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FACULTY OF SOCIAL, HUMAN AND MATHEMATICAL SCIENCES

School of Psychology

Exploring the associations between reward disturbances, internet addiction and depression

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UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF SOCIAL AND HUMAN SCIENCES

Psychology

Thesis for the degree of Doctor of Clinical Psychology

EXPLORING THE ASSOCIATIONS BETWEEN REWARD DISTURBANCES, INTERNET ADDICTION, AND DEPRESSION

A review of the literature on the relationship between Internet Gaming Disorder (IGD) and depression was conducted; a total of 22 papers met inclusion criteria. The review was structured by three questions: 1) Is there an association between IGD and depression? 2) What mediators and moderators may be involved in this relationship? 3) Is there any evidence to suggest causal pathways? The majority of the reviewed research identified an association between IGD and depression. Some potential mediators and moderators were identified, including self-esteem and loneliness, although methodological limitations restricted the inferences that could be drawn from the findings. The research is still in its infancy and more sophisticated research methods are required to further understand the nature of the association between IGD and depression.

A quasi-experimental design was used to explore the proposed association between reward disturbances, internet addiction and depression. Specifically, it was hypothesised that the internet addict group would experience reduced 'liking' of positive stimuli and increased 'wanting' of internet stimuli, whilst being less motivated to obtain reward in comparison with controls. The internet addiction group reported significantly higher depression scores, however there were no differences in groups' 'liking' of stimuli, yet the internet addiction group reported greater arousal overall. There were no between group differences for motivation, although within group correlations revealed that for the internet addiction group there was a dissociation between 'liking' of rewards and motivation to obtain them; there was also a positive correlation between BDI-II scores and motivation. These findings were not in line with hypotheses, and may suggest that the internet addiction group experience greater reward sensitivity, and are therefore drawn to internet use to satiate this heightened reward sensitivity; or that internet addiction may serve as a form of experiential avoidance, thus potentially maintaining depression.

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Declaration of Authorship

I, Phillip Bishop, declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

Title:

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;

2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;

3. Where I have consulted the published work of others, this is always clearly attributed;

4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;

5. I have acknowledged all main sources of help;

6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;

7. None of this work has been published before submission

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Finally, I would like to thank all my friends and family for tolerating the complete lack of contact they have had from me for the past year or two. A special thanks to my partner Kate for putting up with me when I've been stressed.

Chapter 1: Literature Review: Exploring the association between Internet Gaming Disorder and Depression

1.1 Introduction

1.1.1 Depression

Depression is a serious, recurrent disorder, associated with reductions in quality of life and increases in mortality (Kessler & Bromet, 2014); it is estimated that 350 million people worldwide are affected (Marcus et al., 2012). Of concern, longitudinal studies suggest that depression has a rising global prevalence rate, and leading to conclusions that we are in the midst of an epidemic (Hidaka, 2012).

1.1.2 Internet Use

Hidaka (2012) states that 'modernity' is a possible cause for this epidemic, and argues that resultant changes in lifestyle have led to reductions in physical activity, sleep, and increases in social isolation which may be leading to the increases in depression. Internet use in particular has been associated with reductions in physical activity (Matusitz & McCormick, 2012), sleep (Hale & Guan, 2015), and increased social isolation (Kraut et al., 1998) and could therefore be a possible avenue for further exploration in increases in depression. Consistently, the internet is becoming increasingly accessible; in the UK, the Office for National Statistics (2015) reported that 39.3 million adults accessed the Internet every day in 2015, 23.1 million more than in 2006. When comparable records began; 86% of households now have internet access, in comparison with 57% in 2006.

It is clear that not everyone that uses the internet becomes depressed. However, its use can become problematic and represented by urges, preoccupation or difficult to control behaviours that relate to access and can lead to impairment or distress (Shaw & Black, 2008). A recent meta-analysis (Ho, et al., 2014) found a significant association between internet addiction and depression: 26.3% of the internet-addicted patients (n=1641) studied had depression, in comparison with 11.7% of controls (n=11,210), indicating a pooled odds ratio of 2.77. However, the authors concluded that the direction of this relationship remains unclear, with further longitudinal studies required to help establish a cause-effect relationship.

1.1.3 Gaming

The relationship between internet addiction and depression has received a great deal of research attention, yet internet addiction may best be understood through its specific uses, rather than as a unitary construct (Montag et al., 2015). One such use that is rapidly growing in popularity is online gaming. A recent survey by the Internet Advertising Bureau (2014) estimated that 33.5 million (69%) Britons or 82% of 8-65 year olds play video games. This is not just restricted to teenagers, with people over 44 years of age accounting for 27% of the gaming audience. Nor is it restricted to males, with females representing 52% of gamers.

1.1.4 Internet Gaming Disorder (IGD)

Video games attract people due to their ability to satisfy basic psychological needs for competence, autonomy and relatedness (Przybylski, Rigby, & Ryan, 2010). However, there may be a darker side to video game use, with cross-theoretical research arguing that video game addiction is a meaningful concept, and even comparable to substance addiction in kind, if not magnitude (Hellman et al., 2013). King et al. (2013) conducted a meta-analysis of research on video game addiction since 2000, exploring the key diagnostic features and found the majority of assessment tools assessed three features: withdrawal; loss of control; and conflict associated with interpersonal relationships, work and/or school commitments. It was argued that these three features may define the core features of internet addiction.

The significance of this growing body of research was reflected in the latest Diagnostic and Statistical Manual (DSM-V) (American Psychiatric Association, 2013), which included a proposed disorder of Internet Gaming Disorder (IGD) as an appendix (see Appendix A for details of diagnostic criteria). The lack of standardized diagnostic criteria and terminology made generalizing existing research findings difficult (and were cited as reasons for IGD's omission from the main manual), yet it was concluded that the disorder warranted further research (Petry & O'Brien, 2013). As noted, a range of different terms for the disorder have been used in the literature, yet for the remainder of this review, the term Internet Gaming Disorder (IGD) will be used to refer to those who experience problematic or addictive gaming.

IGD has an estimated prevalence of between 1.6% (Muller et al., 2015) and 3.62% (Strittmatter et al., 2015) amongst European adolescents. This figure may be even higher in some Asian countries; for example, 8.7% amongst Singaporean youth (Choo et al., 2010).

1.1.5 Purpose of this review

Online gaming constitutes an increasingly popular use of the internet and has been identified by the DSM as a possible mental health disorder warranting further research. Whilst still in its infancy, research is beginning to explore the possible impacts of IGD. Within this emerging body of literature, studies are beginning to focus upon an association with depression. General internet addiction has been associated with depression for a number of years (e.g. Adalier & Balkan, 2012), so it would seem logical to question whether the same was true of IGD.

Despite this growing interest, to the author's knowledge, no current review of the relationship between depression and online gaming has been undertaken. Therefore it is important to review and critically evaluate existing research to explore for a potential association with depression. Should the evidence indicate such an association, this could have important clinical and research implications for the prevention and/or treatment of depression.

The aim of this review was therefore to examine evidence for association between IGD and depression and to explore for potential mediating and moderating factors in the relationship. Finally, research examining the causal direction was explored.

1.1.6 Review Questions

1. Is there an association between internet gaming and depression?
2. If so, what additional factors may be involved as moderators and mediators in this relationship?
3. Finally, is there any evidence as to the direction of this relationship?

1.2 Method

1.2.1 Eligibility Criteria

Due to the relatively limited literature on IGD and depression, it was not possible to exclude studies based on design. Therefore, included studies utilised three types of design: 1) cross-sectional designs, which were required to include both measures of depression and problematic gaming; 2) prospective longitudinal designs to measure both gaming and depression initially, and then at least depression at a later assessment point; 3) studies that used experimental designs to manipulate the amount of gaming an individual was exposed to and measure subsequent changes to depression.

1.2.1.1 Participants

To meet inclusion criteria for the study, it was decided that studies were required have participants under 65 years of age. The rationale for this was that depression in older age can differ fundamentally from earlier in the lifespan, with lower prevalence, different risks (including the likelihood of stressful life events) and aetiology (including neurobiological changes) (Fiske, Wetherell, & Gatz, 2010). There were no exclusions based upon the population that the sample was drawn from and participants were included from both clinical and non-clinical populations.

1.2.1.2 Types of measures

Studies were included that measured both depression and video game use, and explored an association between the two. Video gaming use was operationalized as playing computer games either online or offline: although the DSM-V has labelled the disorder Internet Gaming Disorder, it explicitly states that this can incorporate both online and offline games (Petry, 2015). Within this, there needed to be a specific measure of gaming, to ensure a distinction from more generic internet or technology use. Ideally this would have been measured through a validated gaming addiction measure, yet the relative paucity of research necessitated the additional inclusion of studies measuring problematic gaming by time spent playing.

Depression was operationalized as: an alteration in mood (feelings of loneliness, sadness, apathy); a negative self-concept associated with self-blame; changes to sleep, appetite or libido, changes in activity levels; and regressive wishes (to hide, escape, or die) (Beck & Alford, 2014).

1.2.2 Information sources

Publications were identified for the present review via a computerised search. Online databases that were used included: PubMed and Web of Science (which included a search of the MEDLINE database). The search took place on 11 November, 2015. Due to the recent development of the field it was not considered necessary to limit the search to a specific time period.

1.2.3 Search Terms

Table 1 lists all of the search terms that were used to identify relevant studies.

Table 1

Search Terms Entered in Databases

	Depression	Gaming
Search terms	Depression; depress*; "well being"; Well-being mental health	Video games; computer games; internet addiction; MMORPG; internet gaming disorder; problematic video gaming; gaming addiction; online game

Note. MMORPG = Massively Multiplayer Online Role Playing Game

1.2.4 Study Selection

From the search results, titles were initially scanned, and studies that were clearly not relevant were excluded. Abstracts of the remaining papers were then assessed for suitability. Additionally, the reference lists of review papers were scanned for relevant studies (e.g. Kuss & Griffiths, 2012; Peukert, Sieslack, Barth, & Batra, 2010), as were the reference lists of all of the papers included for review.

1.3 Results

A total of 4,899 papers were returned from the search results of the two databases searched. Of these papers, 4,737 were excluded after reading the title as they were irrelevant. This left a total of 162 studies, as detailed in Figure 1. Following removal of papers that were duplicates, or irrelevant, a final 22 papers were selected for the review.

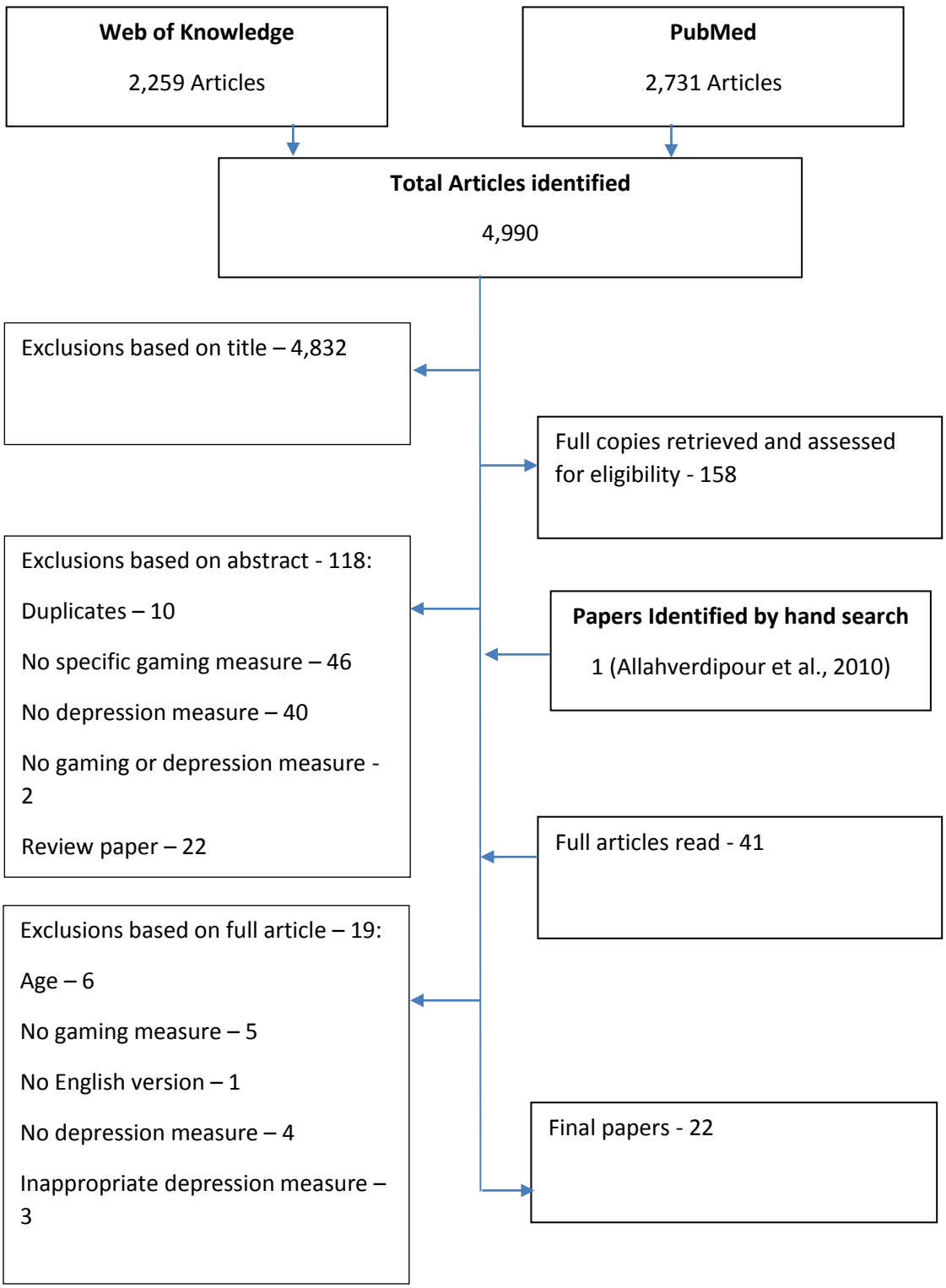

Figure 1: Graphical representation of literature search results

Table 2

Details of studies on depression and Internet Gaming Disorder

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
Allahverdipour, Bazargan, Farhadinasab & Moeini (2010)	Cross-sectional study designed to examine correlates of excessive video game use in an Islamic country	444 students attending schools randomly selected from all middle schools in an area. 51% female, 49% male. Age range: 12 to 15	General Health Questionnaire (4 subscales: somatisation, anxiety, depression, and social dysfunction); Orpinas' Aggression Scale; perceived side-effects of game use; video violence exposure	No significant association between depression and game playing (p =0.06)	Strengths: explores gaming and depression association in a novel population. Limitations: no gaming addiction measure; low computer game use in sample	A – Moderate B – Weak C – N/A D – Moderate E – Strong F – N/A Overall: Moderate
Bickham, Hswen, & Rich	Longitudinal study designed to assess the association between	126 12 to 15 year olds recruited from public schools, summer	Time use diaries for media use; ecological momentary assessment	Video game playing was unrelated to	Strengths: Media use was assessed by time	A –Weak B – Weak

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
(2015)	different types of media use and young adolescents' depressive symptoms; to explore the potential for household media rules to reduce young people's depression	camps and after school clubs in a small city in North-Eastern USA; males 53%, females 47%	(capture activities, emotions, and context); Beck Depression Inventory for Primary Care; media rules and regulations (questions about restrictions placed on media use by parents)	depressive symptoms but mobile phone use and TV viewing were	use diaries and ecological momentary assessment in addition to self-report measures. Limitations: small sample size; no measure of problematic gaming, only time spent	C – N/A D – Moderate E – Strong F – Strong Overall: Weak
Brunborg, Mentzoni & Froyland (2014)	Two-wave panel design study exploring whether video game addiction is associated with depression, alcohol use, academic achievement and conduct problems	1,928 Norwegian adolescents, nationally-representative sample; age range 13 to 17 years; 55.5% female, 44.5% female	Game Addiction Scale for Adolescents; video game time exposure; Hopkins Symptom Checklist (depression); academic achievement; heavy	Video game addiction was related to depression, lower academic achievement, and conduct	Strengths: nationally representative, large sample; design allows for inspection of temporal	A – Strong B – Weak C – N/A D – Moderate E – Moderate

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
			episodic drinking	problems, but time spent on video games was not related to any of the studied negative outcomes	stability of measures. Limitations: Large drop out from Time 1 to Time 2; only 6 items on depression measure, four of which could be measuring alternative difficulties (two tiredness, two anxiety)	F – N/A Overall: Moderate
Dupuis & Ramsey (2011)	Cross-sectional study exploring relationship between depression, gaming, and perceived	321 participants recruited from psychology course and online. No gender	Social involvement in games; time spent playing; Multidimensional	Involvement in MMORPGs was not associated with perceived	Strengths: explores social aspect of gaming Limitations:	A – Moderate B – Weak C – N/A

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
	social support	information described	Scale of Perceived Social Support; Center for Epidemiological Studies Depression Scale (CES-D)	social support; lack of perceived social support was associated with higher levels of depression	greater focus on social involvement than on gaming addiction; did not explore direct association between gaming and depression	D – Moderate E – Moderate F – N/A Overall: Strong
Ferguson & Rueda (2010)	Study exploring the effects of violent video games. Experimental design, four conditions: violent (bad guy), violent (good guy), non-violent, no game	103 young adults (23.6 years) recruited from U.S university, 39.8% female, 60.2% male	Frustration task (paced auditory serial addition task); Taylor Competitive Reaction Time Test (aggression measure); Aggression Questionnaire-Short Form; State Hostility Scale; Beck	Violent games reduce depression through mood management: real-life video game play was predictive of decreased	Strengths: Experimental design Limitations: inappropriate depression measure; very short exposure to games (45	A – Weak B – Strong C – Strong D – Moderate E – Weak F – N/A

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
			Depression Inventory-II	depression following the frustration task	minutes)	Overall: Weak
Gentile et al. (2011)	Longitudinal panel study designed to assess whether pathological gaming is a primary or secondary problem	2,998; 27% female, 73% male; recruited from Primary schools in Singapore	General Media Habits Questionnaire; Barratt Impulsiveness Scale; Personal Strengths Inventory; Children's Empathic Attitudes Questionnaire; Normative Beliefs about Aggression; Hostile Attitude Bias; Self-report of Aggression; Parent-Family Connectedness; Pathological Video	Depression, along with anxiety, social phobia and lower school performance seemed to act as outcomes of pathological gaming	Strengths: longitudinal design with three time points, large sample Limitations: due to the large sample size, very small effect sizes were reported as significant yet likely had little clinical	A – Strong B – Moderate C – N/A D – Moderate E – Strong F – Strong Overall: Strong

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
			Game Use; Problematic Gaming; ADHD Screen; Asian Adolescent Depression Scale; anxiety; Social Phobia; School performance		significance	
Hyun et al. (2015)	Cross-sectional study designed to identify factors that may influence the development of online gaming addiction	408 participants: 255 with online gaming addiction, 153 healthy controls. Korea. Age range: 12 to 45. 11.5% females, 88.5% males	Korean-Wechsler Adult Intelligence Scale; Wisconsin Card Sorting Test (executive function); Adupauls' ADHD Scale; Beck Depressive Inventory; Beck Anxiety Scale; BIS/BAS; Family Environment Scale	Psychological factors (attention, mood, anxiety and impulsivity) were strongest risk factors for online gaming addiction for patients with pure online	Limitations: Although the factors are labelled as risk factors for online game addiction, the cross-sectional design would not make it possible to tell	A – Moderate B – Weak C – Weak D – Moderate E – Strong F – N/A Overall: Weak

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
			(Family interaction); Social Avoidance and Distress Scale; Two - Factor Self-esteem Scale- Korean	gaming addiction	whether they were predictors or consequences; very low percentage of females	
King, Delfabbro, Zwaans & Kaptsis (2013)	Cross-sectional study designed to assess the clinical features of pathological video gaming and pathological Internet use in a normative Australian adolescent sample	1,287 Australian students, aged 12 to 18; equal gender representation (numbers not reported)	PTU Checklist (two columns, one for Internet addiction, one for problematic gaming); RCADS (anxiety and depression); SAS-A (social anxiety); Revised UCLA Loneliness Scale; TISS (social skills)	Depression was significantly greater in the PVG & PIU group and the PIU group, in comparison with the no PTU group. There was no significant	Strengths: explored Internet addiction as well as gaming; Limitations: only 23 participants in the PVG category (1.7%)	A – Moderate B – Weak C – Moderate D – Moderate E – Moderate F – N/A Overall: Moderate

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
				difference between the PVG group and the no PTU group in terms of depression		
Kiraly et al. (2014)	Cross-sectional study examining the interrelation and overlap between PIU and POG in terms of gender, school achievement, time spent using the Internet and/or online gaming, psychological well-being, and preferred online activities	2,073 Hungarian 16 year olds; 50% male, 50% female. Recruited from participating schools in a European survey on alcohol and other drugs	Problematic Internet Use Questionnaire (6-items); Problematic Online Gaming Questionnaire Short-Form; Centre of Epidemiological Studies Depression Scale (short-form); Rosenberg's Self-Esteem Scale	Depressive symptoms were associated with both PIU and POG, affecting PIU slightly more	Strengths: differentiated Internet gaming disorder from more general Internet addiction	A – Strong B – Weak C – N/A D – Moderate E – Moderate F – N/A Overall: Moderate

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
Laconi, Tricard, & Chabrol (2015)	Cross-sectional study design exploring the differences between Generalised Problematic Internet Use and Specific Problematic Internet Use	378 participants, aged between 18 and 65; recruited online through Facebook and via an online platform available to students at a university in France	Internet Addiction Test; Game Addiction Scale; Canadian Problem Gambling Index; Sexual Compulsivity Scale; Bergen Work Addiction Scale; Shorter PROMIS Questionnaire (shopping); Centre for Epidemiological Studies-Depression Scale; Rosenberg Self-Esteem Scale; Satisfaction with Life	Significant correlation between gaming and depression, in males (0.32) and females (0.34) and for young adults (0.29) but not adults (correlation not reported)	Strengths: differentiated gaming and general Internet use; used a gaming measure. Limitations: numerous variables for relatively small sample size	A – Weak B – Weak C – N/A D – Moderate E – Moderate F – N/A Overall: Weak

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
			Scale			
Lee & Jeong (2014)	Cross-sectional study designed to assess a resilience model in the relationship between worry, daily internet video game playing, daily sleep duration, mentors, social networks and depression	6,068 Korean undergraduate and graduate students; 23.9% female, 76.1% male	Korean version of the Beck Depression Inventory; number of worries; number of mentors; number of campus social support networks; hours spent gaming per day	Daily hours spent video gaming and daily sleep duration partially mediated the association between number of worries and depression; the mediating effect of daily hours spent video gaming on the relationship between the	Strengths: explored the role of social support Limitations: Video game play analysed as a moderator between worries and depression; time measured rather than addiction	A – Strong B – Weak C – N/A D – Moderate E – Weak F – N/A Overall: Weak

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
				number of worries and depression was moderated by the number of mentors and the number of campus social networks, respectively		
Lemola et al. (2011)	Cross-sectional design exploring whether amount and circadian time of habitual computer game playing were related to depressive symptoms	646 adolescents, aged between 13 and 30; 90.9% male, 9.0% female; recruited from online game World of Warcraft and connected forums	Insomnia Severity Index; hours and times of game playing; Centre for Epidemiological Studies Depression Scale	Habitual computer game playing between 10pm and 6am was related to an increased risk of depression,	Strengths: explored time of sleep, as well as total duration Limitations: no control group to compare sleeping habits	A – Strong B – Weak C – N/A D – Moderate E – Strong

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
				independent of the total amount of playing time	and depression of non-gamers	F – N/A Overall: Moderate
Li, Liau, & Khoo (2011)	Cross-sectional study exploring whether actual-ideal self-discrepancy is related to pathological gaming through escapism, as a means of reducing depression for adolescent massively multiplayer online gamers	161 students with MMO gaming experiences, recruited from two secondary schools in Singapore; age range 13 to 15; 49.1% boys, 50.9% girls	Self-Attribute Statement Scale; MMO Player Motivation Scale (escapism items); Pathological gaming (10-item scale developed from DSM-IV-R pathological gambling items); Asian Adolescent Depression Scale	Depression mediated the relationship between AISDs and escapism; escapism mediated the relationship between depression and pathological gaming	Strengths: explored role of escapism; proposed a mediational model with good face validity; explored the direct association between depression and problematic gaming	A – Weak B – Weak C – N/A D – Moderate E – Moderate F – N/A Overall: Weak

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
Mentzoni et al. (2011)	Cross-sectional study exploring the prevalence of video-game related problems and addiction	816 participants randomly selected from the Norwegian National Registry. Age range: 15 to 40; 43.8% male, 56.2% female	Video game use (whether and to what extent); Gaming Addiction Scale for Adolescents; Satisfaction with Life Scale; Hospital Anxiety and Depression Scale	Problematic use of video games was associated with elevated levels of depression	Strengths: validated gaming addiction scale; nationally representative sample	A – Weak B – Weak C – Moderate D – Moderate E – Strong F – N/A Overall: Weak
Primack, Swanier, Georgiopoulos, Land, & Fine (2009)	Longitudinal study designed to assess the association between media exposure in adolescence and depression in young adulthood	4,142 adolescents from a nationally representative sample; 52.5% female, 47.5% male	Centres for Epidemiological Studies-Depression Scale; media exposure; sociodemographic covariates	No consistent relationship found between development of depression and exposure to computer games	Strengths: large sample size. Limitations: Seven year latency period, during which media use was not monitored; only measured	A – Strong B – Moderate C – N/A D – Moderate E – Weak F – Moderate

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
					until 2002 - great leaps in gaming technology since (i.e. online, which is likely more addictive)	Overall: Moderate
Strittmatter et al. (2015)	Cross-sectional study examining whether gamers differ from non-gamers in relation to psychological well being among students who show pathological Internet use	8,807 European representative students (Estonia, Germany, Italy, Romania, and Spain). 55.5% female, 44.5% male. Mean age: 15.0 years	Young Diagnostic Questionnaire (problematic Internet use); type and frequency of Internet use; Beck Depression Inventory-II; World Health Organisation Five Well-being Index; Paykey Suicidal Scale	Increased risk of depression in those with PIU-G compared with controls; Students with PIU-NG had a higher risk of depression than those with PIU-G	Strengths: very large sample, covering different countries within Europe	A – Strong B – Weak C – Moderate D – Moderate E – Strong F – N/A Overall: Moderate

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
Thomee, Harenstam, & Hagberg (2012)	Prospective cohort study examining whether high computer use is a prospective risk for developing mental health symptoms	4,163 young adults (20-24 years old), population-based sample in Sweden; 65% female, 35% male	Stress (single-item variable); Karolinska Sleep Questionnaire; Primary Care Evaluation of Mental Disorders (2 depression items); social support; sociodemographic information	Medium computer gaming was associated with symptoms of depression	Strengths: large, population-based sample Limitations: depression measure only comprised of 2 items	A – Weak B – Moderate C – N/A D – Moderate E – Weak F – Moderate Overall: Weak
Tortolero et al. (2014)	Cross-sectional study examining the relationship between playing daily violent video games and depression.	5,147 fifth-grade students in the U.S. cities; mean age 11.2 years; 48.9% boys, 51.1% girls	Major Depressive Disorder Scale of the DISC Predictive Scales; video game time exposure; video game violence	Students who reported playing high violence games for over two hours per day reported significantly	Strengths: large sample size; explored a specific genre of game (violent). Limitations: No	A – Strong B – Weak C – Moderate D – Moderate

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
				more depression than those who reported playing low violence games for under two hours per day	gaming measure, only time spent playing	E – Weak F – N/A Overall: Weak
Valadez & Ferguson (2012)	Experimental design, six conditions - violent game play, non-violent game play, non-violent game play within an otherwise violent game; 45 minute game play or 15 minutes	100 participants, 49% females, 51% male; age range 18 to 45 (mean age 19.9)	State Hostility Scale; BDI-II; matrices subscale of Kaufman Brief Intelligence Test-II; Paced Auditory Serial-Addition Task; video game habits (what games and how often)	Neither randomised video game time nor video game type had any effect on depression	Strengths: Explored two lengths of exposure time and different game genres. Limitations: 45 minutes was the longest exposure time, yet is still brief in	A – Weak B – Strong C – Strong D – Moderate E – Weak F – N/A Overall: Moderate

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
					comparison to real-life exposures; BDI-II inappropriate measure for short-term mood change	
van Rooij et al. (2010)	Data-driven identification of a group of addicted online gamers	Online gamers in Holland,467 participants, 13 - 16 year olds	CIUS, weekly hours gaming; UCLA Loneliness Scale; Depressive Mood List; Revised Social Anxiety Scale for Children; RSES	Significant differences found for depressive mood in the most addicted group (out of 6 groups) vs other groups	Strengths: Explored different categories of gamers; helped to delineate differences between total time spent gaming and addiction, and	A – Strong B – Weak C – N/A D – Moderate E – Strong F – N/A Overall: Moderate

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
					the consequences of each Limitations: used two time points, effectively giving two chances to find results	
van Rooij et al. (2014)	Cross-sectional study looking at association between video game addiction, depressive mood, negative self-esteem, loneliness, social anxiety, education performance, and use of cannabis, alcohol and	8478 adolescents recruited from schools in Holland; mean age 14.2 years; 49% boys, 51% girls	VAT; RSES; UCLA Loneliness Scale; 6-item Depressive Mood List; Revised Social Anxiety Scale for Children	High problematic gamers showed significantly higher scores on depressive mood measure than non-gamers	Strengths: large sample size Limitations: limited 6-item depression measure	A – Strong B – Weak C – Moderate D – Moderate E – Strong F – N/A

Author	Design and Aims	Sample	Measures	Main Findings	Critique	QATQS Rating (see note for rating details)
	nicotine					Overall: Moderate
Wei, Chen, Huang & Bai (2012)	Cross-sectional study exploring the association between online gaming and depression, somatic symptoms, and social phobia	722 online gamers; mean age 21.8; 83.2% male, 16.8% female	Depression and Somatic Symptoms Scale (DSSS); Social Phobia Inventory (SPIN); Chen's Internet Addiction Scale (CIAS); Internet and online gaming hours and history	Depression was associated with female gender, higher social phobia, higher internet addiction scores, and longer weekly online gaming hours	Strengths: used a validated gaming addiction measure Limitations: no control group; generic Internet addiction test, not gaming	A – Moderate B – Weak C – Moderate D – Moderate E – Weak F – N/A Overall: Weak

Note. QATQS (Quality Assessment Tool for Quantitative Studies), National Collaborating Centre for Methods and Tools (2008); A = Selection Bias; B = Design; C = Confounders; D = Blinding; E = Data Collection Measures; F = Withdrawals and Drop-outs.

MMORPG = massively multiplayer online role playing game; MMO = Massively Multiplayer Online; ADHD = Attention Deficit Hyperactivity Disorder; PTU = Problematic Technology Use; PVG = Problematic Video Game Use; PIU = Problematic Internet Use; TISS = Teenage Inventory of Social Skills; POG = Problematic Online Gaming; PROMIS = Patient Reported Outcomes Measurement Information System; PIU-G = Problematic Internet Use-Gaming; PIU-NG = Problematic Internet Use - Non-Gaming; BDI-II = Beck Depression Inventory-II; RSES = Rosenberg Self-Esteem Scale; VAT = Video Game Addiction Test; AISD = Actual-Ideal Self-Discrepancy

1.3.1 Cross-Sectional Studies

1.3.1.1 Association between IGD and depression

In total, 15 of the studies examined for the presence of an association between gaming and depression. Of these, only two studies did not find one. Of the remaining seven, two were experimental in design, and four were longitudinal, so will be examined in detail below. A final study (Dupuis & Ramsey, 2011) used a mediational model and did not report a direct association between gaming and depression.

1.3.1.2 Studies that found an Association between IGD and Depression

Eight of the 13 studies that found an association between gaming and depression recruited from a general population; many samples were large and nationally representative (combined *n* = 33,695) (see Table 2 for full details). The majority of these studies sampled adolescents, although one included those aged between 15 and 40 (Mentzoni et al., 2011), one undergraduates (Lee & Jeong, 2014), and another those between 18 and 65 (Laconi et al., 2015). The majority of these studies used European samples, with two sampling from Asia, and one from the U.S.

An additional five studies specifically recruited gamers to explore their depression scores in relation to the severity of their gaming dependence. Just one of these compared gamers with non-gamers (Hyun et al., 2015); another examined data from a nationally representative sample in Holland (van Rooij et al., 2010) yet included only those classified as online gamers in their analysis.

These studies generally recruited from Asian countries (Taiwan, Korea, and Singapore), with two using European samples. Overall, these studies included smaller sample sizes than those that recruited from general samples (combined *n* = 2404).

Table 3

Effect sizes of the association between gaming and depression

Study	Effect Size
Hyun et al. (2015)	r =0.16
Brunborg et al. (2014)	$\dot{\rho}$ = 0.12 (t1), $\dot{\rho}$ = 0.11 (t2)
Mentzoni et al. (2011)	d =0.20
Wei et al. (2012)	r =0.22 (hours)
Lee & Jeong (2014)	r =0.04 (hours)
Lemola et al. (2011)	r =0.20 (playing at night); total playing duration (r =0.03, n/s) (hours)
Kiraly et al. (2014)	r =0.20
Laconi et al. (2015)	Males, r = 0.32; females, r =0.34
Van Rooij et al. (2014)	Boys, d =0.91; girls, d =1.23
Strittmatter et al. (2015)	d =0.58
Van Rooij et al. (2010)	r =0.09
Tortolero et al. (2014)	d =0.16 (high time, high violence) (hours); males, d =0.19
Li et al. (2011)	r =0.31

Note. Hours = studies that measured problematic gaming by hours spent, rather than a specific addiction measure

1.3.1.5 Results of studies that found an association between gaming and depression

A summary of effect sizes can be seen in Table 3. Notable findings were: Lemola et al. (2011) did not find an association between total hours spent gaming, but did find one with habitual playing at night and depression (r =0.20). Laconi et al. (2015) did not find an association between gaming and depression in adults, but did for young adults (r =0.29), although the adult sample was comparatively much smaller. Van Rooij et al. (2010) identified an addicted subgroup of heavy gamers with significantly higher depression scores than the other groups; this was a very small

subgroup, 3.3% of the sample. Tortolero et al. (2014) found an association between depression and violent games, but not for non-violent games. Overall, these mixed findings indicate that the relationship is a far from straightforward one.

1.3.1.6 Strengths of studies that found an association

Nine of the studies used validated gaming addiction measures to assess IGD. Participants were drawn from a variety of continents and many studies used large, nationally representative samples. A range of ages were included, indicating that the reported associations are not tied to a particular age range, although the predominant focus was on adolescents.

1.3.1.7 Limitations of studies that found an association

Four of the studies did not use gaming measures (Lee & Jeong, 2014; Tortolero et al., 2014; Wei et al., 2012; Lemola et al., 2011): Lee and Jeong (2014) used daily hours spent gaming as a measure which had a very small effect size (r =0.04), yet was still significantly associated with depression, possibly due to the large sample size (n =6068). Equally, many studies used different measures of gaming addiction, all measuring slightly different constructs, with some using DSM-IV gambling criteria (APA, 1994), and others using general internet addiction scales. Therefore classification was inconsistent, possibly influencing the findings. Whilst a range of nationalities were studied, there was a dearth of studies in the U.S. and non-Westernised cultures, other than the solitary Iranian study (Allahverdipour et al., 2010).

All of the studies used self-report measures of gaming and were often conducted on adolescents so it is unclear how accurate these measures may have been, particularly the ones using time spent gaming as a measure. Finally, the majority of studies did not differentiate between types of games, and as Brunborg et al. (2014) note, some categories may be more problematic than others.

1.3.1.8 Studies that found no Association between Online Gaming and Depression

Of the two studies that did not find a significant association, Allahverdipour et al. (2010) identified a trend between gaming and depression (p = 0.06) (effect size could not be calculated due to insufficient data reporting); and interestingly found that those in the moderate use group had lower depression scores than those in the non-gamer or high gamer groups. King et al. (2013) sampled 1,287 Australian adolescents aged 12 to 18. Participants were classified as having no problematic technology use (PTU), problematic video gaming (PVG), problematic Internet use (PIU), or problematic video game and Internet use (PVG & PIU). Those classified with PIU, and

those with both PVG and PIU were found to have higher depression than controls, whereas those with PVG alone did not significantly differ. Based on the overlap between PIU and PVG, it is therefore difficult to conclude that there was no association between gaming and depression.

1.3.1.9 Strengths of studies that found no association

Both studies had relatively large sample sizes, with a combined 1,731 participants. They were also from countries with very different cultures (Iran and Western Australia) to the majority of other studies that were based in Asia or Europe.

1.3.1.10 Limitations of studies that found no association

Methodological limitations of the two studies could have affected results, leading to the findings that IGD and depression were not associated. For example, Allahverdipour et al. (2010) measured problematic gaming by time, rather than a measure of gaming addiction. Time spent gaming does not necessarily indicate how problematic it is (Przybylski 2009); therefore, it is impossible to tell how many participants (if any) could be classified as having IGD. Time spent playing games may be a predictor of addiction (Gentile et al., 2011), yet the highest use category was only 10 hours or more per week; and was similar for those with PTU in King et al.'s (2013) study, with an average use of 6.7 hours per week. This is less than an average gamer's 11.3 weekly hours in Europe, or 12.5 hours in the U.S. (Statista, 2013), and therefore not necessarily indicative of gaming addiction. The proposed DSM-V IGD requires the symptoms to be paired with clinically significant impairment or distress (American Psychiatric Association, 2013) and it is arguable that this limited time would not be indicative of impairment. It is possible that cultural differences in these two locations (Iran and Western Australia) led to less frequent (and possibly problematic) gaming.

King et al. (2013) classified only 23 participants in the PVG-only category, out of a sample of 1,287 and it is therefore difficult to make more general conclusions based upon this small percentage. Allahverdipour et al.'s (2010) sample was considerably smaller at 444, and may therefore have included even smaller numbers with IGD. Finally,

1.3.1.11 Summary of the association between IGD and depression

The majority of evidence would suggest an association between IGD and depression, particularly during adolescence. Cross-sectional designs do not allow for determination of a cause-effect relationship and the reported associations could therefore be explained in a number of ways, with very different clinical implications. Those who experience depression could be drawn to

gaming as a means of coping; IGD could lead to subsequent depression; or further variables may mediate this relationship. On balance, it is unlikely that the answer is a straightforward one, and it is more likely that IGD and depression interact and exacerbate each other (Brunborg et al., 2014).

The results highlight the scarcity of studies that have explored video game use in adults (with those that did finding mixed results). A recent survey in the U.S. found that only 26% of gamers are under-18 years of age (Entertainment Software Association, 2015); therefore, adults are a very relevant group, yet largely overlooked in the current literature.

1.3.2 Other factors that may mediate or moderate the association between depression and problematic video gaming

As is clear from the often small effect size of the gaming time–depression relationship, it is unlikely that the act of playing games for a period of time leads directly to depression for the majority of people. Therefore, the focus of this review now turns to additional factors that have been implicated to examine whether they may act as mediators or moderators between gaming and depression. This is not intended to be an exhaustive review, but rather an initial exploration of factors that have been explored in the studies that met inclusion criteria for this review.

1.3.2.1 Cognitive model of gaming addiction

There is no published theory that specifically describes the relationship between gaming and depression. However, the cognitive theory of IGD (King, 2014) is relevant to the present question. King (2014) suggests that the DSM-V (APA, 2013) criteria largely fit into four main categories: beliefs about game reward and tangibility; maladaptive and inflexible rules about gaming behaviour; over-reliance on gaming to meet self-esteem needs; and gaming as a method of gaining social acceptance. These categories theoretically help to explain the relationship between depression and gaming and also correspond to many of the correlates that have been studied, and thus provide structure.

1.3.2.2 Beliefs about game reward and tangibility

King's (2014) first cognitive category relates to over-valuation of gaming rewards, such that they are perceived as greater value than other activities, resulting in preoccupation with gaming. King (2014) argues that this category relates to the DSM-V (APA, 2013) criteria of 'loss of interest in previous hobbies and entertainment as a result of gaming'. Physiological theories of addiction are relevant here: Volkow et al.'s (2010) theory of drug addiction cites dopamine dysfunction as a central process, and posits that those with addiction subsequently experience reduced reward from non-addiction reinforcers, and increased incentive salience (Robinson & Berridge, 1993) for drug-

related cues, leading to mood disturbance. Evidence for this process comes from Lubman et al. (2009), who found that opiate addicts experienced reduced self-report and physiological arousal to naturally pleasant stimuli, as compared with controls. Kuss and Griffiths (2012a) argue that IGD is characterized by reductions in dopaminergic activity. Reductions in experiences of reward from non-gaming sources could help explain a reduction in behaviours that provide a source of positive reinforcement, and would align with behavioural models of depression (e.g. Jacobson et al., 2001).

Unfortunately, none of the included studies have focused upon the strength of gamers' interests away from gaming or their experiences of pleasure and reward from sources other than games. This category remains very relevant as a potential mechanism in the relationship between gaming and depression, and this gap in the literature provided motivation for the below empirical paper, examining reward dysfunction in those with internet addiction.

1.3.2.3 Maladaptive and inflexible rules about gaming behaviour

King (2014) describes this category as the justifications that those with IGD have for continuing to engage in games (for example, to reached desired goals), despite negative consequences. He argues that this category is most relevant to the DSM-V (APA, 2013) criteria for the need to spend increasing amounts of time engaged in gaming, and unsuccessful attempts to control participation in games.

This category is relevant to the depression-IGD association, through gaming potentially becoming a barrier to processes and behaviours that affect mood. For example, an inability to control gaming time could lead to reductions sleep and exercise, or alternatively to lost academic or employment opportunities. Time of falling asleep (circadian rhythm sleep disorders) has been associated with depression (Okawa & Uchiyama, 2007), as has reductions in sleep during the working week in adolescents (Wolfson & Carskadon, 1998). Similarly, exercise has been negatively correlated with depression (Goodwin, 2003); and social isolation is associated with increased risk for depression in adolescents (Hall-Lande, Eisenberg, Christenson, & Neumark-Sztainer, 2007).

Two papers explored the relation of gaming to sleep and depression. Lemola et al. (2011) sampled young people aged 13 to 30, who played a specific online game, World of Warcraft. They found that there was no main effect for total weekly playing time on depression. However, those who habitually played late at night (after 10pm) showed significantly higher depression scores than those who played less after this time. The study found that sleep problems were highly correlated with depression, but not with habitual playing at night, indicating that gaming affected time of sleep, rather than caused more general sleep problems. Due to the study's cross-sectional design, it

is not possible to infer causality from the results; it is also possible that those who were depressed were having difficulties sleeping (e.g. Riemann, 2001) and therefore self-occupied by playing games at night.

Thomee et al. (2012) attempted to remedy this shortcoming by using a prospective cohort design, yet did not find an association between gaming and sleep disturbances. However, the sleep measure used was a single question item, simply asking how often the participants had been "bothered by sleep problems over the past month" and was designed to measure problems with falling asleep, waking during the night or early in the morning. The study also included variables of total computer use (including gaming, and email/chat), and use without breaks; for both variables there was an association with sleep disturbances. This again highlights the overlap between gaming and more general media use and the difficulty of determining respective contributions to difficulties.

Mentzoni et al. (2011) explored the relationship between gaming and exercise, as measured by participants' frequency of exercising. Participants were categorised as non-gamers, gamers, and problematic gamers. There were no significant differences between groups in terms of exercise; however, exercise was measured by a single self-report item, measuring frequency of engagement in sports or exercise, from never through to daily. There was no examination of duration or intensity. Based on this limited measure, it would be premature to conclude that those who experience problematic video gaming do not exercise less than others.

Brunborg et al. (2014) explored the association between video game addiction and academic achievement and found a significant negative correlation (r =-0.17). Whilst it could be concluded that gaming addiction caused missed homework or schooling, it is equally possible that academic achievement was poor, leading to depression and an escape into gaming.

The final study relevant to this category examined the role of household media rules and their effects on depression (Bickham et al., 2015) as a means of externally imposing rules on the addicted individuals. Rules were measured in terms of type of games participants were allowed to play, how long for, and when. The authors reported their findings indicated that rules of this kind were associated with higher levels of depression, yet this was more of a trend (p <0.10). It is possible that the higher levels of depression were related to the withdrawal criteria, whereby those unable to access games may have felt frustrated, which impacted their mood; yet alternatively, the parents that noticed negative effects of gaming may have felt more need to impose the rules.

1.3.2.4 Summary of studies relating to maladaptive and inflexible rules about game behaviour

It would be premature to infer firm conclusions as to whether excessive gaming leads to depression due to a loss of sleep, exercise, or academic achievement, based on the limited findings of research in this section. Altered circadian timings resulting from game play were associated with depression (Lemola et al., 2011) yet general sleep problems were not associated with gaming (Lemola et al., 2011; Thomee et al., 2012). Reduced academic achievement may play in the association (Brunborg et al., 2014) whilst Mentzoni et al.'s (2011) exercise measure was arguably too limited to allow for general conclusions in regards to exercise and IGD. Therefore, further research is required, but based on these findings sleep loss, reduced academic achievement, and exercise may be implicated in an association between gaming and depression.

1.3.2.5 Over-reliance on gaming to meet self-esteem needs

King (2014) states that the over-reliance on gaming to meet self-esteem needs category is most relevant to DSM-V criteria of 'withdrawal symptoms when internet gaming is not available'; and 'use of internet games to escape or relieve a negative mood'. Self-esteem has theoretically been related to violence (e.g. Ostrowski, 2010), so studies on violent games will be included in this section, as will studies that explore ways of escaping negative mood states.

1.3.2.6 Self-Esteem

There is a strong relationship between self-esteem and depression (Sowislo & Orth, 2013); therefore determining an association between gaming and self-esteem could help explain the gaming-depression association. Five papers included in the current study examined the association between gaming and self-esteem.

1.3.2.7 Summary of self-esteem results

All five of the studies that explored low self-esteem found a significant correlation with problematic gaming, although Laconi et al. (2015) only found an association for females, not males. Effect sizes, reported in Table 4, ranged from 0.12 (Kiraly et al., 2014) to 0.81 (van Rooij, 2014).

Table 4

Effect sizes for the relationship between low self-esteem and gaming

Study	Males	Females	Total
Kiraly et al. (2014)			*r* =-0.12
Laconi et al. (2015)	*n/s*	*r* =-0.34	
Van Rooij et al. (2014)	*d* =0.69	*d* =0.81	
Van Rooij et al. (2010)			*r* = 0.21
Hyun et al. (2015)			*r* =0.11

Actual-ideal self-discrepancy (AISD) relates to low self-esteem (Moretti & Higgins, 1990) and this was explored by Li et al. (2011) in relation to gaming and depression. It was found that whilst there was a direct relationship between AISD and pathological gaming, this was better explained by the mediation model, with AISD leading to depression, which in turn led to escapism, and finally to pathological gaming. This model would therefore propose that people with AISD may develop depression and turn to gaming as a means of escaping the mood disturbances.

1.3.2.8 Critique of studies that explored self-esteem

Studies sampled adults and adolescents, with Laconi et al.'s (2015) participants aged between 18 and 65, and Hyun et al.'s (2015) aged 12 to 45. Laconi et al. (2015) found a moderately large effect size for adults (*r* = -0.49); there was an association for females, yet not for males. However, they reported that the majority of their sample (60%) had low self-esteem, which may have affected overall findings. Hyun et al. (2015) sampled outpatients at a specialist clinic receiving treatment for 'problematic online gaming habits'. Therefore they were perhaps extreme cases, with stigma of mental illness associated with reductions in self-esteem (Link et al., 2001) so the findings may not be fully generalizable. The studies that explored self-esteem used participants from European and Asian countries.

Sowislo and Orth's (2013) meta-analysis of self-esteem studies tested two theories of self-esteem and depression. Findings supported the Vulnerability Model: that those with low self-esteem were more susceptible to depression; rather than the Scar Model: that depression reduces self-esteem. It is therefore possible to conclude that those with IGD may have increased risk for low self-esteem, which may be a precursor to depression. However, it remains unclear whether low self-esteem precedes IGD, or vice-versa.

1.3.2.9 Studies that explored violence

Numerous theories suggest that low self-esteem may lead to violence (Ostrowski, 2010). Some suggest that those with low self-esteem feel a need to act out or use attention-seeking

behaviour as a way to increase their self-esteem; or to provide themselves with an increased sense of power and independence, or control over their environment. It is possible that those with low self-esteem could choose to do this virtually, and turn to violent video games; or that those with IGD neglect friendships, academic achievement, etc. which reduces their self-esteem.

The relationship between violent video games and depression has not been well studied to date (Tortolero et al., 2014). However, there is value in further exploration, due to correlations between early-life exposure to violence (either as victims or witnesses) and depression (e.g. Buka, Stichick, Birdthistle, & Earls, 2001); especially given the increasingly realistic manner in which violence is portrayed in games.

Two cross-sectional studies explored the association between playing violent games and depression. Allahverdipour et al. (2010) categorized video games as violent or non-violent, yet they did not report findings in the results, potentially suggesting a non-significant association. Tortolero et al. (2014) explored the effects of both exposure time (low vs. high) and violence (low vs. high) on children aged 10-11. In comparison with the control participants (low time, low violence), the only significant difference was in the high time (over two hours per day), high violence group, who had significantly higher depression (d = 0.16). This finding suggests that violent content in games may be implicated in the depression-IGD association, as there were no effects for high violence, low time, or for low violence, high time.

Two studies used an experimental design to test for changes in depression levels following relatively short exposure times to violent games. Ferguson and Rueda (2010) theorised that violent media might offer a chance to explore feelings of loss of control, disappointment or helplessness by offering circumstances over which they could virtually assert themselves. Therefore, they predicted that exposure to violent games would actually reduce depressive symptoms following a frustration task. They sampled 103 young adults (95.1% Hispanic) from a university in southern U.S. Participants were given frustration induction task and then randomised to 45-minutes of play of: a non-violent game; a violent game (playing the good character); a violent game (playing the bad character); or no game.

The researchers found that randomised play had no effects on aggressive behaviour. However, they did find that participants' real life history of playing violent games was predictive of decreased depression. They interpreted results such that violent games reduce depression and hostile feelings in players through mood management and concluded that media with violent content might be sought out by people with depressed mood.

Valadez and Ferguson (2012) used a similar design, but included an additional time variable, so that participants were exposed to a violent or non-violent game for either 15 or 45 minutes. Results indicated that neither type of video game play, nor time spent playing games increased depression or hostility. Beyond this, the researchers concluded that video games actually relaxed participants and reduced negative moods.

1.3.2.10 Critique of studies that explored violence

Both studies used very short exposure times to video games, up to just 45 minutes; this was acknowledged by Valadez and Ferguson (2012) who suggested that future research should make sessions longer, as this was not representative of real-life play. The depression measure used was the BDI-II, which appears a questionable choice for the study design. The BDI-II is designed to measure mood over the previous two weeks; it is impossible in a single session experiment to measure changes to difficulties with sleep, suicidal thoughts, crying, and tiredness, for example, as these would unlikely change within the space of an hour.

1.3.2.11 Escaping negative mood

King's (2014) self-esteem category is related to DSM-V (APA, 2013) IGD criteria of escaping negative mood, which could theoretically lead an individual to focus on gaming as a method of avoidance (e.g. Davis, 2001). Leventhal (2008) argues that avoidance denies opportunity to develop new and positive aspects of life, possibly leading to negative ideas about the self and others that contribute to avoidance and depression. Similarly, avoidant patterns often function to deny depressed people access or opportunity to contact potentially antidepressant sources of reinforcement (Jacobson et al., 2001). A focus on gaming may not give the individual contact with disconfirmatory evidence about their negative beliefs about the self, others, and the world and might therefore maintain depression.

Experiential avoidance as a means of coping has been found to be a mediator between anxiety and alcohol use (Stewart et al., 2002). Similarly, deliberate self-harm (DSH) can be viewed as escape from unwanted emotional experiences (Chapman, Gratz & Brown, 2005). An association between gaming and DSH and alcohol use may therefore point to gaming as an additional means of escaping life's problems; although alternatively it could also be that gaming is causing these problems and the individual is escaping from them through alcohol and DSH.

Brunborg et al. (2014) explored whether there was an association between video game addiction and heavy episodic drinking. Heavy episodic drinking has been found to be more significantly associated with depression than total volume of alcohol consumed (Graham, Massak,

Demers, & Rehm, 2007). Results indicated that neither video game amount nor video game addiction were associated with heavy episodic drinking. Strittmatter et al. (2015) found a strong correlation between video game addiction and self-injurious behaviours, with a large effect size (*d* =2.84).

1.3.2.12 Summary of studies that explored escaping a negative mood

Findings suggest that there is indeed an association between low self-esteem and gaming. Due to the cross-sectional designs, it is unknown whether low self-esteem is directly involved in the association between gaming and depression, although theory and existing research would suggest it is. Li's et al. (2011) found support for their model proposing that AISD leads to depression, which in turn leads to escapism, and finally to pathological gaming. Therefore, gaming may be used as a mechanism to manage depression by means of avoidance, but this may actually become pathological. Unfortunately, none of the longitudinal studies measured self-esteem, so it is not possible to tell what direction this relationship takes: whether those with low self-esteem are more likely to be problematic gamers, or whether problematic gaming erodes self-esteem, perhaps through a reduction in activities that may boost self-esteem such as exercise, academic endeavor, etc. This construct would require further exploration, either through longitudinal or experimental studies, yet appears a very promising avenue.

Results were mixed in relation to violent video games and depression. Tortolero et al.'s (2014) cross-sectional study found an association between exposure to violent video games and depression in children, this finding was not replicated by the experimental studies, which concluded that violent games may actually help to reduce depression. The limitations of the experimental studies, in relation to depression measures and the very brief exposure times mean that the findings must be approached with caution, yet it could tentatively be concluded that very brief exposure to violent games does not cause depression. The effects of longer-term exposure to violent games remain unclear.

There was a very large effect size for the association between problematic gaming and self-harm which is a method of avoiding emotional pain (Lloyd-Richardson, Perrine, Dierker, & Kelley, 2007). Problematic gaming could potentially represent a method of avoidance, and thus would be a consequence of depression, rather than a cause. However, there was no association between gaming and heavy episodic drinking, which would be another method of experiential avoidance, thus making the role of avoidance unclear.

1.3.2.13 Gaming as a means of gaining social acceptance

This category of cognitions relates to gaming's role in potentially elevating social status and offering a sense of belonging. This category is reportedly most similar to the DSM-V criteria of 'has jeopardised or lost a significant relationship, job, or educational or career opportunity because of participation in internet gaming'. King (2014) suggests that this may involve withdrawal from social relationships outside of gaming.

Caplan's (2003) social skills deficit theory predicts that an individual's social incompetence leads to a preference for online social interaction which can in turn become compulsive and excessive, leading to negative outcomes at home and work, which further exacerbate psychosocial problems, including depression. Social competence has been associated with social anxiety (Miers, 2013), and will therefore also be considered in this section.

1.3.2.14 Social anxiety

Social anxiety during adolescence and young adulthood is an important predictor of subsequent depressive disorders (Stein, 2001). In total, five studies explored social anxiety in relation to IGD, four of which were cross-sectional and reported mixed results. King et al. (2013) did not find an association between gaming and social anxiety, but did for loneliness in their Australian sample. Wei et al. (2012) found a small (yet significant) correlation between hours gaming per week and social anxiety (r =0.150). Hyun et al. (2015) found a significant difference between gamers and non-gamers on the Social Avoidance and Distress Scale; Allahverdipour et al. (2010) found a difference between the four groups of participants, classified by time spent gaming. They did not report post-hoc analysis, yet the non-gamers group had the highest "social dysfunction" scores, implying that gamers had lower social anxiety scores.

Gentile et al.'s (2011) study used a longitudinal design to explore social anxiety and social competence. Lower social competence was found to act as a risk for developing IGD, albeit with a very small effect size (η_p^2 =0.004). They also found that social anxiety acted as an outcome of IGD, with a slightly larger effect size (η_p^2 =0.038). The small effect sizes make the clinical significance of these findings debatable, however.

1.3.2.15 Loneliness

Loneliness has been associated with both depression and internet use: during childhood it can predispose children to adolescent depressive symptoms (Qualter et al., 2010); whilst those who

are lonely or have poor social skills are at increased risk of developing IGD (Kim, LaRose, & Peng, 2009).

Van Rooij et al. (2014) included a loneliness measure in their cross-sectional study on 8,478 adolescents. Those classified as problematic gamers showed significantly higher scores on loneliness measures as compared with low problematic gamers, with relatively large effect sizes: boys, $d = 0.58$; girls, $d = 0.78$. Van Rooij et al. (2010) explored specific categories of gamers and found that the loneliest group was the severely addicted participants. Of relevance, the group with the lowest loneliness scores were the heavy, non-addicted gamers. The authors explain this finding through a dualistic effect: gaming offers a second environment in which to communicate with others, yet may become problematic when it begins to overshadow real life. This may reduce loneliness for social gamers yet may exacerbate it for those who become overly reliant on gaming because online relationships may not provide adequate contacts for optimal well-being. This explanation could help to explain the presence of depression in those with online gaming disorder, and the absence in heavy users that were not addicted in van Rooij et al.'s (2010) sample.

The following two studies did not directly measured loneliness, yet did explore the role of social support in the association between depression and IGD; improving social support is often a recommended intervention for loneliness (Hawkley, 2010). Dupuis and Ramsey (2011) found an association between lack of perceived social support and depression. However, there was no significant association between social involvement in MMORPGs and perceived social support. In fact, although it has been suggested that greater social involvement in MMORPGs is related to higher levels of perceived social support, the direction of the data suggests the opposite was true. The authors concluded that the significant relationship of perceived social support and lower depression comes from the relationships in the real world and that social support was not provided by the game environment. Lee and Jeong (2014) found that social support networks reduced the amount of time people played video games as a method of avoiding life's difficulties. Both studies therefore provide evidence that sources of social support away from gaming were more beneficial than those within.

1.3.2.16 Summary of studies that explored loneliness, social anxiety and self-esteem

There were moderate to large effect sizes for loneliness, social anxiety, and low self-esteem in association with gaming. These factors have previously been associated with depression, through theory and research. Due to the design of the studies, it is not possible to comment on the direction of this relationship: these factors may lead to IGD, or conversely, that problematic gaming could lead to loneliness, social anxiety (through lack of social skills development) and even

low self-esteem (potentially through reduction of friendships and academic achievement, for example).

A permissible conclusion based on available research, is that those who have IGD may also experience elevated loneliness, social anxiety, and low self-esteem. More research is required to explore potential pathways. Whilst this category of cognitions relates to gaming as a means of gaining social acceptance, it must be considered that an online environment may not necessarily enable this. The online disinhibition effect may make conversation easier and allow people to share personal things, yet it also has another side, one which makes rude language, threats, criticisms and anger more prevalent (Suler, 2004). People may be drawn to gaming as a way to make friends, but it does not necessarily follow that this will be the end result. Those with already low social skills may face disinhibited behaviour online, possibly worsening their mood and self-esteem.

1.3.2.17 Conclusions that can currently be drawn about factors that may influence the relationship between IGD and depression

It does appear that many of the factors studied may be associated with problematic gaming: self-esteem, loneliness and social anxiety, in particular. However, from the designs of the studies used, it remains unclear as to whether these are directly involved in the relationship between gaming and depression, and if so, to what extent. Equally, it is impossible to state which pathways these relationships take, although it seems likely to be a complex interaction between factors.

It is also important to establish whether the above factors may act as moderators or mediators in the relationship. It is not possible to provide definitive answers to this question based upon the designs of the studies included in this review. However, self-esteem could hypothetically act as a mediator, with a possible pathway being the onset of IGD, leading to the neglect of other areas of life, such as relationships, academic or work achievements, which could impact self-esteem before leading to depression. There could be a similar pathway for loneliness, with an individual neglecting important others to the extent that they feel cut off from meaningful relationships before impacting mood. Social anxiety could theoretically be an existing difficulty, leading an individual to focus upon gaming due to difficulties in social situations, although this coping mechanism could likely exacerbate anxiety, leading to mood problems. However, it is also possible that social anxiety may arise as an outcome of IGD, which is in accordance with Gentile et al.'s (2011) findings.

It is possible that factors such as exercise and sleep may act as moderators in the IGD-depression relationship, enhancing mood difficulties that may be experienced prior to or as a result of the onset of IGD.

1.3.3 Is there any evidence of a causal relationship between problematic video gaming and depression?

The above cross-sectional studies have helped to establish that an association between gaming and depression does indeed exist and that additional factors may be implicated, yet this type of design cannot help with the question of directionality. This is a vital consideration with important clinical implications: understanding the nature of this association would improve understanding as to whether problematic gaming has potentially serious implications for mood, or whether it is at best an ineffective coping strategy for mood disturbances. To help answer this question, four of the studies included in this review will now be considered. All used a longitudinal design to help elucidate the direction of this relationship.

1.3.3.1 Studies that did not find a causal association between IGD and depression

Primack et al. (2009) used data from a nationally representative sample of American adolescents. Wave one data was collected in 1995 and included 6,504 participants; the final sample was re-interviewed in 2002 and consisted of 4,142 participants (63.7% of the original sample; 697 were excluded due to depression at Time 1). The study focused on general media exposure, including: television, videocassettes, computer games, and radio. Results were analysed using multiple logistic regression to explore the contribution of each variable to depression at follow-up. Findings indicated that baseline television and overall media use were predictive of depression at follow-up, but not computer games, videocassettes, or radio.

A more recent study examining media use and depression was conducted by Bickham, Hswen and Rich in 2015. Using two time points one year apart they explored the effects of television, music, video games, computers, and mobile phones on depression. They also explored the effect of household rules for media on depression. Depression was measured by six items from the Beck Depression Inventory for Primary Care. This study used a much lower sample size, with 103 participants followed up at Time 2.

Again, no effect of video games on depression was found, either at baseline or at follow up. When baseline depression scores were controlled for, mobile phone use and TV viewing were predictive of depression. Interestingly, the introduction of household rules to control video game use actually resulted in higher depression scores, although this was not statistically significant.

1.3.3.2 Strengths of studies that did not find a causal association

Bickham et al.'s (2015) study was not solely reliant upon self-report measures, as many of the other studies included in this review have been. In addition to survey measures, time use diaries

were used, as was ecological momentary assessment, which was used to overcome recall bias. Primack et al. (2009) used a large sample (*n* =4,142).

1.3.3.3 Limitations of studies that did not find a causal association

Primack et al.'s (2009) study included a seven year latency period between the two time points. Participants' media habits were not measured beyond their Time 1 score; it is therefore unclear how much these had changed over the intervening years. Whilst they included some covariates of depression, such as gender and ethnicity, there was no exploration of life events that had occurred for participants in the intervening seven years. In reference to gaming specifically, the results are not widely generalizable to today. Media use was measured in 1995, a time when games were very primitive in comparison to today and were far less likely to have been played online. This may be reflected in the mean daily duration of play, which was a mere 0.41 hours. The depression measured asked participants about depressive symptoms over the past week. DSM-V states that symptoms need to be present for at least two weeks for a diagnosis of depression; it is therefore unclear how accurate the depression measure was. They also excluded those who were already depressed at Time 1 from their analysis, a total of 697 participants. As has previously been established, gaming addiction appears a relatively stable construct (e.g. Gentile et al., 2011), so many problematic gamers were potentially excluded from the study.

Bickham et al.'s (2015) time use diaries were only used one day of the working week and once at the weekend. This would assume that the participants' media use was similar all of the week, and it is unclear whether this is the case. Specifically in relation to video games, there was a low mean use of games, of just 1.06 hours per day based upon the survey, or 0.75 hours per day from the time use diaries. This does not imply clinically significant impairments, and it is possible that given the small sample size that there were very low numbers with IGD included in the sample, and therefore it is perhaps not surprising that no association was found between gaming and depression.

As was common with many of the studies, neither included a measure of gaming addiction, but instead measured time spent playing. Neither study was designed specifically to test the relationship between gaming and depression, but rather explored a range of media exposure. It is unclear how many people were included that had online gaming disorder, therefore it is difficult to conclude that gaming does not lead to depression, but it could be concluded that any amount of time spent playing video games does not necessarily lead to depression.

1.3.3.4 Studies that found a causal relationship between gaming and depression

Two following longitudinal studies did find that gaming might be causally related to depression, albeit to differing degrees. Thomee et al. (2012) used two time points, including a one year follow-up. The sample was comprised of 4,163 participants aged between 20 and 24, selected from the general population of Sweden. Media use was recorded by time spent daily on general computer use, on emailing or chatting, and on gaming. Additionally, there were measurements of computer use for two hours or more without breaks, and how often sleep was lost due to late-night computer use. Depression was measured by two items from the Primary Care Evaluation of Mental Disorders: "during the past month, have you often been bothered by a) little interest or pleasure in doing things; b) feeling down, depressed or hopeless?" People with depression at baseline were excluded from the analysis at Time 2.

Findings indicated that the only clear association between gaming and depression was for women who were classified with medium levels of gaming. This did not hold for men, despite the percentage of whom spent over an hour on gaming per day was four times higher than for women.

The final longitudinal study spanned two years, with a sample of 3,034 secondary school children (Gentile et al., 2011) and was the only longitudinal study to focus specifically on gaming, rather than generic media use. This was the only longitudinal study that included three time points, and included a measure of problematic gaming, rather than time spent playing games. It also had a full depression measure, the Asian Adolescent Depression Scale. For data analysis, participants were divided into four different categories: 'stops', those who were pathological gamers at the start of the study but no longer met the criteria by the end; 'starts', those who became pathological gamers during the course of study; 'stays', those who remained pathological gamers throughout the three time points; 'never', those who never met criteria at any of the three time points.

The final model accounted for a significant amount of variance in depression (r^2 =0.49), and found that time spent playing games and impulsivity were significant predictors of becoming a pathological gamer. Of relevance to the other studies, 84% of those who were pathological gamers at time one remained so by time three indicating the stability of IGD. A major finding was that those who became pathological gamers during the course of the research ended up with increased levels of depression, anxiety and social phobia. This was in stark contrast to those who stopped being pathological gamers, whose levels of depression, social phobia and anxiety were lower than those who remained pathological gamers. The authors concluded that gaming predicts mental health disorders longitudinally, beyond being merely correlated with them.

Gentile et al. (2011) made a very important point about the findings: although the data provides evidence that pathological gaming can influence mental health issues, they expect that

many relationships are reciprocal and that depression is likely to increase the severity of pathological gaming. Whilst the study design may be better at elucidating the causal nature of the relationship between gaming and depression, care must be taken whilst interpreting the results. Whilst depression levels dropped for those who stopped gaming during the study, an alternative explanation could be that depression levels dropped first, leading to a reduction in gaming behaviours during the latency periods which were a year-long and other life events were not measured during this time.

1.3.3.5 Strengths of studies that found a causal relationship

Gentile et al.'s (2011) study is arguably the highest quality of those included in this review, due to its specific focus on gaming, the inclusion of a measure of gaming addiction, and the measurement of three separate time points, whilst using a large sample size. It included a number of measures so has helped provide more information about the potential causes of pathological gaming, as well as the consequences.

1.3.3.6 Limitations of studies that found a causal relationship

Although Gentile et al.'s (2011) study reported many significant findings they were generally represented by very small effect sizes. One of the largest effect sizes found was the difference between the 'stops' and 'stays' group for depression at Time 3; however, this was still a small effect size (η_p^2 =0.038). In comparing the starts versus never group for predictors of gaming addiction, the effect size was η_p^2 =0.002. It is debatable whether these small effect sizes would translate into clinically meaningful findings.

In terms of generalisability, it must be noted that participants in this study were Singaporean, and may have had higher levels of gaming than many comparable studies. For example, the average weekly time spent playing games was over 20 hours at each time point. This is significantly greater than the other longitudinal studies that reported average times of less than seven hours per week. Equally, those going to local area network cafes was a risk factor for becoming a pathological gamer; the authors note that these are popular in Singapore, but may not be so in other cultures.

Although Thomee et al.'s (2012) study is included in the section that found a causal relationship the findings were weak and could not easily be used as evidence that gaming causes depression. The findings may have been influenced by methodological limitations there was no record of mental health or media exposure during the latency period, which was a year long, nor at follow up; it was therefore unclear as to the stability of media use. The authors noted that the depression measure had high sensitivity for major depression diagnosis, but lower specificity which

likely affected the diagnosis for depression, possibly leading to over-reporting. The study's other limitation appears to be the exclusion of those with pre-existing depression from the analysis, possibly excluding a very relevant proportion of the sample. This is highlighted by Gentile et al.'s study (2011) which included three time points over two years and found that the majority of pathological gamers remained so two years later (84%). Finally, Thomee et al. (2012) did not include a gaming measure beyond time spent playing. It is possible that a combination of these design limitations led to the relatively modest findings.

1.3.3.7 Summary of longitudinal studies

Findings from the longitudinal studies must be interpreted with caution. Three of the four studies did not focus specifically on gaming, nor did they use a gaming addiction measure (the limitations of which will be discussed below). The one longitudinal study that did use a measure of gaming addiction (Gentile et al., 2011) did find that gaming can lead to depression, but also yielded low effect sizes. Time spent gaming was a predictor of being a pathological gamer, but only in addition to impulsivity.

It is important to note that longitudinal designs are somewhat limited in their capacity to further our understanding of causality. Whilst a more appropriate design for this type of question than a cross-sectional design, it is still possible that additional factors that are not being measured by the study may contribute towards levels of internet addiction or depression.

Based on this limited evidence, it is not possible to make any firm conclusions as to the direction of the IGD-depression relationship. Further studies that use validated gaming measures are required and, fundamentally, high quality experimental designs are required to help further our understanding of cause and effect.

1.4 Discussion

A growing body of literature is beginning to explore the association between online gaming and depression; it is clearly very early on in this process, with the earliest paper found by this literature search from 2009. It is important to establish an association between the two constructs, before exploring specific mechanisms and causal pathways; therefore, a large number of the papers reviewed were cross-sectional by design.

In relation to the review's first question, based upon the studies included in this review, the majority of evidence does point towards an association between gaming and depression. It appears that a small minority of those who play games may become addicted, and it is generally this group

that experiences depression, rather than the vast majority of those that play games regularly. This relationship has been established in a number of different continents, mainly with adolescent participants.

1.4.1 Concept of Addiction

The majority of studies that used a measure of time for exploring gaming severity found a much smaller effect size (e.g. Lee & Jeong, 2014, $r = 0.04$); or no significant association at all (Allahverdipour, 2010; Lemola et al., 2011). The exceptions to this were Wei et al., (2012), who sampled Taiwanese gamers and found a dose-response effect for time spent playing on depression ($r = 0.22$). Hyun found a significant difference between gamers and non-gamers on the Korean BDI ($r = 0.16$). However, for both studies the average hours per day for the gamers were much higher than the majority of other studies (28.2 and 41.3 hours). Whilst time spent playing may not represent a problem, along with impulsivity, it has been found to be a predictor of pathological gaming (Gentile et al., 2011). The high hours spent playing in these two studies could therefore indicate that many participants were at risk of addiction, if not already addicted, and may infer clinical impairment. There were much higher effect sizes when gaming addiction was measured. For example, Stritmatter et al. (2015) reported an effect size of 0.58 when comparing depression levels for those who were addicted versus those who were not; van Rooij et al. (2014) found an effect size of 0.91 for boys and 1.23 for girls.

Brunborg et al. (2014) used measures of both time and addiction: they did not find an association of time spent gaming and depression, yet found a moderate association between video game addiction and depression ($r = 0.25$). Van Rooij et al. (2010) measured both time spent playing games and scores on the CIUS and identified two sub-groups of gamers that had the heaviest weekly use: one group were identified as non-addicted due to their CIUS scores, whilst the other were addicted. The addicted group had significantly higher depression scores as compared to the other five groups at time two ($x^2 = 11.42$, $p = 0.044$); the heavy but non-addicted group's depression score at Time 2 was lower than all other groups of gamers, further indicating that the amount of time a person spends gaming is not necessarily problematic alone. Tortolero (2014) examined the effects of time and violence in games upon depression. Again, there was no significant difference between those who played non-violent games and spent high time playing, but there was for violent games, albeit with a low effect size (d=0.13).

These results were consistent with existing research in relation to gaming addiction. For example, two case studies by Griffiths (2010) found that one participant was likely addicted, and the excessive use was having a severe impact on his lifestyle, including work and relationships. In contrast, for the other, who spent similarly high amounts of time each day (an average of 14 hours)

there were no apparent adverse consequences. Przybylski et al. (2009) explored people's motivation for playing games. They found that those with high life satisfaction were more likely to be passionate about playing games, to choose to play, and to enjoy them. Those with lives that were not satisfying, on the other hand, were found to be at risk for a disordered pattern of gaming, characterised by long hours of compulsive, tense and unenjoyable play.

It therefore seems that time spent playing is not necessarily a helpful measure in the search for a relationship between depression and gaming. If a gamer is passionate about gaming and enjoys it, he may not feel sad, nor may it be accompanied by harmful effects, whereas if someone feels compelled to play games to the detriment of other areas of life, and gets no enjoyment from gaming, this could be related to mood, even though both would spend the same time engaging in the same pursuit.

Those classifiable as addicted to video games may be a very small minority. For example, Mentzoni et al. (2011) found only 0.6% of their sample were addicted, which equated to just four respondents from their sample of 816. The studies with smaller sample sizes may therefore not be picking up adequate numbers of this group of users, and therefore under reporting the depression association.

Associated Factors

Nearly all studies exploring additional factors were cross-sectional by design, so it is impossible to make any conclusions about cause-effect. However, it is possible to conclude that low self-esteem, disrupted time of falling asleep, social anxiety, and loneliness all appear to be altered to some degree in those with problematic gaming. Further research is needed to clarify whether these difficulties relate to depression.

1.4.2 Does gaming cause depression?

Based upon the papers studied in this review, it is far too early to begin to speak of a causal relationship. There is currently a lack of quality longitudinal studies; the one study identified for this review was based upon adolescents in Singapore, and found very small effect sizes, to the extent that their clinical relevance is questionable. There may also be different cultural attitudes towards gaming in Singapore, in comparison to Europe or the U.S., and so it is difficult to generalize the findings. Two experimental studies were included and they did not find that brief exposure to gaming caused depression. However, their choice of depression measure has been questioned, as well as exposures to a specific genre of game which were so brief that they did not replicate real-life times. It is important, however, to continue this line of research and explore the effects different categories of games have on mental health and depression in particular.

1.4.3 Future research

The continuing lack of consistency in defining and classifying IGD needs to be addressed. This is reflected in different measures that have been used in the included research and classifying problematic gaming by time alone is arguably leading to under-reporting of difficulties associated with IGD. Further research needs to identify and agree on what gaming addiction is; once this is established, perhaps a gold-standard measure of gaming addiction can be created to allow for consistency in the research.

There is a lack of research on adults that play games, despite adolescents making up only around a quarter of those who play games regularly. The percentage of adults that might be diagnosable with IGD remains unclear.

Ideally, a randomised controlled trial (RCT) on a population of non-gamers would be undertaken to establish the role that playing games has on an individual's mood. However, this is unlikely to be a feasible or ethical process. In the absence of this, more quality longitudinal studies in a range of countries could be undertaken, with emphasis on the inclusion of a validated measure of gaming addiction, rather than retrospective, self-reported measures of time playing games. Alternatively, treatment studies could explore the effect of supported reduction in video gaming on participants' depression levels. Additionally, further experimental studies could benefit the area, using appropriate measures for depression or short-term mood change, whilst including longer exposure times to games.

Whilst some studies have focused upon violence or MMORPGs as a specific gaming genre, more needs to be done to explore whether all game types are harmful, or whether some may in fact be beneficial for the users' mood.

1.4.4 Clinical Implications

The present findings highlight an association between IGD and depression. Further work is needed to determine the direction of this relationship, which could potentially have important treatment and preventative consequences in relation to both depression and IGD.

It can be concluded that a number of unwanted mental health difficulties are associated with IGD, which appears to be a chronic disorder. Whilst there is no convincing evidence at this stage to suggest that IGD causes depression, at the very least its association with depression and other mental health difficulties implies that it is an ineffective coping mechanism, and does not significantly alleviate these difficulties. Further, the lack of convincing causal evidence at this stage

is perhaps more representative of a small (yet growing) body of research with various methodological limitations, rather than being evidence of IGD not causing depression. Therefore, thorough assessment of IGD (where relevant) could potentially be of benefit, particularly for children and adolescents. This may enable identification and support for individuals to engage, for example, in other behaviours that provide more positive sources of reinforcement, that help improve self-esteem, or that provide fundamental requirements such as sleep, exercise, or social contact.

1.5 Conclusion

The majority of research examined in this review points towards an association between gaming and depression, albeit with mixed effect sizes (possibly due to the use of different measurement tools), which appears to be present across a range of samples from different countries and continents. Based upon the available research, it is not yet possible to make conclusions about the causal directions in the association.

Self-esteem, social anxiety, sleep, impaired academic achievement and loneliness may work as mediators or moderators within this association, and would be potential avenues to explore further. Much of the research has focused on adolescents, yet the majority of regular gamers are adults, indicating a significant shortcoming in the research. Enhanced understanding requires more sophisticated design than the cross-sectional surveys that dominate the literature at present.

Chapter 2: Empirical Paper

Exploring the associations between reward disturbances, internet addiction and depression

2.1 Introduction

2.1.1 Depression

The core features of depression are depressed mood and the loss of interest or pleasure in nearly all activities (American Psychiatric Association (APA), 2013). Kline (1964) has asserted that more suffering has resulted from depression than any other single disease. It is currently estimated that 350 million people worldwide are affected (World Health Organisation, 2015). Longitudinal studies suggest that global prevalence rates are continuing to rise (Hidaka, 2012), leading to suggestions of an epidemic. In addition to individual costs, a government report estimated that depression cost the UK between £20.2 and £23.8 billion per year in 2007 (Department of Health, 2011).

Given the associated costs of depression, it is important to attempt to understand its increasing prevalence. Whilst a definitive answer will likely involve an interaction of numerous factors, Hidaka (2012) cites "modernity" as a factor.

2.1.2 Internet Addiction

One aspect of modern life that is increasing at a rapid rate is Internet use: in 1995 it was estimated that less than 1% of the world's population regularly used the Internet (Internet Live Stats, 2014). In December 2013 the proportion of internet users was estimated to have risen to 39%, or 2.8 billion people (Internet World Stats, 2014). In the UK, the proportion of internet users was even higher, with an estimated 76% of adults accessing the Internet daily (Office for National Statistics, 2014).

Many benefits have been attributed to Internet use, such as improved academic performance (Jackson et al., 2006), increased social support (Fogel, Albert, Schnabel, Ditkoff, & Neugut, 2002), and reduced loneliness (Morahan-Martin & Schumacher, 2003). However, internet use can become problematic, and has the capacity to become addictive (Young & Rogers, 1998).

Internet addiction was not included as a mental health disorder in the most recent version of the DSM (APA, 2013), and remains a controversial term (Starcevic, 2012). This is partially due to the lack of consensus on the validity and reliability of the construct itself, and disagreement as to its causes and consequences (Meerkerk et al., 2009). Nevertheless, Internet Gaming Disorder (IGD) has been included in the appendix of DSM-V (APA, 2013), indicating movement towards the recognition of internet-related activities as discrete mental health disorders.

Despite this controversy, some have gone as far as to say that internet addiction is "an important global mental health problem" (Ko et al., 2012, pp. 1). In a review Kuss and Griffiths (2014) concluded that there are a number of core symptoms, including: compulsive use, negative outcomes, and increased salience of internet-related cues. This is consistent with arguments that internet addiction is characterised by irresistible preoccupations or excessive use for longer periods than planned (Grant, Schreiber, & Odlaug, 2013); and impaired control over the behaviour, increased tolerance, withdrawal, and high rates of relapse (Olsen, 2011).

There is still no gold-standard for diagnosis of internet addiction (Kuss et al., 2014), and a consequence of this inconsistency is the wide range of reported prevalence rates: from 0.8% in Italy, through to 26.7% in Hong Kong (Shek & Yu, 2012). Despite these difficulties, a global prevalence of 6% has been estimated (Cheng, 2014).

This diagnostic inconsistency is also reflected in the range of terms used for internet addiction (Young, 1998), which also include pathological internet use (Davis, 2001), compulsive internet use (Meerkerk et al., 2009), and problematic internet use (Caplan, 2002). For the present study, the term 'internet addiction' will be used, due to similarities with substance and other behavioural addictions, discussed below.

2.1.3 Association between Internet addiction and depression

Internet addiction is associated with a range of negative consequences (Brand, Young, & Laier, 2014) including psychological problems such as anxiety disorders and attention deficit and hyperactivity disorder (Ko et al., 2012).

Internet addiction has also been associated with depression since the internet's infancy (Young & Rogers, 1998), and this remains a consistent finding (e.g. Adalier & Balkan, 2012; Morrison & Gore, 2010). The nature of this association is currently unclear, and causal relationships are yet to be identified (Morrison & Gore, 2010). However, an early longitudinal study (Kraut, 1998) examined the impact of the internet on 169 people during their first one to two years online and found that more frequent use of the internet was associated with an increase in depression.

2.1.4 Addictions and Reward

The exact mechanisms underlying the association between depression and internet addiction are yet to be fully understood, yet research on substance addictions may help to elucidate the relationship. A recent review concluded that internet addiction was a different expression of addiction, yet comprised similar symptoms to substance addictions (Kuss et al., 2012). Of particular relevance, internet addiction can cause similar changes to the structure of the brain as substance addictions (Leeman & Potenza, 2013; Olsen, 2011).

Substance addictions are known to be associated with depression (e.g. Swendsen & Merikangas, 2000); crucially, it appears that addiction is important beyond substance use and there is a greater association between drug dependence and depression, than for drug abuse and depression (Grant, 1995). However, the literature on the direction of this relationship is mixed. For example, one longitudinal study found that both alcohol dependence and depression posed significant risk for the other a year later (Gilman & Abraham, 2001). Contrastingly, Kang and Lee (2010) found that smoking at year one was significantly related to depression at year 2, yet the same was not true of the reverse.

Volkow et al.'s. (2010) model of addiction is of particular relevance to the present study and provides the framework for understanding the association between internet addiction and depression, whilst suggesting possible causal pathways. The authors posit that addiction is primarily a disease of the brain's reward system, with the neurotransmitter dopamine central to this process. Addiction, according to the model, is characterised by dysfunctions in three main areas: decreased sensitivity to non-drug rewards; enhanced sensitivity to conditioned expectations to drugs and cues; and resultant negative mood and weakened control. Each of these three components of the model will now be explored in relation to internet addiction.

Volkow et al.'s (2010) model utilises Robinson and Berridge's (1993) seminal paper on incentive-sensitisation theory, which proposed that reward was not simply a unitary process, but rather could be separated into 'liking' and 'wanting'; or 'consummatory' and 'anticipatory' reward (Gard et al., 2006).

These proposed reward dysfunctions have strong parallels with a core feature of depression: anhedonia (Gorwood, 2008). Recent neuroscientific research has expanded on the original understanding of anhedonia as an inability to experience pleasure (Snaith, 1995), and it is now believed to encompass a broad range of reward-related deficits (Thomsen, 2015). Of particular relevance, it has recently been argued that anhedonia can be compartmentalised into motivation ('wanting') and consumption ('liking') components (Alvarez's, 2014). Crucially, there is evidence

that anhedonia can arise from drug addiction, rather than being a precursor (Garfield, Lubman & Yucel, 2014).

2.1.5 Decreased reward sensitivity ('liking')

'Liking' is a term that refers to the hedonic capacity of a substance or behaviour, and represents a subjective experience of pleasure (Berridge, Robinson & Aldridge, 2009). Volkow et al. (2010) propose that addictive substances have a high reward value, and that chronic use leads to a resetting of reward thresholds by causing disruption on a cellular level, resulting in a reduction in dopamine release and receptors. This hypo-dopaminergic state, the authors argue, explains decreased 'liking' of natural rewards, and the ongoing use of drugs as a means of temporary compensation for this.

There is evidence of this process in drug addicts: Lubman et al. (2009) found that opiate addicts were less physiologically aroused and rated positive pictures as less arousing when viewing naturally positive images. Similarly, Versace et al. (2012) found that heavy smokers exhibited dampened event-related potential (ERP) responses to naturally pleasant stimuli, in comparison to controls. Parvaz et al. (2012) found that chronic drug use was associated with reduced sensitivity to non-drug reward, but this was not the case for recent acute drug use. This process is also evident in internet addiction, which has been shown to be characterised by an overall reward deficiency relating to decreased dopaminergic activity (Hou et al., 2012). Similarly, neuroimaging studies indicate that brain areas associated with reward, addiction, craving and emotion are increasingly activated during computer use, particularly for gaming addicts (Hoeft et al., 2008).

Whilst 'liking' is related to an experience of pleasure, accurate representations may not be a conscious process (Schooler & Mauss, 2009). Lang et al. (1993) found that skin conductance levels were highly correlated with arousal (r =0.81), and that heart rate response was correlated with viewing pleasant stimuli (r =0.76), and to a less degree with arousal (r =0.48).

2.1.6 Wanting and incentive salience - enhanced sensitivity to conditioned expectations to drugs and cues

The second component of Volkow et al.'s (2010) model proposes that, for those with addiction, a drug's saliency value and its associated cues are enhanced in the reward and motivation circuits, at the expense of other reinforcers, which are reduced. This has been termed incentive salience, or 'wanting', and is a type of motivation that promotes approach toward and consumption of rewards, and is associated with anticipation of the reward (Berridge, 2007) or the acquisition of an unconscious desire for the reward (Robinson et al. 2015). Incentive salience has been heavily implicated in the formation and maintenance of addictions, and the dopaminergic

system is also involved in this process, facilitating compulsive 'wanting' of addiction-related stimuli in those who are addicted (Berridge, 2007). According to incentive salience theory, attentional and approach biases toward addiction-related cues may operate outside awareness, and increasing levels of addiction lead the cues to acquire more incentive salience (Mogg, Field, & Bradley, 2005).

In a review, Goldstein and Volkow (2002) concluded that in drug addiction, there is frequent overvaluing of drug reinforcers and undervaluing of alternative reinforcers. Evidence for reduction in motivation towards non-drug related reinforcers was found by van Hell et al. (2010) who evidenced reduced reward anticipation for non-drug related tasks in cannabis smokers. Similarly, Dunning et al. (2011) found that cocaine users exhibited strong electrocortical activity when viewing drug-related images in comparison with controls.

There is evidence for increased 'wanting' and arousal of drug-related stimuli in participants with opiate addiction (Lubman et al., 2009). Crucially, there is evidence of cue induced craving in those with internet addiction (Ko et al., 2012); and the authors of this research concluded that cue-induced craving for those with online gaming addiction was similar to the craving experienced by those with substance addiction.

2.1.7 Reward Dysfunction and Depression

Finally, Volkow et al.'s (2010) model asserts that reward systems interact with circuits involved with mood, which may account for the association between drug addiction and depression, and therefore potentially for internet addiction and depression. On a neurological level, people with depression experience anhedonia and reduced motivation, so it has been proposed that the dopamine system is also involved with depression, and possibly even its aetiology (Nestler & Carlezon, 2006). Dysfunction in the dopamine system has been evidenced in people with Internet addiction (Hou, et al., 2012; Brand et al., 2014).

Alterations in reward processing may represent a vulnerability factor for the development of depression (Forbes & Dahl, 2005). Additionally, acute stress reduces reward responsiveness (in a similar fashion to that proposed for addictions), and it has been argued that this reduction may be the mechanism that mediates the link between stress and depression (Bogdan & Pizzagalli, 2006).

In addition to neurological changes, it is conceivable that the association between reward system dysfunction and depression can be explained on a behavioural level. Inability to pursue positive experiences relates to the early behavioural theories of depression, asserting that it can result from a loss of positive reinforcement (e.g. Bandura, 1971). Disruptions to a reward system may reduce an individual's motivation to pursue future rewards and engage in pleasurable

activities, which might in turn maintain and/or exacerbate depressive symptoms (Pizzagalli, 2014). More recently, Epstein et al. (2006) have proposed a pathophysiological model of depression, comprised of reward and motivational dysfunction, suggesting an inability to engage in rewarding activities. Evidence in support of this theory comes from Treadway et al. (2009), who found that anhedonia was associated with decreased motivation for rewards. Consistent with this, there is a great degree of success for behavioural activation treatment for depression, which encourages individuals to engage in activities that provide positive reinforcement (Jacobson et al., 2001).

Thomsen (2015) recently proposed a definition of anhedonia, incorporating an inability to pursue pleasurable experience, in addition to experiencing and learning about it. Low reward-seeking behaviours have been demonstrated to predict depression in adolescents above and beyond baseline depressive symptoms (Rawal, Collishaw, Thapar, & Rice, 2013). Those with drug addictions often experience anhedonia, which in turn has been associated with reduced motivation to seek rewards (Treadway, Buckholtz, Schwartzman, Lambert & Zald, 2009).

In those with depression, levels of anticipatory anhedonia predicted motivation to exert effort for rewards (Sherdell, Waugh & Gotlib, 2012); in those with addictions, anhedonia may work in a similar way by reducing motivation to seek natural rewards, with subsequent depression arising due to a lack of positive reinforcement (Beevers & Meyer, 2002).

To summarise, it is possible that internet addiction affects the brain on a neurological level, impairing an affected individual's ability to experience pleasure whilst simultaneously increasing their craving for internet-related activities. These factors may combine to reduce motivation, resulting in subsequent reduction in positive reinforcement, and eventually depression.

2.1.8 Research Aims

Based upon Volkow's (2010) addiction model, the current study proposes that a mechanism mediating the observed association between depression and internet addiction may be a disrupted reward system (see Figure 2). It is proposed that this is experienced by the individual as reduced 'liking' of natural reinforcers, with a simultaneously increased 'wanting' of internet stimuli and resultant reduced drive to participate in naturally rewarding activities. It is hypothesised that these disruptions result in a reduction of contact with positive reinforcement from the environment, thus impacting mood and potentially leading to depression. The present research specifically aims to examine responses to positive and internet stimuli and to test participants' motivation to pursue positive reinforcement.

2.1.9 Research Question

Can changes in reward sensitivity help to explain the association between depression and internet addiction?

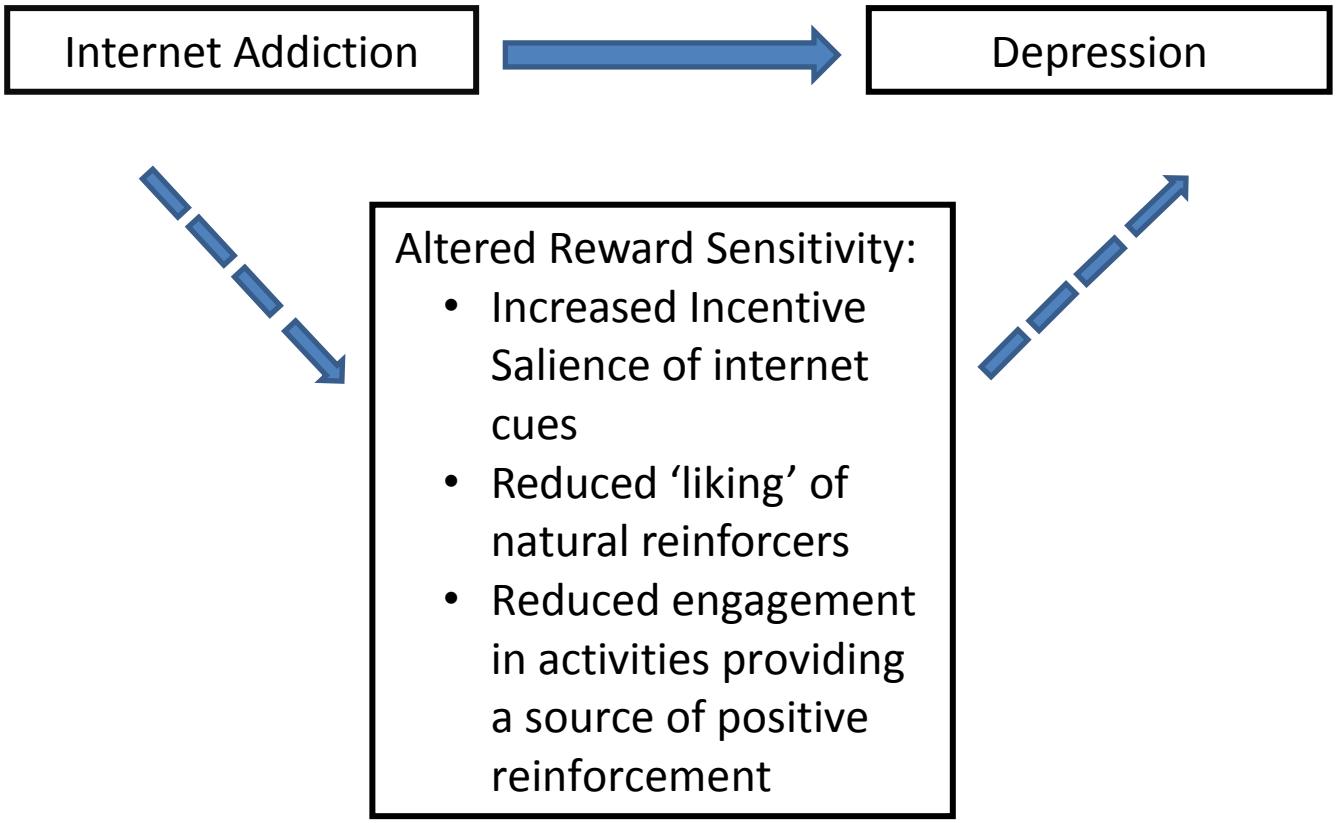

Figure 2 Theoretical proposed mediational model of internet addiction and depression

Hypotheses

1. Those with internet addiction will score significantly higher on the BDI-II than the control group.
2. Those with internet addiction will experience lower physiological arousal (heart-rate and skin conductance) and self-reported valence for the naturally positive stimuli than those in the control group.
3. Those with internet addiction will experience greater physiological arousal during the viewing of internet-related stimuli and will report greater self-reported arousal than those in the control group.
4. Those with internet addiction will demonstrate less effort (perform fewer mouse clicks) to obtain the reward of viewing entertaining clips in the motivation task than the control group.

2.2 Methods

2.2.1 Design

The study used a between subjects quasi-experimental design. The independent variable (IV) was internet addiction (those with internet addiction vs. controls); participants' allocation to group was determined by their scores on the Compulsive Internet Use Scale (CIUS; Meerkerk et al., 2009). The dependent variables (DVs) were: scores on the Snaith Hamilton Pleasure Scale (SHAPS; Hamilton et al., 1995); physiological responses (heart-rate and skin conductance) and self-reported valence and emotional arousal scores for neutral, naturally positive, and internet-related stimuli; scores on the Beck Depression Inventory-II (BDI-II; Beck, Steer & Brown, 1996); and scores on a computerised motivational task (measuring effort expended to view the desired stimuli and 'liking' of the stimuli).

2.2.2 Participants

The sample consisted of 36 participants, recruited from the University of Southampton. Participants received either course credit or £6 for their participation and were required to fill in a screening questionnaire, the CIUS, prior to taking part in the main study. Participants who scored 17 or under on this scale were included in the control group; those whose score met the recommended cut off of 18 (Guertler et al., 2013) were included in the addiction group. Of the 158 who completed the screening questionnaire, only 43 (27%) scored below the cut-off. Therefore, there was a large selection from those who scored in the "internet addiction" category and those who scored highest were prioritised for recruitment.

The study was approved by the University of Southampton Ethics Committee (see Appendix B). Thirty-five participants were students, one was retired. Thirty were undergraduates, twenty seven of whom studied psychology; five were trainee clinical psychologists. The majority were female (69.4%) and White British (69.4%). The age range was 18 to 65, with the mean 23.03 (SD 9.13).

2.2.3 Materials

2.2.3.1 Beck Depression Inventory-II (BDI-II)

Depression was measured by the BDI-II (Beck, Steer & Brown, 1996) as it remains the gold standard measure (Cusin, Yang & Yeung, 2009). The BDI-II is used to assess the severity of depression in clinical and non-clinical populations. It is a self-report inventory, comprised of 21

items (each scored 0-3) with a score range of 0 to 63. A recent review indicated that it remains a reliable (0.73 – 0.96), and valid (0.49 – 0.87) test, with an internal consistency of 0.9 (Wang & Gorenstein, 2013).

2.2.3.2 Compulsive Internet Use Scale (CIUS)

The CIUS (Meerkerk, Van den Eijnden, Vermulst, & Garretsen, 2009) is a measurement for compulsive internet use. The authors use the term 'compulsive internet use', as they argue, the internet is not inherently addictive, but rather specific online activities are and manifest as compulsive use of the internet. However, the authors state that the terms are interchangeable (Meerkerk et al., 2009). The CIUS is comprised of 14 items, with responses based on a five-point Likert scale. Items are scored 'Never' (0) through to 'Very Often' (4), giving a score range of 0 to 56.

The measure is based on DSM-IV (APA, 1994) criteria for Dependence and Pathological Gambling, and on criteria for behavioural addictions. The resulting items measure: loss of control (spending more time online than intended and unsuccessful attempts to control this time); preoccupation (thinking about the internet when not online and preferring its use above other activities); withdrawal (feelings of unrest and agitation when the internet is not available); coping or mood modification (using the internet to relieve negative affective states); and conflict (with others because of internet use and feelings of guilt and remorse).

Normative data for the measure was based on two studies of heavy internet users, who used the internet more than 16 hours per week (447 participants in the first study and 229 in the second) and a third convenience sample of 17,000 internet users. The CIUS demonstrates good test-retest reliability (0.83), validity (0.7) and internal consistency (0.48 – 0.69) (Meerkerk et al., 2009). A cut-off score of 18 and over on the scale has been suggested to help diagnose problematic internet users (Guertler et al., 2013).

2.2.3.4 Snaith-Hamilton Pleasure Scale (SHAPS)

The SHAPS was designed to measure the degree to which a person is able to experience pleasure, or the anticipation of a pleasurable experience (Hamilton et al., 1995). The SHAPS is comprised of 14 items, and each item is measured with one of four responses: strongly agree, agree, disagree, and strongly disagree. Each item is scored either as a one (either of the 'disagree' responses) or a zero (either of the 'agree' responses), giving a score range of 0-14 (the higher the

score the less able the individual is to experience pleasure). A score of 2 or more would indicate an abnormal level of hedonic tone (Hamilton et al., 1995).

The SHAPS has good internal consistency (α =0.91) and adequate test-retest reliability (r =0.70, p <0.001) (Franken, Rassin & Muris, 2007). The SHAPS was significantly correlated with the BDI (r =0.23, p <0.05), indicating that anhedonia as measured by the SHAPS was a related construct, but distinct to depression (Franken et al., 2007).

2.2.3.5 Responses to Internet-Related and Naturally Positive Stimuli ('Liking' and 'Wanting')

Participants were shown 36 images in total, in a partial replication of a design used by Lubman et al. (2009). Twelve of the images were neutral, 12 were naturally positive and a further 12 were internet-related. The neutral and naturally positive images were chosen from the International Affective Picture System (IAPS) (Lang, Bradley & Cuthbert, 1997). IAPS images represent a range of normative emotional stimuli that were rated by participants on a scale of 1 (low) through to 9 (high); the images chosen for the current study were selected from those with the highest valence ratings (all scores were above 7.6) and from those with ratings indicating neutral valence (ranging from 4.82 to 5.06). Arousal was not controlled for when selecting the images, although the majority of images had similar arousal ratings.

To select the internet-related stimuli, an online pilot study was created, with participants recruited from a convenience sample through the author's Facebook contacts. Participants were not screened for internet addiction prior to their participation so it is possible that the screening test was completed by both healthy controls and those with internet addiction. Participants were asked to rate a total of 50 items, as to how much they believed each item was internet-related; they were not asked to score the images for subjective valence and arousal ratings. In total, 83 respondents completed the survey and the 12 images that scored the highest mean were selected, based upon a seven-point Likert scale. The images were mainly comprised of screen shots of web pages for popular websites, such as BBC News, Facebook, Amazon, and YouTube, with additional images of hardware, such as phones, tablets and laptops.

Each image was displayed on screen for six seconds, and skin-conductance and heart rate data were recorded for six seconds, beginning a second from when the image was displayed. Physiological data was recorded using an MP150 amplifier, and AcqKnowledge software (version 3.8.1) (Biopac, 2002), and the stimuli were displayed using the Inquisit2 programme (Millisecond, 2002), which also recorded the self-report responses of participants.

Skin conductance data was automatically recorded by AcqKnowledge (Biopac, 2002); heart-rate data needed to be calculated manually (see Appendix I). A baseline measure for each

image was taken for the second prior to the image being displayed and the final measurements were adjusted to reflect this baseline.

Additionally, two self-reported measures were taken immediately after each image was presented. Self-reported arousal levels were measured by the question: "Please rate how emotionally aroused you felt whilst looking at the picture" (arousal is a possible index or salience, but not positivity, e.g. Zinc et al., 2004), as measured on a scale of zero to eight. Self-reported valence ratings were taken by the question: "Please rate how much you liked or disliked the image", and was measured on a scale of -4 (very much disliked) through to +4 (very much liked). These questions were presented on the same screen as the images, and responses were measured by keyboard strokes.

2.2.3.6 Motivation Task

'Wanting' can also be measured by examining a person's motivation to work for a reward **(**Thomsen, 2015). The focus of the second task, therefore, was to measure participants' motivation to obtain a preferred positive reward. To do this, a task designed by Sherdell, Waugh and Gotlib (2012) was replicated: motivation was operationalised as the amount of effort participants exerted to obtain a humorous reward. The original study used cartoon strips as rewards, citing humour's ability to activate mesolimbic reward regions of the brain, but also due to the lack of an inherent anticipatory component, allowing the rewards to be additionally assessed for 'liking'. Humour also reduces satiation effects with increased consumption, in comparison with other food-related rewards that were considered.

In the current study, the cartoon strips were replaced by short moving images (GIFs) as it was felt that this would enhance the humour reward, whilst making it more contemporary and desirable. The two categories represented humorous and non-humorous GIFs. The GIFs for each category were selected during a pilot study, which used another convenience sample (n =120) taken from the author's Facebook contacts. In total 120 GIFs were included in the survey (60 selected to be humorous, and 60 non-humorous). Participants scored the images on a scale of 1 (extremely unfunny) to 10 (extremely funny). The 36 GIFs with the highest mean scores were selected for the humorous category, whilst the 36 lowest scoring GIFs were used in the non-humorous category. The 10 images that ranked below the top 36 were used in the initial comparison part of the study for the humorous category, and the 10 ranking above the bottom 36 were used as the non-humorous category.

As in the Sherdell el al. (2012) study, participants were initially asked to rate their preference between images from the two categories (for a total of 10 pairs), in order to measure preference for humorous over non-humorous GIFs (see Appendix K). The categories were labelled

'LUM' and 'GUP' which were nonsense words that were used to avoid influencing choice and 'liking' ratings. Participants were then presented each image individually, and asked to rate their 'liking' using a visual-analogue scale (see Appendix J).

Participants were then asked to choose between the two category labels, with each choice associated with a 'click-cost' (the number of times they would need to click on a black square that moved randomly around the computer screen to view their chosen reward) which could be between 0 and 50 clicks. The costs were set so that the humorous category was always associated with more clicks than the non-humorous category choice.

Following each choice, the next click cost was determined by an algorithm (Richards, Zhang, Mitchell, & de Will, 1999) designed to narrow the range of values from which the next click cost was selected. Effectively, if a participant chose a non-humorous reward it would reduce the next cost of the humorous category; whereas if they chose the humorous category it would increase the next cost of the non-humorous choice. This continued to adjust until the difference between the two choices was five clicks. This was recorded as the indifference point (when the participant was indifferent between the two choices) and this served as an index of motivation for each participant; a higher value represented more motivation to view the humorous category. Two indifference points were calculated for each participant, one when the non-humorous deck was initially set to 0 and one for when it was set to 15. This allowed an exploration of the effects of inertia, as participants may have been less willing to work for a reward when there was a "no work" condition. If the indifference point was calculated before the end of the trial, then randomly selected click counts were used until each participant had completed 36 trials. Participants were asked to rate how much they enjoyed the task on three separate occasions, with the average of these scores taken as their overall task liking.

2.2.4 Procedure

Participants attended a single session, lasting approximately one hour. On arrival, they were given a paper version of the information sheet (see Appendix D**)** and a consent form (see Appendix E). Once consent had been obtained, participants were asked to complete a demographics questionnaire (see Appendix K), the BDI-II, and the SHAPS. They were asked to complete the CIUS again due to a time delay between their original completion of the measure and their participation in the study. Participants' second completion of the CIUS corresponded with their group allocation from their original completion.

2.2.4.1 Physiological and explicit responses to internet related, positive and neutral stimuli

Participants were given verbal instructions for the first task, measuring their responses to three categories of stimuli (internet-related, positive and neutral). They were asked to clean their wrists and fingers with a mild exfoliating pad and surgical spirit, to ensure optimal conditions for the apparatus to detect heart rate and skin conductance. Next, participants' wrists were fitted with EEG pads and SCR sensors on the middle and ring finger on their non-dominant hand and connected to the computer. Participants were given brief instructions on how to respond to the questions on screen before they were shown the 36 images which were displayed on screen for six seconds each.

2.2.4.2 Motivation Task

Once all images were viewed, participants were disconnected from the computer and given verbal instructions for the motivation task which was run from a separate laptop.

As in the original study, there were instances where an indifference point could not be calculated. This was because the participant's choices had not narrowed the range between the two categories to 5; in the present study this happened six times. Four participants were in the non-addicted group, and two from the addicted group. In these cases, the bound range was extended to 10 so that the indifference point could be calculated.

When the programme came to an end, participants alerted the researcher. The task took approximately 20 minutes, but varied by the participant's motivation.

Once participants completed all measures they received a written debriefing form (Appendix F) and were given an opportunity to ask any questions they had about the study. Included in the debriefing were details of services and contacts for those struggling with depression and/or internet addiction; participants were then thanked for their time and awarded either course credits, or £6.

2.2.5 Data Analysis

The main aim of the present research was to establish differences in responses to naturally positive stimuli between those with internet addiction and controls; it was therefore decided that effect size calculations would be based upon this outcome. The current study partially replicated a design used by Lubman et al. (2009) who sampled drug users. Unfortunately, this study only presented descriptive statistics as a small bar chart, meaning that it was necessary to interpret this to work out the mean and standard deviation group scores for the purpose of estimating the size of the effect of drug use on reaction to positive stimuli. The researchers found that subjective valence ratings were the most accurate predictor of differences between drug users and controls so this

measure was used to calculate an effect size. The bar chart was interpreted to show that the controls' mean valence score was 14.5 (n=19), with the drug users' mean 12.8 (n=31), with a standard deviation of 2.18, giving an effect size of $f = 0.38$. G*Power (Faul, Erdfelder, Lang & Buchner, 2007) was used to calculate estimated sample sizes, with a sample size of 36 participants deemed necessary to detect differences, with a power of 0.8.

Once skin conductance and heart rate was calculated for each image, these data were averaged across the three categories of images to give three scores per participant (neutral, positive, and internet-related) for heart rate, skin conductance, self-report valence and self-report arousal.

For the skin conductance, heart rate and explicit ratings difference scores were calculated for the naturally positive and internet-related categories by subtracting the mean neutral category score from each. This gave each participant physiological and self-report scores for internet and positive stimuli.

Initially, the use of multivariate analysis of variance (MANOVA) was considered to explore valence and arousal separately. However, there was very low correlation between physiological measures of arousal (SCR) and self-report arousal, and low correlation between HR and self-reported valence (see Appendix G). This low correlation could have led to difficulty in interpretation and the possibility of obscuring an interesting effect so physiological and self-reported measures were explored separately using MANOVAs.

The data were examined using Z-scores, and no score returned a score of over 3, indicating that there were no significant outliers. However, data for one participant was excluded due to difficulties recording physiological data. The data were tested for normal distribution by using Kolmogorov-Smirnoff and by examining the histograms for each variable by group.

The motivational task was analysed initially by a series of t-tests (parametric) and Mann-Whitney U tests (non-parametric). A series of bivariate correlational tests were then used to further explore within group differences in the motivational task data.

2.3 Results

Table 5

Means, standard deviations (SD) and frequencies for demographics, trait measures and variables

Variable	Non-Addicts (n=17) Means (SD)	Addicts (n=19) Means (SD)
Age	24.53 (11.93)	21.84 (6.81)
Gender	Female = 11 Male = 6	Female = 14 Male = 5
Ethnicity	White British = 12 White Other = 3 Asian Bangladeshi = 1 Mixed = 1	White British = 13 White Other = 3 Asian Indian = 1 Asian Bangladeshi = 1 Chinese = 1
Occupation	Undergraduates = 12 Postgraduates = 4 Retired = 1	Undergraduates = 18 Postgraduates = 1
Course of Undergraduate Study	Psychology = 9 Psychology with Criminology = 2 History = 1	Psychology = 16 Psychology with Criminology = 1 Sociology = 1
Course of Postgraduate Study	Clinical Psychology = 4	Clinical Psychology = 1
Weekly Hours of Internet Use	12.65 (8.51)	28.42 (16.13)

Variable	Non-Addicts (n=17)	Addicts (n=19)
	Means (SD)	Means (SD)
Compulsive Internet Use Scale (CIUS)	10.88 (4.99)	32.58 (4.95)
Snaith-Hamilton Pleasure Scale (SHAPS)	1.12 (2.26)	1.42 (1.74)
Beck Depression Inventory-II (BDI-II)	6.76 (5.32)	14.68 (7.55)
BDI-II Categories	Minimal = 15	Minimal = 8
	Mild = 1	Mild = 6
	Moderate = 1	Moderate = 5
	Severe = 0	Severe = 0

2.3.1 Participant Characteristics

There were no differences between the two groups on demographic variables: age, U = 138.5, p = 0.459; gender, χ^2 (1) = 0.34, p = 0.559; ethnicity, χ^2 (5) = 2.94, p = 0.710; occupation, χ^2 (2, n =36) = 3.90, p = 0.142; or course of study, χ^2 (5) = 7.60, p = 0.180. The groups were significantly different on their CIUS scores, t (34) = -13.09, p = 0.001.

2.3.2 Hypothesis 1 – Depression

Consistent with Hypothesis 1, the two groups differed significantly on their BDI-II scores, t (34) = -3.596, p = 0.001, 95% CI [8.36, 13.53]. These differences were also significant in terms of categorical severity of depression (minimal, mild, moderate, severe) according to recommended cut-off scores (Beck et al., 1996), χ^2 (2) = 8.28, p = 0.016, indicating clinical significance. However, there were no significant differences between groups on categorical classification of anhedonia by the SHAPS, χ^2 (6) =6.710, p =0.349, 95% CI [0.61, 1.95].

2.3.3 Hypothesis 2 and 3 – self-report and physiological measures for internet and positive images

Table 6

Means and Standard Deviations for responses to internet and positive stimuli

	Individuals with Addiction (n=19)		Individuals without Addiction (n=16)	
Variable	Positive	Internet-Related	Positive	Internet-Related
	Mean (SD) [95% CI]	Mean (SD) [95% CI]	Mean (SD) [95% CI]	Mean (SD) [95% CI]
Skin Conductance (area)	1.71×10^{-3} (1.97×10^{-2}) [-7.79×10^{-2}, 0.01]	3.32×10^{-3} (1.30×10^{-2}) [-0.02, 4.16×10^{-2}]	3.00×10^{-6} (6.83×10^{-3}) [7.79×10^{-2}, 0.01]	6.02×10^{-3} (2.50×10^{-2}) [-0.02, 4.16×10^{-2}]
Heart Rate	-0.05 (1.63) [-0.40, 2.40]	-0.89 (1.82) [-0.82, 2.13]	0.51 (1.71) [-0.40, 2.40]	-0.73 (1.56) [-0.82, 2.13]
Valence (self-report)	2.47 (0.83) [-0.84, 0.28]	0.42 (0.66) [-0.79, 0.19]	2.11 (0.78) [-0.84, 0.28]	0.03 (0.69) [-0.79, 0.19]
Arousal (self-report)	2.83 (1.22) [-1.36, 0.44]	1.32 (1.08) [-1.53, -0.35]	2.18 (1.24) [-1.36, 0.44]	0.27 (0.42) [-1.53, -0.35]

Note. 'Positive' and 'Internet' variables based on difference scores (respective category minus neutral category)

2.3.4 Self-report results

A 2 (Group: Internet addiction vs Control) x 2 (Stimuli: Positive vs Internet-related) repeated measures MANOVA (DVs: self-report positive arousal; self-report positive valence; self-report internet valence; self-report internet arousal) examined the difference between those with internet addiction and controls. Contrary to the hypothesis there was no significant interaction between picture category and internet use group, Hotelling's T^2 [0.05] F (2,32) = 0.80, p = 0.457, η_p^2 = 0.048. However, there was a significant main effect of group (internet addiction vs. controls)

on responses to stimuli, reflecting a more pronounced response to stimuli from those in the internet addiction group, F (2,32) = 3.49, p=0.043, η_p^2 = 0.179.

There was also a significant main effect of category of image, reflecting a greater response to naturally positive images than internet images, Hotelling's T^2 [7.75] F(2, 32) = 123.94, p = 0.001, η_p^2 = 0.886. Follow up ANOVAs found there was a significant overall difference between groups for arousal, F(1,33) = 7.05, p = 0.012, η_p^2 = 0.176; but not for valence, F(1,32)=3.09, p = 0.088, η_p^2 = 0.086. However, this did not interact with image category, for valence F(1, 33) 0.02, p =0.884, η_p^2= 0.001, nor for arousal, F (1, 33) = 1.53, p =0.224, η_p^2 = 0.044.

Figure 3 represents difference scores (how much more arousing than the neutral stimuli both groups reported finding the positive and internet stimuli) for self-reported arousal. Overall, the internet group reported a bigger difference in arousal induced by both categories of pictures over neutral pictures than the control group, although there was no interaction between group and stimuli type. The control group's internet arousal score was almost 0 indicating no great difference in relation to the neutral category, whereas the internet addiction groups score was relatively much higher.

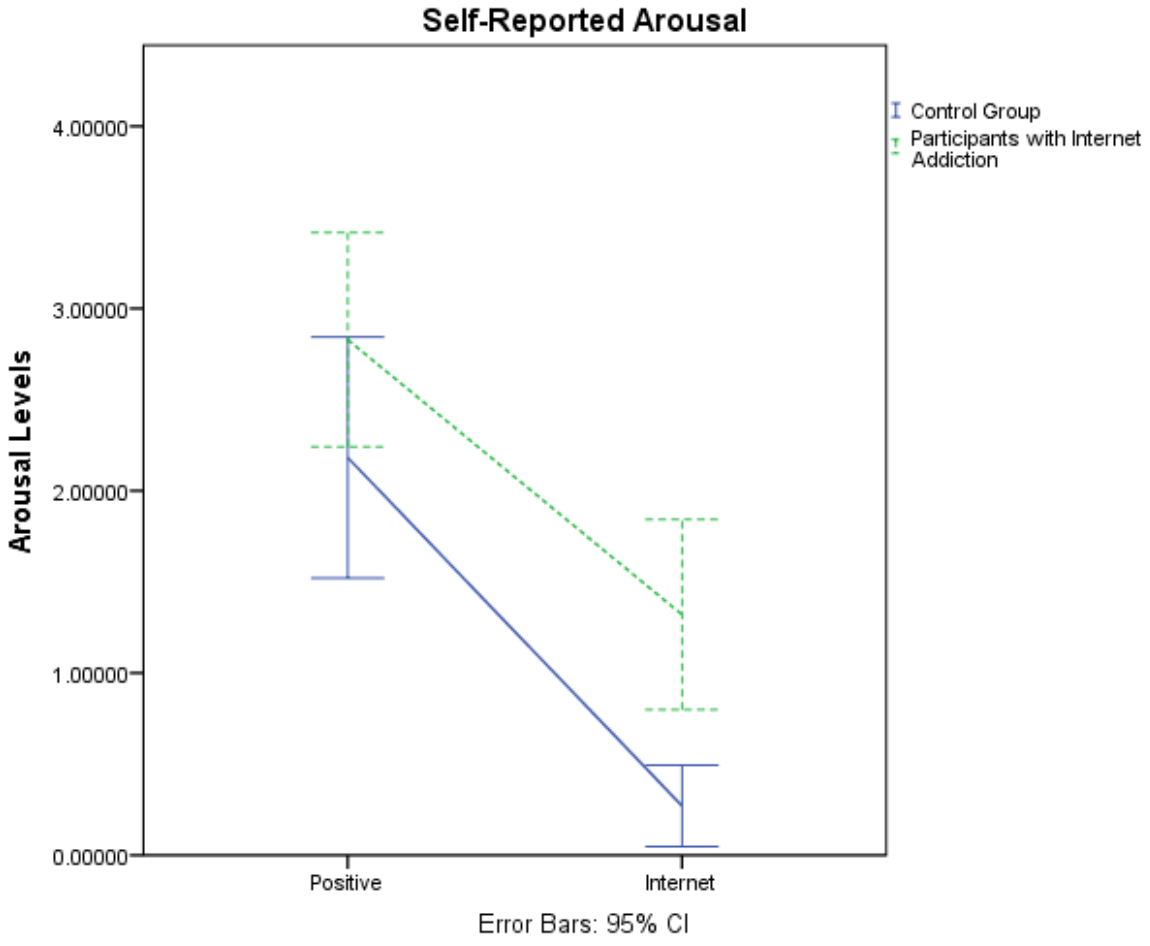

Figure 3. Self-reported arousal ratings for positive and internet stimuli.

Figure 4 indicates difference scores (internet and positive categories both minus neutral scores) for self-reported valence levels for both groups across internet and naturally positive categories of stimuli. Both groups liked the naturally positive images more than the internet-related images; there was no interaction of group by category of image or main effect of group. On average, the control group liked the internet stimuli no more than the neutral stimuli, whereas the internet addiction group liked internet stimuli slightly more than neutral, yet this was not statistically significant.

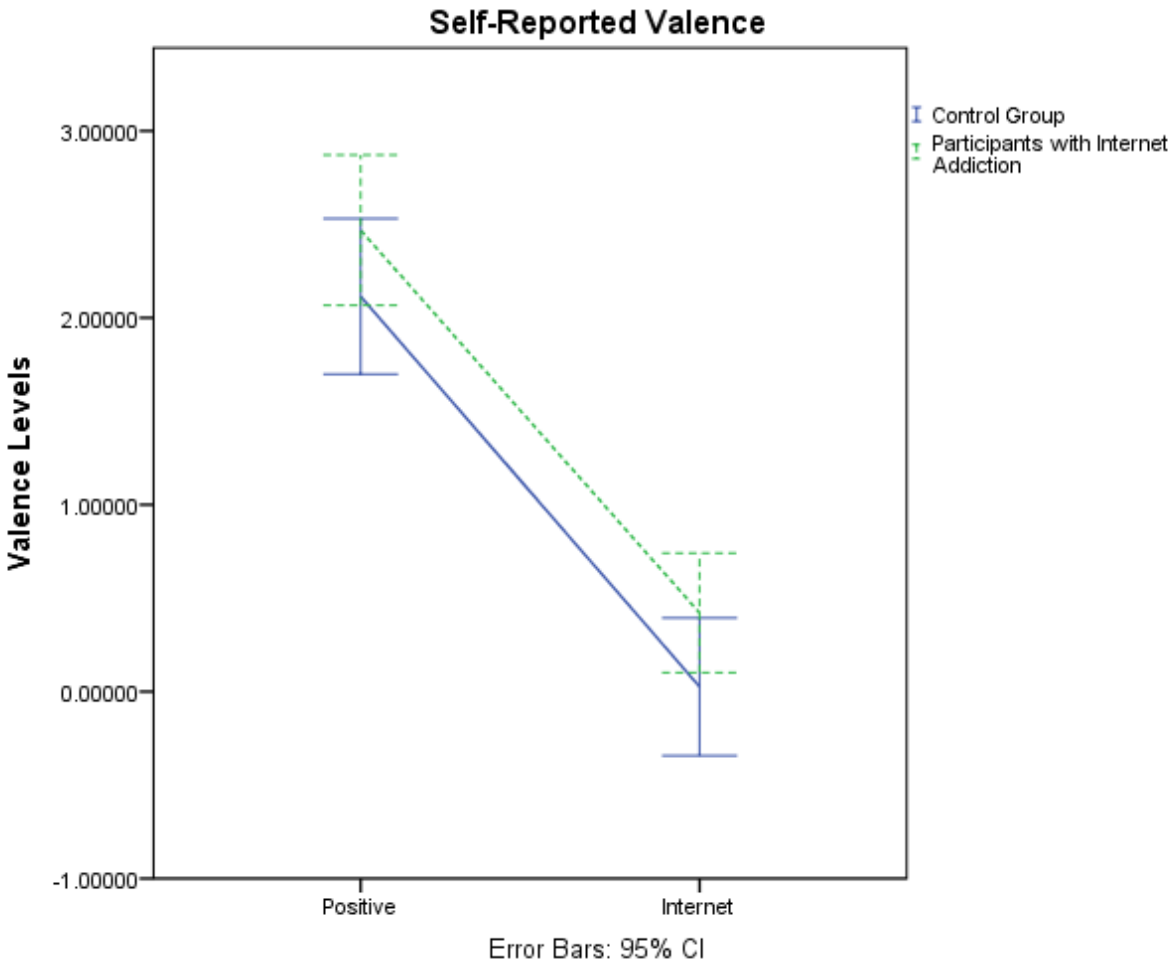

Figure 4. Self-reported valence ratings for positive and internet stimuli.

2.3.5 Physiological results

The physiological data was not normally distributed so was log transformed, leading to data that was closer to a normal distribution; however, this did not affect the outcomes, also yielding non-significant results. Therefore, for clarity, it was decided that the original data would be reported below.

A 2 (group: internet addiction vs controls) x 2 (stimuli: positive vs internet-related) repeated measures MANOVA (DVs: positive heart rate; internet heart rate; positive skin conductance; internet conductance) examined the difference between groups on physiological measures (HR and skin conductance responses) to two types of images and the differences within individuals to the two categories of images.

There was no significant interaction between picture category and internet use group, Hotelling's T^2 [0.10] F (2,32) = 1.54, p = 0.231, η_p^2 = 0.09. There was a significant within subject main effect of picture category, Hotelling's T^2 [0.45] F(2,32) = 7.20, p = 0.003, η_p^2 = 0.31, indicating a stronger response to the positive stimuli. There were no overall significant differences between groups on their physiological reactions to the two different groups of stimuli, F(1,33) = 0.67, p = 0.519, η_p^2 = 0.04.

There was a significant main effect for heart rate between picture categories within subjects, F(1,33) = 14.71, p = 0.001, η_p^2 = 0.308, indicating an increased reaction to positive stimuli. There was no main effect for skin conductance between categories within subjects, F(1,33) = 0.02, p = 0.889, η_p^2 = 0.001.

Figure 5 represents difference scores (how much more arousing than neutral stimuli both groups reported finding the positive and internet stimuli) for skin conductance. The responses appear as predicted: those in the internet addiction category were more aroused by internet-related stimuli than the control group, and slightly less aroused by the positive stimuli. However, the scale

is so small that this effect is not of statistical or clinical significance.

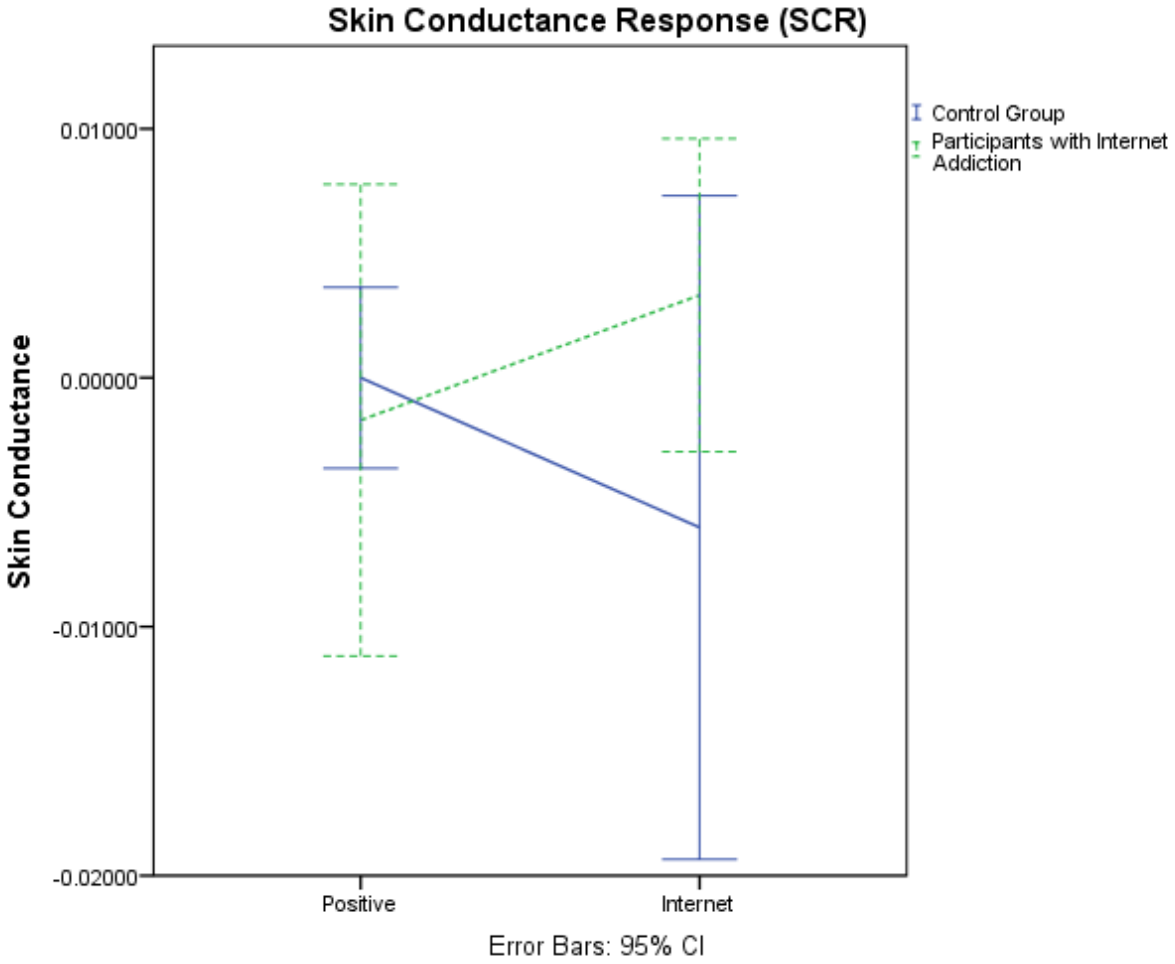

Figure 5. Skin conductance responses to positive and internet stimuli.

Figure 6 indicates that heart rate was greater for both groups for the positive images than for internet images. It represents a slight (although not statistically significant) interaction: those in the control group had faster heart beats overall, yet this slowed more in relation to the internet stimuli than the control groups'. This is contrary to the hypothesis, as it was predicted that the internet addiction groups' heart-rates would increase for internet stimuli, in comparison with controls.

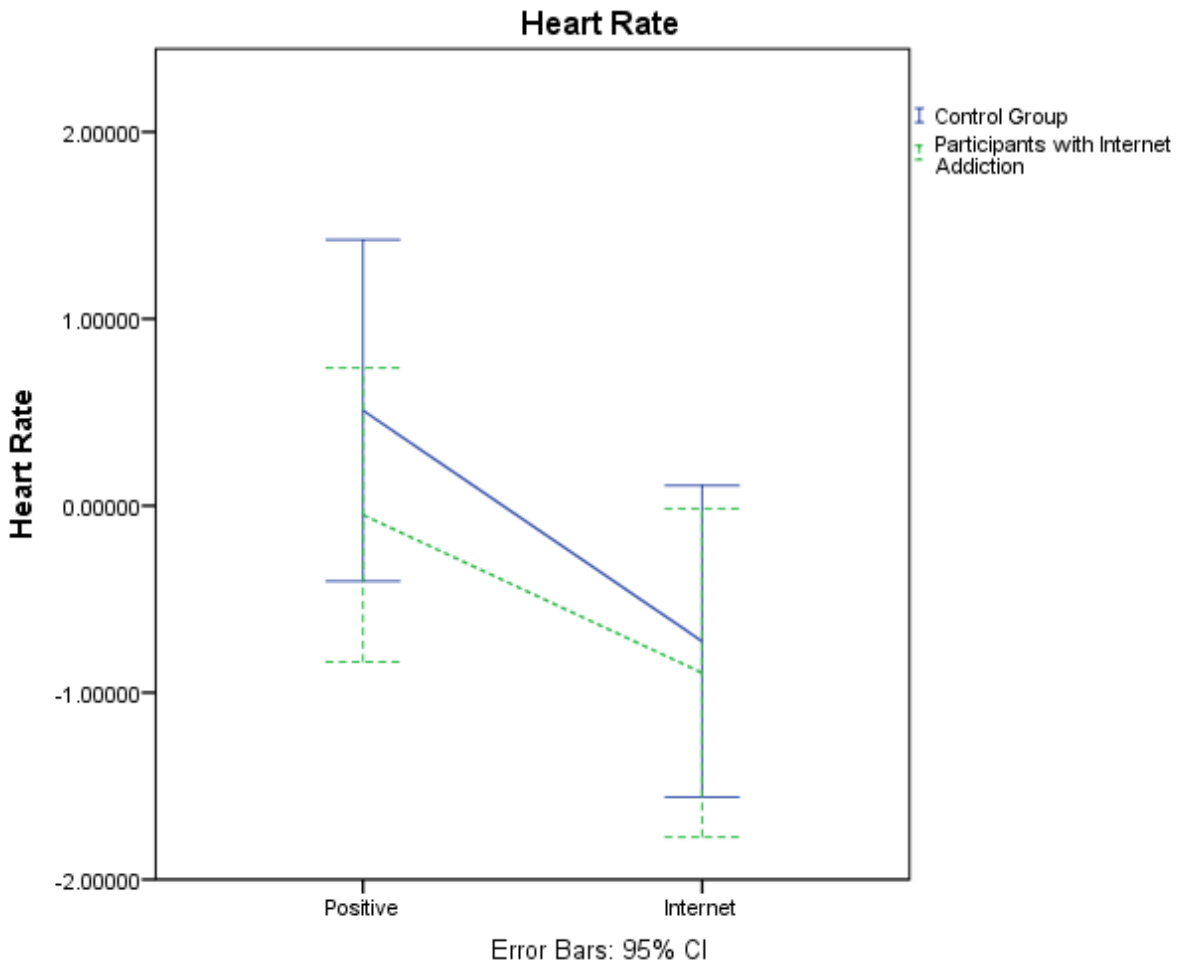

Figure 6. Heart rate responses to positive and internet stimuli.

2.3.6 Hypothesis 4 - Motivation task results

There were no differences between the internet addiction and control groups on the motivational task (see Table 7). Running multiple t-tests increases the risk of a Type 1 Error yet there were no significant differences between any DVs, so this was not an issue.

Table 7

Mean scores and between group differences for motivation task

Variable	Means (SD)Low	Internet	Test	P Value
Indifference 0	23.82 (17.00)	26.58 (14.72)	*U* =141.50	0.522, n/s
Indifference 15	30.88 (10.20)	35.79 (14.65)	*t* =-1.45 (34)	0.155, n/s
Difference between humorous and non-humorous GIF ratings*	21.32 (14.65)	19.47 (19.07)	*U* =161.00	0.987, n/s
Humorous GIFs Average Rating	67.18 (9.46)	67.64 (14.32)	*t* =-0.11(34)	0.912, n/s
Non-Humorous GIFs Average Rating	42.17 (7.17)	48.17 (10.81)	*U* = 132.00	0.350, n/s
Task Liking	62.98 (8.37)	68.59 (14.98)	*t* =-1.40(28.81)	0.171, n/s

*Average non-humorous rating for each participant subtracted from the average humorous rating

There were no significant between-group differences on all DVs on the motivation task; however, intra-group correlations enabled further exploration of within group differences and returned some more interesting findings. For the full correlations table see Appendix H.

In similar findings to Sherdell et al. (2012), for those in the control group there was a significant correlation between how much participants liked the humorous GIFs and their motivation to see these rewards: the more they liked the GIFs, the more motivated they were to view them. For the high internet use group there was no such association. Mean scores indicated that the internet addiction's motivation scores were slightly higher overall, but it does not appear that this motivation was driven by liking of the humorous reward.

In the internet addiction group there was a positive correlation between motivation and BDI-II scores, indicating that the more depressed a person was, the more motivated they were to obtain the humorous reward. There was also a positive correlation between their total SHAPS score and how much they liked the task.

2.4 Discussion

2.4.1 Discussion summary

The present study hypothesised that disturbances in reward processing mediate the association between depression and internet addiction. The study's main focus, in regards to this proposed model, was to examine differences in reward sensitivity between an internet addiction and control group by measuring responses to positive and internet stimuli, and motivation to obtain positive reward. It was hypothesised that these disturbances may lead to reductions in motivation to engage in naturally rewarding behaviours, which may reduce positive reinforcement received from the environment.

2.4.2 Hypothesis 1

It was important to establish whether there was an association between internet addiction and depression in the study's sample. Consistent with this hypothesis, those in the internet addiction group reported significantly higher depression scores on the BDI-II than the control group, with a large effect size (d =1.21). This is a finding accordant with a growing body of research that has evidenced an association between depression and internet addiction (e.g. Adalier & Balkan, 2012).

2.4.3 Hypotheses 2 and 3

Volkow et al.'s (2010) substance addiction model provided a theoretical framework for the present study. Concordantly, it was hypothesised that the reported association between internet addiction and depression would be mediated by changes to reward sensitivity. The present study did not conduct a full mediational analysis, yet focused specifically on the relationship between internet addiction and disturbances in reward processing. It was hypothesised that those with internet addiction would experience greater arousal for internet-related stimuli ('wanting') and reduced valence ('liking') for naturally positive stimuli. However, there were no significant interactions between stimuli category and internet use group for physiological, nor for self-reported measures.

There was a significant main effect for self-reported arousal by group indicating that, relative to the control group, those with internet addiction were overall more aroused by the positive and internet stimuli. This pattern was not repeated for self-reported valence, indicating that the two groups 'liked' the stimuli to a similar degree.

The finding that the internet addiction group experienced more 'wanting' overall, but did not significantly differ from controls in terms of 'liking' is contrary to the reward deficit theory proposed by Volkow et al. (2010), yet consistent with the impulsivity hypothesis of addiction (e.g. Perry & Carroll, 2008) which proposes that addiction is a result of increased sensitivity to reward, coupled with inhibition difficulties.

This theoretical debate is reflected in the addiction research findings. For example, Lubman et al. (2009) found that opiate dependent participants experienced lower arousal in relation to naturally pleasant stimuli, yet rated drug-related pictures as more arousing. There is also neuroimaging evidence that reward deficiency is relevant for those with internet addiction (Kuss & Griffiths, 2012). Meerkerk, van den Eijnden, Franken and Garretsen (2010) found that sensitivity to reward could not be related to compulsive internet use in their sample. However, the results of the present study do correspond with Dong, Huang, and Du's (2011) findings: they explored reactions on a gain and loss task and found those with internet gaming addiction experienced greater reward sensitivity than controls, in addition to reduced loss sensitivity. The authors explained this by citing Rational Addiction Theory (Becker & Murphy, 1988), which posits that immediate reward seeking is prioritised in those with addiction to the neglect of long-term adverse consequences. A body of research on substance addiction suggests that addiction is characterised by increased incentive-motivational neurocircuitry, yet both reduced sensitivity and increased sensitivity may contribute to addiction (Hommer et al., 2011).

Whilst it was hypothesised that reduced 'liking' of non-internet stimuli may be a crucial factor in the association between internet addiction and depression, increased 'wanting' may actually be more relevant. It is possible that this manifests as compulsive use of the internet that is hard to control, potentially leading to reductions in alternative sources of positive reinforcement (Meerkerk et al., 2010).

2.4.4 Hypothesis 4

There were no differences between the two groups on any of the dependent variables in the motivation task, indicating that both groups 'liked' the GIFs to a similar degree and were similarly motivated to obtain the humorous over the non-humorous rewards. However, correlational analysis explored within-group differences and returned a number of interesting findings. For the control group, there was a clear association between how much participants liked the humorous GIFs over

the unfunny ones and their motivation to obtain the humorous reward. However, for the internet addiction group, there was almost no association at all (r =0.012).

Research has demonstrated that 'wanting' and 'liking' can become dissociated, particularly for those with addiction (Robinson, 2015; Mori, 2016), often evidenced by manipulations of dopamine (e.g. Berridge, 2007). The result of this dissociation is that users experience excessive drug taking and intense craving, despite experiencing minimal pleasure (Robinson, 2015).

The current study chose to replicate a computer-based click task as a means of recording effort for a reward, which was chosen for its humour value. However, it is possible that for the internet addiction group, use of computer equipment had acquired incentive salience, and therefore become a conditioned stimulus. Berridge (2012) argues that incentive salience integrates physiological state with learned associations about the reward cue. This, he argues, allows behaviour to be guided by appetite-appropriate stimuli even without need of further learning (Berridge, 2012). It is possible then that this process was replicated in the current study's internet addiction sample, which evidenced more clicks on average than controls, despite this not being positively correlated with pleasure ratings.

An alternative explanation of these results could be found in the correlation between depression scores and motivation in the internet addiction group. This finding could imply that those in the internet addiction group are using it as a means of 'experiential avoidance': "the phenomenon that occurs when a person is unwilling to remain in contact with particular private experiences and takes steps to alter the form of frequency of these" (Hayes et al., 1996, pp. 1155). It is therefore possible that the motivation for funny GIFs, and possibly even the square clicking task, served as a form of experiential avoidance in helping to avoid the private events that were associated with depression by focusing their attention elsewhere, in a similar fashion to private internet use (Kingston, Clarke, & Remington, 2010).

Although there is some evidence to suggest that internet addiction is a cause rather than result of depression (Kraut, 1998; Ko et al., 2014), the direction of the relationship is still unclear and requires further exploration (Kuss & Griffiths, 2014). The implication of the current finding is that internet addiction could represent a faulty coping mechanism, used as a way to avoid low mood and depression. This is contrary to the theoretical framework utilised for this study, yet is consistent with Davis' (2001) CBT model of internet addiction, which proposes that pathology (e.g. mood disturbance) contributes to the onset of internet addiction, rather than resulting from it. This is in accordance with Kingston et al. (2010), who propose that internet addiction is a form of experiential avoidance, that is, a method of avoiding distressing private experiences. However the relationship between internet addiction and depression is unlikely to be straightforward and both disorders are likely to interact with one another.

To summarise, it is possible that the dissociation between 'liking' and 'wanting' on this task could be explained in a number of meaningful ways: through a compulsive use of the internet (assuming that the task and computer it was based on could have been imbued with incentive salience) creating arousal and motivation that were not related to the intended motivation for naturally positive reward. Alternatively, the motivation could have been explained by experiential avoidance in those in the internet addiction group that were already feeling depressed and using the task as a means of distraction.

2.5 Strengths and Weaknesses

2.5.1 Study's Strengths

The present study adds to a growing body of research highlighting the association between depression and internet addiction. It also highlights a possible dissociation between 'liking' and 'wanting' in those with internet addiction, a process that is common in substance addicts. This dissociation could be interpreted in a number of meaningful ways in regards to helping understand the association between depression and internet addiction. It could be that internet addiction serves as a form of experiential avoidance, and is thus a maladaptive means of coping and therefore unlikely to reduce depression. Alternatively, internet addiction could be seen as compulsive, meaning the individual feels compelled to use it, despite a lack of positive reinforcement, which may potentially impact mood. This provides a number of interesting avenues for future research.

2.5.2 Study's Limitations

There is an alternative explanation as to why the findings were not consistent with the hypotheses: it is possible that the study's methodological limitations did not enable the detection of the predicted reward differences.

One possible limitation of the study was the cut-off score used for the CIUS. The creators of the CIUS (Meerkerk et al., 2009) suggested a cut-off of 28, although this was based upon a somewhat arbitrary determination, with the authors reasoning that people should be affected by the difficulties at least sometimes, giving a score of at least two out of four for each of the items. Guertler et al. (2013) validated the CIUS against the Internet Addiction Test (Young, 1998), and suggested a cut-off score of 18. However, it is possible that this score is perhaps a little too sensitive, with only 27% of the 158 predominantly undergraduate psychologists completing the screening test not being classified as being addicted to the internet. It is debatable that such a high percentage of students at a demanding university could have been addicted to the internet (which is

accompanied by clinically significant impairment), in comparison with a 6% prevalence of internet addiction globally. This increased sensitivity could potentially have classified those without significant symptoms of internet addiction as addicted, therefore altering the results.

As noted above, it is possible that the medium by which the stimuli and the motivation task were presented impacted the results. The stimuli were presented on a computer and were essentially similar to images that might be viewed via the internet and may have therefore have been imbued with incentive salience, cueing thoughts of internet use for those with internet addiction and increasing arousal. Similarly, the motivation task was based on a laptop, with humorous GIF rewards that are generally accessed via the internet and a clicking task that had similarities to internet use. It is therefore possible that the arousal and motivation rates experienced by the internet addiction group resulted from this similarity, rather than representing arousal related to positive stimuli or a drive to obtain natural (humorous) rewards.

Another potential limitation was the physiological measures that were used. Although it is possible that there were no group differences, it is also possible that the measures were not sensitive enough to detect differences, or that more appropriate measures could have been used. The mean difference scores were generally negative, meaning that people's physiological reaction was stronger for the neutral categories than for the internet or naturally positive, which was not the intention and may be indicative of a lack of sensitivity. There was no evidence of the expected correlations with the self-report data: theoretically it would have made sense to analyse the 'liking' and 'wanting' components of the stimuli task separately (heart rate analysed with self-reported valence, and skin conductance analysed with self-reported arousal). However there were very small correlations, so this was not possible. Additionally, the self-report measure for valence was likely measured using a less than sensitive scale (-4 to +4); none of the images were designed to be unpleasant so a better scale would have been 0-8, to allow for more sensitivity.

An additional limitation to the physiological measures was the associated stimuli. Whilst the images were not explicitly controlled for their arousal ratings, they generally had scores within a narrow range. However, there were a number of exceptions that had far higher or lower arousal ratings than the majority. For example, included in the pleasant stimuli were images of skiing and rafting, which had far higher scores than the majority of other images, as did the image of a stove in the neutral category. If this study were to be replicated it would be important to control more carefully for arousal ratings, in addition to valence ratings. Similarly, although the internet-related images were chosen to be relatively consistent in relation to their valence and arousal ratings, this was not measured during the pilot so it is unclear whether the images varied in terms of their valence and arousal potentials, so it is not possible to tell whether this impacted the results.

A final consideration in relation to the heart rate measurements is that of initial deceleration following attention to emotionally arousing stimuli (e.g. Bradley & Lang, 2007). Due to methodological constraints, the current study was able to record heart rate over a period of time following the viewing of each image. However, the initial deceleration may have partially obscured any later increase in heart rate, making any changes more difficult to detect.

An obvious limitation of the current study was its design and its limited capacity to infer cause and effect from the results: it is still unclear as to whether the proposed reward deficiencies precede internet addiction or result from it. In addition, despite a limited number of studies suggesting that depression results from internet addiction, there is the other possibility to consider, that internet addiction is a result of depression and is an attempt at regulating mood (Kuss et al., 2014). It is still unclear as to whether people's mood becomes low first and they turn to internet as a means to cope with this. Further understanding of the direction of this relationship would have important implications in working with those with internet addiction, and potentially depression.

There is also the issue of generalisability due to the sample's limitations: it was a small sample size, predominantly female (69.4%), with a relative lack of ethnic (69.4% White British) and age diversity (majority around 18-19). All except one participant was a psychology student. This population is one with relatively more free time than other groups, so their internet use may not be representative.

The SHAPS was restricted to measuring subjective experiences of hedonic impact (i.e. 'liking'); however, some of the more recently developed questionnaires also include aspects of reward motivation (i.e. wanting); for example the Temporal Experience of Pleasure Scale (TEPS) (Gard, 2006) differentiates between anticipatory and consummatory experiences of pleasure. It is possible that there were trait differences of anhedonia between the two groups that were not detected by the SHAPS and a more sophisticated measure could have been selected.

Carter and Tiffany (1999) reported that self-report effect sizes were large for drug addicts, yet physiological measures were relatively small. The power calculations for the present study were based upon substance addiction models; however, it is possible that the effect size for those with internet addiction was even smaller (Hellman et al., 2013) and therefore the study was not adequately powered to detect this effect.

2.6 Clinical Implications

Internet addiction is still a debated concept, and therefore may not receive adequate attention in clinical settings. Yet the present study adds to a growing body of literature that provides evidence of a strong relationship between internet addiction and depression, even in non-

clinical populations. There is evidence to suggest that internet addiction is a stable disorder (e.g. Shek & Yu, 2012), and therefore left untreated this experience of depression may continue. Even if the internet addiction is not a cause of depression, the association suggests that it is a maladaptive and ineffective means of coping. The correlation between task liking and depression for the internet addiction group could also imply that internet addiction manifests as a result of maladaptive attempts at mood management.

The dissociation between 'liking' and 'wanting' in the internet addiction group could have a number of clinical implications. Were it to be explained by compulsive internet, the individual may feel unable to control their internet use and would require support in reducing this, as it may be impacting functioning in other areas of life. Alternatively, the internet addiction could be serving as an ineffective means of coping with depression; supporting the individual with this form of experiential avoidance could enable them to engage in activities more in line with their core values. Additionally, both of these explanations would reduce the likelihood of the affected individual engaging in behaviours that were more likely to provide a source positive reinforcement. Behavioural activation treatment for depression is an effective intervention for this (e.g. Jacobson et al., 2001).

2.7 Future Research

It is clear that further research is required on the association between internet addiction and depression. The current research proposed a model that could help explain the association between internet addiction and depression and drew upon substance addiction models. Whilst the hypotheses were not supported by the results, a number of avenues for further research appear very relevant.

Theory would suggest that reward sensitivity is likely altered in internet addiction, and this could help to explain why it may lead to depression. It is possible that methodological limitations of the present study did not enable the identification of these differences; addressing these limitations could go some way to exploring the relationship further. A particular shortcoming of the present research is the difficulty in distinguishing internet and positive stimuli; this could be easily rectified in future research.

A full mediational analysis with a much larger sample would be required to test the proposed association between reward sensitivity and depression in those with internet addiction, as the present study focused predominantly on the association between internet addiction and reward sensitivity. This larger sample could also help to detect the relatively small effect sizes, particularly in regards to physiological measures.

However, it still appears that good quality longitudinal and experimental studies are required to further explore the nature of the relationship: whether there is an initial reward deficit in those likely to experience internet addiction, or whether internet addiction alters this. This could have big implications on reducing depression if it is the former, or of helping patients to find more adaptive methods of coping if the latter.

2.8 Conclusion

Internet addiction remains a debated disorder; however, the results of the present study highlighted a clear association between it and depression, indicating important clinical implications. In addition, for those with internet addiction 'wanting' and 'liking' appear to be dissociated in regards to internet use, as has been evidenced in those with substance addiction. Although methodological limitations make firm conclusions difficult, this dissociation could be explained in a number of ways: the internet is used as a means of avoidance and an ineffective method of coping with mood disturbance. Or conversely, through incentive salience the internet is used compulsively, and those with addiction struggle to control its use, possibly resulting in depression through a lack of positive reinforcement from the environment. The study's design did not enable a firm answer to these questions, yet these findings highlight possible avenues for future research that could have clinically meaningful implications.

References

Adalıer, A., & Balkan, E. (2012). The relationship between internet addiction and psychological symptoms. *International Journal of Global Education, 1*(2). Retrieved from http://www.iojpe.org/ojs/index.php/ijge/article/viewFile/72/87

Allahverdipour, H., Bazargan, M., Farhadinasab, A., & Moeini, B. (2010). Correlates of video games playing among adolescents in an Islamic country. *BMC Public Health, 10(1),* 1. doi**:** 10.1186/1471-2458-10-286

Alvarez, G. (2014). Wanting versus liking: anhedonia and the difference between motivation and consumption processes. *Washington University Undergraduate Research Digest, Volume 9, Issue 2.* Retrieved from http://openscholarship.wustl.edu/vol9_iss2/6/

American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders: DSM- IV. (4th Ed).* Washington, DC: American Psychiatric Association

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th Ed.). Arlington, VA: American Psychiatric Publishing

Anderson, C. A., Berkowitz, L., Donnerstein, E., Huesmann, L. R., Johnson, J. D., Linz, D., ... & Wartella, E. (2003). The influence of media violence on youth. *Psychological science in the public interest*, *4*(3), 81-110. doi: 10.1111/j.1529-1006.2003.pspi_1433.x

Bech, P., Bille, J., Møller, S. B., Hellström, L. C., & Østergaard, S. D. (2014). Psychometric validation of the Hopkins Symptom Checklist (SCL-90) subscales for depression , anxiety , and interpersonal sensitivity. *Journal of Affective Disorders*, *160*, 98–103. http://doi.org/10.1016/j.jad.2013.12.005

Becker, G. S., & Murphy, K. M. (1988). A theory of rational addiction. *The Journal of Political Economy*, *96(4)*, 675-700.

Beevers, C. G., & Meyer, B. (2002). Lack of positive experiences and positive expectancies mediate the relationship between BAS responsiveness and depression. *Cognition & Emotion, 16(4),* 549-564. http://doi.org/10.1080/02699930143000365

Berridge, K. C. (2009). Physiology & Behavior " Liking " and " wanting " food rewards : Brain substrates and roles in eating disorders. *Physiology & Behavior*, *97*(5), 537–550. http://doi.org/10.1016/j.physbeh.2009.02.044

Berridge, K. C., Robinson, T. E., & Aldridge, J. W. (2009). Dissecting components of reward:'liking','wanting', and learning. *Current opinion in pharmacology*, *9(1)*, 65-73. doi:10.1016/j.coph.2008.12.014

Berridge, K. C., & Robinson, T. E. (1995). The mind of an addicted brain: neural sensitization of wanting versus liking. *Current Directions in Psychological Science*, *4*(3), 71-76.

Bickham, D. S., Hswen, Y., & Rich, M. (2015). Media use and depression: exposure, household rules, and symptoms among young adolescents in the USA. *International journal of public health*, *60*(2), 147-155. http://doi.org/10.1007/s00038-014-0647-6

Bogdan, R., & Pizzagalli, D. A. (2006). Acute stress reduces reward responsiveness: implications for depression. *Biological psychiatry*, *60*(10), 1147-1154. http://doi.org/10.1016/j.biopsych.2006.03.037

Bradley, M. M. & Lang, P. J. (2007). Motivation and emotion. In J.T. Cacioppo, L. G. Tassinary, and G. Berntson (Eds.) *Handbook of Psychophysiology (2rd Edition).* New York: Cambridge University Press

Brand, M., Young, K. S., & Laier, C. (2014). Prefrontal control and Internet addiction: a theoretical model and review of neuropsychological and neuroimaging findings. *Front Hum Neurosci*, *8*(375), 1-13. http://doi.org/10.3389/fnhum.2014.00375

Brunborg, G. S., Mentzoni, R. A., & Frøyland, L. R. (2014). Is video gaming, or video game addiction, associated with depression, academic achievement, heavy episodic drinking, or conduct problems? *Journal of Behavioral Addictions*, *3*(1), 27–32. http://doi.org/10.1556/JBA.3.2014.002

Buka, S. L., Stichick, T. L., Birdthistle, I., & Earls, F. J. (2001). Youth exposure to violence: prevalence, risks, and consequences. *American Journal of Orthopsychiatry*, *71*(3), 298. http://dx.doi.org/10.1037/0002-9432.71.3.298

Cacioppo, J. T., Hughes, M. E., Waite, L. J., Hawkley, L. C., & Thisted, R. A. (2006). Loneliness as a specific risk factor for depressive symptoms: cross-sectional and longitudinal analyses. *Psychology and Aging*, *21*(1), 140-151. http://doi.org/10.1037/0882-7974.21.1.140

Caplan, S. E. (2002). Problematic Internet use and psychosocial well-being: development of a theory-based cognitive–behavioral measurement instrument. *Computers in Human Behavior*, *18*(5), 553-575. doi:10.1016/S0747-5632(02)00004-3

Carvalho, J. P., & Hopko, D. R. (2011). Journal of Behavior Therapy and Behavioral theory of

depression : Reinforcement as a mediating variable between avoidance and depression. *Journal of Behavior Therapy and Experimental Psychiatry*, *42*(2), 154–162. http://doi.org/10.1016/j.jbtep.2010.10.001

Cheng, C., & Li, A. Y. (2014). Internet addiction prevalence and quality of (real) life : A meta-analysis of 31 Nations Across Seven World Regions, *Cyberpsychology, Behavior, and Social Networking*, *17*(12), 755-760. http://doi.org/10.1089/cyber.2014.0317

Davis, R. A. (2001). A cognitive-behavioral model of pathological Internet use. *Computers in Human Behavior*, *17*(2), 187-195. doi:10.1016/S0747-5632(00)00041-8

Department of Health (2011). No health without mental health: A cross-governmental mental health outcomes strategy for people of all ages. (Publication No. 14679). London: UK. Government Printing Office. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/213761/dh_124058.pdf

Dimidjian, S., Barrera Jr, M., Martell, C., Muñoz, R. F., & Lewinsohn, P. M. (2011). The origins and current status of behavioral activation treatments for depression. *Annual Review of Clinical Psychology*, *7*, 1-38. http://doi.org/10.1146/annurev-clinpsy-032210-104535

Dunning, J. P., Parvaz, M. A., Hajcak, G., Maloney, T., Alia-Klein, N., Woicik, P. A., ... & Goldstein, R. Z. (2011). Motivated attention to cocaine and emotional cues in abstinent and current cocaine users–an ERP study. *European Journal of Neuroscience*, *33*(9), 1716-1723. http://doi.org/10.1111/j.1460-9568.2011.07663.x

Dupuis, E. C., & Ramsey, M. A. (2011). The relation of social support to depression in massively multiplayer online role-playing games. *Journal of Applied Social Psychology*, *41*(10), 2479-2491. doi:10.1111/j.1559-1816.2011.00821.x

Entertainment Software Association (2015). Essential facts about the computer and video game industry. ESA Publications. Retrieved from http://www.theesa.com/wp-content/uploads/2015/04/ESA-Essential-Facts-2015.pdf

Epstein, J., Pan, H., Kocsis, J. H., Yang, Y., Butler, T., Chusid, J., ... & Silbersweig, D. A. (2006). Lack of ventral striatal response to positive stimuli in depressed versus normal subjects. *American Journal of Psychiatry*. doi:10.1176/appi.ajp.163.10.1784

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191. doi: 10.3758/BF03193146

Ferguson, C. J., Coulson, M., & Barnett, J. (2011). A meta-analysis of pathological gaming prevalence and comorbidity with mental health, academic and social problems. *Journal of Psychiatric Research*, *45*(12), 1573-1578. http://doi.org/10.1016/j.jpsychires.2011.09.005

Ferguson, C. J., Coulson, M., & Barnett, J. (2011). A meta-analysis of pathological gaming prevalence and comorbidity with mental health , academic and social problems. *Journal of Psychiatric Research*, *45*(12), 1573–1578. http://doi.org/10.1016/j.jpsychires.2011.09.005

Ferguson, C. J., Miguel, C. S., & Hartley, R. D. (2009). A Multivariate Analysis of Youth Violence and Aggression: The Influence of Family, Peers, Depression, and Media Violence. *The Journal of Pediatrics*, *155*(6), 904–908.e3. http://doi.org/10.1016/j.jpeds.2009.06.021

Ferguson, C. J., & Rueda, S. M. (2010). The Hitman Study. *European Psychologist*, *15*(2), 99–108. http://doi.org/10.1027/1016-9040/a000010.

Forbes, E. E., & Dahl, R. E. (2005). Neural systems of positive affect: relevance to understanding child and adolescent depression?. *Development and Psychopathology*, *17*(03), 827-850. doi: http://dx.doi.org/10.1017/S095457940505039X

Gard, D. E., Gard, M. G., Kring, A. M., & John, O. P. (2006). Anticipatory and consummatory components of the experience of pleasure: a scale development study. *Journal of Research in Personality*, *40*(6), 1086-1102. http://doi.org/10.1016/j.jrp.2005.11.001

Gentile, D. (2009). Pathological video-game use among youth ages 8 to 18 A National Study. *Psychological Science*, *20*(5), 594-602. doi: 10.1111/j.1467-9280.2009.02340.x

Gilman, S. E., & Abraham, H. D. (2001). A longitudinal study of the order of onset of alcohol dependence and major depression. *Drug and Alcohol Dependence*, *63*(3), 277-286. doi:10.1016/S0376-8716(00)00216-7

Gentile, D. A., Choo, H., Liau, A., Sim, T., Li, D., Fung, D., & Khoo, A. (2011). Pathological video game use among youths: a two-year longitudinal study. *Pediatrics*, *127*(2) 319-329. http://doi.org/10.1542/peds.2010-1353

Goldstein, R. Z., & Volkow, N. D. (2002). Drug addiction and its underlying neurobiological basis: neuroimaging evidence for the involvement of the frontal cortex. *American Journal of Psychiatry*, 159(10), 1642–1652. http://dx.doi.org/10.1176/appi.ajp.159.10.1642

Gorwood, P. (2008). Neurobiological mechanisms of anhedonia. *Dialogues in Clinical Neuroscience*, *10*(3), 291-299. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3181880/

Grant, B. F. (1995). Comorbidity between DSM-IV drug use disorders and major depression: results of a national survey of adults. *Journal of Substance Abuse*, *7*(4), 481-497.

Grant, J. E., Schreiber, L. R., & Odlaug, B. L. (2013). Phenomenology and treatment of behavioural addictions. *Canadian Journal of Psychiatry*, *58*(5), 252. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/23756285

Greenwald, M. K., Bradley, M. M., Hamm, A. O., & Lang, P. J. (1993). Looking at pictures: evaluative, facial, visceral and behavioral responses. *Psychophysiology*, *30*(3), 261-273.

Griffiths, M. D. (2010). The role of context in online gaming excess and addiction: Some case study evidence. *International Journal of Mental Health and Addiction*, *8*(1), 119-125. http://doi.org/10.1007/s11469-009-9229-x

Griffiths, M., J Kuss, D., & L King, D. (2012). Video game addiction: Past, present and future. *Current Psychiatry Reviews*, *8*(4), 308-318. doi: http://dx.doi.org/10.2174/157340012803520414

Griffiths, M. D., Davies, M. N., & Chappell, D. (2004). Online computer gaming: a comparison of adolescent and adult gamers. *Journal of Adolescence*, *27*(1), 87-96. http://doi.org/10.1016/j.adolescence.2003.10.007

Grüsser, S. M., Thalemann, R., & Griffiths, M. D. (2006). Excessive computer game playing: evidence for addiction and aggression?. *CyberPsychology & Behavior*, *10*(2), 290-292. http://doi.org/10.1089/cpb.2006.9956

Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents : A systematic literature review. *Sleep Medicine Reviews*, *21*, 50–58. http://doi.org/10.1016/j.smrv.2014.07.007

Hayes, S. C., Wilson, K. G., Gifford, E. V., Follette, V. M., & Strosahl, K. (1996). Experiential avoidance and behavioral disorders: A functional dimensional approach to diagnosis and treatment. *Journal of Consulting and Clinical Psychology*, *64*(6), 1152.

Hellman, M., Schoenmakers, T. M., Nordstrom, B. R., & van Holst, R. J. (2013). Is there such a thing as online video game addiction? A cross-disciplinary review. *Addiction Research & Theory*, *21*(2), 102-112. http://doi.org/10.3109/16066359.2012.693222

Hidaka, B. H. (2012). Depression as a disease of modernity: explanations for increasing prevalence. *Journal of Affective Disorders*, *140*(3), 205-214. doi:10.1016/j.jad.2011.12.036

Hoeft, F., Watson, C. L., Kesler, S. R., Bettinger, K. E., & Reiss, A. L. (2008). Gender differences in the mesocorticolimbic system during computer game-play. *Journal of Psychiatric Research*, *42*(4), 253-258. doi:10.1016/j.jpsychires.2007.11.010

Hou, H., Jia, S., Hu, S., Fan, R., Sun, W., Sun, T., & Zhang, H. (2012). Reduced striatal dopamine transporters in people with internet addiction disorder. *BioMed Research International*, *2012*. http://doi.org/10.1155/2012/854524

Hyun, G. J., Han, D. H., Lee, Y. S., Kang, K. D., Yoo, S. K., Chung, U.-S., & Renshaw, P. F. (2015). Risk factors associated with online game addiction: A hierarchical model. *Computers in Human Behavior*, *48*, 706–713. http://doi.org/10.1016/j.chb.2015.02.008

Jacobson, N. S., Martell, C. R., & Dimidjian, S. (2001). Behavioral activation treatment for depression: Returning to contextual roots. *Clinical Psychology: Science and Practice*, *8*(3), 255-270. doi: 10.1093/clipsy.8.3.255

Kang, E., & Lee, J. (2010). A longitudinal study on the causal association between smoking and depression. *J Prev Med Public Health*, *43*(3), 193-204. http://doi.org/10.3961/jpmph.2010.43.3.193

Kessler, R. C. (1997). The effects of stressful life events on depression. *Annual Review of Psychology*, *48*, *191-214.*

Kessler, R. C., & Bromet, E. J. (2013). The epidemiology of depression across cultures. *Annual Review of Public Health*, *34*, 119. doi:10.1146/annurev-publhealth-031912-114409

King, D. L., & Delfabbro, P. H. (2014). Clinical Psychology Review The cognitive psychology of Internet gaming disorder. *Clinical Psychology Review*, *34*(4), 298–308. http://doi.org/10.1016/j.cpr.2014.03.006

King, D. L., Delfabbro, P. H., Zwaans, T., & Kaptsis, D. (2013). Clinical features and axis I comorbidity of Australian adolescent pathological Internet and video game users. *Australian & New Zealand Journal of Psychiatry*, *47*(11), 1058–1067. http://doi.org/10.1177/0004867413491159

Király, O., Griffiths, M. D., Urbán, R., Farkas, J., Kökönyei, G., Elekes, Z., … Demetrovics, Z. (2014). Problematic Internet Use and Problematic Online Gaming Are Not the Same: Findings from a Large Nationally Representative Adolescent Sample. *Cyberpsychology, Behavior, and Social Networking*, *17*(12), 749–754. http://doi.org/10.1089/cyber.2014.0475

Ko, C., Liu, G., Hsiao, S., Yen, J., & Yang, M. (2009). Brain activities associated with gaming urge of online gaming addiction. *Journal of Psychiatric Research*, *43*(7), 739–747. http://doi.org/10.1016/j.jpsychires.2008.09.012

Ko, C. H., Yen, J. Y., Yen, C. F., Chen, C. S., & Chen, C. C. (2012). The association between Internet addiction and psychiatric disorder: a review of the literature. *European Psychiatry*, *27*(1), 1-8. http://doi.org/10.1016/j.eurpsy.2010.04.011

Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukophadhyay, T., & Scherlis, W. (1998). Internet paradox: A social technology that reduces social involvement and psychological well-being?. *American Psychologist*, *53*(9), 1017. http://dx.doi.org/10.1037/0003-066X.53.9.1017

Kühn, S., Romanowski, A., Schilling, C., Lorenz, R., Mörsen, C., Seiferth, N., ... & Conrod, P. J. (2011). The neural basis of video gaming. *Translational psychiatry*, *1*(11), e53. http://doi.org/10.1038/tp.2011.53

Kuss, D. J., & Griffiths, M. D. (2012a). Internet and gaming addiction: a systematic literature review of neuroimaging studies. *Brain Sciences*, *2*(3), 347-374. http://doi.org/10.3390/brainsci2030347

Kuss, D. J., & Griffiths, M. D. (2012b). Online gaming addiction in children and adolescents: A review of empirical research. *Journal of Behavioral Addictions*, *1*(1), 3-22. http://doi.org/10.1556/JBA.1.2012.1.1

Kuss, D., D Griffiths, M., Karila, L., & Billieux, J. (2014). Internet addiction: a systematic review of epidemiological research for the last decade. *Current Pharmaceutical Design*, *20*(25), 4026-4052. doi: 10.2174/13816128113199990617

Laconi, S., Tricard, N., & Chabrol, H. (2015). Differences between specific and generalized problematic Internet uses according to gender, age, time spent online and psychopathological symptoms. *Computers in Human Behavior*, *48*, 236-244. http://doi.org/10.1016/j.chb.2015.02.006

Lam, L. T. (2014). Internet gaming addiction, problematic use of the Internet, and sleep problems: A systematic review. *Current Psychiatry Reports*, *16*(4), 1-9. http://doi.org/10.1007/s11920-014-0444-1

Lee, J.-S., & Jeong, B. (2014). Having mentors and campus social networks moderates the impact of worries and video gaming on depressive symptoms: a moderated mediation analysis. *BMC Public Health*, *14* (1), 426. http://doi.org/10.1186/1471-2458-14-426

Lemola, S., Brand, S., Vogler, N., Perkinson-Gloor, N., Allemand, M., & Grob, A. (2011). Habitual computer game playing at night is related to depressive symptoms. *Personality and Individual Differences*, *51*(2), 117–122. http://doi.org/10.1016/j.paid.2011.03.024

Lépine, J. P., & Briley, M. (2011). The increasing burden of depression. *Neuropsychiatr Dis Treat*, *7*(Suppl 1), 3-7. http://doi.org/10.2147/NDT.S19617

Leventhal, A. M. (2008). Sadness, depression, and avoidance behavior. *Behavior Modification, 32(6), 759-779*. http://doi.org/10.1177/0145445508317167

Levine, S. Z. (2013). Evaluating the seven-item Center for Epidemiologic Studies Depression Scale short-form: a longitudinal US community study. *Social Psychiatry and Psychiatric Epidemiology*, *48*(9), 1519-1526. doi:10.1007/s00127-012-0650-2

Li, D., Liau, A., & Khoo, A. (2011). Examining the influence of actual-ideal self-discrepancies, depression, and escapism, on pathological gaming among massively multiplayer online adolescent gamers. *Cyberpsychology, Behavior and Social Networking*, *14*(9), 535–539. http://doi.org/10.1089/cyber.2010.0463

Liu, M., & Peng, W. (2009). Cognitive and psychological predictors of the negative outcomes associated with playing MMOGs (massively multiplayer online games). *Computers in Human Behavior*, *25*(6), 1306-1311. http://doi.org/10.1016/j.chb.2009.06.002

Lloyd-Richardson, E. E., Perrine, N., Dierker, L., & Kelley, M. L. (2007). Characteristics and functions of non-suicidal self-injury in a community sample of adolescents. *Psychological Medicine*, *37*(08), 1183-1192. http://doi.org/10.1017/S003329170700027X.Characteristics

Lubman, D. I., Yücel, M., Kettle, J. W., Scaffidi, A., MacKenzie, T., Simmons, J. G., & Allen, N. B. (2009). Responsiveness to drug cues and natural rewards in opiate addiction: associations with later heroin use. *Archives of General Psychiatry*, *66*(2), 205-212. doi:10.1001/archgenpsychiatry.2008.522

Marcus, M., Yasamy, M. T., van Ommeren, M., Chisholm, D., & Saxena, S. (2012). Depression: A global public health concern. World Health Organisation. WHO International Publications: UK. Retrieved from http://www.who.int/mental_health/management/depression/who_paper_depression_wfmh_2012.pdf

Matusitz, J., & McCormick, J. (2012). Sedentarism: the effects of Internet use on human obesity in the United States. *Social Work in Public Health*, *27*(3), 250-269. http://doi.org/10.1080/19371918.2011.542998

Meerkerk, G. J., Van Den Eijnden, R. J., Vermulst, A. A., & Garretsen, H. F. (2009). The compulsive internet use scale (CIUS): some psychometric properties. *CyberPsychology & Behavior*, *12*(1), 1-6. doi:10.1089/cpb.2008.0181

Mentzoni, R. A., Brunborg, G. S., Molde, H., Myrseth, H., Skouverøe, K. J. M., Hetland, J., & Pallesen, S. (2011). Problematic video game use: estimated prevalence and associations with mental and physical health. *Cyberpsychology, Behavior, and Social Networking*, *14*(10), 591-596. http://doi.org/10.1089/cyber.2010.0260

Montag, C., Bey, K., Sha, P., Li, M., Chen, Y. F., Liu, W. Y., ... & Reuter, M. (2015). Is it meaningful to distinguish between generalized and specific Internet addiction? Evidence from a cross-cultural study from Germany, Sweden, Taiwan and China. *Asia-Pacific Psychiatry*, *7*(1), 20-26. http://doi.org/10.1111/appy.12122

Morrison, C. M., & Gore, H. (2010). The relationship between excessive Internet use and depression: a questionnaire-based study of 1,319 young people and adults. *Psychopathology*, *43*(2), 121-126. http://doi.org/10.1159/000277001

National Collaborating Centre for Methods and Tools (2008). *Quality Assessment Tool for Quantitative Studies*. Hamilton, ON: McMaster University. (Updated 13 April, 2010) Retrieved from http://www.nccmt.ca/resources/search/14.

Nestler, E. J., & Carlezon, W. A. (2006). The mesolimbic dopamine reward circuit in depression. *Biological Psychiatry*, *59*(12), 1151-1159. http://doi.org/10.1016/j.biopsych.2005.09.018

Olsen, C. M. (2011). Natural rewards, neuroplasticity, and non-drug addictions. *Neuropharmacology*, *61*(7), 1109-1122. doi:10.1016/j.neuropharm.2011.03.010

Ostrowsky, M. K. (2010). Are violent people more likely to have low self-esteem or high self-esteem?. *Aggression and Violent Behavior*, *15*(1), 69-75. http://doi.org/10.1016/j.avb.2009.08.004

Parvaz, M. A., Maloney, T., Moeller, S. J., Woicik, P. A., Alia-Klein, N., Telang, F., ... & Goldstein, R. Z. (2012). Sensitivity to monetary reward is most severely compromised in recently abstaining cocaine addicted individuals: a cross-sectional ERP study. *Psychiatry Research: Neuroimaging*, *203*(1), 75-82. http://doi.org/10.1016/j.pscychresns.2012.01.001.Sensitivity

Peng, W., & Liu, M. (2010). Online gaming dependency: a preliminary study in China. *Cyberpsychology, Behavior, and Social Networking*, *13*(3), 329-333. doi:10.1089/cyber.2009.0082

Petry, N. M., & O'Brien, C. P. (2013). Internet gaming disorder and the DSM-5. *Addiction*, *108*(7), 1186-1187. http://doi.org/10.1111/add.12162

Petry, N. M., Rehbein, F., Gentile, D. A., Lemmens, J. S., Rumpf, H. J., Mößle, T., ... & Auriacombe, M. (2014). An international consensus for assessing internet gaming disorder using the new DSM-5 approach.*Addiction*, *109*(9), 1399-1406. http://doi.org/10.1111/add.12457

Peukert, P., Sieslack, S., Barth, G., & Batra, A. (2010). Internet-and computer game addiction: phenomenology, comorbidity, etiology, diagnostics and therapeutic implications for the addictives and their relatives.*Psychiatrische Praxis*, *37*(5), 219-224. doi: 10.1055/s-0030-1248442

Pizzagalli, D. A., Evins, A. E., Schetter, E. C., Frank, M. J., Pajtas, P. E., Santesso, D. L., & Culhane, M. (2008). Single dose of a dopamine agonist impairs reinforcement learning in humans: behavioral evidence from a laboratory-based measure of reward responsiveness. *Psychopharmacology*,*196*(2), 221-232. http://dx.doi.org/10.1007/s00213-007-0957-y

Pizzagalli, D. A. (2014). Depression, stress, and anhedonia: toward a synthesis and integrated model. *Annual review of clinical psychology*, *10*, 393. http://doi.org/10.1146/annurev-clinpsy-050212-185606

Primack, B. A., Swanier, B., Georgiopoulos, A. M., Land, S. R., & Fine, M. J. (2009). Association between media use in adolescence and depression in young adulthood: a longitudinal study. *Archives of General Psychiatry*, *66*(2), 181-188. http://doi.org/10.1001/archgenpsychiatry.2008.532.

Przybylski, A. K., Weinstein, N., Ryan, R. M., & Rigby, C. S. (2009). Having to versus wanting to play: Background and consequences of harmonious versus obsessive engagement in video games. *CyberPsychology & Behavior*, *12*(5), 485-492. doi: 10.1089/cpb.2009.0083

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A motivational model of video game engagement. *Review of General Psychology*, *14*(2), 154. http://doi.org/10.1037/a0019440

Qualter, P., Brown, S. L., Munn, P., & Rotenberg, K. J. (2010). Childhood loneliness as a predictor of adolescent depressive symptoms: an 8-year longitudinal study. *European Child & Adolescent Psychiatry*, *19*(6), 493-501. http://doi.org/10.1007/s00787-009-0059-y

Rawal, A., Collishaw, S., Thapar, A., & Rice, F. (2013). 'The risks of playing it safe': a prospective longitudinal study of response to reward in the adolescent offspring of depressed parents. *Psychological Medicine*, *43*(01), 27-38. http://doi.org/10.1017/S0033291712001158

Richards, J. B., Zhang, L., Mitchell, S. H., & Wit, H. (1999). Delay or probability discounting in a model of impulsive behavior: effect of alcohol. *Journal of the Experimental Analysis of Behavior*, *71*(2), 121-143.

Robinson, M. J. F., Fischer, A. M., Ahuja, A., Lesser, E. N., & Maniates, H. (2015). Roles of "Wanting" and "Liking" in Motivating Behavior: Gambling, Food, and Drug Addictions. *Current Topics in Behavioral Neurosciences*, 1-32. http://doi.org/10.1007/7854

Shaw, M., & Black, D. W. (2008). Internet addiction. *CNS Drugs*, *22*(5), 353-365. doi:10.2165/00023210-200822050-00001

Shek, D. T., & Yu, L. (2012). Internet addiction phenomenon in early adolescents in Hong Kong. *The Scientific World Journal*, *2012*. http://doi.org/10.1100/2012/104304

Sherdell, L., Waugh, C. E., & Gotlib, I. H. (2012). Anticipatory pleasure predicts motivation for reward in major depression. *Journal of Abnormal Psychology*, *121*(1), 51. http://doi.org/10.1037/a0024945.Anticipatory

Snaith, R. P., Hamilton, M., Morley, S., Humayan, A., Hargreaves, D., & Trigwell, P. (1995). A scale for the assessment of hedonic tone: the Snaith-Hamilton Pleasure Scale. *The British Journal of Psychiatry*, *167*(1), 99-103. http://doi.org/10.1192/bjp.167.1.99

Sowislo, J. F., & Orth, U. (2013). Does low self-esteem predict depression and anxiety? A meta-analysis of longitudinal studies. *Psychological Bulletin*,*139*(1), 213. http://doi.org/10.1037/a0028931

Starcevic, V. (2013). Is Internet addiction a useful concept?. *Australian and New Zealand Journal of Psychiatry*, *47*(1), 16-19. http://doi.org/10.1177/0004867412461693

Stetina, B. U., Kothgassner, O. D., Lehenbauer, M., & Kryspin-exner, I. (2011). Computers in Human Behavior Beyond the fascination of online-games : Probing addictive behavior and depression in the world of online-gaming. *Computers in Human Behavior*, *27*(1), 473–479. http://doi.org/10.1016/j.chb.2010.09.015

Strittmatter, E., Kaess, M., Parzer, P., Fischer, G., Carli, V., Hoven, C. W., … Wasserman, D. (2015). Pathological Internet use among adolescents: Comparing gamers and non-gamers. *Psychiatry Research*, *228*(1), 128–135. http://doi.org/10.1016/j.psychres.2015.04.029

Ströhle, A. (2009). Physical activity, exercise, depression and anxiety disorders. *Journal of Neural Transmission*, *116*(6), 777-784. http://doi.org/10.1007/s00702-008-0092-x

Sublette, V. A., & Mullan, B. (2012). Consequences of play: A systematic review of the effects of

online gaming. *International Journal of Mental Health and Addiction*, *10*(1), 3-23. http://doi.org/10.1007/s11469-010-9304-3

Swendsen, J. D., & Merikangas, K. R. (2000). The comorbidity of depression and substance use disorders. *Clinical psychology review*, *20*(2), 173-189. doi:10.1016/S0272-7358(99)00026-4

Tao, R., Huang, X., Wang, J., Zhang, H., Zhang, Y., & Li, M. (2010). Proposed diagnostic criteria for internet addiction. *Addiction*, *105*(3), 556-564. doi:10.1111/j.1360-0443.2009.02828.x

Thomée, S., Härenstam, A., & Hagberg, M. (2011). Mobile phone use and stress, sleep disturbances, and symptoms of depression among young adults - a prospective cohort study. *BMC Public Health*, *11*(1), 66. http://doi.org/10.1186/1471-2458-11-66

Thomsen, K. R. (2015). Measuring anhedonia: impaired ability to pursue, experience, and learn about reward. *Frontiers in Psychology*, *6*. http://doi.org/10.3389/fpsyg.2015.01409

Tortolero, S. R., Peskin, M. F., Baumler, E. R., Cuccaro, P. M., Elliott, M. N., Davies, S. L., … Schuster, M. A. (2014b). Daily Violent Video Game Playing and Depression in Preadolescent Youth. *Cyberpsychology, Behavior, and Social Networking*, *17*(9), 609–615. http://doi.org/10.1089/cyber.2014.0091

Treadway, M. T., Buckholtz, J. W., Schwartzman, A. N., Lambert, W. E., & Zald, D. H. (2009). Worth the 'EEfRT'? The effort expenditure for rewards task as an objective measure of motivation and anhedonia. *PloS One*, *4*(8), e6598. http://doi.org/10.1371/journal.pone.0006598

Valadez, J. J., & Ferguson, C. J. (2012). Just a game after all: Violent video game exposure and time spent playing effects on hostile feelings, depression, and visuospatial cognition. *Computers in Human Behavior*, *28*(2), 608–616. http://doi.org/10.1016/j.chb.2011.11.006

van Hell, H. H., Vink, M., Ossewaarde, L., Jager, G., Kahn, R. S., & Ramsey, N. F. (2010). Chronic effects of cannabis use on the human reward system : An fMRI study. *European Neuropsychopharmacology*, *20*(3), 153–163. http://doi.org/10.1016/j.euroneuro.2009.11.010

Van Rooij, A. J., Schoenmakers, T. M., Vermulst, A. A., Van Den Eijnden, R. J., & Van De Mheen, D. (2011). Online video game addiction: identification of addicted adolescent gamers. *Addiction*, *106*(1), 205-212. http://doi.org/10.1111/j.1360-0443.2010.03104.x

VAN Rooij, A. J., Kuss, D. J., Griffiths, M. D., Shorter, G. W., Schoenmakers, M. T., & VAN DE Mheen, D. (2014). The (co-)occurrence of problematic video gaming, substance use, and psychosocial problems in adolescents. *Journal of Behavioral Addictions*, *3*(3), 157–65. http://doi.org/10.1556/JBA.3.2014.013

Versace, F., Lam, C. Y., Engelmann, J. M., Robinson, J. D., Minnix, J. A., Brown, V. L., & Cinciripini, P. M. (2012). Beyond cue reactivity: blunted brain responses to pleasant stimuli predict long-term smoking abstinence. *Addiction Biology*, *17*(6), 991-1000. http://doi.org/10.1111/j.1369-1600.2011.00372.x.Beyond

Volkow, N. D., Wang, G. J., Fowler, J. S., Tomasi, D., Telang, F., & Baler, R. (2010). Addiction: decreased reward sensitivity and increased expectation sensitivity conspire to overwhelm the brain's control circuit. *Bioessays*, *32*(9), 748-755. doi: 10.1002/bies.201000042

Weeks, D. G., Michela, J. L., Peplau, L. A., & Bragg, M. E. (1980). Relation between loneliness and depression: a structural equation analysis. *Journal of personality and social psychology*, *39*(6), 1238-1244. http://dx.doi.org/10.1037/h0077709

Wei, H., Chen, M., Huang, P., & Bai, Y. (2012). The association between online gaming , social phobia , and depression : an internet survey. *BMC Psychiatry*, *12*(1), 1. http://doi.org/10.1186/1471-244X-12-92

Wittek, C. T., Finserås, T. R., Pallesen, S., Mentzoni, R. A., Hanss, D., Griffiths, M. D., & Molde, H. (2015). Prevalence and Predictors of Video Game Addiction: A Study Based on a National Representative Sample of Gamers. *International Journal of Mental Health and Addiction*, 1-15. http://doi.org/10.1007/s11469-015-9592-8

Young, K. S., & Rogers, R. C. (1998). The relationship between depression and Internet addiction. *CyberPsychology & Behavior*, *1*(1), 25-28.

Zink, C. F., Pagnoni, G., Martin-Skurski, M. E., Chappelow, J. C., & Berns, G. S. (2004). Human striatal responses to monetary reward depend on saliency. *Neuron*, *42*(3), 509-517. doi: http://dx.doi.org/10.1016/S0896-6273(04)00183-7

Appendix A – Proposed DSM-V Internet Gaming Disorder Criteria

There are nine proposed criteria for Internet Gaming Disorder in the appendix of DSM-V (APA, 2013), these include: preoccupation with internet games; withdrawal when internet gaming is taken away; tolerance, the need to spend increasing amounts of time engaged in Internet gaming; unsuccessful attempts to control participation; loss of interest in hobbies and entertainment as a result of, and with the exception of, internet gaming; continued excessive use of Internet games despite knowledge of psychosocial problems; deception of family members, therapists, or others regarding the amount of Internet gaming; use of Internet gaming to escape or relieve a negative mood; and loss of a significant relationship, job, or educational or career opportunity because of participation in Internet games.

Appendix B – Ethical Approval

Submission ID:**18151**

Submission Overview | **IRGA Form** | **Attachments** | **History** | **Advers**

Approved by the Ethics Committee in **1 day(s)** on 12/11/2015

Date	Activity	Comments
12/11/2015 1:17 am	**Reviewed and approved** by the ethics committee	
10/11/2015 10:14 am	**Approved by supervisor** and sent to ethics committee	
10/11/2015 10:12 am	**Submitted** to supervisor Catherine Brignell (brignell) (Cat B)	
10/11/2015 10:06 am	Revision request by supervisor	As requested so that you can update version numbers
10/11/2015 9:47 am	**Submitted** to supervisor Catherine Brignell (brignell) (Cat B)	
9/11/2015 1:15 pm	Submission Amendment Created (18151)	

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Appendix C – Recruitment Poster

Do you use the internet outside of work a lot?

Or not very regularly?

If you answered yes to either of these questions, then we would love for you to participate in our psychology experiment.

Help us understand more about the effects of internet use. The study should take no longer than one hour and you will receive 12 credits for your time, on completion of the study.

Contact me at pb1g13@soton.ac.uk to receive a further information and to complete a quick screening questionnaire

Recruitment dates: November 2015 –January 2015. Ergo number: 14092

Appendix D – Information Sheet

Version 2; 9 November 2015

Effect of Internet Use on Liking and Motivation

My name is Phil Bishop, I am a Trainee Clinical Psychologist from Southampton University. I am being assisted in collecting data by Emily Hill, third year psychology undergraduate.

Thank you for agreeing to take part in my study. You will shortly be asked to complete a number of questionnaires: the Beck Depression Inventory-II; the behavioural inhibition/ behavioural activation scale; the Compulsive Internet Use Scale; and the Snaith-Hamilton Pleasure Scale. Once these are completed, you will be asked to complete two experimental tasks. The first task will involve looking at a series of pictures on a computer screen. Physiological measures will be taken to test for responses to these images: heart-rate will be taken with electrodes attached to your forearms, electrodes will be attached to your face to measure the muscle activity there and skin conductance will be measured by a finger cuff. This section of the study should last no longer than 20 minutes. Following this you will be given a short computer task, during which you will get to make choices about images to watch on the computer. This section should take no longer than 25 minutes. The study will take no longer than one hour in total. Personal information will not be released to or viewed by anyone other than the researchers involved in this study. Results of this study will not include your name or any identifying characteristics.

On completion of this study you will be paid £6 for your time, or will receive 12 credits if you are a psychology student. However, your participation is voluntary and you may withdraw your participation at any time. If you choose not to participate there will be no consequences to your grades or your treatment as a student.

Published results of this study will maintain your confidentiality. Your participation is voluntary and you may withdraw your participation at any time. If you choose not to participate there will be no consequences to your grades or your treatment as a student.

If you have any questions please feel free to ask before we begin the study.

A summary of this research project will be supplied upon request. To request a project summary please also contact me at pb1g13@soton.ac.uk.

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the Chair of the Ethics Committee, Psychology, University of Southampton, Southampton, SO17 1BJ. Phone: +44 (0)23 8059 3856, email fshs-rso@soton.ac.uk

Appendix E - Consent Form

UNIVERSITY OF Southampton

CONSENT FORM (Version Number 2, 9 November, 2015)

By initialling the below boxes and signing your name below, you will be giving consent to participate in my research. Participation involves completing questionnaires, looking at images whilst physiological measures are taken using electrodes on the skin, and completing a computer task.

Unfortunately, you will not be paid for completing the initial screening questionnaire, but will be paid £6/ receive 12 credits for your time upon completion of the main study.

Study title: Internet Use and Depression

Researcher name: Phil Bishop; Emily Hill

ERGO Study ID number: 14092

RGO reference number:

Please initial the box(es) if you agree with the statement(s):

I have read and understood the information sheet (Version Number 2, 9 November, 2015) and have had the opportunity to ask questions about the study ☐

I agree to take part in this research project and agree for my data to be used for the purpose of this study ☐

I understand my participation is voluntary and I may withdraw at any time without my legal rights being affected ☐

Name of participant (print name)……

Signature of participant……

Date……

Appendix F – Debriefing Statement

Written Debriefing Statement (Version 1, 31 July 2015)

The aim of this research was to further explore the relationship between heavy Internet use and depression, a relationship hypothesised to be mediated by reductions in both experience of pleasure from non-Internet related stimuli and in motivation to do things that are not related to the internet. It is expected that those who reported high Internet use will have exhibited lower levels of liking for the non-Internet stimuli shown and less motivation during the click task. This may translate into reports of lower mood on the Beck Depression Inventory-II. Once again, results of this study will not include your name or any other identifying characteristics. The experiment did not use any deception. You may have a copy of this summary if you wish, and a copy of the research finding once the project is completed.

If you are currently affected by depression, you can contact Steps to Wellbeing which is a free, confidential NHS service and offers support for people with a range of mental health difficulties. http://www.steps2wellbeing.co.uk/

If you are worried about your current levels of internet use and are concerned that you might have an addiction problem, you can visit AddictionHelper.com. This website provides free advice and details of both NHS and private treatments that are available.

If you have any further questions please contact me, Phil Bishop, at pb1g13@soton.ac.uk.

Thank you for your participation in this research.

Signature……. Date…….

If you have questions about your rights as a participant in this research, or if you feel that you have been placed at risk, you may contact the Chair of the Ethics Committee, Psychology, University of Southampton, Southampton, SO17 1BJ. Phone: +44 (0)23 8059 3856, email fshs-rso@soton.ac.uk

Appendix G - Correlations between physiological measures and self-report measures

Table 8

Correlations between self-reported valence and heart rate

Variable	Internet BPM	Internet Valence	Positive BPM	Positive Valence
Internet BPM	1	0.016	0.553**	-0.320
Internet Valence		1	0.019	0.459**
Positive BPM			1	-0.073
Positive Valence				1

** Correlation is significant at 0.01 level

Table 9

Correlations between self-reported arousal and skin conductance responses

Variable	Internet SCR	Internet Arousal	Positive SCR	Positive Arousal
Internet SCR	1	0.120	0.287	0.129
Internet Arousal		1	0.087	0.653**
Positive SCR			1	0.135
Positive Arousal				1

** Correlation is significant at 0.01 level

Appendix H – Correlations between DVs on the Motivation Task

Table 10

Within group correlations in the control group on motivation task

Variable	CIUS	SHAPS	BDI	Indifference 0	Indifference 15	Difference Funny – Unfunny	Task Liking
CIUS	1	-0.032	0.371	0.304	0.076	0.086	0.213
SHAPS		1	0.236	-0.159	0.361	0.001	-0.342
BDI			1	0.007	0.142	-0.165	-0.022
Indifference 0				1	0.232	0.167	0.251
Indifference 15					1	0.524*	0.118
Difference Funny – Unfunny						1	0.507*
Task Liking							1

*Correlation is significant at 0.05 level

Table 11

Within group correlations in the internet addiction group on motivation task

High

Variable	CIUS	SHAPS	BDI	Indifference 0	Indifference 15	Difference Funny – Unfunny	Task Liking
CIUS	1	0.660**	0.445	0.067	0.158	0.181	0.329
SHAPS		1	0.568*	0.048	0.218	0.049	0.476*
BDI			1	0.117	0.502*	0.138	0.452
Indifference 0				1	0.179	0.050	0.086
Indifference 15					1	0.012	0.114
Difference Funny – Unfunny						1	0.389
Task Liking							1

*Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level

Appendix I – Heart Rate Calculations

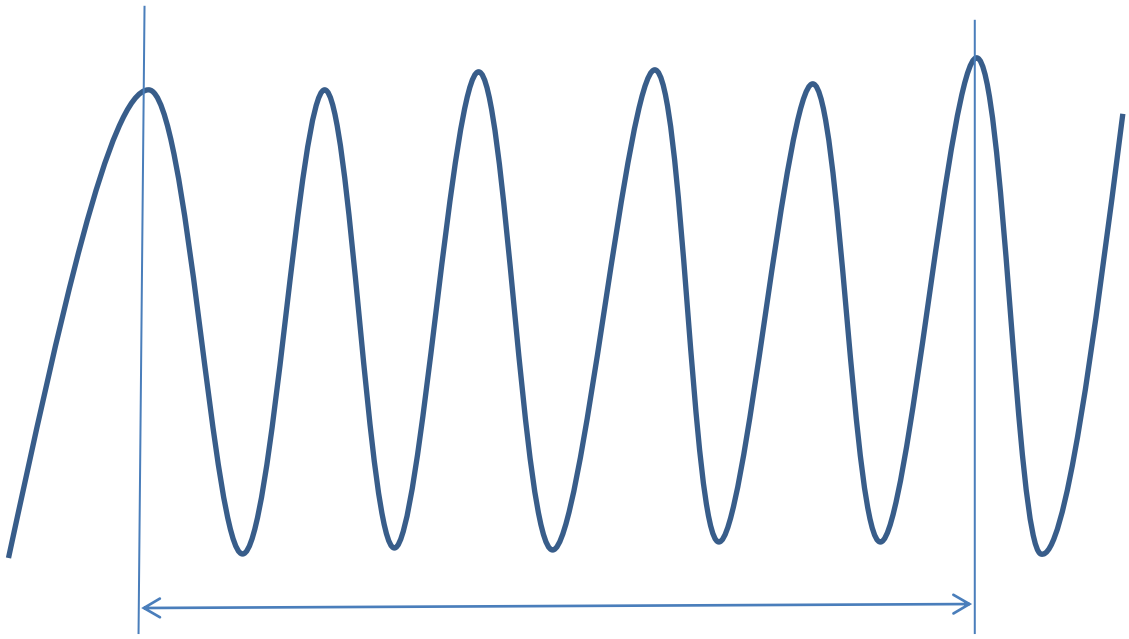

Figure 7. Heart rate calculations.

Heart rate was calculated by recording the number of heart-rate peaks during the six seconds and recording the total time that had elapsed between the two end peaks (see Figure 7 for a graphical representation). Beats-per-minute were worked out using the formula (60 ÷ seconds between two peaks x recorded heart beats).

Appendix J – Motivational Task

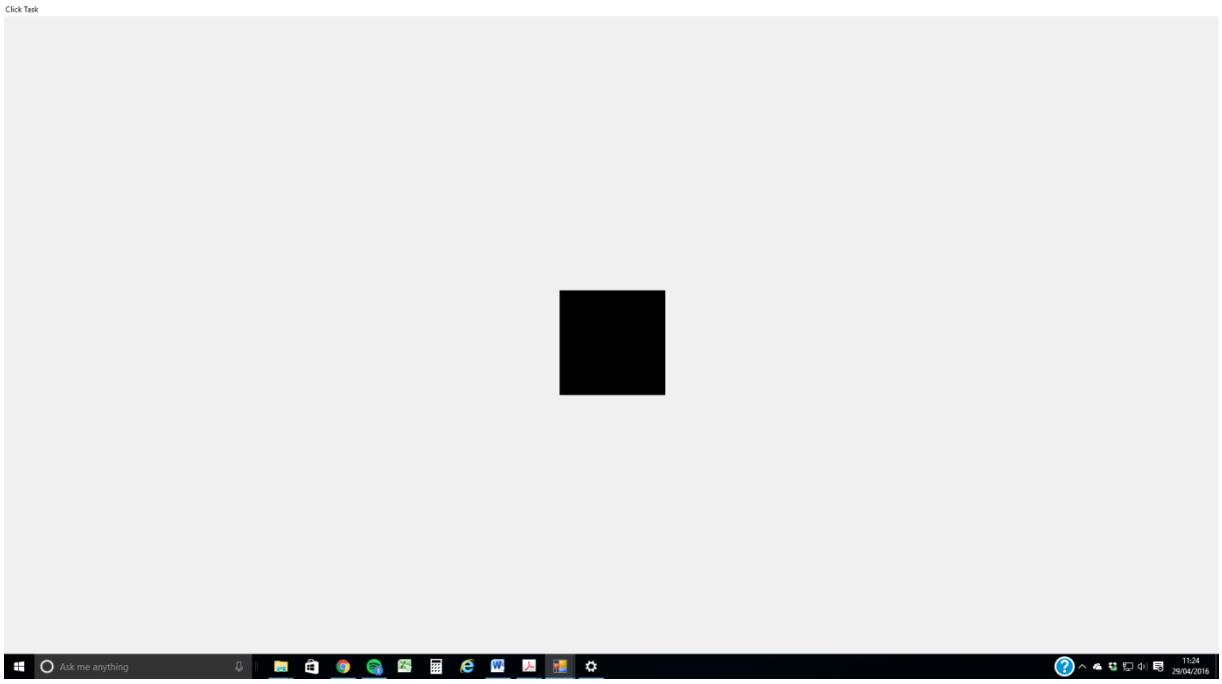

Figure 8. Screenshot of square clicking task.

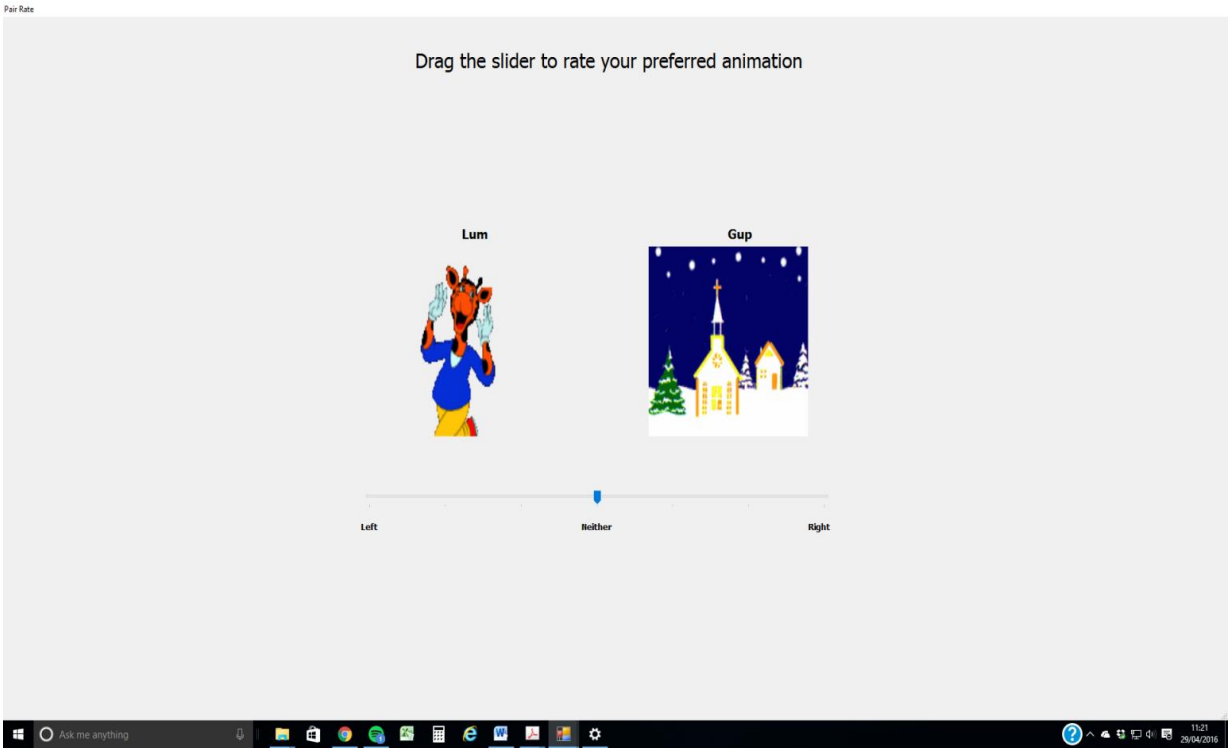

Figure 9. Screenshot of category preference ratings (with example stimuli).

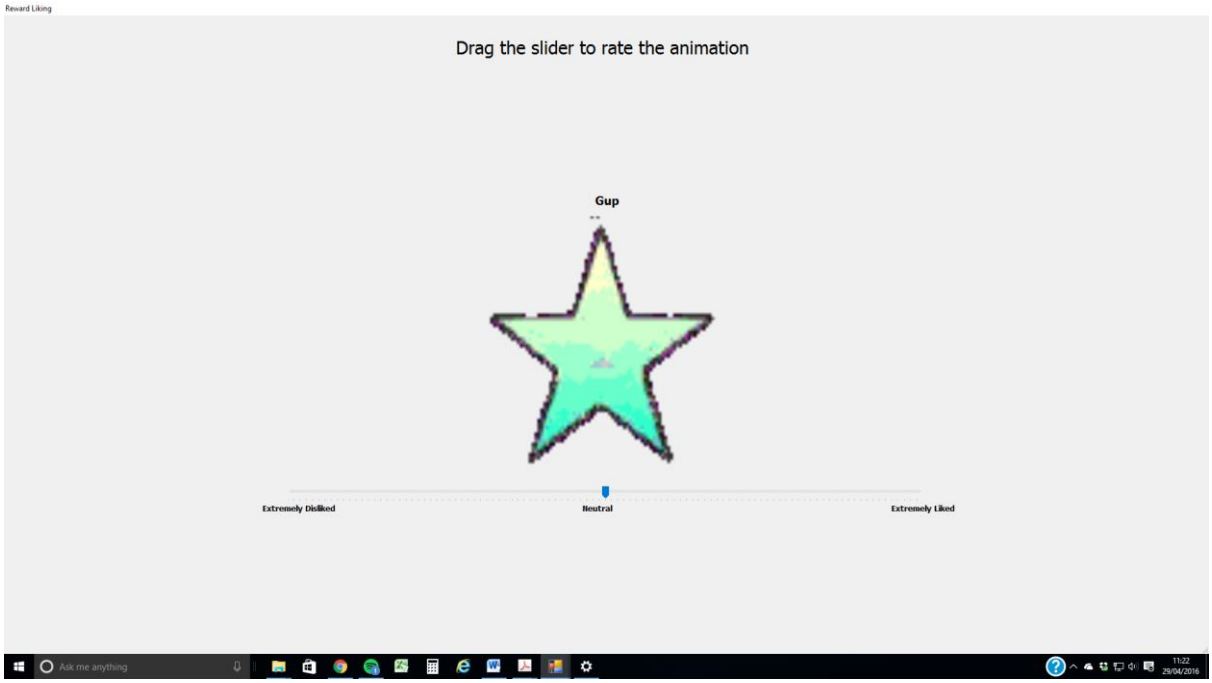

Figure 10. Screenshot of GIF ‘liking’ rating.

Appendix K – Demographics Questionnaire

Date:

Participant Number:

Please state your ethnicity (please tick):

a) Black of Black British

☐Carribean

☐African

☐Any other Black background within (a)

b) White

☐British

☐Irish

☐American

☐Any other White background

c) Asian or Asian British

☐Indian

☐Pakistani

☐Bangladeshi

☐Any other Asian background within ©

d) Mixed

☐While & Black Caribbean

☐White & Black African

☐White & Asian

☐White & Hispanic

☐Any other mixed background

e) Other ethnic groups

☐Chinese

☐Japanese

☐Hispanic

☐Any other ethnic group

☐Do not state

Please state your gender:

☐Male

☐Female

What age are you?

Please state your occupation:

If you are a student, which course are you studying?

Excluding work use, how many hours would you estimate that you spend online per week?

Appendix L – IAPS Images

Pleasant Images and mean IAPS valence ratings

Image	Valence Rating	Arousal Rating
Seal	8.19	4.16
Puppies	8.34	5.41
Porpoise	7.9	5.47
Baby	7.86	5
Babies	8.09	4.7
Nature	8.05	3.22
Sea	8.03	5.46
Beach	8.22	5.71
Fireworks	7.8	5.59
Ice Cream	7.69	5.14
Skier	8.1	6.28
Rafters	7.51	6.61

Neutral Images and mean IAPS valence ratings

Image	Valence Rating	Arousal Rating
Neutral Man	5.01	3.46
Elderly Woman	4.9	3.5
Mushroom	5.15	2.82
Rolling Pin	5	2.42
Spoon	5.04	2
Bowl	4.88	2.33
Baskets	4.99	2.6
Stove	5.12	4.61
Lightbulb	5.14	3.21
Rug	5.06	2.88

Chair	4.96	2.83
Cracker	5.07	3.36