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Impulsivity may be a risk factor in the transition from recreational to problem gaming

Jodie N. Raybould, Michael Larkin, Richard J. Tunney *

School of Psychology, Aston University, Birmingham, UK

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ABSTRACT

Several factors of trait impulsivity were analysed to determine which may contribute towards potentially disordered gaming, as measured by the DSM-5 and ICD-11 criteria. Three-hundred and seventy-two adults, sourced from a convenient sample (prolific.co) and a targeted gaming forum sample (Reddit and Facebook), completed an online survey hosted at Qualtrics.com. Three-hundred and twenty-eight participants continued onto a Go/No-Go reaction time task hosted at Pavlovia.org to measure inhibitory control. Demographic information was collected alongside impulsivity measures (BIS-11, UPPS-P, and 27-MCQ) and dichotomous DSM-5 and ICD-11 gaming disorder symptoms. Impulsivity was found to relate to gaming at both an recreational and potentially disordered level, however negative and positive urgency and delay discounting appear to be associated with the highest symptom counts and may be potential factors in the transition between recreational and disordered gaming.

1. Introduction

There is growing interest in the benefits and potential risks of computer gaming, with evidence emerging that gaming is a benign hobby activity that can be beneficial to mental health (Granic et al., 2014; Johannes et al., 2020; Jones et al., 2014; Konwal et al., 2021), and also evidence that a pre-occupation with gaming can lead to a behavioural addiction similar to Gambling Disorder (Brand et al., 2019; Hahn et al., 2014; King et al., 2013; Sim et al., 2012).

Although concerns about computer games have their origin in the 1980s moral panic around video games and technology (Markey & Ferguson, 2017), it is only in recent years that diagnostic criteria have recognised the idea that a behaviour, similar to a substance, can be addictive. Prior to the inclusion of gambling as an addiction disorder in the DSM, it was classified as an impulse control disorder, a separate category from substance use disorders (Grant et al., 2011). Now, Internet Gaming Disorder (IGD) is under review for inclusion as a disorder in future editions of the Diagnostic and Statistical Manual (DSM) (American Psychiatric Association., 2013), and Gaming Disorder (GD) was recognised by the World Health Organisation in the International Classification of Diseases (ICD-11) (World Health Organisation., 2021) and defined as a pattern of gaming that is characterised by impaired control, increasing priority, and continuation or escalation of the behaviour. Despite this, there remains considerable debate about whether gaming behaviour can be disordered or addictive in the way that gambling, and substance addictions are (Aarseth et al., 2017; James & Tunney, 2017). Within this study we will therefore include both the ICD-11 and DSM-5 definitions of potentially problematic gaming for comparison.

The extent of concern has led China to restrict minors to 3 h of gaming per week (Feng, 2021). These limits have been criticised as arbitrary and not evidence based, and previous sanctions have also been shown to be ineffective in addressing potential gaming issues (Dillio, 2014). Imposing heavy restrictions prematurely poses the risk of over-pathologising gaming and inappropriate treatments being prescribed. With a better understanding of the potential underlying risk factors associated with excessive gaming we may be more able to successfully address concerns around the activity. In particular exploring potential risk factors for the transition to addiction. The issue is important because the gaming industry is worth $300 billion per year, highlighting the significant global influence that the industry has, with an estimated 2.9 billion gamers worldwide (Accenture, 2021). This is compared to a worth of around $711.4 Billion for the Gambling Industry (Global Industry Analysts Inc., 2021) and $1.49 trillion for the Alcohol Industry (Statista Research Department., 2021). Both products of these industries are recognised as addictive and heavily regulated.

* Corresponding author. School of Psychology, Aston University, Birmingham, NG4 7ET, United Kingdom.
E-mail address: r.tunney@aston.ac.uk (R.J. Tunney).

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It is assumed that the core processes leading to problematic behaviours within addiction are likely similar to one another. A potential risk-factor associated with addiction is impulsivity, and the literature suggests impulsivity may be a core process in both substance and behavioural addiction (Lee et al., 2019). Belin et al. (2008) found that high impulsivity predicted the switch into compulsive cocaine use, while Nower and Blaszczynski (2007) stated that negative consequences of impulsivity acted as a transitional catalyst for gambling problems. Trait impulsivity is generally understood to be a dimension of personality. Although we know that impulsivity is a multifaceted trait (Mitchell & Potenza, 2014), there is little agreement on an overall definition, how its factors interrelate, or understanding on how it relates to other personality traits and cognitive abilities (Hodgins & Holub, 2015; Kopetz et al., 2018; Sharma et al., 2013). Because of this, some researchers have labelled impulsivity as an 'artificial umbrella term' (Whiteside & Lynam, 2001) and more recently, not a psychological construct at all (Strickland & Johnson, 2020). Despite the lack of consensus on trait impulsivity, it is known to be related to several different mental health disorders and defining different forms of impulsivity has advanced our understanding of these diseases. Hamilton et al. (2012) found main effects for behavioural inhibition, reward responsiveness, and fun-seeking in hazardous drinkers, and Toplak et al. (2009) investigated impulsivity in patients with ADHD, finding separate dimensions of inattention and hyperactivity/impulsivity. Dalley and Ersche (2018) reported that impatience, or waiting impulsivity, is a potential endophenotype for impulse-control disorders. They went on to discuss impatience as a risk factor and a consequence of drug addiction.

Several studies have investigated the relationship between impulsivity and Gambling Disorder, finding that gambling was related to a number of factors such as attentional and motor impulsivity (Leppink et al., 2016), discounting, and decision making (Ioannidis et al., 2019). Similarly, Şalvarlı and Griffiths (2022) conducted a review of the literature and found evidence of impulsivity in IGD. They reported that all but one of the included studies found a positive relationship between impulsivity and IGD. They noted that the evidence appeared to indicate that altered neurobiological structures explained some of the relationship between impulsivity and gaming. This could suggest a similarity between gaming and established addiction disorders, as changes to the brain are known to be associated with substance use (Kozak et al., 2019) and gambling disorder (Potenza, 2013). Similarities between gaming and addiction are further evidence by studies comparing IGD against Gambling Disorder (Fauth-Bühler & Mann, 2017) and substance use disorders (Choi et al., 2014).

In their study on impulsivity and gambling disorder, Hodgins and Holub (2015) uncovered two factors of impulsivity in gambling participants: a general trait impulsivity factor, and a sensation seeking factor. This study was the first to examine the factor structure of impulsivity in gambling and reported that trait impulsivity correlated with gambling severity, while sensation seeking related to gambling activities. This suggests one factor which promotes involvement in gambling and another that predicts problematic gambling. A more recent study completed by Mestre-Bach et al. (2020) found that domains of impulsivity in gambling disorder were inter-correlated, with deficits in inhibitory control, increased delay discounting, and higher impulsive tendencies. However, motor impulsivity as determined by response inhibition was found to be not directly related to gambling, in contrast to the findings of Ioannidis et al. Despite some areas where the specific findings differ, together these studies do suggest that impulsivity is an important facet of Gambling Disorder.

We aim to examine whether gaming is similar to established addiction disorders in its relation to impulsivity. We predict that gaming will be positively related to several factors of impulsivity, and that a smaller number of impulsivity factors will predict the highest symptom counts on diagnostic tests. These results could help us understand how impulsivity affects gaming behaviour, provide evidence towards whether gaming can be considered addictive, and have implications for policy, treatment, and prevention.

2. Method

2.1. Participants

Three-hundred and ninety-seven participants were recruited for this study. Of these, 196 recruited from gaming forums on Reddit and Facebook (r/gamers and RT UK Chat), and 201 were recruited from the general population using the online participant recruitment tool prolific.co. Participants were paid £5.00 ($6.53US) for completing the study. Five participants withdrew during the survey and 20 failed attention check questions, leaving a total of 372 participants who completed the survey and 328 who completed the survey and also the Go/No-Go tasks. One-hundred and eighty-three of the total sample identified as male, 184 as female, and 5 as neither. The mean age was 26.23 years (SD = 6.843). There were 138 (37.1%) participants who could be classified as having IGD based on the suggested DSM-5 symptom count of five or more criteria. There were 80 (21.51%) participants who could be classified as having GD based on the suggested ICD-11 symptom count of three or more. Table 1 shows the comparison sample analysis between the forum and prolific samples.

2.2. Materials

2.2.1. Impulsivity

The Barratt Impulsivity Scale (BIS-11) (Patton et al., 1995) is a self-report questionnaire designed to measure impulsivity. It is a widely cited instrument that is composed of 30 items scored on a four-point Likert scale. These questions assess impulsivity as a multi-faceted trait with a factor structure that includes 3 s order factors and six first order factors. Internal consistency for the measure in this sample was very good ($\alpha = 0.82$).

The Short Urgency, Premeditation, Perseverance, Sensation Seeking and Positive Urgency Impulsive Behaviour Scale (UPPS-P) (Whiteside & Lynam, 2001) is a self-report measure composed of 20 items scored on a four-point Likert scale. These questions assess impulsivity as a multi-faceted trait with a factor structure that includes 3 s order factors and five first order factors. Internal consistency for the measure in this sample was good ($\alpha = 0.75$).

The Monetary Choice Questionnaire (27-MCQ) (Kirby et al., 1999) is a tool used to assess time preferences. The tool uses 27 questions to assess the extent to which an individual is willing to delay a reward for increased gains. To achieve this, it asks participants to choose between a smaller reward now or a larger reward at a later date. Using the proportion of smaller/sooner choices to analyse the data, higher values mean steeper discounting of the future reward. Internal consistency for the measure in this sample was very good ($\alpha = 0.88$).

Additionally, participants were asked to complete a hot and cold go/no-go task to measure inhibitory control. In the cold task participants were asked to press the space bar when viewing neutral female faces, and not press the space bar when presented with neutral male faces. In the hot task, participants were asked to press the button when viewing happy faces of any gender, and not press the button when viewing fearful faces of any gender. Faces for all stimuli were taken from the RADIATE racially diverse face set (Conley et al., 2018). The order of image appearance for both tasks was randomised and included 60 "Go"

Table 1
Sample analysis.

	Mean	SD	Frequency
Age			
Gender			
IGD			
GD			

(button press) and 20 "No-Go" (no button press) occurrences per run. Participants were shown each cue for 2 s, or until a button was pressed, and were asked to respond as quickly and accurately as possible. Relative inhibitory control is indicted by the ability to inhibit button presses on no-go trials.

2.2.2. Gaming

Gaming involvement was measured as the average hours of play per week, and potential problematic involvement in gaming was measured using two dichotomous measures of IGD and GD. The IGD measure consists of the nine DSM-5 (American Psychiatric Association., 2013) symptom criteria presented as yes/no questions. The items were scored as 0 for no and 1 for yes, giving a total possible score of nine symptom criteria experienced. We used the recommended clinical cut-off of 5/9 symptoms to identify risk of potential diagnosis. Participants were asked to indicate if they had experienced these symptoms within the last year and internal consistency for the measure in this sample was acceptable (KR-20 = 0.67).

The GD measure includes the four ICD-11 (World Health Organisation., 2021) symptom criteria presented as yes/no questions. Items were scored as 0 for no and 1 for yes, giving a total possible score of four symptom criteria experienced. We used the recommended clinical cut-off of 3/4 symptoms to identify risk of potential diagnosis. Internal consistency for the measure in this sample was acceptable (KR-20 = 0.67).

2.3. Procedure

The participants were informed of the study details prior to giving their consent. The study was administered using Qualtrics, an online survey creation tool and hosting platform, and Pavlovia, a website where experiments such as the Go/No-Go task can be developed and run online. First, demographic information was recorded, and participants then completed the measures of impulsivity (BIS-11, UPPS-P,27-MCQ). After a simple attention check where participants were asked to select the answer purple from a multiple choice of four colours participants answered how many hours they spent gaming in an average week, before completing the DSM-5 and ICD-11 gaming criteria dichotomous checklists. At the end of the survey participants were redirected to Pavlovia.org, where they were asked to complete the hot and cold Go/No-Go tasks to measure inhibitory control.

2.4. Statistical methods

The data were analysed using linear regression to first explore the relationship between factors of impulsivity and measures of gaming that may not have reached a clinically significant level. These results were then compared using bivariate logistic regression analysis to identify which factors were significant for symptom counts above the suggested clinical cut-off points for diagnosis. Individual factors from relevant measures were combined into single models to represent their respective measures without losing the factor level detail.

3. Results

Table 2 shows the average scores across all variables of interest. We then compared the forum and prolific samples, finding that they were significantly different across all variables apart from average hours of play, sensation seeking, and cognitive instability. Despite this, separate analysis of the samples resulted in a significant loss of power, so we collapsed the data before conducting the remaining analyses. We ran several common-sense correlation analyses to establish the validity of the data and found that hours of gameplay related to both DSM-5 (r = 0.566, $p < .001$) and ICD-11 (r = 0.396, $p < .001$) symptom counts. In addition, the DSM-5 and ICD-11 symptom counts were related to each other (r = 0.541, $p < .001$), and perseverance measured by the BIS-11 and UPPS-P were also related (r = 0.368, $p < .001$). The mean of hours gaming in an average week was 2.28 (SD = 1.354), while the mean DSM-5 symptom count was 3.82 (SD = 2.224), and the mean ICD-11 symptom count was 1.3 (SD = 1.313).

Table 2
Descriptive Statistics and a Comparison between Forum and Prolific Participant Samples Across Each Variable.

Variable	Mean	SD	Independent Samples *t*-test (df = 370)
BIS-11 Attention	10.870	2.625	t = 5.657, p = .000, CI 95% [.968, 1.999] ***
BIS-11 Cognitive Instability	6.880	1.848	t = .307, p = .759, CI 95% [-.319, .437]
BIS-11 Motor	15.480	2.966	t = 6.820, p = .000, CI 95% [1.413, 2.557] ***
BIS-11 Perseverance	8.050	2.037	t = 13.299, p = .000, CI 95% [1.976, 2.662] ***
BIS-11 Self-Control	13.450	3.223	t = 11.069, p = .000, CI 95% [2.647, 3.790] ***
BIS-11 Cognitive Complexity	11.590	2.330	t = 7.433, p = .000, CI 95% [1.237, 2.126] ***
UPPS-P Negative Urgency	10.210	2.122	t = 4.059, p = .000, CI 95% [.452, 1.302] ***
UPPS-P Positive Urgency	9.310	2.412	t = 10.722, p = .000, CI 95% [1.920, 2.782] ***
UPPS-P Sensation Seeking	10.540	2.290	t = −1.087, p = .278, CI 95% [-.727, .209]
UPPS-P Premeditation	8.260	2.004	t = 8.152, p = .000, CI 95% [1.188, 1.943] ***
UPPS-P Perseverance	8.100	1.937	t = 5.996, p = .000, CI 95% [.776, 1.532] ***
27-MCQ Proportion Smaller/Sooner	0.583	0.213	t = 5.588, p = .000, CI 95% [.077, .161] ***
Cold Go/No-Go False Presses	4.880	4.524	t = 8.200, p = .000, CI 95% [1.328, 2.165] ***
Cold False Reaction Times	0.427	0.159	t = 9.679, p = .000, CI 95% [.942, 1.422] ***
Hot Go/No-Go False Presses	5.280	4.683	t = 8.633, p = .000, CI 95% [.857, 1.363] ***
Hot False Reaction Times	0.488	0.173	t = 7.843, p = .000, CI 95% [2.928, 4.891] ***
DSM-5 Symptom Count	3.820	2.224	t = 3.287, p = .001, CI 95% [.025, .100] **
ICD-11 Symptom Count	1.300	1.313	t = 7.341, p = .000, CI 95% [2.739, 4.746] ***
Daily Hours of Gameplay	2.280	1.354	t = 1.558, p = .120, CI 95% [-.008, .072]

Notes: *** = p < .001; ** = p < .01; * = p < .05.

3.1. Gaming and impulsivity

We next wanted to examine which dimensions of impulsivity were related to gaming, and so began by conducting multiple linear regression analysis, combining individual factors into single models to represent their respective measures (Tables 3, 4 & 5).

Each measure of gaming was related to several impulsivity factors, with attention, motor impulsivity, perseverance, self-control, negative and positive urgency, delay discounting, false-alarm reaction times on a cold task, and number of false alarms on a hot task, common across the three measures. When combining these individual factors using multiple linear regression to reflect their single measures, we find that the factors common across all three gaming measures are perseverance, positive urgency, delay discounting, number of presses on both a hot and cold go/no-go, and false-press reaction times for the cold task. This suggests that perseverance measured by the BIS-11, positive urgency measured by the UPPS-P, delay discounting measured by the 27-MCQ, and inhibitory control measured by hot and cold go/no-go tasks may be the most important factors in developing a strong interest in gaming.

Table 3
Regression Analysis of Relationships between Hours of Gameplay in an Average Week and Factors of Trait Impulsivity.

Hours of Gameplay			
BIS-11	$F_{6,371} = 6.041$, $R^2 = .090$, $p = .000$***	Attention	B = −.024, β = −.047, t = −.700, p = .484
		Cognitive Instability	B = .000, β = .000, t = −.008, p = .993
		Motor	B = .047, β = .103, t = 1.742, p = .082
		Perseverance	B = .089, β = .134, t = 2.329, p = .020*
		Self-Control	B = .085, β = .202, t = 3.124, p = .002**
		Cognitive Complexity	B = −.039, β = −.066, t = −1.174, p = .241
UPPS-P	$F_{5,371} = 7.549$, $R^2 = .093$, $p = .000$***	Negative Urgency	B = .035, β = .055, t = .979, p = .328
		Positive Urgency	B = .164, β = .292, t = 4.872, p = .000***
		Sensation Seeking	B = .000, β = .000, t = .001, p = .999
		Premeditation (Lack of)	B = −.039, β = −.058, t = −.982, p = .327
		Perseverance (Lack of)	B = .009, β = .013, t = .225, p = .822
27-MCQ	$F_{1,371} = 12.016$, $R^2 = .031$, $p = .001$***	Proportion Smaller/Sooner	B = 1.127, β = .177, t = 3.466, p = .001***
Cold Go/ No-Go	$F_{2,269} = 8.332$, $R^2 = .059$, $p = .000$***	False Button Presses	B = .055, β = .182, t = 3.050, p = .003**
		Reaction Time	B = 1.495, β = .175, t = 2.940, p = .004**
Hot Go/ No-Go	$F_{2,286} = 5.069$, $R^2 = .034$, $p = .007$**	False Button Presses	B = .056, β = .190, t = 3.178, p = .002**
		Reaction Time	B = .411, β = .052, t = .864, p = .388

Notes: *** = p < .001; ** = p < .01; * = p < .05.

Table 4
Regression Analysis of Relationships between the DSM-5 Measure of IGD and Factors of Trait Impulsivity.

DSM-5 IGD Symptom Count			
BIS-11	$F_{6,371} = 8.838$, $R^2 = .127$, $p = .000$***	Attention	B = −.044, β = −.051, t = −.782, p = .435
		Cognitive Instability	B = .114, β = .095, t = 1.639, p = .102
		Motor	B = .123, β = .164, t = 2.834, p = .005**
		Perseverance	B = .173, β = .159, t = 2.814, p = .005**
		Self-Control	B = .049, β = .071, t = 1.117, p = .265
		Cognitive Complexity	B = .084, β = .088, t = 1.589, p = .113
UPPS-P	$F_{5,371} = 15.564$, $R^2 = .175$, $p = .000$***	Negative Urgency	B = .192, β = .184, t = 3.441, p = .001***
		Positive Urgency	B = .277, β = .300, t = 5.254, p = .000***
		Sensation Seeking	B = .045, β = .046, t = .943, p = .346
		Premeditation (Lack of)	B = .000, β = .000, t = .006, p = .995
		Perseverance (Lack of)	B = −.055, β = −.048, t = −.888, p = .375
27-MCQ	$F_{1,371} = 16.654$, $R^2 = .043$, $p = .000$***	Proportion Smaller/Sooner	B = 2.168, β = .208, t = 4.081, p = .000***
Cold Go/ No-Go	$F_{2,269} = 8.304$, $R^2 = .059$, $p = .000$***	False Button Presses	B = .065, β = .131, t = 2.193, p = .029*
		Reaction Time	B = 3.014, β = .214, t = 3.593, p = .000***
Hot Go/ No-Go	$F_{2,286} = 3.727$, $R^2 = .026$, $p = .025$*	False Button Presses	B = .075, β = .158, t = 2.632, p = .000***
		Reaction Time	B = .972, β = .076, t = 1.262, p = .208

Notes: *** = p < .001; ** = p < .01; * = p < .05.

3.2. Additional analyses

We next wanted to determine which factors were specifically related to apparent excessive levels of gaming. These analyses were not included in the pre-registration but present logical tests of the relationship between impulsivity and the diagnostic criteria. We therefore transformed data into groups of participants above and below the clinical cut-off for the DSM-5 (+5) and ICD-11 (+3), as well as those above and below a proposed conservative cut-off point for the DSM-5 (+7). Research has suggested that the DSM-5 criteria capture more potentially problematic gamers than the ICD-11 criteria (Borges et al., 2020; Jo et al., 2019). This could suggest that the clinical cut-off point in the DSM-5 is too liberal, or that the ICD-11 is too conservative. Here we therefore test a proposed conservative cut-off point (+7) (Raybould et al., 2022) for the DSM-5 criteria. We then compared this against the clinical cut-off point for IGD and the ICD-11 measure of GD using binomial regression analysis (Table 6 & 7).

We found that the clinical cut-off point for the DSM-5 criteria was related to motor impulsivity, perseverance, negative urgency, positive urgency, delay discounting, false button presses on the cold and hot inhibitory control task, and reaction times from the cold task. In contrast, the conservative cut-off point was related to perseverance, self-control, positive urgency, delay discounting, and reaction times on a cold inhibitory control task. The clinical cut-off point for the ICD-11 criteria was related to motor impulsivity, positive urgency, and delay discounting. Symptom counts above the clinical cut-off point for both IGD (DSM-5) and GD (ICD-11) were related to motor impulsivity, suggesting that this may be an important factor in potentially problematic involvement in gaming. In contrast, self-control was only related to the conservative cut-off point for IGD, which could indicate that self-control is related to the highest levels of potentially problematic involvement in the activity. Interestingly, perseverance was related to IGD at both the clinical and conservative level, but not related to GD. Both negative and positive urgency were related to the clinical cut-off point for IGD, while only positive urgency was related to the conservative cut-off point for IGD and the clinical cut-off in the ICD-11 measure of GD. Finally, we noted that delay discounting, measured by the 27-MCQ, was related to both the clinical cut-off points and the conservative cut-off point. This could suggest that delay discounting is a particularly important factor in the transition from recreational to potentially problematic gaming.

4. Discussion

Findings in this study could suggest that high trait impulsivity may be a risk factor for transitioning from recreational gaming to potentially problematic gaming, as determined by symptom count on the IGD and GD. However, the tentative cut-off criteria suggested within the DSM-5 and ICD-11 are not definitive measures for addiction. An individual who does not reach these thresholds is not guaranteed to be a recreational, non-addicted gamer. Further analysis is needed to determine whether impulsivity is truly a risk-factor for transition. Despite this, our findings do indicate that delay discounting and perseverance appear to be related to gaming at the clinical level and for some of the highest symptom counts. This could suggest that gaming may share some of the same features as formally recognised addiction disorders, potentially lending weight to its inclusion in diagnostic materials. Snider et al. (2019) found delay discounting to be predictive of a number of potentially addictive actions, including smoking and using drugs. Similarly, Rung et al. (2019) discussed delay discounting and impulsive choice as predictive of drug use, and Thomsen et al. (2018) found that sensation seeking and lack of perseverance were associated with alcohol. Further research that is not cross-sectional is needed to test the validity of these initial

Table 5
Regression Analysis of Relationships between the ICD-11 Measure of GD and Factors of Trait Impulsivity.

ICD-11 GD Symptom Count			
BIS-11	$F_{6,371} = 11.079$, $R^2 = .154$, $p = .000$***	Attention	B = −.014, β = −.028, t = −.431, p = .667
		Cognitive Instability	B = .041, β = .057, t = 1.009, p = .314
		Motor	B = .040, β = .090, t = 1.580, p = .115
		Perseverance	B = .140, β = .217, t = 3.909, p = .000***
		Self-Control	B = .060, β = .148, t = 2.366, p = .019*
		Cognitive Complexity	B = .038, β = .068, t = 1.246, p = .213
UPPS-P	$F_{5,371} = 9.127$, $R^2 = .111$, p = .000***	Negative Urgency	B = .018, β = .029, t = .523, p = .601
		Positive Urgency	B = .139, β = .255, t = 4.307, p = .000***
		Sensation Seeking	B = .019, β = .034, t = .668, p = .505
		Premeditation (Lack of)	B = .074, β = .112, t = 1.914, p = .056
		Perseverance (Lack of)	B = −.002, β = −.003, t = −.053, p = .958
27-MCQ	$F_{1,371} = 5.577$, $R^2 = .015$, p = .019*	Proportion Smaller/Sooner	B = .752, β = .122, t = 2.362, p = .019*
Cold Go/ No-Go	$F_{2,269} = 7.165$, $R^2 = .051$, p = .001***	False Button Presses	B = .052, β = .175, t = 2.933, p = .004**
		Reaction Time	B = 1.304, β = .156, t = 2.612, p = .010**
Hot Go/ No-Go	$F_{2,286} = 4.035$, $R^2 = .028$, p = .019**	False Button Presses	B = .047, β = .167, t = 2.788, p = .006**
		Reaction Time	B = .508, β = .067, t = 1.117, p = .265

Notes: *** = p < .001; ** = p < .01; * = p < .05.

findings.

Impulsivity has been long established as a robust predictor of substance use problems (Moeller & Dougherty, 2002; Perry & Carroll, 2008), and in their meta-analysis on Gambling Disor der Ioannidis et al. (2019) found a similar relationship between impulsivity and gambling. This has been further evidenced in individual studies such as Leppink et al. (2016), who reported associations with attentional and motor impulsivity, though not motor inhibition, and Mestre-Bach et al. (2020) who found that gambling related to delay discounting, inhibitory control, and several psychometric measures labelled as impulsive tendencies. Despite some disagreement regarding motor inhibition, or inhibitory control, these findings reveal similarities between gambling and gaming. Specifically, both activities appear to be related to a range of psychometric impulsivity factors, delay discounting, and to some extent inhibitory control.

Perhaps most interestingly, while our full sample was related to a large number of impulsivity factors across both psychometric measures and behavioural tasks, only a few key factors related to the clinical and conservative cut-off points for symptom criteria. This indicates that specific factors of impulsivity may predict potentially problematic gaming and suggests the need to further investigate whether these factors contribute to the transition from recreational to problematic gaming. Piazza and Deroche-Gamonet (2013) found that the transition to addiction in substance use was dependent on a three-step interaction between individual vulnerability and degree of exposure to the substance. In their research they discussed how impulsivity predicted vulnerability to sustained drug use. Could high factors of impulsivity also predict vulnerability to the potentially addictive qualities in video gaming? Further research is needed, as cross-sectional data is not enough to answer this.

We additionally found that symptom counts above the conservative cut-off point for IGD were related to self-control, while symptom counts above the clinical cut-off points for IGD, and GD were not. This could suggest that self-control may be an important factor in high symptom count, and therefore potential gaming addiction.

In contrast to this, delay discounting and positive urgency were significant at all points for both GD and IGD measures, implying that delay discounting and positive urgency may also be predictors of problematic gaming, and potentially important in the transition from recreational to problematic gaming. Delay discounting in particular is a

Table 6
Binary Logistic Regression Analyses Comparing Groups Above and Below Clinical and Conservative Cut-Off Points for Internet Gaming Disorder (DSM-5) in Terms of Trait Impulsivity.

	DSM-5 IGD	
	Clinical Cut-Off (+5)	Conservative Cut-Off (+7)
BIS-11	$\chi^2_6 = 46.429$, $R^2 = .160$, p < .001***	$\chi^2_6 = 30.424$, $R^2 = .146$, p < .001***
Attention	B = .013, SE = .058, Exp (B) = 1.013, 95CI [.904, 1.134], p = .826	B = −.091, SE = .084, Exp(B) = .913, 95CI [.774, 1.076], p = .277
Cognitive Instability	B = .073, SE = .074, Exp (B) = 1.076, 95CI [.930, 1.243], p = .324	B = .090, SE = .109, Exp(B) = 1.094, 95CI [.884, 1.355], p = .408
Motor	B = .115, SE = .046, Exp (B) = 1.121, 95CI [1.024, 1.227], p = .013*	B = .063, SE = .066, Exp(B) = 1.065, 95CI [.935, 1.213], p = .346
Perseverance	B = .179, SE = .065, Exp (B) = 1.196, 95CI [1.054, 1.358], p = .006**	B = .196, SE = .091, Exp(B) = 1.216, 95CI [1.018, 1.453], p = .031*
Self-Control	B = .022, SE = .046, Exp (B) = 1.023, 95CI [.934, 1.119], p = .626	B = .177, SE = .070, Exp(B) = 1.194, 95CI [1.040, 1.370], p = .012*
Cognitive Complexity	B = .095, SE = .057, Exp (B) = 1.100, [95CI [.984, 1.229], p = .093	B = .102, SE = .080, Exp(B) = 1.107, 95CI [.947, 1.295], p = .203
UPPS-P	$\chi^2_5 = 43.695$, $R^2 = .151$, p < .001***	$\chi^2_5 = 50.896$, $R^2 = .238$, p < .001***
Negative Urgency	B = .137, SE = .061, Exp (B) = 1.147, 95CI [1.017, 1.294], p = .025*	B = .181, SE = .095, Exp(B) = 1.198, 95CI [.994, 1.444], p = .058
Positive Urgency	B = .221, SE = .058, Exp (B) = 1.247, 95CI [1.113, 1.398], p < .001***	B = .451, SE = .091, Exp(B) = 1.570, 95CI [1.313, 1.876], p < .001***
Sensation Seeking	B = .017, SE = .052, Exp (B) = 1.017, 95CI [.918, 1.126], p = .751	B = −.037, SE = .079, Exp(B) = .964, 95CI [.826, 1.125], p = .641
Premeditation (Lack of)	B = .078, SE = .068, Exp (B) = 1.081, 95CI [.947, 1.235], p = .248	B = .086, SE = .096, Exp(B) = 1.090, 95CI [.903, 1.315], p = .370
Perseverance (Lack of)	B = .028, SE = .067, Exp (B) = 1.028, 95CI [.901, 1.173], p = .680	B = −.089, SE = .102, Exp(B) = .915, 95CI [.750, 1.117], p = .383
27-MCQ	$\chi^2_1 = 4.796$, $R^2 = .017$, p = .029*	$\chi^2_1 = 20.060$, $R^2 = .098$, p < .001***
Prop. Smaller/ Sooner	*B* = 1.127, *SE* = .522, Exp *(B)* = 3.085, *95CI* [1.109, 8.582], *p* = .031*	*B* = 3.647, *SE* = .874, Exp*(B)* = 38.360, *95CI* [6.915, 212.794], *p* < .001***
Cold Go/No-Go	$\chi^2_2 = 14.562$, $R^2 = .071$, p = .001***	$\chi^2_2 = 11.202$, $R^2 = .073$, p = .004**
False Button Presses	B = .083, SE = .028, Exp (B) = 1.087, 95CI [1.028, 1.148], p = .003**	B = .033, SE = .039, Exp(B) = 1.033, 95CI [.957, 1.115], p = .405
Reaction Time	B = 2.096, SE = .809, Exp (B) = 8.133, 95CI [1.667, 39.681], p = .010*	B = 3.252, SE = .972, Exp(B) = 25.847, 95CI [3.843, 173.844], p = .001***
Hot Go/No-Go	$\chi^2_2 = 10.658$, $R^2 = .050$, p = .005**	$\chi^2_2 = .932$, $R^2 = .006$, p = .627
False Button Presses	B = .085, SE = .027, Exp (B) = 1.089, 95CI [1.033, 1.148], p = .002**	B = .024, SE = .037, Exp(B) = 1.025, 95CI [.953, 1.102], p = .513
Reaction Time	B = .956, SE = .722, Exp (B) = 2.601, 95CI [.632, 10.712], p = .186	B = .823, SE = .958, Exp(B) = 2.277, 95CI [.348, 14.890], p = .390

Notes: *** = p < .001; ** = p < .01; * = p < .05.

Table 7
Binary logistic regression analyses comparing groups above and below the clinical cut-off point for gaming disorder (ICD-11) in terms of trait impulsivity.

	ICD-11 GD Clinical Cut-Off (+3)
BIS-11	$\chi^2_6 = 27.500$, $R^2 = .110$, $p < .001$***
Attention	B = −.031, SE = .066, Exp(B) = .970, 95CI [.852, 1.104], p = .644
Cognitive Instability	B = .054, SE = .086, Exp(B) = 1.056, 95CI [.892, 1.250], p = .527
Motor	B = .116, SE = .053, Exp(B) = 1.123, 95CI [1.012, 1.245], p = .028*
Perseverance	B = .133, SE = .073, Exp(B) = 1.142, 95CI [.991, 1.317], p = .067
Self-Control	B = .066, SE = .054, Exp(B) = 1.068, 95CI [.961, 1.187], p = .221
Cognitive Complexity	B = .071, SE = .064, Exp(B) = 1.073, 95CI [.946, 1.217], p = .271
UPPS-P	$\chi^2_5 = 29.936$, $R^2 = .108$, $p < .001$***
Negative Urgency	B = .082, SE = .071, Exp(B) = 1.086, 95CI [.945, 1.247], p = .246
Positive Urgency	B = .218, SE = .066, Exp(B) = 1.243, 95CI [1.092, 1.416], p = .001***
Sensation Seeking	B = .048, SE = .060, Exp(B) = 1.049, 95CI [.932, 1.181], p = .427
Premeditation (Lack of)	B = .096, SE = .077, Exp(B) = 1.101, 95CI [.948, 1.279], p = .209
Perseverance (Lack of)	B = −.090, SE = .079, Exp(B) = .914, 95CI [.784, 1.066], p = .254
27-MCQ	$\chi^2_1 = 7.651$, $R^2 = .031$, $p = .006$**
Proportion Smaller/ Sooner	*B* = 1.716, *SE* = .639, Exp*(B)* = 5.563, *95CI* [1.590, 19.459], *p* = .007**
Cold Go/No-Go	$\chi^2_2 = 2.455$, $R^2 = .014$, $p = .293$
False Button Presses	B = .019, SE = .031, Exp(B) = 2.601, 95CI [.632, 10.712], p = .535
Reaction Time	B = 1.200, SE = .853, Exp(B) = 2.601, 95CI [.632, 10.712], p = .160
Hot Go/No-Go	$\chi^2_2 = 1.490$, $R^2 = .008$, $p = .222$
False Button Presses	B = .023, SE = .031, Exp(B) = 1.023, 95CI [.963, 1.087], p = .464
Reaction Time	B = 1.246, SE = .854, Exp(B) = 3.476, 95CI [.652, 18.520], p = .144

Notes: *** = p < .001; ** = p < .01; * = p < .05.

well-established factor in Gambling Disorder research, lending further weight to the concept of gaming as similar to existing behavioural addiction (Alessi & Petry, 2003; Dixon et al., 2003).

One possible limitation of these results is the significant differences between our two samples. This would suggest that replicating the study with a much larger sample to allow for separate analysis without power loss could be beneficial. By comparing the samples, we could potentially identify key factors relating to gaming forum use, which is a potential measure of significant interest in gaming. In addition, there is potential for performance in the Go/No-Go task to be biased by facial emotion recognition skills. Although shifting, a process where the instructions are reversed for some of the test blocks as described within Meule (2017), may help to alleviate this bias it introduces the demand for mental flexibility which could impact the purity of the inhibitory control measure. However, depression is a common comorbidity within gaming disorder (Ostinelli et al., 2021) that has been found to sometimes involve deficits in recognizing facial expressions (Demenescu et al., 2010). In future studies exploring these results it may therefore be more appropriate to use a different measure of inhibitory control. Finally, age differences within the study are relatively large ($m = 26.23$, $SD = 6.843$), so future research exploring whether age differences play a role in impulsivity and gaming patterns would be useful.

Our results may also suggest that a clinical cut-off point of five for the DSM-5 is meaningful but too liberal. Here we found that the factors of impulsivity predicting addiction in established disorders are similar to those predicting symptom counts above the more conservative cut-off point. This might indicate that these higher counts are more closely related to addiction than the current cut-off point for the DSM-5. However, cross-sectional data from a sample that is not tested for diagnostic reliability is not sufficient evidence of this, and instead indicates a potential area for future research. There is no clear rationale for the current clinical cut-off of five out of nine diagnostic criteria, and some researchers have even suggested that additional criteria may be needed (Ko et al., 2014; Müller et al., 2014). There is some support for the validity of the current clinical cut-off (Király et al., 2018), but other researchers have discussed concerns that the diagnostic threshold may be too low and could lead to overdiagnosis (Starcevic, 2017). In a recently submitted latent class analysis (Raybould et al., 2022), our findings suggested a cut-off of seven may be more appropriate, and (Peeters et al., 2019) concluded that a strict cut-off point of five could lead to false diagnoses in males. They reported that in wave two of their longitudinal study, 309 males were identified as '*engaged gamers,*' compared to 692 '*recreational gamers*,' and 26 '*problematic gamers*.' In wave three they found 216 '*engaged gamers,*' 468 '*recreational gamers*,' and 15 '*problematic gamers*.' Importantly, 37 (wave two: 29; wave three; 8) of these '*engaged gamers*' would have been labelled as addicted according to the DSM-5 criteria, despite not reaching '*problematic*' status within the study parameters.

4.1. Conclusions

Our results suggest that further analysis of the relationship between impulsivity and gaming may find impulsivity to be a risk factor in the transition from recreational or non-problem to problematic gaming. Future research examining the connection with impulsivity and gaming could provide further evidence in understanding whether gaming should be formally recognised within the DSM-5.

Competing interest

The researchers have no conflict of interest to declare in relation to this study.

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This study was pre-registered at osf.io/mz4wh and datasets analysed during the current study are available in the OSF repository, osf.io/u72pq/files/

References

Aarseth, E., Bean, A. M., Boonen, H., Carras, M. C., Coulson, M., Das, D., … Van Rooij, A. J. (2017). Scholars' open debate paper on the World health organization ICD-11 gaming disorder proposal. *Secondary Scholars' open debate paper on the World Health Organization ICD-11 Gaming Disorder proposal, 6*, 267–270. https://doi.org/10.1556/2006.5.2016.088

Accenture. (2021). *Gaming: The next super platform*. https://www.accenture.com/_acnmedia/PDF-152/Accenture-Gaming-Article.pdf#zoom=40.

Alessi, S., & Petry, N. (2003). Pathological gambling severity is associated with impulsivity in a delay discounting procedure. *Secondary Pathological Gambling Severity is Associated with Impulsivity in a Delay Discounting Procedure, 64*, 345–354. https://doi.org/10.1016/S0376-6357(03)00150-5

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Association.

Belin, D., Mar, A. C., Dalley, J. W., Robbins, T. W., & Everitt, B. J. (2008). High impulsivity predicts the switch to compulsive cocaine taking. *Secondary High Impulsivity Predicts the Switch to Compulsive Cocaine Taking, 320*, 1352–1355. https://doi.org/10.1126/science.1158136

Borges, G., Orozco, R., Benjet, C., Mart Inez, K., Contreras, E. V., P Erez, A. L. J. E., … Ayuso-Mateos, J. E. L. (2020). (Internet) gaming disorder in DSM-5 and ICD-11: A case of the glass half empty or half full: (Internet) le trouble du jeu dans le DSM-5 et la CIM-11: Un cas de verre a moitie vide et a moitie plein. *Secondary (Internet) Gaming Disorder in DSM-5 and ICD-11: A Case of the Glass Half Empty or Half Full: (Internet) Le trouble du jeu dans le DSM-5 et la CIM-11: Un cas de verre a moitie vide et a moitie plein, 66*, 477–484. https://doi.org/10.1177/0706743720948431

Brand, M., Rumpf, H. J., Demetrovics, Z., King, D. L., Potenza, M. N., & Wegmann, E. (2019). *Gaming disorder is a disorder due to addictive behaviors: Evidence from*

behavioral and neuroscientific studies addressing cue reactivity and craving, executive functions, and decision-making. Secondary gaming disorder is a disorder due to addictive behaviors: Evidence from behavioral and neuroscientific studies addressing cue reactivity and craving, executive functions, and decision-making (Vol. 6, pp. 296–302). https://doi.org/10.1007/s40429-019-00258-y

Choi, S., Kim, H., Kim, G., Jeon, Y., Park, S., Lee, J., … Kim, D. (2014). *Similarities and differences among internet gaming disorder, gambling disorder and alcohol use disorder: A focus on impulsivity and compulsivity. Secondary similarities and differences among internet gaming disorder, gambling disorder and alcohol use disorder: A focus on impulsivity and compulsivity* (Vol. 3). https://doi.org/10.1556/jba.3.2014.4.6

Conley, M. I., Dellarco, D. V., Rubien-Thomas, E., O Cohen, A., Cervera, A., Tottenham, N., & Casey, B. J. (2018). *The racially diverse affective expression (RADIATE) face stimulus set. Secondary the racially diverse affective expression (RADIATE) face stimulus set* (Vol. 270, pp. 1059–1067). https://doi.org/10.1016/j.psychres.2018.04.066

Dalley, J. W., & Ersche, K. D. (2018). Neural circuitry and machanisms of waiting impulsivity: Relevance to addiction. *Secondary Neural circuitry and machanisms of waiting impulsivity: Relevance to Addiction*. https://doi.org/10.1098/rstb.2018.0145

Demenescu, L. R., Kortekaas, R., den Boer, J. A., & Aleman, A. (2010). Impaired attribution of emotion to facial expressions in anxiety and major depression. *Secondary Impaired Attribution of Emotion to Facial Expressions in Anxiety and Major Depression, 5*, Article e15058. https://doi.org/10.1371/journal.pone.0015058

Dillio, R. (2014). A critical miss: Video games, violence, and ineffective legislation. *Secondary A Critical Miss: Video Games, Violence, and Ineffective Legislation, 48*, 110–130. https://doi.org/10.1080/21689725.2014.950496

Dixon, M. R., Marley, J., & Jacobs, E. A. (2003). Delay discounting by pathological gamblers. *Secondary Delay Discounting by Pathological Gamblers, 36*, 449–458. https://doi.org/10.1901/jaba.2003.36-449

Fauth-Bühler, M., & Mann, K. (2017). *Neurobiological correlates of internet gaming disorder: Similarities to pathological gambling. Secondary Neurobiological correlates of internet gaming disorder: Similarities to pathological gambling* (Vol. 6, pp. 349–356). https://doi.org/10.1016/j.addbeh.2015.11.004

Feng, Z. (2021). *China cuts children's online gaming to one hour - China clamps down on 'spiritual opium*. BBC News. https://www.bbc.co.uk/news/technology-58384457.

Global Industry Analysts Inc. (2021). *Global gambling market to reach $876 billion by 2026*. https://www.prnewswire.com/news-releases/global-gambling-market-to-reach-876-billion-by-2026-301305923.html.

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). The benefits of playing video games. *Secondary The Benefits of Playing Video Games, 69*, 66–78. https://doi.org/10.1037/a0034857

Grant, J. E., Potenza, M. N., Weinstein, A., & Gorelick, D. A. (2011). Introduction to behavioral addictions. *Secondary Introduction to Behavioral Addictions, 36*, 233–241. https://doi.org/10.3109/00952990.2010.491884

Hahn, T., Notebaert, K. H., Dresler, T., Kowarsch, L., Reif, A., & Fallgatter, A. J. (2014). *Linking online gaming and addictive behavior: Converging evidence for a general reward deficiency in frequent online gamers. Secondary linking online gaming and addictive behavior: Converging evidence for a general reward deficiency in frequent online gamers* (Vol. 8, p. 385). https://doi.org/10.3389/fnbeh.2014.00385

Hamilton, K. R., Sinha, R., & Potenza, M. N. (2012). *Hazardous drinking and dimensions of impulsivity, behavioral approach, and inhibition in adult men and women. Secondary Hazardous drinking and dimensions of impulsivity, behavioral approach, and inhibition in adult men and women* (Vol. 36, pp. 958–966). https://doi.org/10.1111/j.1530-0277.2011.01708.x

Hodgins, D., & Holub, A. (2015). Components of impulsivity in gambling disorder. *Secondary Components of Impulsivity in Gambling Disorder, 13*. https://doi.org/10.1007/s11469-015-9572-z

Ioannidis, K., Hook, R., Wickam, K., Grant, J. E., & Chamberlain, S. R. (2019). *Impulsivity in gambling disorder and problem gambling: A meta-analysis. Secondary impulsivity in gambling disorder and problem gambling: A meta-analysis* (Vol. 44, pp. 1354–1361). https://doi.org/10.1038/s41386-019-0393-9

James, R. J. E., & Tunney, R. J. (2017). *The relationship between gaming disorder and addiction requires a behavioral analysis. Secondary the relationship between gaming disorder and addiction requires a behavioral analysis* (Vol. 6, pp. 306–309). https://doi.org/10.1556/2006.6.2017.045

Jo, Y. S., Bhang, S. Y., Choi, J. S., Lee, H. K., Lee, S. Y., & Kweon, Y. S. (2019). *Clinical characteristics of diagnosis for internet gaming disorder: Comparison of DSM-5 IGD and ICD-11 GD diagnosis. Secondary clinical characteristics of diagnosis for internet gaming disorder: Comparison of DSM-5 IGD and ICD-11 GD diagnosis* (Vol. 8). https://doi.org/10.3390/jcm8070945

Johannes, N., Vuorre, M., & Przybylski, A. K. (2020). Video game play is positively correlated with well-being. *Secondary Video game play is positively correlated with well-being*. https://doi.org/10.31234/osf.io/qrjza

Jones, C. M., Scholes, L., Johnson, D., Katsikitis, M., & Carras, M. C. (2014). Gaming well: Links between videogames and flourishing mental health. *Frontiers in psychology. Secondary Gaming well: Links Between Videogames and Flourishing Mental Health. Frontiers in Psychology, 5*, 260. https://doi.org/10.3389/fpsyg.2014.00260

King, D. L., Haagsma, M. C., Delfabbro, P. H., Gradisar, M., & Griffiths, M. D. (2013). *Toward a consensus definition of pathological video-gaming: A systematic review of psychometric assessment tools. Secondary toward a consensus definition of pathological video-gaming: A systematic review of psychometric assessment tools* (Vol. 33, pp. 331–342). https://doi.org/10.1016/j.cpr.2013.01.002

Király, O., Griffiths, M. D., King, D. L., Lee, H.-K., Lee, S.-Y., Bányai, F., … Demetrovics, Z. (2018). *Policy responses to problematic video game use: A systematic review of current measures and future possibilities. Secondary policy responses to problematic video game use: A systematic review of current measures and future possibilities* (Vol. 7, pp. 503–517). https://doi.org/10.1556/2006.6.2017.050

Kirby, K. N., Petry, N. M., & Bickel, W. K. (1999). *Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. Secondary Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls* (Vol. 128, pp. 78–87). https://doi.org/10.1037//0096-3445.128.1.78

Konwal, M., Conroy, E., Ramsbottom, N., Smithies, T., Toth, A., & Campbell, M. (2021). Gaming your mental health: A narrative review on mitigating symptoms of depression and anxiety using commercial video games. *Secondary Gaming your mental health: A Narrative Review on Mitigating Symptoms of Depression and Anxiety Using Commercial Video Games, 9*, Article e26575. https://doi.org/10.2196/26575

Kopetz, C. E., Woerner, J. I., & Briskin, J. L. (2018). *Another look at impulsivity: Could impulsive behavior be strategic? Secondary another look at impulsivity: Could impulsive behavior be strategic?* (Vol. 12), Article e12385. https://doi.org/10.1111/spc3.12385

Ko, C. H., Yen, J. Y., Chen, S. H., Wang, P. W., Chen, C. S., & Yen, C. F. (2014). Evaluation of the diagnostic criteria of Internet gaming disorder in the DSM-5 among young adults in Taiwan. *Secondary Evaluation of the diagnostic criteria of Internet gaming disorder in the DSM-5 among young adults in Taiwan, 53*, 103–110. https://doi.org/10.1016/j.jpsychires.2014.02.008

Kozak, K., Lucatch, A. M., Lowe, D., Balodis, I. M., MacKillop, J., & George, T. P. (2019). *The neurobiology of impulsivity and substance use disorders: Implications for treatment. Secondary the neurobiology of impulsivity and substance use disorders: Implications for treatment* (Vol. 1451, pp. 71–91). https://doi.org/10.1111/nyas.13977

Lee, R. S. C., Hoppenbrouwers, S., & Franken, I. (2019). A systematic meta-review of impulsivity and compulsivity in addictive behaviors. *Secondary A Systematic Meta-Review of Impulsivity and Compulsivity in Addictive Behaviors, 29*, 14–26. https://doi.org/10.1007/s11065-019-09402-x

Leppink, E. W., Redden, S. A., & Grant, J. E. (2016). Imulsivity and gambling: A complex clinical association across three measures. *Secondary Imulsivity and gambling: A complex clinical association across three measures, 25*, 138–144. https://doi.org/10.1111/ajad.12341

Markey, P., & Ferguson, C. J. (2017). Teaching us to fear: The violent video game moral panic and the politics of game research. *Secondary Teaching Us to Fear: The Violent Video Game Moral Panic and the Politics of Game Research, 10*. https://files.eric.ed.gov/fulltext/EJ1166785.pdf.

Mestre-Bach, G., Steward, T., Granero, R., Fernández-Aranda, F., Mena-Moreno, T., Vintró-Alcaraz, C., … Jiménez-Murcia, S. (2020). Dimensions of impulsivity in gambling disorder. *Secondary Dimensions of Impulsivity in Gambling Disorder, 10*, 397. https://doi.org/10.1038/s41598-019-57117-z

Meule, A. (2017). Reporting and interpreting task performance in go/No-go affective shifting tasks. *Secondary Reporting and Interpreting Task Performance in Go/No-Go Affective Shifting Tasks, 8*. https://doi.org/10.3389/fpsyg.2017.00701

Mitchell, M. R., & Potenza, M. N. (2014). Addictions and personality traits: Impulsivity and related constructs. *Secondary Addictions and Personality Traits: Impulsivity and Related Constructs, 1*, 1–12. https://doi.org/10.1007/s40473-013-0001-y

Moeller, F. G., & Dougherty, D. M., 2002. Impulsivity and substance abuse: What is the connection? Secondary impulsivity and substance abuse: What is the connection? 1, 3-10. https://journals.lww.com/addictiondisorders/Abstract/2002/05000/Impulsivity_and_Substance_Abuse__What_Is_the.2.aspx.

Müller, K. W., Glaesmer, H., Brähler, E., Wölfling, K., & Beutel, M. E. (2014). *Prevalence of Internet addiction in the general population: Results from a German population-based survey. Secondary Prevalence of Internet addiction in the general population: Results from a German population-based survey* (Vol. 33, pp. 757–766). https://doi.org/10.1080/0144929X.2013.810778

Nower, L., & Blaszczynski, A. (2007). Impulsivity and pathological gambling: A descriptive model. Secondary impulsivity and pathological gambling. *A Descriptive Model, 6*, 61–75. https://doi.org/10.1080/14459790600644192

Ostinelli, E. G., Zangani, C., Giordano, B., Maestri, D., Gambini, O., D'Agostino, A., … Purgato, M. (2021). Depressive symptoms and depression in individuals with internet gaming disorder: A systematic review and meta-analysis. *Secondary Depressive symptoms and depression in individuals with internet gaming disorder: A systematic review and meta-analysis, 284*, 136–142. https://doi.org/10.1016/j.jad.2021.02.014

Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt impulsiveness scale. *Secondary Factor structure of the Barratt impulsiveness scale, 51*, 768–774. https://doi.org/10.1002/1097-4679(199511)51:6<768::aid-jclp2270510607>3.0.co;2-1

Peeters, M., Koning, I., Lemmens, J., & van den Eijnden, R. (2019). *Normative, passionate, or problematic? Identification of adolescent gamer subtypes over time. Secondary normative, passionate, or problematic? Identification of adolescent gamer subtypes over time* (Vol. 8, pp. 574–585). https://doi.org/10.1556/2006.8.2019.55

Perry, J. L., & Carroll, M. E. (2008). The role of impulsive behavior in drug abuse. *Secondary The role of impulsive behavior in drug abuse, 200*, 1–26. https://doi.org/10.1007/s00213-008-1173-0

Piazza, P. V., & Deroche-Gamonet, V. (2013). A multistep general theory of transition to addiction. *Secondary A multistep general theory of transition to addiction, 229*, 387–413. https://doi.org/10.1007/s00213-013-3224-4

Potenza, M. N. (2013). Neurobiology of gambling behaviors. *Secondary Neurobiology of gambling behaviors, 23*, 660–667. https://doi.org/10.1016/j.conb.2013.03.004

Raybould, J. N., Watling, D. C., Larkin, M., & Tunney, R. J. (2022). The gaming problem: A latent class Analysis of DSM-5 criteria for internet gaming disorder in a non-clinical sample [version 1; peer review: Awaiting peer review]. *Secondary The Gaming Problem: A Latent Class Analysis of DSM-5 Criteria for Internet Gaming Disorder in a Non-Clinical Sample [version 1; peer review: awaiting peer review], 11*. https://doi.org/10.12688/f1000research.123390.1

Rung, J. M., Peck, S., Hinnenkamp, J. E., Preston, E., & Madden, G. J. (2019). *Changing delay discounting and impulsive choice: Implications for addictions, prevention, and human health. Secondary changing delay discounting and impulsive choice: Implications*

for addictions, prevention, and human health (Vol. 42, pp. 397–417). https://doi.org/10.1007/s40614-019-00200-7

Şalvarlı, Ş.İ., & Griffiths, M. D. (2022). The association between internet gaming disorder and impulsivity: A systematic review of literature. *Secondary The Association Between Internet Gaming Disorder and Impulsivity: A Systematic Review of Literature, 20*, 92–118. https://doi.org/10.1007/s11469-019-00126-w

Sharma, L., Markon, K. E., & Clark, L. A. (2013). Toward a theory of distinct types of "impulsive" behaviors: A meta-analysis of self-report and behavioral measures. *Secondary Toward a Theory of Distinct Types of "Impulsive" Behaviors: A Meta-Analysis of Self-Report and Behavioral Measures, 140*. https://doi.org/10.1037/a0034418

Sim, T., Gentile, D. A., Bricolo, F., Serpollini, G., & Gulamoydeen, F. (2012). A conceptual review of research on the pathological use of computers, video games, and the internet. *Secondary A conceptual review of research on the pathological use of computers, video games, and the internet, 10*, 748–769. https://doi.org/10.1007/s11469-011-9369-7

Snider, S. E., DeHart, W. B., Epstein, L. H., & Bickel, W. K. (2019). Does delay discounting predict maladaptive health and financial behaviors in smokers? *Secondary Does delay discounting predict maladaptive health and financial behaviors in smokers?, 38*, 21–28. https://doi.org/10.1037/hea0000695

Starcevic, V. (2017). Internet gaming disorder: Inadequate diagnostic criteria wrapped in a constraining conceptual model Commentary on: Chaos and confusion in DSM-5 diagnosis of Internet Gaming Disorder: Issues, concerns, and recommendations for clarity in the field (Kuss et al.). Secondary Internet gaming disorder: Inadequate diagnostic criteria wrapped in a constraining conceptual model Commentary on: Chaos and confusion in DSM-5 diagnosis of Internet Gaming Disorder: Issues, concerns, and recommendations for clarity in the field. *Kuss et al.), 6*, 110–113. https://doi.org/10.1556/2006.6.2017.012

Statista Research Department. (2021). *Global market value of alcoholic beverages 2012-2025*. https://www.statista.com/forecasts/696641/market-value-alcoholic-beverages-worldwide.

Strickland, J. C., & Johnson, M. W. (2020). *Rejecting impulsivity as a psychological construct: A theoretical, empirical, and sociocultural argument. Secondary rejecting impulsivity as a psychological construct: A theoretical, empirical, and sociocultural argument* (Vol. 128, pp. 336–361). https://doi.org/10.1037/rev0000263

Thomsen, K. R., Callesen, M. B., Hesse, M., Kvamme, T. L., Pedersen, M. M., Pedersen, M. U., & Voon, V. (2018). Impulsivity traits and addiction-related behaviors in youth. *Secondary Impulsivity traits and addiction-related behaviors in youth, 7*, 317–330. https://doi.org/10.1556/2006.7.2018.22

Toplak, M., Pitch, A., Flora, D. B., & Iwenofu, L. (2009). The unity and diversity of inattention and hyperactivity/impulsivity in ADHD: Evidence for a general factor with separable dimensions. *Secondary The Unity and Diversity of Inattention and Hyperactivity/Impulsivity in ADHD: Evidence for a General Factor with Separable Dimensions, 37*, 1137–1150. https://doi.org/10.1007/s10802-009-9336-y

Whiteside, S. P., & Lynam, D. R. (2001). *The Five Factor Model and impulsivity: Using a structural model of personality to understand impulsivity. . Secondary the Five Factor Model and impulsivity: Using a structural model of personality to understand impulsivity* (Vol. 30, pp. 669–689). https://doi.org/10.1016/S0191-8869(00)00064-7

World Health Organisation. (2021). *6*5*C1 gaming disorder. ICD-11 for mortality and morbidity statistics*. https://icd.who.int/browse11/l-m/en#/http%3A%2F%2Fid.who.int%2Ficd%2Fentity%2F1448597234.