2021-07-17

Loot boxes, problem gambling and problem video gaming: A systematic review and meta-synthesis

Spicer, Stuart

http://hdl.handle.net/10026.1/17268

10.1177/14614448211027175
New Media and Society
SAGE Publications

Page Proof Instructions and Queries

Please respond to and approve your proof through the "Edit" tab, using this PDF to review figure and table formatting and placement. This PDF can also be downloaded for your records. We strongly encourage you to provide any edits through the "Edit" tab, should you wish to provide corrections via PDF, please see the instructions below and email this PDF to your Production Editor.

Journal Title: New Media & Society

Article Number: 1027175

Thank you for choosing to publish with us. This is your final opportunity to ensure your article will be accurate at publication. Please review your proof carefully and respond to the queries using the circled tools in the image below, which are available in Adobe Reader DC* by clicking **Tools** from the top menu, then clicking **Comment**.

Please use *only* the tools circled in the image, as edits via other tools/methods can be lost during file conversion. For comments, questions, or formatting requests, please use [T]. Please do *not* use comment bubbles/sticky notes.

*If you do not see these tools, please ensure you have opened this file with **Adobe Reader DC**, available for free at get.adobe.com/reader or by going to Help > Check for Updates within other versions of Reader. For more detailed instructions, please see us.sagepub.com/ReaderXProofs.

No.	Query
GQ1	Please confirm that all author information, including names, affiliations, sequence, and contact details, is correct.
GQ2	Please confirm that the funding and conflict of interest statements are accurate.
GQ3	Please note that we cannot add/amend ORCID iDs for any article at the proof stage. Following ORCID's guidelines, the publisher can include only ORCID iDs that the authors have specifically validated for each manuscript prior to official acceptance for publication.
1	Bold formatting in some of the phrases in the original MS has been removed. Please check.
2	Please clarify whether 'Zendle et al. (2019)' refers to 'Zendle et al. (2019a)' or 'Zendle et al. (2019b)' throughout the text.
3	Please clarify whether 'Drummond et al. (2020)' refers to 'Drummond et al. (2020a)' or 'Drummond et al. (2020b)' throughout the text.
4	Please provide complete reference details for 'Lenhard (2016)', or delete the citation.
5	Please provide complete reference details for 'Gilpin (1992)', or delete the citation.
6	Please provide complete reference details for 'Lin (2019)', or delete the citation.
7	Please note that bold formatting has been removed from Tables 1 and 2.
8	Please note that the given URL in 'Digital, Culture, Media and Sport Committee (2019)' does not lead to the desired web page. Please provide an active URL.
9	Please note that 'a' and 'b' have been added to references 'Drummond, Sauer, Ferguson, et al. (2020)' and 'Drummond, Sauer, Hall, et al. (2020)', respectively, to avoid confusion between two references with identical year. Please check.
10	Please note that the given URL in 'Ipsos/Gambling Commission (2019)' does not lead to the desired web page. Please provide an active URL.
11	Please provide date of work paper for 'Von Meduna et al. (2019)'.

12	Please note that ‘a’ and ‘b’ have been added to references ‘Zendle, Cairns, Barnett, et al. (2020)’ and ‘Zendle, Meyer, Cairns, et al. (2020)’, respectively, to avoid confusion between two references with identical year. Please check.
13	Please note that ‘a’ and ‘b’ have been added to references ‘Zendle, Meyer and Over (2019)’ and ‘Zendle, Meyer, Waters, et al. (2019)’, respectively, to avoid confusion between two references with identical year. Please check.
14	Please check whether the inserted details are correct for ‘Zendle et al. (2019b)’.
15	Please provide a 2 to 3 sentence biography for each of the authors.

Review Article (Invited Authors Only)

new media & society
1–22

DOI: 10.1177/14614448211027175
journals.sagepub.com/home/nms
SAGE

Loot boxes, problem gambling and problem video gaming: A systematic review and meta-synthesis

Stuart Gordon Spicer [GQ: 1]
University of Plymouth, UK

Laura Louise Nicklin
Maria Uther
Joanne Lloyd
University of Wolverhampton, UK

Helen Lloyd
James Close
University of Plymouth, UK

Abstract
Loot boxes (LBs) are video game-related purchases with a chance-based outcome. Due to similarities with gambling, they have come under increasing scrutiny from media, academics and policymakers alike. Initial evidence suggested that LB engagement might be associated with both problem gambling (PG) and problem video gaming (PVG). We therefore conducted a systematic review of the evidence for associations between LB purchasing, PG and PVG. For LB/PG, 12 of 13 publications reported a positive relationship, with a moderately sized mean effect of $r = .27$. For LB/PVG, the mean effect was $r = .40$, although this finding was drawn from only six surveys in total. For PG/PVG, the mean effect was $r = .21$, with only 11 of 20 studies reporting significant effects. While further evidence is required to determine the direction of causality, the strength of relationships suggests that policy action on LBs may have benefits for harm minimisation.

Corresponding author:
Stuart Gordon Spicer, School of Psychology, University of Plymouth, Plymouth, Devon PL4 8AA, UK.
Email: stuart.spicer@plymouth.ac.uk

Keywords
Addiction, impulsivity, loot boxes, mental health, microtransactions, nudges, problem gambling, problem video gaming, systematic review, wellbeing

Background[AQ: 1]

Loot boxes (LBs) are video game-related purchases with a chance-based outcome. They come in various configurations and guises, and might be called boxes, crates, cases, card packs, shards or eggs. Due to these complexities, there is often confusion about what exactly constitutes an LB. Our definition encapsulates any purchasable game content with a randomised outcome. The contents within LBs might include 'pay to win' features such as improved weapons or power ups, or instead, they might be purely cosmetic upgrades and customisation. LBs may also be purchased with in-game currency, or they might be opened using purchasable 'keys', such as the 'crate and key' mechanics found in games like *Counter Strike: Global Offensive* or the similar 'eggs and incubator' mechanics found in *Pokémon Go*. Furthermore, 'free' LBs are offered in some games – but these are also *always* available as paid-for content (i.e. or else they would not be classified as LBs under our definition, because there is no opportunity for monetary exchange). These sorts of free giveaways are often aimed at encouraging future LB purchasing (Zendle et al., 2019a).[AQ: 2]

LBs have become increasingly prevalent over the past decade (Zendle et al., 2020b), are available in the majority of video games across various formats (Zendle et al., 2020b) and have become increasingly sophisticated (Koeder et al., 2018). An estimated 44–78% of gamers are thought to have purchased LBs (Brooks and Clark, 2019; Li et al., 2019; Zendle and Cairns, 2018). Widely available to children (Zendle et al., 2020b), they have come under increasing scrutiny from academics, policymakers, the media (Drummond et al., 2020a) and the gaming community itself (Allan, 2018), due to structural and psychological similarities with gambling (Drummond and Sauer, 2018).

The first academic studies on LBs were published in 2018 (Drummond and Sauer, 2018; Zendle and Cairns, 2018, 2019), where the first survey of LB purchasing appeared to confirm such concerns: establishing a significant, moderate-sized correlation between problem gambling (PG) severity and LB purchasing (Zendle and Cairns, 2018). Due to the correlational nature of the evidence, the direction of the relationship is unknown, but there are three possibilities: (a) problem gamblers purchase more LBs, (b) LB purchasers are more likely to start gambling – that is, via 'gateway effects' or (c) there is a complex, dynamic relationship between the two behaviours.

There has been considerable debate about the extent to which LBs constitute gambling. Some senior gaming executives have argued that since LBs always contain an item, they are the digital analogue of baseball cards or Kinder Eggs (Digital, Culture, Media and Sport Committee, 2019). However, analysis of game-related marketplaces such as the *Steam Community Market* (where digital assets obtained in LBs can be bought and sold) reveals that the items obtained within LBs usually constitute a monetary loss (Drummond et al., 2020b). This type of 'loss disguised as a win' has parallels with traditional gambling games such as online slots, where 'wins' can actually be lower than the stake wagered. Some academics have therefore argued that LBs could be regulated under existing gambling laws (Drummond et al., 2020b).

While LBs are a relatively new innovation in video gaming, controversies around links between video games and gambling predate the emergence of LBs by several decades (Lain and Brown, 1989). It has been hypothesised that both PVG and PG may be driven by shared cognitive biases or distortion (Fisher, 1993; Gupta and Derevensky, 1996; Lain and Brown, 1989). While there is some debate about classifying problem video gaming (PVG) as a psychological disorder (Aarseth et al., 2017; Kuss et al., 2017), Gaming Disorder is included in the 11th revision of the International Classification of Diseases (ICD-11; World Health Organization [WHO], 2018), and the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (*DSM*-5; American Psychiatric Association [APA], 2013) recommends Internet Gaming Disorder as a condition requiring further research.

Similar to gambling, video gaming often operates on chance-based principles, reinforced by the physiological arousal of aesthetic elements such as lights, sounds and graphics. It has already been suggested that habituation and repeated exposure to video games (i.e. regardless of LBs) could lead adolescents, via gateway effects, to develop later gambling problems (Fisher, 1993; Gupta and Derevensky, 1996; Lain and Brown, 1989).

Early research appeared to support such conclusions (Gupta and Derevensky, 1996; Ladouceur and Dubé, 1995). However, these studies were conducted during the era of 'coin-op[erated]' arcade games, often co-located with similar-looking gambling devices. Today is an era of increasing *domestic* proximity between gaming and gambling (i.e. both activities are increasingly available within the home). LBs are one aspect of this ongoing technological and cultural gambling-gaming convergence (Brooks and Clark, 2019; King et al., 2015), with increasing prevalence of in-game casinos, free-to-play 'social' casinos (Kim et al., 2015), eSports betting (Macey and Hamari, 2019a), crypto-games (Scholten et al., 2019) and game-related wagering (Abarbanel and Macey, 2019).

LBs provide a well-defined opportunity to understand how such gambling-related features interact with problematic gaming and gambling; and longer terms harms associated with these behaviours. We conducted an independent, systematic literature review, to assess the consistency, robustness, effect sizes and quality of evidence (Moher et al., 2009) for associations between the three constructs of interest: LB/PG, LBs and LB/PVG, and PG/PVG.

Methods

A systematic review and, where possible, a meta-analysis was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA [Moher et al., 2009]) to account for survey heterogeneity, infrequent reporting of standard deviation/error and cross-sectional nature of evidence (see below).

Literature searches

We searched literature databases for publications related to LBs (Search 1) and also for links between PG and PVG (Search 2). See Box 1 for full search terms. Initial searches were conducted prior to 28 March 2020. However, further/subsequent papers were

Box 1. Terms used for literature searches.

Search 1: loot boxes
'loot box' OR 'loot boxes' (microtransactions OR microtransaction) AND 'chance based' AND games AND (video OR computer OR online OR mobile) (microtransactions OR microtransaction) AND 'chance based' AND gaming AND (video OR computer OR online OR mobile) gaming AND gambling AND 'reward schedule' AND variable AND online (video OR computer OR mobile)
Search 2: problem gaming and problem gambling
('problem gambling' or 'gambling addiction') AND ('problem video gaming' OR 'problem gaming' OR 'gaming addiction')

Search 1 shows different combinations of searches relating to loot boxes. Search 2 shows searches relating to problem gaming and problem gambling. While the syntax in different databases varies, the logic of searches is consistent with details below.

included via expert knowledge, publication alerts and a snowballing approach (i.e. via the references of primary articles). Non-English articles were excluded and duplicates were removed. For Search 1, further papers were excluded if they were not relevant to LBs, only discussed LBs as a peripheral subject or were publications of a non-empirical nature (e.g. reviews, commentaries and book chapters).

For Search 2, we targeted papers investigating associations between gambling and video gaming. Studies were excluded if they did not measure both gambling and gaming; were pre-year 2000 (i.e. generally pre-Internet, and often 'coin-op'); were specific to a certain gaming context (i.e. social casinos, which are free-to-play structural homologues of online casinos and known to have high migration rates into online gambling [Gainsbury et al., 2016; Kim et al., 2015]); or failed to investigate direct correlations between gaming and gambling. Screening was divided between S.G.S., L.L.N., J.C. and J.L., with at least two researchers assessing all primary research.

Results synthesis

For surveys of gamers reporting associations between our three constructs of interest, we extracted key statistical results. Due to heterogeneity of reporting, it was often necessary to convert results into a standardised Pearson's r value, using (where possible) the method specified by Lenhard and Lenhard (2016) or otherwise alternate conversions (Gilpin, 1993; Lin, 2020). Where publications reported multiple statistical tests (i.e. bivariate correlations and path analysis, e.g. Molde et al., 2019), we extracted bivariate Pearson's r values, as the most commonly (and directly comparable) statistic in the literature.

We transformed each r value using Fisher's z and then calculated a weighted mean z value (using the Hunter–Schmidt method; Field and Gillett, 2010) for the three associations of interest (LB/PG, LB/PVG and PG/PVG). These mean z values were then reverse transformed to provide the final weighted mean *r* values. Stem and leaf plots were generated as a visual proxy of the consistency/reproducibility of studies (Field and Gillett, 2010). Other meta-analytical approaches (i.e. confidence intervals; forest plots; funnel plots) could not be calculated due lack of available data: standard deviation/errors were often not reported in the literature and not sufficiently available when contacting authors directly (only 33% authors responded with necessary data).

Quality appraisal

We utilised the Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018) to assess the quality of evidence, using items relating to quantitative descriptive studies: 4.1 = appropriate sampling strategy; 4.2 = representative population; 4.3 = appropriate measures; 4.4 = low nonresponse bias; 4.5 = appropriate statistical approach. For item 4.3, we scored all methods of LB measurement positively (as yet, there is no 'gold standard' approach), and for gambling/gaming measures, we scored positively for all previously validated scales (e.g. PGSI [Problem Gambling Severity Index], IGD [Internet Gaming Disorder]) and negatively for one-off, non-validated scales or measures of gaming/gambling participation. In addition, we assessed whether publications were peer-reviewed (due to existence of pre-print papers; item 4.6), if publications were pre-registered (or a replication study; item 4.7), if data were open access (item 4.8) and if there was a low risk of cohort response bias (item 4.9). This final assessment judged from the perspective of our review questions (i.e. associations between LB/PG/PVG in the general population). Here, some studies had a relevant sampling strategy for the goals of the primary study (e.g. elite athletes Håkansson et al., 2018) and therefore scored appropriately for item 4.1 on the MMAT, but were limited/biased cohorts for investigating such population-wide associations. Our full checklist was assessed by two researchers (J.C. and S.S.), with any discrepancies discussed and resolved.

Results and discussion

Literature searches

For Search 1 (LB-related searches), we identified 256 publications, although only 23 of these were primary research. See Figure 1 for identification, screening and inclusion of publications. Of the 23 empirical publications, 18 were surveys of gamers, including some measure of LB behaviour. In addition to the survey data, there were three scoping papers (Drummond and Sauer, 2018; Kaneko et al., 2018; Zendle et al., 2020b). These investigated issues such as the size and scope of LBs in gaming. Also, two preliminary lab-based experimental studies (Brady and Prentice, 2021; Larche et al., 2019), observed gamers opening LBs. The remaining 233 publications were non-empirical, consisting of commentaries, editorials and informal reviews.

From the 18 surveys, 14 reported associations between some combination of LB, PG and/or PVG. Of the remaining four papers, three did not report associations with PG or PVG (Kristiansen and Severin, 2019; Macey and Hamari, 2019b; Seo et al., 2019), and one did not clearly differentiate between randomised and non-randomised in-game purchases (Shibuya et al., 2019). For publications that reported correlations, these included

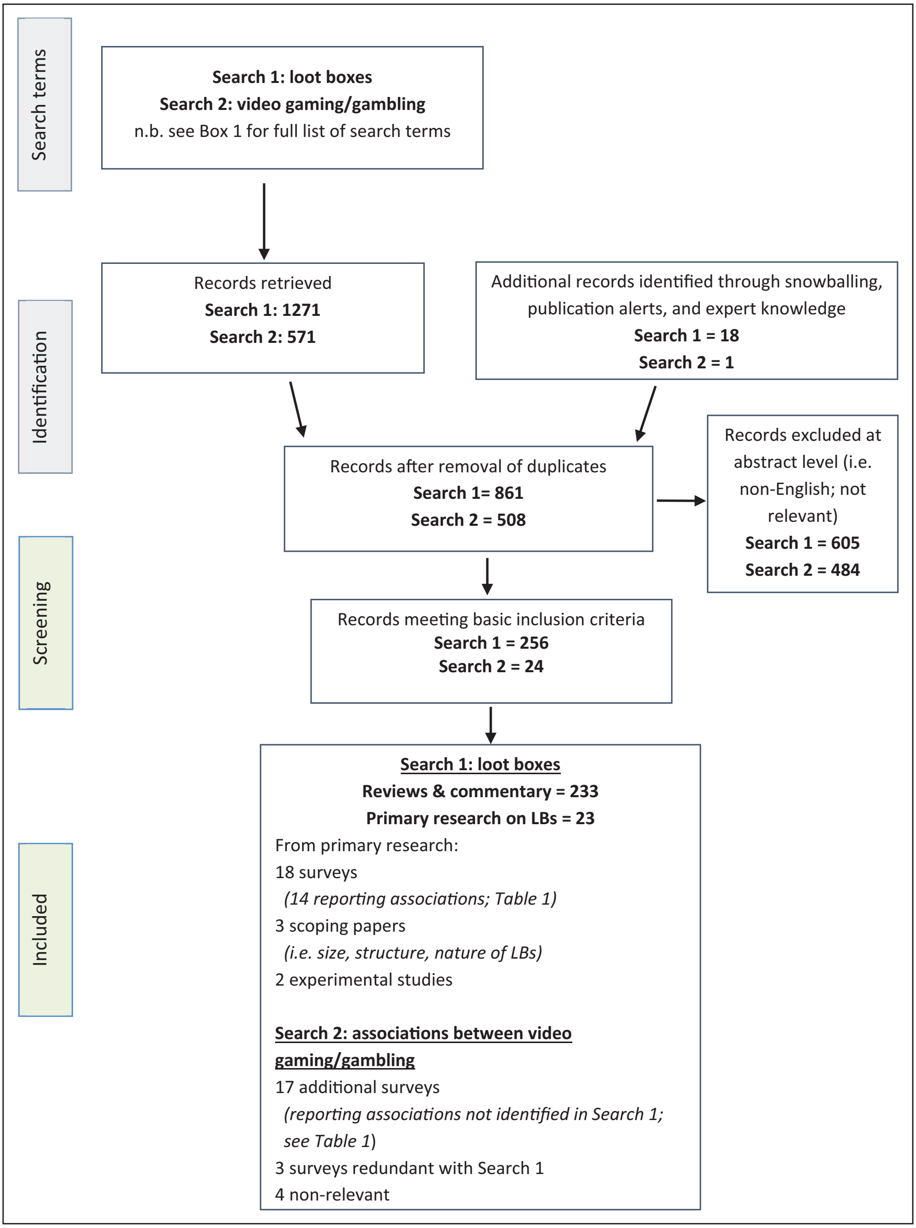

Figure 1. Flow diagram of literature searches and screening. Searches were conducted in two streams, with Search 1 seeking to identify surveys of loot boxes and Search 2 identifying surveys investigating associations between gaming and gambling behaviour.

LB/PG (13 studies), LB/PVG (6 studies) and PG/PVG (3 studies) with a small number of studies also reporting measures of wellbeing, impulsivity and motivations (Drummond et al., 2020a; Li et al., 2019; Zendle et al., 2019a).

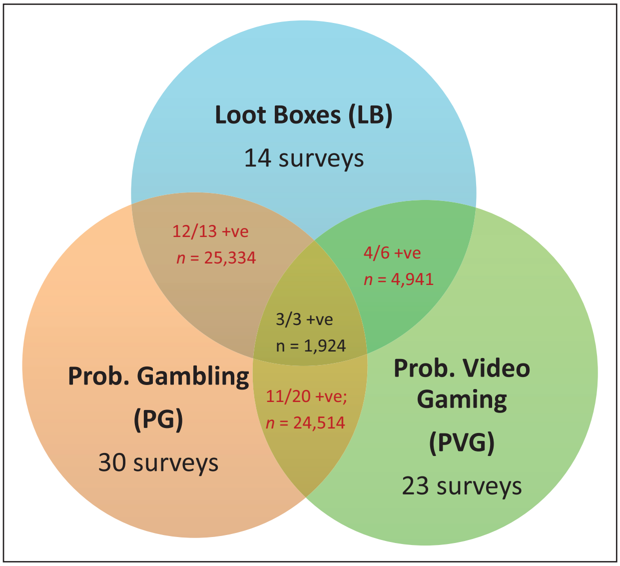

Figure 2. Surveys reporting associations between loot boxes, problem gambling and problem video gaming. The proportions (in red) at the intersection of each circle represent the number of papers reporting significant correlations between these two constructs, with *n* as the total number of participants. The number at the central intersection is the publications reporting all three associations (i.e. LBs vs PG, LBs vs PVG and PG vs PVG).

For Search 2, we identified an additional 17 surveys that explored associations between PG/PVG. The relationships between these constructs are summarised in Figure 2. An overview of publications and the results of associations between these three constructs (i.e. LB/PG, LB/PVG and PG/PVG) are listed in Table 1.

Evidence synthesis

The 13 publications (14 studies) investigating LB/PG (total $n=25{,}334$; n usable for meta-synthesis = 19,334) were all cross-sectional, apart from one longitudinal survey (Zendle, 2019b). In all, 13 (93%) studies established positive associations, with a moderate weighted effect size of $r=.27$. There was a heterogeneity of measurement approach (e.g. measuring LB spend, engagement or frequency). While PGSI was used to measure PG in all but two studies (Kristiansen and Severin, 2020; Zendle et al., 2019a), studies varied in using numerical PGSI scores or categories (i.e. PG status).

The six studies investigating LB/PVG (total $n=4941$; meta-synthesis $n=3433$) established a larger weighted effect size ($r=.40$), but with only 57% of studies revealing positive associations. The studies were relatively heterogeneous, although all were cross-sectional, and PVG was measured using the IGD in all but one (Von Meduna et al., 2020). One study ($n=1508$; Von Meduna et al., 2019) with mixed results was omitted from our analysis because it was not possible to generate a standardised r value.

The 20 studies investigating PG/PVG (total $n=24{,}514$; meta-synthesis $n=23{,}794$) established a moderate weighted effect size of $r=.21$. Being drawn from a longer time

Table 1.[AQ: 3][AQ: 4][AQ: 5][AQ: 6] Primary publications on LB/PG, LB/PVG and PG/PVG, including standardised *r* values (with method of conversion for associations), and MMAT quality analysis.

Publication details			Results synthesis				MMAT quality analysis								
Author and date	Design	No.	LB/PG	LB/PVG	PVG/PG	Conversion Method	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9
Kristiansen and Severin (2020)	Cross-sectional	1137	0.11			Lenhard (2016)									
Macey and Hamari (2019a)	Cross-sectional	582	0.27			Gilpin (1992)									
Wardle and Zendle (2021)	Cross-sectional	3549	0.38			Lenhard (2016)									
Zendle (2019b)	Longitudinal	112	0.49			Lenhard (2016)									
Zendle and Cairns (2018)	Cross-sectional	7422	0.23			Lenhard (2016)									
Zendle and Cairns (2019)	Cross-sectional	1172	0.23			Lenhard (2016)									
Zendle et al. (2019)	Cross-sectional	1155	0.35			Lenhard (2016)									
Zendle et al. (2020a)	Cross-sectional	1200	0.3			Lenhard (2016)									
Von Meduna et al. (2019)	Cross-sectional	1508	N/A	N/A		N/A									
Zendle (2019a)	Cross-sectional	1081	0.14	0.41		Lenhard (2016)									
Brooks and Clark (2019)	Cross-sectional	144	0.23	0.18	0.43	No conversion									
		113	−0.01	0	0.19	No conversion									
Drummond et al. (2020)	Cross-sectional	1049	0.34	0.6	0.6	No conversion									
Li et al. (2019)	Cross-sectional	618	0.19	0.27	0.46	Lenhard (2016)									
King et al. (2020)	Cross-sectional	428		0.1		No conversion									
Biegun et al. (2020)	Cross-sectional	651			0.07	Lenhard (2016)									
Broman and Håkansson (2018)	Cross-sectional	605			N/A	N/A									
Delfabbro et al. (2009)	Cross-sectional	2669			0.12	Lenhard (2016)									
Ford and Håkansson (2020)	Cross-sectional	2038			0.3	Lin (2019)									
Forrest et al. (2016)	Cross-sectional	485			0.09	No conversion									

(Continued)

Table 1. (Continued)

Publication details			Results synthesis				MMAT quality analysis								
Author and date	Design	No.	LB/ PG	LB/ PVG	PVG/ PG	Conversion Method	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9
Fu and Yu (2015)	Cross-sectional	700			0.29	No conversion	green	green	red	green	green	green	red	red	green
Håkansson et al. (2018)	Cross-sectional	352			0.05	Lenhard (2016)	green	green	green	red	green	green	red	red	red
Jiménez-Murcia et al. (2014)	Cross-sectional	193			0.05	Lenhard (2016)	green	green	red	green	green	green	red	red	red
Karlsson et al. (2019)	Cross-sectional	1593			0.3	Lin (2019)	green	green	green	green	green	green	red	red	green
King et al. (2012)	Cross-sectional	115			N/A	N/A	red	red	red	green	green	green	red	red	red
Macey and Hamari (2018)	Cross-sectional	613			−0.1	Lenhard (2016)	green	red	green	red	green	green	red	red	red
McBride and Derevensky (2016)	Cross-sectional	1229			0.17	Lenhard (2016)	red	red	green	green	green	green	red	red	red
Mills et al. (2020)	Cross-sectional	1621			0.38	Lenhard (2016)	green	red	green	red	green	green	red	red	red
Molde et al. (2019)	Longitudinal	4601			0.25	No conversion	green	green	green	red	green	green	red	red	red
Vadlin et al. (2018)	Longitudinal	1576			0.08	Lenhard (2016)	green	green	green	red	green	green	red	red	red
Walther et al. (2012)	Cross-sectional	2553			0.12	No conversion	green	green	green	red	green	green	red	red	red
Wood et al. (2004)	Cross-sectional	996			0.18	No conversion	green	green	red	green	red	green	red	red	green

MMAT: Mixed Methods Appraisal Tool; LB: loot box; PG: problem gambling; PVG: problem video gaming; NA: not applicable.
Standardised *r* values are listed in columns LB/PG, LB/PVG and PG/PVG, where statistically significant results are shown in green, null results in red, mixed results in yellow and reverse correlations in deep red (i.e. statistically significant, but negatively correlated). For the MMAT quality analysis, green = positive for this checklist item; red = negative. The checklist items are as follows: 4.1 = appropriate sampling strategy; 4.2 = representative population; 4.3 = appropriate measures; 4.4 = low nonresponse bias; 4.5 = appropriate statistical approach. We also included an additional four items on the checklist (see 'Methods'), where 4.6 = peer-reviewed; 4.7 = pre-registered/replication study; 4.8 = open-access data; 4.9 = low risk of cohort response bias. See Supplemental Table 1 for full details.

Table 2. [AQ: 7] Mean *r* values for each of the three key relationships.

Association	Meta *n*	*M r*	W-*M r*
Loot boxes and problem gambling	19,334	0.25	0.27
Loot boxes and problem video gaming	3433	0.26	0.40
Problem gambling and problem video gaming	23,794	0.21	0.21

'W-Mean' is transformed and weighted according to the sample in each study. 'Meta *n*' refers to the *n* used for statistical conversion – see 'Methods' and 'Results synthesis' sections.

period (i.e. past 20 years, rather than only the past 3 years for LB literature), these studies were the most methodologically heterogeneous, using PVG measures such as IGD, GAS (Gaming Addiction Scale) and GAIT (Gaming Addiction Identification Test); and PG measures such as PGSI, CPGI (Canadian Problem Gambling Index) and SOGS (South Oaks Gambling Screen). Eight studies used PGSI, while five used IGD. All but two studies were cross-sectional. Over half (57%) of the PG/PVG studies established positive associations. For two further studies, it was not possible to generate a standardised *r* value. See Figure 2 and Table 1 for further details.

Across all studies, there was a large variation in cohorts. Samples sizes ranged from 112 to 7422, sourced from a variety of forums and participation pools, with a large geographic spread (including Europe, America and Australia). Extended details of surveys are provided in Supplemental Table 1. A summary of the associations is provided in Table 2.

The stem and leaf plots of individual associations (Figure 3) illustrate the reason for apparent discrepancies between effect sizes and reproducibility. While the LB/PG associations (which were consistently reported) cluster around the mean value, the associations between LB/PVG and PVG/PG exhibit a broader spread of results (i.e. a greater number of higher and lower values). Potential reasons for this are explored in the discussion below.

Evidence quality

According to the MMAT, the quality of the evidence (see Table 1) provided by publications on LBs was of moderate quality, but improving over time. They currently include pre-registered/replication studies (4 publications), open-access data (7 studies) and representative samples (4 studies); including a nationally representative sample of around 1100 Danish adolescents (Kristiansen and Severin, 2020); and a nationally representative sample of around 1100 UK adults (Zendle, 2019a).

Publications derived from the secondary searches (i.e. non-LB papers, focusing on PG/PVG interactions) covered a broader span of time and were generally of lower quality than the LB publications, with no studies being pre-registered or open access, although five publications did include nationally representative samples.

LBs and PG

These publications found positive associations, apart from one with mixed findings (a positive effect in a first study of 144 adults, but no evidence of an association in a second

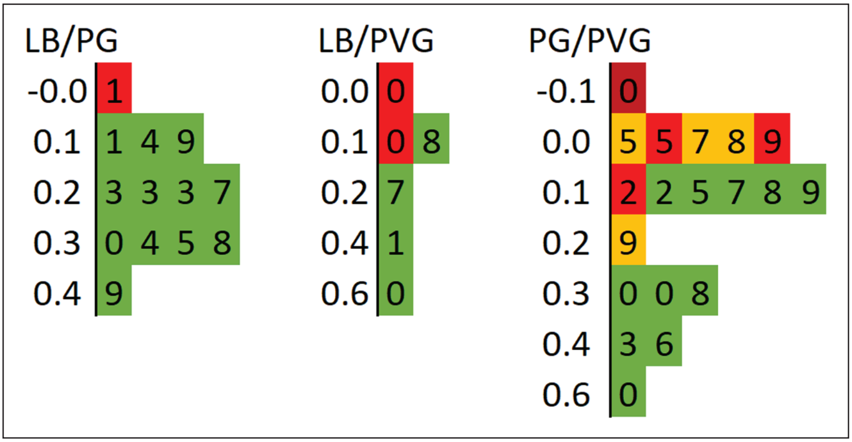

Figure 3. Stem and leaf plots of the three key associations. These represent the distribution of converted effect sizes, rounded to two decimal places. The values to the left of each line represent where each value sits to the first decimal place, while the values to the right of the line represent the second decimal place of each value, for example, the bottom value for LB/PG is $r = .49$. Statistically significant results are shown in green, null results in red, mixed results in yellow and reverse correlations in deep red (i.e. statistically significant, but negatively correlated).

[relatively small sample] study of 113 Canadian undergraduate students [Brooks and Clark, 2019]). Replications have been demonstrated across various cohorts, nationalities (Europe, North America and Australasia) and age groups (including younger adolescents [Kristiansen and Severin, 2020], older adolescents [Zendle et al., 2019a] and adults). The magnitude of the relationship is not significantly altered after controlling for age and gender (Drummond et al., 2020a; Kristiansen and Severin, 2020; Li et al., 2019).

Specific findings of these papers further support the conclusion that LB purchasing and gambling are related behaviours. First, LB purchasing is predicted by gambling-related cognitions (e.g. illusions of control Raylu and Oei, 2004); implicated as an etiological factor in gambling disorder (Brooks and Clark, 2019). Second, associations with PG are weakest with free LBs (Kristiansen and Severin, 2020; Zendle and Cairns, 2018), slightly stronger for LBs that use in-game currency or show near misses (Zendle et al., 2020a), and stronger when players are actively engaged in selling LBs on secondary marketplaces (Kristiansen and Severin, 2020; Larche et al., 2019; Zendle et al., 2020a). This suggests that LB purchasing has a closer link with gambling, when the contents have potential monetary value. Third, in a naturalistic follow-up study, the removal of LBs (in the game *Heroes of the Storm*) resulted in problem gamblers spending significantly less money; although this was a small cohort study, with longitudinal data giving mixed-model-dependent results (Zendle, 2019b). Fourth, the strength of association is only moderately altered by the various available configurations of LBs, including options such as showing near-misses, use of in-game currencies and cosmetic versus pay2win content (Kristiansen and Severin, 2020; Zendle and Cairns, 2018, 2019)

Observable differences in survey results (Figure 3) were likely related to heterogeneity of: samples (different nationalities and ages, ranging from convenience gamer samples to demographically representative cohorts); instruments (e.g. to measure gaming and gambling); units of comparison (e.g. scale data versus categorical 'problem' status); LB measurements (e.g. spend, engagement, or the Risky Loot Box Index scale of problematic LB behaviour [Brooks and Clark, 2019]); analytical methods (e.g. Pearson's/Spearman's correlations, Kruskal Wallis H Test, Kendall's tau, ANOVA, Mann–Whitney *U* test, bivariate and multiple regressions). However, there was less survey heterogeneity for LB/PG than with PG/PVG (see below).

LBs and PVG

The LB/PVG results are more mixed than for LB/PG (see Table 1 and Figure 3), an issue that is likely related to both a greater survey heterogeneity (see Supplemental Table 1) and a smaller number of published surveys. Moreover, the larger effect size is influenced by the presence of two larger cohort studies (see Table 1; Drummond et al., 2020a; Zendle, 2019a) – although one of these studies was conducted with a nationally representative sample (Zendle, 2019a). Furthermore, another ($n=1508$) survey with mixed results (Von Meduna et al., 2019) was excluded from our analysis, because it was not possible to produce an *r* statistic from unadjusted (regression) coefficients using available methods (Gilpin, 1993; Lenhard and Lenhard, 2016; Lin, 2020). Further LB studies (measuring PVG) are needed to confirm whether such associations are reproducibly larger than those with PG – it is important to know which of these problematic behaviours is most predictive of LB purchasing, in order to develop future interventions accordingly.

The survey with mixed results (Von Meduna et al., 2019), which used a cohort of German pay2win players, illustrates how unit of analysis (i.e. categorical vs scale data) influences results. Here, high-risk gaming (rather than gambling) was more strongly associated with the *initial decision* to purchase an LB (i.e. a binary yes/no). However, with LB *purchasing frequency*, the finding was reversed. Instead, there was no association with gaming, but there was a significant association with high-risk gambling. In other words, while problem gaming influenced the *decision* to purchase LBs, once this threshold had been crossed, PG predicted the *frequency* of purchases.

A further study of spending in Fortnite (before LBs were removed from this game; King et al., 2020), found no significant association between LB spend and gaming disorder status, and instead found that spending was driven by social influences. Conflicting with the other studies, this result (along with Von Meduna et al., 2019) highlights the context-dependent nature of relationships between LBs, gaming and gambling, mediated via the multiway interactions between these similar underlying constructs, alongside additional, external motivations (e.g. social influences).

PVG and PG

There are several possible reasons for the less consistent results for PG/PVG than LB/PG (Table 1 and Figure 3). First, some results are from limited cohorts (e.g. sexual minorities

[Broman and Håkansson, 2018] or elite athletes [Håkansson et al., 2018]), which may not be generalizable. Second, in some studies, the association between PG/PVG was of negligible magnitude after controlling for age and gender (Biegun et al., 2020; Forrest et al., 2016), or when considered alongside other factors, such as time spent gaming, gaming motivations and feelings of social alienation (Biegun et al., 2020). Such results suggest that uncontrolled, bivariate correlations may be overstating the links between video games and gambling – and in some studies reporting positive associations the effect size was small (Fu and Yu, 2015; Wood et al., 2004). In contrast, associations between LBs and PG are not substantially altered after controlling for gender and age (Brooks and Clark, 2019; Drummond et al., 2020a; Kristiansen and Severin, 2020; Li et al., 2019).

Third, these studies were even more heterogeneous than LB studies and conducted over a larger time frame. The two longitudinal studies provide a good example. In one, a study of Swedish adolescents, PVG was not a likely predictor of later PG (Vadlin et al., 2018). Conversely, a longitudinal study using a representative Norwegian cohort, established a relationship between PVG and later PG, but no evidence of the reverse relationship (Molde et al., 2019). Without further data, explaining these disparate conclusions is speculative, but may be due to the younger cohort of the Swedish sample (with limited access to gambling), or the Norwegian cohort (who had already started gambling).

Finally, in some samples, gaming and gambling may be subject to exclusivity effects. In a study of Swedish eSports enthusiasts, PVG and PG had an inverse relationship (Macey and Hamari, 2018). This may have been due to the 'dedicated' gamer cohort being more sceptical of the chance-based, uncontrolled features in games. Such exclusivity effects may explain some non-significant associations, where one Australian survey established that gambling was a generally unpopular activity among video gamers (Forrest et al., 2016). Another study established that gamers reported lower enjoyment of gambling and (contrary to gamblers) were less likely to attribute gambling wins to illusion of control or superstitious explanatory factor (King et al., 2012).

Such findings illustrate that the interactions between gaming and gambling may be operating in both asymmetrical and non-linear fashions. Heavy gaming (in certain contexts) may have exclusivity effects on gambling. More research is needed to determine whether the inverse may be true. Furthermore, these relationships may not scale linearly – that is 'dedicated' gamers and gamblers may behave differently to 'recreational' players. Here, the majority of studies with positive (or mixed) associations used either convenience or nationally representative samples (13/15), whereas studies establishing no (or negative) links between the two activities used either dedicated gamer or gambler cohorts (4/5 studies; Table 1). Such complex interactions, combined with variability in cohorts, measurement and study design, may explain the inconsistently reproduced relationships between video gaming and gambling.

LBs, PG and PVG

In an attempt to better understand the complex interactions between these behaviours, three surveys have recently investigated LB purchasing within the broader context of *both* PVG and PG (Brooks and Clark, 2019; Drummond et al., 2020a; Li et al., 2019). All three studies established significant correlations, of moderate effect size, between all three behaviours (see Table 1). Furthermore, the one pre-registered, demographically representative sample (Drummond et al., 2020a) confirmed that a combination of excessive gaming *and* PG interact additively to drive even greater increases of LB purchasing. Similarly, a path analysis (Li et al., 2019) revealed that LB purchasing was independently related to both PVG and PG severity, while also indirectly influenced by the increased gaming associated with PVG.

Other risk factors

Beyond PG, risk factors for increased LB purchasing may include male sex (Kristiansen and Severin, 2020), impulsivity – although evidence is currently weak (Zendle et al., 2019a) or negative (King et al., 2020), and gambling-related cognitions (Brooks and Clark, 2019). Furthermore, there may be an inverse relationship with age. Two surveys of adolescent LB behaviour established links with PG (Kristiansen and Severin, 2020; Zendle et al., 2019a), and in one, the link was more than twice as strong as with adults (Zendle et al., 2019a). There has been much commentary around the potential dangers of LBs for young people, who are more vulnerable (Fisher, 1993; Griffiths, 1999) and have a higher prevalence of PG (Calado et al., 2017; Forrest and McHale, 2018; Splevins et al., 2010).

Any dangers posed by LB engagement could be a particular issue for young people to whom they are widely available (Drummond and Sauer, 2018; Zendle et al., 2019b), with around 25–40% of UK children and adolescents purchasing them (Gambling Commission, 2018; Ipsos/Gambling Commission, 2019; Royal Society for Public Health, 2019). However, with a lack of longitudinal studies, any gateway effects remain entirely hypothetical. Moreover, any associations between LB and PG may be explained by the shared structural mechanics (Gainsbury, 2019), rather than any direct causation. These potential shared mechanics might be mediated by underlying extraneous variables such as impulsivity (Cosenza et al., 2019), although further research is needed.

Conclusion

Associations between LB/PG have been repeated across a variety of cohorts, nationalities and age groups, with improving study designs (including open-science, pre-registered studies and nationally representative cohorts). While associations between LB/PVG and PG/PVG are of similar or larger magnitude, the results are more mixed. This likely reflects the greater heterogeneity of study methods. Nonetheless, the magnitude of all three associations is of statistical and practical significance (Ferguson, 2009). These relationships are often stronger than relationships between PG and well-established comorbidities, including depression ($p=.10$) and major drug problems ($r=.12$) (Feigelman et al., 1995; Zendle and Cairns, 2018), and comparable to the relationship between PG and current alcohol dependence (Welte et al., 2006).

The results suggest that PVG, PG and high LB engagement are related behaviours, comprised a mix of overlapping (*and divergent*) drivers, pathways and possible dangers. The three publications that have investigated all three behaviours highlight a complex interaction of direct and indirect effects. Furthermore, preliminary evidence has linked such associations with psychological harm, albeit a finding that is indirect (Li et al., 2019) and cautiously interpreted by Drummond et al. (2020a). Further research into downstream harms is required.

Furthermore, the cross-sectional nature of all these surveys means results are purely correlational, and there is no way to distinguish between the various alternatives. PG might drive increased LB purchasing. Alternatively, LB purchasing – via the exposure and habituation of 'gateway effects' – might lead to a higher incidence of future gambling problems. Or, perhaps more likely, the associations might be the result of bidirectional links between all these related behaviours – where, for example, we already know that there are complex relationships between gambling and other risky behaviours (Derevensky et al., 1996; Forrest and McHale, 2018).

Strengths, limitations and future research recommendations

We could not conduct more sophisticated meta-analytical approaches, due to lack of data availability (see 'Method'). Furthermore, evidence was largely correlational, and many researchers have emphasised that longitudinal studies are required (Kristiansen and Severin, 2020; Li et al., 2019; Zendle and Cairns, 2019). However, gateway effects are difficult to prove, even with longitudinal studies: temporality, just like correlation, does not prove causation (Kandel, 2002). Complex, dynamic processes drive interactions between gaming and gambling. Future studies will need to control for demographic, psychological, gambling, and gaming profiles and utilise open science approaches, validated scales and agreed standards for measuring LB engagement. Studies with representative samples should investigate influences on wellbeing, financial harms and long-term outcomes (Li et al., 2019; Zendle, 2019a), especially in children and adolescents. At present, only six studies have investigated LB/PVG; and only three have investigated LB/PG/PVG. Surveys including all three constructs are required, along with attention to units of analysis and cohorts. Such steps may allow future research to confirm potential explanations of the existing data. For example, it may be that (a) while PVG drives the *initial decision* to purchase LBs, PG drives the *level of engagement* and (b) that there are exclusivity effects in 'dedicated' gamer cohorts, rendering them less liable to PG. Future studies should allow for a clearer understanding of these processes, while unpicking some of the inconsistencies in the literature.

Some limitations of survey data could be overcome with other research methods, including lab-based experimental work, objective records of expenditure and qualitative research. For example, extended qualitative interviews would enable exploration of gamers' perceptions of the gaming/gambling interface, along with perceptions of causality and mechanisms of impact, and exploration of meanings of value beyond current legal standards of 'money's worth' (Digital, Culture, Media and Sport Committee, 2019).

Finally, LBs represent only one category of game monetisation, alongside items including downloadable content, season passes, events, skins and weapons. Other forms of gaming–gambling convergence overlap with this monetisation ecosystem (e.g. in-game casinos, eSports betting, crypto-games and game-related wagering).

Policy implications

Numerous academic researchers (Drummond et al., 2019; Zendle et al., 2019a), public organisations (Office of the Children's Commissioner, 2019; Royal Society for Public Health, 2019), charities (A Parent Zone Report, 2019) and even senior games developers (Perez, 2020) have called for industry and government action on LBs. Responses have included legislation in Belgium, The Netherlands and Denmark, with several other nations (including the United Kingdom, Australia, Sweden and the United States) now also proposing legislation (McCaffrey, 2019). Our findings – establishing reproducible links between LB purchasing, and both PG *and* PVG – suggest that such policy may be warranted for harm minimisation purposes. While the cross-sectional nature of the evidence means that directions of causality cannot be established, from the perspectives of harm minimisation, such questions are something of a moot point: either LBs *cause* PG, or at-risk individuals (such as problem gamblers and gamers) are more *engaged* with LBs. Either way, policy action may have utility for harm minimisation.

This policy need not extend to offline 'lucky dip' activities; where there is evidence to distinguish LBs from the traditional 'surprise mechanics' of Kinder Eggs or trading card games. One study investigating players of an offline collectible card game, for example, could not reproduce any associations with PG (Zendle et al., 2021), suggesting that LBs qualitatively differ from these traditional contexts. These differences include the greater scale, scope, availability and technological sophistication of LBs (Zendle et al., 2021), leading to a 'continuous play' effect that is not seen with traditional 'surprise' games. Policy on LBs need not extend to all offline activities.

LBs, represent the most obvious face of an increasing convergence of gambling and gaming (Derevensky and Griffiths, 2019; Johnson and Brock, 2019). For example, an analysis of patents (King et al., 2019) has revealed that some game designers are engaging in practices that specifically target psychological tendencies with so-called 'dark-nudges' (Ekre, 2015; Harris, 2016; Hodent, 2019; Jernström, 2016), and players can also be manipulated in ways that would be considered illegal in the context of traditional gambling (King and Delfabbro, 2018; King et al., 2019). In the dynamic and rapidly evolving world of video games – and with large financial incentives for potentially unscrupulous developers – any legislation against LBs is in danger of quickly being rendered anachronistic. Long-term mitigation of risk will require provisions for ongoing research, development of child-focused data protection (such as the Information Commissioner's Office [ICO, 2020] 'Age Appropriate Design Code') and, finally, educational approaches designed to curb the exploitation of psychological nudges and biases (A Parent Zone Report, 2019; King and Delfabbro, 2018).

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding [GQ: 2]

The author(s) disclosed receipt of the following financial support for the research, authorship and/or publication of this article: This work was supported by funding from the charity GambleAware, with J.C. being further supported by the National Institute for Health Research (NIHR) Applied Research Collaboration (ARC), South West Peninsula.

ORCID iDs [GQ: 3]

Stuart Gordon Spicer https://orcid.org/0000-0001-7585-8886

Laura Louise Nicklin https://orcid.org/0000-0002-6195-9501

Joanne Lloyd https://orcid.org/0000-0003-3891-7247

Supplemental material

Supplemental material for this article is available online.

References

A Parent Zone Report (2019) The rip-off games: how the new business model of online gaming exploits children. A Parent Zone Report. Available at: https://parentzone.org.uk/system/files/attachments/The%20Ripoff%20Games%20-%20Parent%20Zone%20report.pdf

Aarseth E, Bean AM, Boonen H, et al. (2017) Scholars' open debate paper on the World Health Organization ICD-11 Gaming Disorder proposal. *Journal of Behavioral Addictions* 6(3): 267–270.

Abarbanel B and Macey J (2019) VGO, NFT, OMG! Commentary on continued developments in skins wagering. *Gaming Law Review* 23(1): 23–25.

Allan D (2018) Loot box controversy deepens on both sides of the Atlantic. Available at: https://www.techradar.com/news/loot-box-controversy-deepens-on-both-sides-of-the-atlantic (accessed 18 January 2021).

American Psychiatric Association (APA) (2013) *Diagnostic and Statistical Manual of Mental Disorders (DSM-5®)*. Washington, DC: APA.

Biegun J, Edgerton JD and Roberts LW (2020) Measuring problem online video gaming and its association with problem gambling and suspected motivational, mental health, and behavioral risk factors in a sample of university students. *Games and Culture* 16: 434–456.

Brady A and Prentice G (2021) Are loot boxes addictive? Analyzing participant's physiological arousal while opening a loot box. *Games and Culture* 16: 419–433.

Broman N and Håkansson A (2018) Problematic gaming and internet use but not gambling may be overrepresented in sexual minorities – a pilot population web survey study. *Frontiers in Psychology* 9: 2184.

Brooks GA and Clark L (2019) Associations between loot box use, problematic gaming and gambling, and gambling-related cognitions. *Addictive Behaviors* 96: 26–34.

Calado F, Alexandre J and Griffiths MD (2017) Prevalence of adolescent problem gambling: a systematic review of recent research. *Journal of Gambling Studies* 33(2): 397–424.

Cosenza M, Ciccarelli M and Nigro G (2019) The steamy mirror of adolescent gamblers: mentalization, impulsivity, and time horizon. *Addictive Behaviors* 89: 156–162.

Delfabbro P, King D, Lambos C, et al. (2009) Is video-game playing a risk factor for pathological gambling in Australian adolescents? *Journal of Gambling Studies* 25(3): 391–405.

Derevensky JL and Griffiths MD (2019) Convergence between gambling and gaming: does the gambling and gaming industry have a responsibility in protecting the consumer? *Gaming Law Review* 23(9): 633–639.

Derevensky JL, Gupta R and Della Cioppa G (1996) A developmental perspective of gambling behavior in children and adolescents. *Journal of Gambling Studies* 12(1): 49–66.

Digital, Culture, Media and Sport Committee (2019) Digital, Culture, Media and Sport Committee report on immersive and addictive technologies. House of Commons. Available at: https://www.parliament.uk/business/committees/committees-a-z/commons-select/digital-culture-media-and-sport-committee/inquiries/parliament-2017/immersive-technologies/[AQ: 8]

Drummond A and Sauer JD (2018) Video game loot boxes are psychologically akin to gambling. *Nature Human Behaviour* 2(8): 530–532.

Drummond A, Sauer JD and Hall LC (2019) Loot box limit-setting: a potential policy to protect video game users with gambling problems? *Addiction* 114(5): 935–936.

Drummond A, Sauer JD, Ferguson CJ, et al. (2020a) The relationship between problem gambling, excessive gaming, psychological distress and spending on loot boxes in Aotearoa New Zealand, Australia, and the United States – a cross-national survey. *PLoS One* 15(3): e0230378.[AQ: 9]

Drummond A, Sauer JD, Hall LC, et al. (2020b) Why loot boxes could be regulated as gambling. *Nature Human Behaviour* 4: 986–988.

Ekre EA (2015) The whales of microtransactions, and the elephant in the room. *Model View Culture*, 24 November. Available at: https://modelviewculture.com/pieces/the-whales-of-microtransactions-and-the-elephant-in-the-room

Feigelman W, Kleinman PH, Lesieur HR, et al. (1995) Pathological gambling among methadone patients. *Drug and Alcohol Dependence* 39(2): 75–81.

Ferguson CJ (2009) An effect size primer: a guide for clinicians and researchers. *Professional Psychology: Research and Practice* 40(5): 532–538.

Field AP and Gillett R (2010) How to do a meta-analysis. *British Journal of Mathematical & Statistical Psychology* 63(3): 665–694.

Fisher S (1993) Gambling and pathological gambling in adolescents. *Journal of Gambling Studies* 9(3): 277–288.

Ford M and Håkansson A (2020) Problem gambling, associations with comorbid health conditions, substance use, and behavioural addictions: opportunities for pathways to treatment. *PLoS One* 15(1): e0227644.

Forrest CJ, King DL and Delfabbro PH (2016) The gambling preferences and behaviors of a community sample of Australian regular video game players. *Journal of Gambling Studies* 32(2): 409–420.

Forrest D and McHale I (2018) *Gambling and Problem Gambling among Young Adults: Insights From A Longitudinal Study of Parents and Children*. University of Liverpool. Available at: https://about.gambleaware.org/media/1799/gambling-and-problem-gambling-among-young-adults-revision-10818-final-publish-002.pdf

Fu W and Yu CKC (2015) Predicting disordered gambling with illusory control, gaming preferences, and internet gaming addiction among Chinese youth. *International Journal of Mental Health and Addiction* 13(3): 391–401.

Gainsbury SM (2019) Gaming-gambling convergence: research, regulation, and reactions. *Gaming Law Review* 23(2): 80–83.

Gainsbury SM, Russell AMT, King DL, et al. (2016) Migration from social casino games to gambling: motivations and characteristics of gamers who gamble. *Computers in Human Behavior* 63: 59–67.

Gambling Commission (2018) *Young People and Gambling 2018 A Research Study among 11-16 Year Olds in Great Britain*. Birmingham: Gambling Commission.

Gilpin AR (1993) Table for conversion of Kendall's Tau to Spearman's Rho within the context of measures of magnitude of effect for meta-analysis. *Educational and Psychological Measurement* 53(1): 87–92.

Griffiths M (1999) Gambling technologies: prospects for problem gambling. *Journal of Gambling Studies* 15(3): 265–283.

Gupta R and Derevensky JL (1996) The relationship between gambling and video-game playing behavior in children and adolescents. *Journal of Gambling Studies* 12(4): 375–394.

Håkansson A, Kenttä G and Åkesdotter C (2018) Problem gambling and gaming in elite athletes. *Addictive Behaviors Reports* 8: 79–84.

Harris T (2016) *How Technology Is Hijacking Your Mind – From a Magician and Google Design Ethicist*. Available at: https://medium.com/thrive-global/how-technology-hijacks-peoples-minds-from-a-magician-and-google-s-design-ethicist-56d62ef5edf3#.ukiczwwqd

Hodent C (2019) Ethics in the videogame industry: a mythbusting and scientific approach. Available at: https://celiahodent.com/ethics-in-the-videogame-industry/

Hong QN, Fàbregues S, Bartlett G, et al. (2018) The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for Information* 34(4): 285–291.

Information Commissioner's Office (ICO) (2020) *Age Appropriate Design: A Code of Practice for Online Services*. ICO. Available at: https://ico.org.uk/for-organisations/guide-to-data-protection/key-data-protection-themes/age-appropriate-design-a-code-of-practice-for-online-services/ (accessed 14 January 2021).

Ipsos/Gambling Commission (2019) *Young People and Gambling Survey 2019: A Research Study among 11-16 Year Olds in Great Britain*. Ipsos/Gambling Commission. Available at: https://www.gamblingcommission.gov.uk/PDF/Young-People-Gambling-Report-2019.pdf**[AQ: 10]**

Jernström T (2016) *Let's Go Whaling: Tricks for Monetising Mobile Game Players with Free-to-Play*. Helsinki. Available at: https://www.youtube.com/watch?v=xNjI03CGkb4

Jiménez-Murcia S, Fernández-Aranda F, Granero R, et al. (2014) Video game addiction in gambling disorder: clinical, psychopathological, and personality correlates. *Biomed Research International* 2014: 315062.

Johnson MR and Brock T (2019) What do game developers think about loot boxes? Available at: http://www.digra.org/digital-library/publications/what-do-game-developers-think-about-loot-boxes/

Kandel DB (ed.) (2002) *Stages and Pathways of Drug Involvement: Examining the Gateway Hypothesis*. Cambridge; New York: Cambridge University Press.

Kaneko Y, Yada K, Ihara W, et al. (2018) How game users consume virtual currency: the relationship between consumed quantity, inventory, and elapsed time since last consumption in the mobile game world. In: *Proceedings of the IEEE international conference on data mining workshops (ICDMW'2018)*, Singapore, 17–20 November, pp. 848–855. New York: IEEE.

Karlsson J, Broman N and Håkansson A (2019) Associations between problematic gambling, gaming, and internet use: a cross-sectional population survey. *Journal of Addiction* 2019: 1464858.

Kim HS, Wohl MJA, Salmon MM, et al. (2015) Do social casino gamers migrate to online gambling? An assessment of migration rate and potential predictors. *Journal of Gambling Studies* 31(4): 1819–1831.

King DL and Delfabbro PH (2018) Predatory monetization schemes in video games (e.g. 'loot boxes') and internet gaming disorder. *Addiction* 113(11): 1967–1969.

King DL, Delfabbro PH, Gainsbury SM, et al. (2019) Unfair play? Video games as exploitative monetized services: an examination of game patents from a consumer protection perspective. *Computers in Human Behavior* 101: 131–143.

King DL, Ejova A and Delfabbro PH (2012) Illusory control, gambling, and video gaming: an investigation of regular gamblers and video game players. *Journal of Gambling Studies* 28(3): 421–435.

King DL, Gainsbury SM, Delfabbro PH, et al. (2015) Distinguishing between gaming and gambling activities in addiction research. *Journal of Behavioral Addictions* 4(4): 215–220.

King DL, Russell AMT, Delfabbro PH, et al. (2020) *Fortnite* microtransaction spending was associated with peers' purchasing behaviors but not gaming disorder symptoms. *Addictive Behaviors* 104: 106311.

Koeder MJ, Tanaka E and Mitomo H (2018) 'Lootboxes' in digital games – a gamble with consumers in need of regulation? An evaluation based on learnings from Japan. In: *Proceedings of the 22nd biennial conference of the International Telecommunications Society (ITS): 'beyond the boundaries: challenges for business, policy and society'*, Seoul, South Korea, 24–27 June.

Kristiansen S and Severin MC (2019) Exploring groups of simulated gambling behaviour: a typological study among Danish adolescents. *International Gambling Studies* 20: 135–150.

Kristiansen S and Severin MC (2020) Loot box engagement and problem gambling among adolescent gamers: findings from a national survey. *Addictive Behaviors* 103: 106254.

Kuss DJ, Griffiths MD and Pontes HM (2017) DSM-5 diagnosis of Internet Gaming Disorder: some ways forward in overcoming issues and concerns in the gaming studies field: response to the commentaries. *Journal of Behavioral Addictions* 6(2): 133–141.

Ladouceur R and Dubé D (1995) Prevalence of pathological gambling and associated problems in individuals who visit non-gambling video arcades. *Journal of Gambling Studies* 11(4): 361–365.

Lain R and Brown F (1989) Gaming, gambling, risk taking, addictions and a developmental model of a pathology of man-machine relationships. In: Klabbers JHG, Scheper WJ, Takkenberg CA, et al. (eds) *Simulation-Gaming*. Amsterdam: Elsevier, p. 368.

Larche CJ, Chini K, Lee C, et al. (2019) Rare loot box rewards trigger larger arousal and reward responses, and greater urge to open more loot boxes. *Journal of Gambling Studies* 37: 141–163.

Lenhard W and Lenhard A (2016) *Calculation of Effect Sizes*. Dettelbach. Available at: https://www.psychometrica.de/effect_size.html

Li W, Mills D and Nower L (2019) The relationship of loot box purchases to problem video gaming and problem gambling. *Addictive Behaviors* 97: 27–34.

Lin H (2020) *Effect Size Converter*. HTML. Available at: https://github.com/hauselin/esconvert (accessed 27 November 2020).

McBride J and Derevensky JL (2016) Gambling and video game playing among youth. *Journal of Gambling Issues* 34: 156–178.

McCaffrey M (2019) The macro problem of microtransactions: the self-regulatory challenges of video game loot boxes. *Business Horizons* 62(4): 483–495.

Macey J and Hamari J (2018) Investigating relationships between video gaming, spectating esports, and gambling. *Computers in Human Behavior* 80: 344–353.

Macey J and Hamari J (2019a) eSports, skins and loot boxes: participants, practices and problematic behaviour associated with emergent forms of gambling. *New Media & Society* 21(1): 20–41.

Macey J and Hamari J (2019b) The games we play: relationships between game genre, business model and loot box opening. In: *Proceedings of the 3rd international GamiFIN conference (GamiFIN'2019)*, Levi, 8–10 April.

Mills DJ, Marchica L, Keough MT, et al. (2020) Exploring differences in substance use among emerging adults at-risk for problem gambling, and/or problem video gaming. *International Gambling Studies* 20: 539–555.

Moher D, Liberati A, Tetzlaff J, et al. (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ* 339: b2535.

Molde H, Holmøy B, Merkesdal AG, et al. (2019) Are video games a gateway to gambling? a longitudinal study based on a representative Norwegian sample. *Journal of Gambling Studies* 35(2): 545–557.

Office of the Children's Commissioner (2019) *Gaming the System*. London: Office of the Children's Commissioner.

Perez M (2020) 'Fortnite' billionaire Tim Sweeney: keep game companies out of politics. *Forbes*, 12 February. Available at: https://www.forbes.com/sites/mattperez/2020/02/12/fortnite-billionaire-tim-sweeney-keep-game-companies-out-of-politics/

Raylu N and Oei TPS (2004) The Gambling Related Cognitions Scale (GRCS): development, confirmatory factor validation and psychometric properties. *Addiction* 99(6): 757–769.

Royal Society for Public Health (2019) *Skins in the Game: A High-Stakes Relationship Between Gambling and Young People's Health and Wellbeing?* London: Royal Society for Public Health.

Scholten OJ, Hughes NGJ, Deterding S, et al. (2019) Ethereum crypto-games: mechanics, prevalence, and gambling similarities. In: *Proceedings of the annual symposium on computer-human interaction in play*, Barcelona, 22 October, pp. 379–389. New York: ACM.

Seo Y, Jung Y, Sng J, et al. (2019) Rational or irrational decision? Examination on gamers' intention to purchase probability-type items. *Interacting with Computers* 31: 603–641.

Shibuya A, Teramoto M, Shoun A, et al. (2019) Long-term effects of in-game purchases and event game mechanics on young mobile social game players in Japan. *Simulation & Gaming* 50(1): 76–92.

Splevins K, Mireskandari S, Clayton K, et al. (2010) Prevalence of adolescent problem gambling, related harms and help-seeking behaviours among an Australian population. *Journal of Gambling Studies* 26(2): 189–204.

Vadlin S, Åslund C and Nilsson KW (2018) A longitudinal study of the individual- and group-level problematic gaming and associations with problem gambling among Swedish adolescents. *Brain and Behavior* 8(4): e00949.

Von Meduna M, Steinmetz F, Ante L, et al. (2019) *Loot boxes – a game changer?* Work paper series no. 2, March, pp. 1–14. Hamburg: Gambling Research Division, Universität Hamburg.[AQ: 11]

Von Meduna M, Steinmetz F, Ante L, et al. (2020) Loot boxes are gambling-like elements in video games with harmful potential: results from a large-scale population survey. *Technology in Society* 63: 101395.

Walther B, Morgenstern M and Hanewinkel R (2012) Co-occurrence of addictive behaviours: personality factors related to substance use, gambling and computer gaming. *European Addiction Research* 18(4): 167–174.

Wardle H and Zendle D (2021) Loot boxes, gambling, and problem gambling among young people: results from a cross-sectional online survey. *Cyberpsychology, Behavior, and Social Networking* 24: 267–274.

Welte JW, Wieczorek WF, Barnes GM, et al. (2006) Multiple risk factors for frequent and problem gambling: individual, social, and ecological. *Journal of Applied Social Psychology* 36(6): 1548–1568.

Wood RTA, Gupta R, Derevensky JL, et al. (2004) Video game playing and gambling in adolescents: common risk factors. *Journal of Child & Adolescent Substance Abuse* 14(1): 77–100.

World Health Organization (WHO) (2018) International classification of diseases for mortality and morbidity statistics (ICD-11 MMS, 11th revision). Available at: https://icd.who.int/browse11/l-m/en (accessed 27 November 2020).

Zendle D (2019a) Gambling-like video game practices: links with problem gambling and disordered gaming in a nationally representative sample. Available at: https://doi.org/10.31234/osf.io/fh3vx

Zendle D (2019b) Problem gamblers spend less money when loot boxes are removed from a game: a before and after study of *Heroes of the Storm*. *PeerJ* 7: e7700.

Zendle D and Cairns P (2018) Video game loot boxes are linked to problem gambling: results of a large-scale survey. *PLoS One* 13(11): e0206767.

Zendle D and Cairns P (2019) Loot boxes are again linked to problem gambling: results of a replication study. *PLoS One* 14(3): e0213194.

Zendle D, Cairns P, Barnett H, et al. (2020a) Paying for loot boxes is linked to problem gambling, regardless of specific features like cash-out and pay-to-win. *Computers in Human Behavior* 102: 181–191.**[AQ: 12]**

Zendle D, Meyer R and Over H (2019a) Adolescents and loot boxes: links with problem gambling and motivations for purchase. *Royal Society Open Science* 6(6): 190049.**[AQ: 13]**

Zendle D, Meyer R, Cairns P, et al. (2020b) The prevalence of loot boxes in mobile and desktop games. *Addiction* 115: 1768–1772.

Zendle D, Meyer R, Waters S, et al. (2019b) The prevalence of loot boxes means that content descriptors are just as important as limit setting when it comes to minimising potential harm: a reply to Drummond et al. Unpublished working paper. Available at: https://psyarxiv.com/pnq6x/download/?format=pdf#:~:text=Page%201-,The%20prevalence%20of%20loot%20boxes%20means%20that%20content%20descriptors%20are,reply%20to%20Drummond%20et%20al.&text=Loot%20boxes%20are%20items%20in,provide%20players%20with%20randomised**[AQ: 14]**

Zendle D, Walasek L, Cairns P, et al. (2021) Links between problem gambling and spending on booster packs in collectible card games: a conceptual replication of research on loot boxes. *PLoS One* 16: e0247855.

Author biographies

[AQ: 15]