction using adapted versions of the DSM-III-R or DSM-IV criteria for pathological gambling [46]. Although there are clearly many similarities between gambling and video gaming, they are different behaviors and specific video game screening instruments should have been developed. Based on further analysis of the adapted DSM criteria used, these studies were later criticized as being more likely to be assessing video game preoccupation rather than video game addiction [47].

Gaming Addiction in the 2000s

The 2000s saw a substantial growth in the number of studies on video game addiction particularly as gaming expanded into the new online medium where games could be played as part of a gaming community (i.e., massively multiplayer online role playing games [MMORPGs] such as *World of Warcraft* and *Everquest*). Approximately sixty studies were published on gaming addiction between 2000 and 2010 [7] and a vast majority of these examined

MMORPG addiction and was not limited to the study of adolescent males. Furthermore, many of these studies collected their data online and a significant minority of studies examined various other aspects of video game addiction using non-self-report methodologies. These include studies using polysomnographic measures and visual and verbal memory tests [48], medical examinations including the patient's history, and physical, radiologic, intraoperative, and pathologic findings [49], functional Magnetic Resonance Imaging [50-52], electroencephalography [53], and geno-typing [54].

Given the methodological shortcomings of the studies published prior to 2000, and the fact that gaming has evolved substantially over the last decade, the remainder of this review will mainly focus on studies published in the last decade (i.e., post-2000 papers) with the exception of those concerning the health and medical consequences of excessive video game play (as most of these are case study-based and the medical effects do not appear to be dependent on the medium in which the games are played).

GAMING ADDICTION: THE PRESENT

Prevalence of Problematic Video Game Use and Video Game Addiction

Table **1** presents a summary of prevalence studies examining problematic video gaming from 1994 to 2012. The studies were selected on the basis of having at least 300 participants, and using some kind of screening instrument to assess problematic video game playing (rather than self-diagnosis). Estimated prevalence rates of problematic gaming range from 1.7% to over 10% among general samples. Prevalence rates among video game players were in some cases much higher (see Table **1**). These studies also indicate that, in general, males are significantly more likely than females to report problems relating to their gaming. According to King and colleagues [15], the differences in methods of assessing game-based problems may partly account for differences in prevalence rates. Furthermore, many studies fail to assess prior problems (i.e., lifetime prevalence). King *et al*. [15] also noted that some studies do not consider subclinical cases (i.e., meeting some but not all criteria for problematic use), and the presence of co-morbid psychopathology is not routinely assessed.

From a substantive perspective, there are some generalizations that can be made with regard to the demographic characteristics of gamers and problem gamers. The literature, to date, suggests that adolescent males and young male adults appear to be at greater risk of experiencing problematic video game play. However, the course and severity of these problems is not well known [15] and the finding that this group is more at risk may be a consequence of sampling bias as well as the fact that this group plays video games more frequently than other socio-demographic groups. It has also been suggested that university students may be especially vulnerable to developing problematic video gaming. Reasons for this include their flexible tuition and study hours, ready access to high-speed broadband on a 24/7 basis, and multiple stressors

Table 1.   Prevalence of "Video Game Addiction" in the Largest Survey Studies (1994-2012)

Study	Year	Location	Sample	Age (years)	Assessment Screen	Prevalence (%)	Gender (ratio)
Fisher [121]	1994	England	467 secondary school children	11-16	DSM-IV*	6.0	M = F (1:1)
Griffiths & Hunt [122]	1998	England	387 adolescents	12-16	DSM-III	19.9	M>F (3:1)
Grüsser *et al.* [116]	2005	Germany	323 schoolchildren	11-12	DSM-IV-TR*/ICD-10**	9.3	M>F (3:1)
Grüsser *et al.* [117]	2007	Germany	7,069 gamers	15+	ICD-10 criteria**	11.9	NR
Lee & Han [123]	2007	Korea	2,584 students	5th/6th grade	DSM-IV-TR	2.5	NR
Wan & Chiou [124]	2007	Taiwan	416 adolescents	17-24	OAST	34.0	NR
Xu & Yuan [125]	2008	China	623 adolescents	13-18	DSM-IV and others	21.5	NR
Gentile *et al.* [118]	2009	U.S.	1,178 students	8-18	DSM-IV-TR criteria*	8.5	M > F (4:1)
Batthyány *et al.* [56]	2009	Austria	1,068 students	13-18	CSVK-R	2.7	M>F (3:1)
Lemmens *et al.* [126]	2009	Holland	721 adolescents	12-18	DSM-IV-TR	1.4-9.4	NR
Arnesen [127]	2010	Norway	2,500 young adults	16-40	DSM-IV-TR	0.6-4.0	M>F (4:1)
Choo *et al.* [128]	2010	Singapore	2,998 children and adolescents	9-13	DSM-IV	8.7	M>F (3:1)
Rehbein *et al.* [62]	2010	Germany	15,168 schoolchildren	14-16	KFN-CSAS-II	1.7	M > F (10:1)
Thomas & Martin [119]	2010	Australia	1,326 students	15-54	DSM-IV-TR criteria*	5.0	M > F (3:1)
Porter *et al.* [99]	2010	Australia	1,945 gamers	14-40+	DSM-IV-TR criteria*	8.0	NR
Van Rooij *et al.* [129]	2010	Holland	3,048 adolescents	13-16	DSM-IV-TR*	3.0	NR
Wölfling *et al.* [130]	2010	Germany	1,710	13-18	ICD-10**	7.5-8.4	NR
Zamani *et al* [68]	2010	Iran	564 students	"Students"	QACG	17.1	M > F (NR)
Jeong & Kim [70]	2011	South Korea	600 students	12-18	IAT (adapted version)	2.2	M = F (1:1)
Lemmens *et al.* [131,132]	2011	Holland	851 adolescents	11-17	DSM-IV-TR	4.0-6.0	N
Mentzoni *et al.* [133]	2011	Norway	2,500 individuals	15-40	GASA	0.6	M>F
Gentile *et al.* [120]	2011	Singapore	3,034 students	12-18	DSM-IV-TR criteria*	9.0	M > F (3:1)
Hussain *et al* [134]	2012	England	1,420 gamers	12-62	DSM	3.6-44.5	NR

* Specific DSM-IV-TR criteria varied across studies. Adapted DSM-IV criteria for pathological gambling were used in several studies.
** Refers to symptoms of dependence described in the ICD-10.
Note: NR = Not reported; IAT = Internet Addiction Test KFN-CSAS-II = Video Game Dependency Scale; CSVK-R = Fragebogen zum Computerspielverhalten bei Kindern und Jugendlichen; QACG = Questionnaire of Addiction to Computer Games

associated with adjusting to new social obligations and/or living out-of-home for the first time [15, 55].

Negative Consequences of Excessive Video Game Use

Irrespective of whether problematic video game play can be classed as an addiction, there is now a relatively large number of studies all indicating that excessive video game play can lead to a wide variety of negative psychosocial consequences for a minority of affected individuals. These include sacrificing work, education, hobbies, socializing, time with partner/family, and sleep [56-64], increased stress [56], an absence of real life relationships [65], lower psychosocial well-being and loneliness [66], poorer social skills [67,68], decreased academic achievement [28,62, 69,70], increased inattention [56,71], aggressive/oppositional behavior and hostility [69,71], maladaptive coping [56,72,73], decreases in verbal memory performance [48], maladaptive cognitions [60], and suicidal ideation [62].

In addition to the reported negative psychosocial consequences, there are also many reported health and medical consequences that may result from excessive video game playing. These include epileptic seizures [74-79], auditory hallucinations [80], enuresis [81], encoprisis [82], obesity [83-86], wrist pain [87], neck pain [88], tenosynovitis – also called ''nintendinitis'' [89-92], blisters, calluses, sore tendons, and numbness of fingers [93], hand-arm vibration syndrome [94], sleep abnormalities [48,65], psychosomatic challenges [56], and repetitive strain injuries [95].

Taken together, this relatively long list of potential psychosocial and medical negative consequences clearly indicates that excessive gaming is an issue irrespective of whether it is an addiction. It also suggests that more extensive recognition by the medical community is needed of the wide range of potential negative and life-limiting consequences of excessive video play.

Factors Associated with Problematic Video Game Use and Video Game Addiction

A number of studies have examined the role of different personality factors, comorbidity factors, and biological factors, and their association with gaming addiction. In relation to personality traits, gaming addiction has been shown to have association with neuroticism [61,96], aggression and hostility [69,96-98], avoidant and schizoid interpersonal tendencies [67], loneliness and introversion [97], social inhibition [99], boredom inclination [69], sensation-seeking [69,96], diminished agreeableness [61], diminished self-control and narcissistic personality traits [98], low self-esteem [100], state and trait anxiety [96], and low emotional intelligence [101]. Considering the relatively high frequency of co-occurring personality, comorbidity and biological factors, it is hard to assess the etiological significance of these associations with gaming addiction as they may not be unique to the disorder. Further research is therefore needed.

Research has also shown gaming addiction to be associated with a variety of comorbid disorders. These

include attention deficit hyperactivity disorder [54,56,67,71], symptoms of generalized anxiety disorder, panic disorder, depression, social phobia [65], school phobia [56], and various psychosomatic symptoms [56].

Through use of fMRI, biological research has shown that gaming addicts show similar neural processes and increased activity in brain areas associated with substance-related addictions and other behavioral addictions, such as pathological gambling (significant activation in the left occipital lobe, parahippocampal gyrus, dorsolateral prefrontal cortex, nucleus accumbens, right orbitofrontal cortex, bilateral anterior cingulate, medial frontal cortex, and the caudate nucleus [50-52]. It has also been reported that gaming addicts (like substance addicts) have a higher prevalence of two specific polymorphisms of the dopaminergic system (i.e., Taq1A1 allele of the dopamine D2 receptor and the Val158Met in the Catecholamine-O-Methyltransferase) [102], which suggests that among some players there might be some genetic predisposition to develop video game addiction.

Treatment of Problematic Video Game Use and Video Game Addiction

Clinical interventions and treatment for problematic and/or addictive video game play vary considerably in the literature, with most of the very few published studies employing some type of cognitive-behavioral therapy (CBT), pharmacotherapy, and/or self-devised psychological interventions [13-15,50,102]. Currently, the evidence base on the treatment of problematic and/or addictive gaming is limited. Furthermore, the lack of consistent approaches to treating problematic video game playing and video game addiction makes it difficult to produce any definitive conclusions as to the efficacy of treatment, although at this stage the effectiveness of CBT (as with the treatment efficacy of other addictions) appears to be supported by preliminary evidence [15].

Problematic cognitions are thought to maintain problematic gaming behaviors. Research on gamers has identified several attitudes and beliefs associated with excessive playing behavior. These include the belief that no amount of time spent playing is "long enough" that produces a need to continue playing a video game until every level, reward, or feature is completed [15]. Emotional responses associated with in-game rewards and completion of the video game encourage players to then seek out and begin playing new games, thus initiating a never-ending cycle of playing behavior [11,13]. Other common cognitive beliefs among problem video game players include thoughts about gaining power and status through the game, thoughts of mentally escaping from the real world, and thinking of the computer as a companion or "electronic friend" [15].

Motivational interviewing (MI) can be used as part of a therapeutic intervention. MI borrows strategies from cognitive therapy, client-centered counseling, systems theory, and the social psychology of persuasion, and contains elements of both directive and non-directive therapeutic approaches. It is based on theories of cognitive dissonance and attempts to promote a favorable attitude change. Briefly,

instructing video game addicts of the problems of dependency and the advantages of abstinence tends to result in the addict making contradictory arguments. Motivational interviewing encourages clients to give their own reasons for attempting to change their problematic gaming behavior. The underlying theme of such a therapeutic approach is the issue of ambivalence (the mixed feelings the addict has to their behavior), and how the therapist can use MI to resolve it and allow the client to build commitment and reach a decision to change. Nevertheless, there remains a need for controlled and randomized, comparative studies of psychological and pharmacological treatments, administered individually and in combination with each other, to determine the optimal treatment approach.

The lack of comparative treatment studies might suggest that there is a general lack of demand for psychological services for problematic video game play and/or video game addiction [14]. However, this may not necessarily be the case. For instance, Woog [103] surveyed a random sample of 5000 US mental health professionals. Although only 229 participants completed the questionnaire that was used in this study, two-thirds had treated someone with excessive computer use problems in the year prior to the survey. Woog also reported that problematic gaming was most common among 11- to 17-year old clients. However, this client group may be more likely to present in therapy as anecdotal evidence suggests they are typically forced by concerned parents to attend treatment. Adult gaming addicts may not

Table 2.   Selected Characteristics of Treatment Studies for Internet and Online Video Game Addiction

Researcher(s)	Assessment	Extent of Gaming Problem in IA Diagnosis	Conditions	N	Age Range (years)	Treatment Outcome	Treatment Effect Size
Du *et al.* (2010) [107]	Beard's Diagnostic Questionnaire	NC	1. CBT (8 sessions) 2. Control	56	12-17	CBT reduced Internet overuse and associated symptoms, and improved time management skills. Treatment gains were observed at 6-month follow-up.	Cohen's d=1.08 (post) and 1.35 (6-month follow-up)
Han *et al.* (2009) [105]	YIAS-K score of 50 or higher	100% reported a video gaming problem	1. Methylphenidate (8 weeks)	62	8-12	Methylphenidate significantly reduced severity of IA symptoms and overall Internet usage.	NR
Han *et al.* (2010) [50]	>4 hr per day/30 hr per week; YIAS score of 50 or higher; DSM-IV criteria for substance abuse	100% reported a video gaming problem	1. Bupropion (6 weeks) 2. Control	19	17-29	Bupropion reduced cravings for video game play, total game play time, and cue-induced brain activity.	NR
Kim (2008) [104]	K-IAS (score not specified)	NC	1. R/T group counseling (5 weeks) 2. Control	25	NR	10 counseling sessions reduced addiction symptoms and increased self-esteem, as compared to the control group.	NR
Shek *et al.* (2009)	YIAS-10 score of 4; YIAS-8 score of 5; YIAS-7 score of 3; CIAS score of 3	NC	1. Multi-modal counseling (15 to 19 months)	59	11-18	Counseling produced a decrease in IA symptoms. Participants reported high satisfaction with the program.	NR
Su *et al.* (2011) [108]	YDQ score of 5; Internet use of 14 hours or more per week	NC	1. HOSC-NE (one session) 2. HOSC-LE (one session) 3. HOSC-NI (one session) 4. Control	65	NR	All treatment groups demonstrated significant decreases in online activity (hours) and YDQ scores after 1-month. The "expert system" treatments were the most effective.	Cohen's d=0.72–0.82 (YDQ score); Cohen's d=0.75–0.98 (activity)
Young (2007) [106]	IAT (score not specified)	10% reported a video gaming problem	1. CBT (12 sessions)	114	NR	CBT reduced most clients' thoughts and behaviours related to compulsive Internet use, at 6-month follow-up.	NR

<u>Abbreviations:</u> CBT: Cognitive Behavior Therapy; CIAS: Chinese Internet Addiction Scale; DSM-IV: Diagnostic and Statistical Manual of Mental Disorders (4th Edition); HOSC: Healthy Online Self-Helping Center [NE: Natural Environment; LE: Learning Environment; NI: Non-Interactive]; IA: Internet Addiction; IAT: Internet Addiction Test; K-IAS: Korean Internet Addiction Scale; NC: Not clear; NR: Not reported; YDQ: Young's Diagnostic Questionnaire; YIAS: Young Internet Addiction Scale; R/T: Reality Training; YIAS-K: Young Internet Addiction Scale – Korean Version

seek treatment, or seek treatment at a later stage for other psychological problems (e.g., depression) that develop after experiencing the severe negative consequences of gaming.

In South East Asia there appears to be significant demand for treatment for online-related problems including gaming addiction. The South Korean government has reportedly established a network of over 140 counseling centers for treatment of online addiction [104]. In Western countries, gaming addiction clinics have also started to emerge in places such as Holland and the UK [13,16]. There are also treatment groups that are modeled on 12-step self-help treatment (e.g., Online Gamers Anonymous)[13]. However, little detail is known about the treatment protocols or their efficacy.

King and colleagues [15] in a recent review of Internet and video game addiction treatment highlighted that most studies have failed to employ an objective measurement of game usage to confirm participants' self-reported usage at baseline or following intervention. Another issue is that many studies do not include a control group for between-group comparison. Treatment dose and duration also vary considerably across studies, for both pharmacological and non-pharmacological interventions. Unfortunately, the lack of consistent approaches to treating problematic video game play makes it difficult to produce any definitive conclusions as to the efficacy of treatment.

Table **2** presents a summary of the published literature on the treatment of video game addiction. The search protocol described in King, Delfabbro, Griffiths, and Gradisar[16] was used to identify any recent papers not described in their paper. However, no additional papers were identified. All identified studies referred to video game addiction as a component or subtype of Internet addiction. Only three of the seven studies [50,105,106] clearly stated the extent to which problem video gaming was a symptom or component of the Internet addiction. Only two studies [107,108] reported treatment effect sizes. Therefore, the clinical significance of treatment outcomes of published treatment studies is somewhat unclear.

Block [109] suggested that the diagnosis for online problems (including excessive gaming) should be included in the upcoming DSM-V as a compulsive-impulsive spectrum disorder although others have argued it should be considered a form of pathological technology use [110]. Publication of clinical criteria in a future DSM would facilitate and enhance standardization of research and treatment in the gaming studies field. It may also help minimize the potential for inappropriate clustering of clinical behaviors within an overly broad classification of problematic online behavior [15].

GAMING ADDICTION: THE FUTURE?

Future Trends in Video Gaming

The amount and the quality of research in the gaming addiction field has progressed much over the last decade but is still in its infancy compared to other more established behavioral addictions, such as pathological gambling. Before looking at the changes and trends over the last 30 years, this section briefly provides a considered (and somewhat theoretical) examination of what might happen in the gaming addiction field from a number of different standpoints (e.g., methodological, conceptual, technological). These are loosely modeled on the technological trends in gambling recently outlined by Griffiths [111].

- There is likely to be an even bigger increase in empirical research into problematic video game playing and video game addiction. This will of course be dependent on both appropriate funding streams and/or whether gaming addiction ends up being included in future psychiatric disorder classifications (e.g., DSM, ICD, etc.). Future research is likely to include more epidemiological and/or general population data on media use, leading to better insights into the onset and course of problematic video game play and addiction.

- Given the many different screening instruments that have been developed over the last decade, there is likely to be a refinement of video game addiction measures and greater consensus on its conceptualization, either as a single disorder and/or incorporated into other known disorders (e.g., impulse control disorder). This is also likely to lead to improved assessment tools based on such conceptualization(s).

- Measures of gaming use and subsequent behavior are likely to diversify in terms of media use, including social networking sites (SNS) and associated Internet resources [112]. Already, games such as *Call of Duty* and *Battlefield 3* are being released with their own SNS (e.g., *COD Elite*) that track player behavior and provide feedback to players as to how to improve their game (thus functionally reinforcing video game play and thus have implications for excessive and/or potentially addictive play).

- Given the pressure on media enterprises to 'monetize' their business and look for different revenue streams, there is likely to be even greater media convergence between gaming and other more profit-making activities such as gambling [19,113]. Given the well established addictive potential of gambling, this may also have implications for the incidence of video game addiction.

- Gaming on the move is likely to be a big growth area that may have implications for excessive gaming *via* 'convenience' hardware such as handheld gaming consoles, PDA devices, mobile phones, tablet computers, and MP3 players.

- Given the fact that the Internet is gender-neutral, there is likely to be increasing feminization of gaming where increasing numbers of females not only engage in the playing of online games, but also develop problems as a result. Casual gaming online is already popular among females [114]. However, the biggest difference between male and female gaming is likely to be content-based (e.g., males may prefer competitive type gaming experiences whereas females may prefer co-operative type gaming experiences).

- Given the increasing number of research teams in the gambling field being given direct access to gambling companies' behavioral tracking data [115], there is likely to be an increasing number of such collaborations in the gaming studies field.

- Given the increased importance of additional research into the structural and situational characteristics of consumptive behaviors (e.g., smoking nicotine, drinking alcohol, gambling, etc.), it is likely that research on design features within games and their psychological impact (including potential addiction) will increase as well. Such research has already begun [116-118].

- As the diagnosis of video game addiction becomes more legitimate in psychiatric and medical circles, it will lead to better randomized controlled trials on interventions for problematic video game play than the ones already carried out [16]. There is also likely to be an increase in the online medium itself being used as a treatment channel. The reasons that people like to engage in some online leisure activities (i.e., the fact that the online environment is non-face-to-face, convenient, accessible, affordable, anonymous, non-threatening, non-alienating, non-stigmatizing, etc.) may also be the very same reasons why people would want to seek advice, help and treatment online rather than in face-to-face situations [119,120].

CONCLUSIONS

Based on the published empirical studies, and particularly those published over the last decade, it appears that in extreme cases, excessive video game playing can have potentially damaging effects upon individuals who appear to display compulsive and/or addictive behaviors similar to other more traditional addictions. However, the field has been hindered by the use of inconsistent and non-standardized criteria to assess and identify problematic and/or addictive video game use. Furthermore, most studies' recruitment methods have serious sampling biases with an over-reliance on self-selected samples.

Despite these shortcomings, there are several noticeable trends that can be drawn from this review of problematic video game play and video game addiction.

- There has been a significant increase in empirical research decade by decade since the early 1980s.

- There has been a noticeable (and arguably strategic) shift in researching the mode of video game play. In the 1980s, research mainly concerned 'pay-to-play' arcade video games. In the 1990s, research mainly concerned stand alone (offline) video games played at home on consoles, PCs or handheld devices. In the 2000s, research mainly concerned online massively multiplayer video games.

- There has been a noticeable shift in how data are collected. Up until the early 2000s, data about video game behavior was typically collected face-to-face, whereas contemporary studies collect data online, strategically targeting online forums where gamers are known to (virtually) congregate. These samples are typically self-selecting and (by default) unrepresentative of the general population. Therefore, generalization is almost always one of the methodological shortcomings of this data collection approach.

- Survey study sample sizes have generally increased. In the 1980s and 1990s, sample sizes were typically in the low hundreds. In the 2000s, sample sizes in their thousands – even if unrepresentative – are not uncommon.

- There has been a diversification in the way data are collected including experiments, physiological investigations, secondary analysis of existing data (such as that collected from online forums), and behavioral tracking studies.

- There has been increased research on adult (i.e., non-child and non-adolescent) samples reflecting the fact that the demographics of gaming have changed.

- There has been increasing sophistication in relation to issues concerning assessment and measurement of problematic video game play and video game addiction. In the last few years, instruments have been developed that have more robust psychometric properties in terms of reliability and validity. However, there are still some concerns as many of the most widely used screening instruments were adapted from adult screens and much of the video game literature has examined children and adolescents. King and colleagues [15] assert that to enable future advances in the development and testing of interventions for video game-related problems, there must be some consensus among clinicians and researchers as to the precise classification of these problems.

Clearly, there exist a number of gaps in current understanding of problematic video game play and video game addiction. King *et al.* [3] note there is a need for epidemiological research to determine the incidence and prevalence of clinically significant problems associated with video game play in the broader population. There are too few clinical studies that describe the unique features and symptoms of problematic video game play and/or video game addiction. Most of the studies tend to examine problematic video play from the perspective of the individual. However, there is a small body of research suggesting that the characteristics of the video games themselves may have a role in the acquisition, development and maintenance of video game addiction. These studies have investigated the role of structural characteristics of video games in maintaining problem playing behavior [116-118], but there is little empirical research that examines why some individuals may be protected from developing excessive playing habits, or simply mature out of their problem playing behavior.

Another growing concern is the recent explosion of online and mobile gaming although, as yet, little research has been done. There are also strong links between online gaming, gambling, non-gambling fantasy games, role-playing games, board games and card games. These may be an additional cause for concern as youth migrate from free gaming sites to online gambling sites as these have greater

financial consequences and may lead not just to loss of time but to loss of money. It should also be noted that video game playing does not occur in a vacuum but is just one behavior engaged in alongside many others. To date, very few studies have been used to examine links between video games and other risk behaviors (e.g., gambling, drug and alcohol use, seatbelt use, poor school performance, conduct problems, truancy, delinquency, violence and sexual activity).

By examining the evolution of the literature on gaming addiction, this review has demonstrated that (i) past research was fundamentally different from more contemporary studies, (ii) the amount and quality of research has substantially increased over a short amount of time, and (iii) there are many potential avenues for future research including prevalence of problems, diagnostic and screening development, and treatment efficacy. While the current empirical base is relatively small, gaming addiction has become a more mainstream area for psychological and psychiatric research and is likely to become an area of significant importance given the widespread popularity of gaming.

CONFLICT OF INTEREST

The author(s) confirm that this article content has no conflicts of interest.

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