Exploring the association between loot boxes and problem gambling: are video gamers referring to loot boxes when they complete gambling screening tools?

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Abstract

Concerns regarding the similarities between video game 'loot boxes' and gambling have been supported by correlations in survey studies between loot box engagement and problem gambling scores. It is generally noted that this correlation could reflect loot box users migrating to conventional gambling, and/or people with gambling problems being attracted to loot boxes when they play video games. We describe a third possibility, that when gamers complete problem gambling screens they may be referring to harms incurred from their loot box use. Using three secondary datasets from cross-sectional online surveys, we explore this account in two ways. First, in participants who do not endorse any participation in conventional forms of gambling, we compare rates of positive (i.e. non-zero) scores on the Problem Gambling Severity Index (PGSI) in participants with and without loot box use. Second, noting that some PGSI items have less relevance to loot box use versus gambling, we compare endorsement rates of individual PGSI items, in gamers versus gamblers, and loot box users vs non-loot box users (focusing on item 3 "going back another day to win back the money you lost"). In analysis 1, positive PGSI scorers among non-gamblers were significantly elevated in loot box users vs non-loot box users, although absolute numbers were low overall. In analysis 2, there were no reliable differences (gamers vs gamblers, loot box users vs non-loot box users) in PGSI item 3 endorsement rates. We conclude that these results provide partial support for this third option, and highlight a need for future studies to consider this possibility more directly.

Keywords: video gaming; monetization; chasing; gambling disorder; financial harms; psychometrics.

Introduction

Loot boxes are a form of video game monetization that have raised controversy in recent years due in part to their similarities with traditional gambling (Drummond & Sauer, 2018; King & Delfabbro, 2018). Definitions of gambling focus on three elements: 1) the stake, 2) the element of chance, and 3) the prize that the player has a prospect of winning (Abarbanel, 2018; Reber, 2012). In the case of loot boxes, video gamers can spend in-game or real currency to open a virtual container, holding a randomized prize. These prizes vary in value from common items to rare 'legendary' items. The average market value of these prizes is lower than the typical cost of loot boxes, indicating both the monetary 'worth' of these virtual items and a 'house edge' that is characteristic of commercial gambling (Drummond, Sauer, Hall, Zendle, & Loudon, 2020). From these similarities, researchers have argued that loot boxes are psychologically akin to gambling and constitute a form of 'predatory monetization' (King & Delfabbro, 2018).

A key piece of evidence substantiating these concerns comes from cross-sectional surveys, reporting positive correlations between loot box engagement (e.g. monthly spending on loot boxes) and indices of problem gambling (e.g. Problem Gambling Severity Index, PGSI). A sample (n = 7,422) of adult gamers recruited via the online forum Reddit showed a correlation between loot box spending and PGSI scores (Zendle & Cairns, 2018), and this finding was replicated in several subsequent studies (Brooks & Clark, 2019; Li, Mills, & Nower, 2019; von Meduna, Steinmetz, Ante, Reynolds, & Fiedler, 2020). Similar effects are observed in adolescent

samples (Kristiansen & Severin, 2020; Zendle, Meyer, & Over, 2019), with disordered gaming (Zendle, 2020), and with ratings of harmful use on a risky loot-box index (Brooks & Clark, 2019). The bivariate relationship between loot box engagement and problem gambling is supported by recent meta- and mega- analyses (Close et al., 2021; Garea, Drummond, Sauer, Hall, & Williams, 2021).

In interpreting these correlational effects, researchers have been cautious to avoid asserting causality, but the public dialogue has repeatedly highlighted two possible mechanisms (e.g. Brooks & Clark, 2019; UK DCMS, 2019; Zendle, 2019, 2020). One is that the use of loot boxes may serve as a gateway into traditional gambling, for example via youth exposure. Prospective studies have charted such 'migration' effects from social casino games to real-money gambling (Kim, Wohl, Salmon, Gupta, & Derevensky, 2015), and similar longitudinal designs are needed to examine loot box use. Direct evidence for this pathway would indicate regulatory responses such as youth age restrictions. An alternative pathway is that when people with pre-existing gambling problems use video games, they are attracted to loot box features. Zendle (2019) analyzed spending within the game "Heroes of the Storm" before and after the removal of loot boxes from the game. Participants were segregated by level of problem gambling, and the group with gambling problems showed a greater decrease in spending after the removal of loot boxes, consistent with this reverse pathway. Evidence for this mechanism would indicate a distinct regulatory response, directed at those with pre-existing gambling involvement. We note that the two pathways are neither mutually exclusive nor are they the only possible explanations for the correlation.

We note a further possibility that may contribute to the link between loot box engagement and gambling problems. Given the reliance on self-report measures of disordered gambling, what if loot box users complete the PGSI referring to harms and symptoms arising from *their loot box use*[1], rather than referring to conventional forms of gambling? Brooks & Clark (2019) reported that over two thirds of loot box users do consider loot boxes to be gambling. To be clear, if supported, this account would not diminish or undermine the importance of the correlational effect: participants in prior research are still endorsing PGSI items that indicate psychological distress and financial harm. If these harms refer directly to their loot box use, it would arguably sharpen any regulatory focus on loot boxes.

The present study sought to explore this account using two approaches. First, we reasoned that if gamers completing the PGSI are referring to their loot box use, we should see a subset of participants with positive PGSI scores who do not endorse using conventional forms of gambling, and these positive scorers should be elevated among gamers who use loot boxes compared to gamers who do not (Analysis 1). Second, we examined individual items on the PGSI (see Table 1). Some PGSI items appear to apply well to both conventional gambling and loot boxes, e.g. item 4 "Have you borrowed money or sold anything to gamble?", but certain PGSI items seem less applicable to problematic loot box use. Specifically, PGSI item 3 ("Have you ever gone back on another day to win back the money that you lost?") seems less relevant to the real-world expression of chasing in the case of loot boxes. We examined the overall

[1] As noted by a reviewer, some jurisdictions have recently moved to formally recognize loot boxes as gambling, making any distinction between loot boxes and 'conventional' gambling redundant. In the 3 datasets in the present paper (from UK and North America), loot boxes were not formally classified as gambling at the time these surveys were run, and therefore the question as to whether participants could be referring to their loot box use when they complete the PGSI represents a discrete alternative to the two pathways described in the text.

distribution of PGSI item endorsements, and specifically tested item 3 endorsement rates, between samples of gamers versus gamblers (Analysis 2a), and loot-box versus non-loot-box users (Analysis 2b).

Insert Table 1

Methods

Participants

This study used three secondary datasets (for further details, see Supplementary Materials). Dataset 1 (Brooks & Clark, 2019) comprised 144 participants recruited using Amazon Mechanical Turk (mTurk) and 116 undergraduate participants from the University of British Columbia. Pre-screening confirmed familiarity with loot boxes and prior experience playing video games; these two groups are labelled "Gamers". Attention checks were applied, where overly fast responders (< 10 minutes), inconsistent responders, and responders who endorsed fictitious gambling forms were all excluded; the Ns reported are after cleaning. In Dataset 2 (Zhang & Clark, unpublished), 2,544 participants were recruited on mTurk via a pre-screening survey that indicated past year gambling. As an unpublished dataset, this study protocol was approved by the UBC Behavioural Research Ethics Board. 89 participants were excluded due to incomplete PGSI data, and 177 for inconsistent responses regarding past-year gambling on a subsequent assessment. After these exclusions, 2,278 participants were included; this cohort is labelled "Gamblers". Dataset 3 (Zendle, 2020) is an open dataset available at OSF (https://osf.io/3jpey/), comprising a demographically representative UK sample of 1,201 individuals. This dataset had been cleaned by excluding individuals who failed any of 4 data

quality checks (see Supplementary Material; see Zendle, 2020), such that the final dataset comprised 1,081 participants.

Procedures

Problem Gambling Severity Index (PGSI) (Ferris & Wynne, 2001). The 9-item PGSI (see Table 1) is a widely-used screening instrument for gambling problems over the past 12 months, using an ordinal scale for item endorsement ("Never", "Sometimes", "Often", or "Always") that generates a total score from 0 to 27. For these analyses, we considered any response other than "Never" to be an item endorsement or 'positive PGSI score'.

Statistical Analysis

A composite, de-identified datasheet, and analysis file is available at https://gitlab.math.ubc.ca/cgr-ubc-open/sidloski_lootboxpgsi/-/tree/main .

Analysis 1: Positive PGSI scores among participants who do not endorse gambling

We identified subgroups of participants who reported no traditional gambling experience. Dataset 2 was not used for this analysis because gambling involvement was an inclusion criterion. In Dataset 1, we pooled gamers from the MTurk and undergraduate samples to maximize the number of non-gamblers for analysis. The gamers who answered "Never" to an item "Have you ever gambled?" were then subdivided based on their endorsement of having purchased loot boxes. One participant in Dataset 1 did not respond to the gambling question and was excluded from Analysis 1. In Dataset 3, participants responded to a series of items assessing frequency of involvement in 11 conventional forms of gambling: lottery tickets, scratch cards, sports betting, horse/dog race betting, playing games of skill for money, bingo (online, in

person), slot machines/EGMs (online, in person), casino table games (online, in person). Further frequency items that represented gambling-like aspects of video gaming, including token wagering, esports betting, and real-money gaming were not considered here (we note that only 4 participants endorsed these features without other forms of gambling). In Dataset 3, participants were selected if they answered either "I have never done this" or "I have done this before, but not within the past twelve months" to all 11 gambling forms. The latter response option was included for consistency with the 12-month timeframe of the PGSI. As in Dataset 1, non-gamblers in Dataset 3 were subdivided on their use of loot boxes (in the past year). In both datasets, the rates of positive PGSI scorers were compared between the subgroups who did versus did not use loot boxes using chi-square tests, with Yates's continuity correction applied given the presence of some small cell sizes.

Analysis 2: Comparing PGSI item distributions between gamers and gamblers

This analysis presents PGSI item distributions and tested for differences in the PGSI item 3 endorsement rates. Analysis 2a compares participants recruited as 'gamers' in Dataset 1 (Brooks & Clark 2019) against participants recruited as 'gamblers' in Dataset 2. As Dataset 2 was recruited using mTurk, only the mTurk sample from Dataset 1 (n = 144) was included in this comparison, to enhance demographic similarity (e.g. mean age of the mTurk gamers was 35.6, and MTurk gamblers were 37.6, compared to the Dataset 1 undergraduate sample mostly aged 19 - 21). Analysis 2b used Dataset 3 as a demographically representative UK sample; we compared PGSI item distributions between participants who did vs did not endorse loot box use (in the past twelve months).

For analysis 2a and 2b, we began by exploring the distributions for the PGSI total scores in each subgroup, given that PGSI item sensitivity is likely to vary as a function of overall problem gambling severity. There were few participants who scored PGSI 8+, as the conventional threshold for gambling problems. From inspecting the histograms (see Figure 1), we distinguished three subgroups using PGSI totals of 1-2 ('at-risk' problem gambling), 3-4 ('moderate-risk' problem gambling), and 5+ ('high risk' problem gambling) (see also Williams et al., 2021). Rates of endorsement of PGSI item 3 were compared at each of these three levels of gambling severity using chi-squared tests.

Results

Analysis 1: Positive PGSI scorers

In participants who did not endorse gambling in Dataset 1, among 38 participants who purchased loot boxes, 15 (39.5%) recorded positive scores on the PGSI. Among the non-loot box users, 7 of 30 (23.3%) recorded positive PGSI scores. This difference was not statistically significant, $\chi 2 = 1.33$, $p = .249$.

In Dataset 3, 310 of 1,081 participants (28.7%) did not endorse any past-year gambling. Among these participants, 28 (9.0%) recorded a positive PGSI score. In the subset who endorsed using loot boxes, 4 of 13 (30.8%) recorded a positive PGSI score, whereas in those who did not use loot boxes, 24 of 297 (8.1%) recorded a positive PGSI score. These rates differed significantly, $\chi 2 = 5.29$, $p = 0.021$.

In Dataset 1, few participants did not purchase loot boxes (the eligibility criteria ensured familiarity with loot boxes). We compared the rate of positive PGSI scorers among the loot box

users (without gambling involvement, n = 38) in Dataset 1 to the larger comparison group of non-loot box users (without gambling involvement, n = 297) in Dataset 3. This difference was statistically significant, $\chi 2 = 29.30$, $p < 0.001$ (see Table 2), although we note these samples were recruited using different methods and were not intended to be demographically comparable.

Insert Table 2

Analysis 2: Comparing PGSI item distributions

The distributions for the PGSI total scores in Datasets 1 and 2 were positively skewed, and the gamblers (Dataset 2) showed higher PGSI totals than the gamers (Dataset 1) (gamblers, median = 2, mean = 3.97, range 0 – 27; gamers median = 0, mean = 1.90, range 0 – 19; U = 103,888, p < .001) (see Figure 1). The PGSI totals in Dataset 3 were also positive skewed, and the loot box users showed higher PGSI totals than the non-loot-box-users (loot box users, median = 0, mean = 1.82, range 0 – 18; non-loot-box-users, median = 0, mean = 0.79, range 0 – 25; U = 32,341, p < .001).

Insert Figure 1

Analysis 2a examined the PGSI item distributions between the Gamers and the Gamblers (see Figure 2). Among participants endorsing *any* PGSI items, the most endorsed items among Gamblers were item 3 (“loss chasing”; 69.9%) and item 9 (“guilty”; 68.7%). Among Gamers, the most endorsed items were item 9 (66.7%), item 3 (55.0%), and item 1 (“bet more than you can afford”; 53.3%). At the lowest level of PGSI severity (1-2) (with the largest group sizes), the most endorsed items among Gamblers (n = 619) were again items 3 and 9, while items 4, 5, 7 and 8 were endorsed very infrequently (see Table 1). In the Gamers (PGSI 1-2, n = 27), items 1,

3 and 9 were most endorsed, and items 4, 7 and 8 were not endorsed by any participants. For comparing the item 3 endorsements, we tested *within* each PGSI bracket given the differences in the overall PGSI distribution between Gamblers and Gamers. At each level of PGSI severity, the number of participants endorsing item 3 did not differ significantly between gamblers and gamers (see Table 3).

Insert Table 3 and Figure 2

Analysis 2b examined the item distributions between the loot box users and non-loot box users in Dataset 3. Again, the most endorsed PGSI items were item 3 (57.5% of loot box users, 64.6% of non-users), item 9 (65.0% loot box users, 47.2% non-users) and item 1 (52.5% loot box users, 39.0% non-users), while items 4, 7, and 8 were least endorsed. In testing item 3 endorsement between the loot box and non-loot box users within each PGSI bracket, no significant differences were observed (see Table 4).

Insert Table 4 and Figure 3

Discussion

This study used secondary data to examine the possibility that the established relationship between loot box engagement and problem gambling (Close et al., 2021; Garea et al., 2021) could be driven, at least in part, by gamers referring to their loot box use as gambling, when they complete gambling screening instruments such as the PGSI. We explored this account in two ways. First, we looked for positive PGSI scores in participants who elsewhere denied involvement in conventional forms of gambling. Among these non-gamblers in a dataset from

Zendle (2020), the rate of positive PGSI scorers was significantly higher in those who endorsed purchasing loot boxes compared to non- loot box users, supporting the idea that these participants are directly referring to consequences from their loot box use on the PGSI. Second, we reasoned that certain PGSI items may be less applicable to loot box use than to conventional gambling forms, and specifically the PGSI chasing item (item 3). We examined item-wise endorsement rates between gamers and gamblers, and between loot box users versus non-loot box users. The general profile of most-endorsed and least-endorsed items was similar between these groups, and there were no significant differences in item 3 endorsement, which does not provide supportive evidence for our account.

In our view, the observation that *any* participants record a score on the PGSI while simultaneously denying past year gambling involvement is itself intriguing. In the nationally representative UK survey by Zendle (2020; dataset 3), 71.3% of the full sample reported some form of past-year gambling, but among the 310 participants who did not report past year gambling, 9% recorded a positive PGSI. In our view, this is unlikely to reflect careless or inattentive responding, because these datasets were already cleaned for standard attention checks. The supportive evidence that these participants may be referring directly to their loot box use on the PGSI is consistent with prior findings that most gamers do consider loot boxes to be gambling (Brooks & Clark, 2019). However, there are at least two further possibilities for the occurrence of positive PGSIs that warrant consideration. In Dataset 3, participants recorded their past year engagement with 11 specific forms of gambling, but these 11 forms were not exhaustive. Some of the positive PGSI scores in Dataset 3 may be attributable to engagement in rare (e.g. culturally-specific or emerging) forms of gambling. In Table 2, a small number of positive PGSI scores were evident among non-gamblers *and non-loot box users* that could not be

attributed to any specific activity. This explanation does not readily account for the differential rate of positive PGSIs with loot box use. Although 'breadth' of gambling (i.e. engagement across multiple gambling forms) is generally predictive of gambling problems (LaPlante, Nelson, & Gray, 2014), we see little reason to think that participants who *only* engage in rare forms of gambling (i.e. they deny participating in any conventional forms) would also use loot boxes. In Zendle (2020), rates of engagement with 4 emerging forms (e.g. esports betting) were trivially low. Lastly, the gambling engagement item in Dataset 1 (Brooks & Clark 2019) was just a single item "Have you ever gambled?" that would also capture non-standard forms of gambling. Nevertheless, we recognize that the statistical effects in Analysis 1 provide only indirect evidence that loot boxes are the activity to which participants are referring. The wider principle that (other) emerging 'gambling-like' activities (such as crypto-investing) could generate similar positive PGSI scores warrants further attention.

A second possible explanation for the positive PGSIs in ostensible 'non-gamblers' relates to the concept of 'legacy harms' (Langham et al., 2016) that negative consequences on the PGSI (referring to the past year) could reflect lingering harms after the individual has ceased actual gambling. While interesting, this account would not provide an obvious explanation for why loot box users were more likely to record positive PGSIs than non-loot box users. We also note that the positive PGSI scores in Dataset 1, in which the gambling engagement item asked "Have you *ever* gambled?" cannot be attributed to this 'legacy' explanation.

Our analysis of individual items on the PGSI showed a range of item sensitivities. Even among 'low risk' gamblers (PGSI totals of 1-2), some items are endorsed quite frequently (item 3 "loss chasing", item 9 "guilt", item 1 "bet more than can afford") while other items are endorsed rarely

or not at all (e.g. item 4 “borrowed money”). These sensitivity gradients are much in line with prior work on instrument validation (Currie, Casey, & Hodgins, 2010; Orford, Wardle, Griffiths, Sproston, & Erens, 2010; Holtgraves, 2009), where chasing is often the most endorsed diagnostic criterion (Toce-Gerstein et al., 2003). By visual inspection, PGSI item distributions were similar between gamers and gamblers, and between loot box users and non-loot box users (Figures 2 and 3). We had reasoned that the PGSI chasing item could be less applicable to loot boxes, given that the desired goal is the acquisition of an in-game prize rather than money, and that loot box ‘entrapment’ may be more likely within sessions that between sessions (O’Connor & Dickerson, 2003). However, with no significant differences in the endorsement profiles, this analysis did not provide supportive evidence that gamers (Dataset 1) or loot box users (Dataset 3) are referring to gaming-specific behaviours when they complete the PGSI. Further behavioural analysis of loot box consumption during gaming would be needed to confirm whether our assumptions about within- and between- session chasing of loot box prizes are well-founded.

Taken together, the two analyses provide partial support that gamers may refer to their loot box use when completing the PGSI, and therefore that this effect could contribute to the established relationship between loot box use and gambling problems. By this account, gamers would be referring to one and the same activity, without implying a longitudinal ‘pathway’ from one activity (e.g. loot box exposure) to the other (e.g. conventional gambling). This account is not exclusive with either of the longitudinal ‘pathways’, and given the effect size that has been described in meta-analyses of relationship between loot box use and gambling problems (Garea et al., 2021; Close et al., 2021), we consider it unlikely that our account entirely mediates the relationship. Rather, multiple drivers may be at work. We suggest our data provide sufficient grounds for future survey studies to consider this possibility directly, such as by including

frequency items for the dominant forms of gambling (Zendle, 2020) or modifying PGSI instructions to specify eligible gambling forms. Although we consider our account to be parsimonious, our evidential support is based on a small absolute number of positive PGSI scorers in Analysis 1, creating a risk of both Type 1 and Type 2 errors for our effects of interest.

The present study was prompted by the awareness that research participants, through no fault of their own, often do not complete questionnaires in the manner intended by researchers. As we have taken care to note, our account does not diminish the practical importance of the PGSI scores as an expression of harm in these participants. Put simply, if gamers are referring directly to consequences of their loot box engagement, this would both support regulatory action of loot boxes (King & Delfabbro, 2019) and strengthen the phenomenological overlap with disordered gambling (i.e. through common financial harms).

Our study has a few limitations, primarily regarding the operationalization of the two analyses within the existing datasets. As noted earlier, the assessed forms of gambling involvement, and the timeframe for assessment, both differed somewhat between Datasets 1 and 3, although to an extent these differences help shed light on some competing explanations. Second, the three datasets varied widely in sample size. Dataset 3 was the largest sample of loot box users, but loot box engagement was operationalized on a self-reported 'purchasing' question and lacked a measure of actual spending. Even among the larger sample of Dataset 3 (n = 1,081), substantial filtering of our operationalized tests led some cells to have very low cell counts, in some cases with < 5 observations. Third, in our comparisons between datasets (gamblers vs gamers for the item analysis, or the comparison of positive PGSI scores in Brooks & Clark against the non-

gamblers from Zendle 2020), these groups were not recruited with direct comparisons in mind, and there are likely to be demographic differences.

Students of psychology learn that "correlation does not mean causation", and that a range of explanations may underlie robust bivariate effects. For loot boxes, distinct causal explanations point to different regulatory responses; for example, interventions directed primarily at reducing youth exposure such as improved age verification, versus targeted interventions in people who are already involved in gambling. Survey experiments can take some concrete steps in their design to help clarify these issues, but undoubtedly there is also a need to move beyond cross-sectional surveys, in order to delineate the relationships between loot box use and gambling, and to more thoroughly characterize the new domain of financial harms associated with video-game microtransactions.

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Table 1: Problem Gambling Severity Index (PGSI)

1. Have you bet more than you could really afford to lose?
2. Still thinking about the last 12 months, have you needed to gamble with larger amounts of money to get the same feeling of excitement?
3. When you gambled, did you go back another day to try to win back the money you lost?
4. Have you borrowed money or sold anything to get money to gamble?
5. Have you felt that you might have a problem with gambling?
6. Has gambling caused you any health problems, including stress of anxiety?
7. Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?
8. Has you gambling caused any financial problems for you or your household?
9. Have you felt guilty about the way you gamble or what happens when you gamble?

Table 2: Positive (non-zero) PGSI scorers among Loot Box vs. Non-Loot Box Users, in Datasets 1 and 3

Dataset 1	PGSI > 0	PGSI = 0	
Loot Box Use: Yes	15	23	38
Loot Box Use: No	7	23	30
	23	46	$\chi^2 = 1.33$, $p = .249$

Dataset 3	PGSI > 0	PGSI = 0	
Loot Box Use: Yes	4	9	13
Loot Box Use: No	24	273	297
	28	282	$\chi^2 = 5.29$, $p = .021$

	PGSI > 0	PGSI = 0	
Loot Box Use: Yes (dataset 1)	15	23	38
Loot Box Use: No (dataset 3)	24	273	297
	39	296	$\chi^2 = 29.30$, $p < .0001$

Table 3: PGSI Item 3 endorsements in Analysis 2a: Gamers vs. Gamblers (Datasets 1 and 2)

PGSI Score: 1-2	Endorsed Item 3	Did Not Endorse Item 3	
Gamers	8	19	27
Gamblers	274	345	619
	282	364	$\chi^2 = 1.70$, $p = 0.19$
PGSI Score: 3-4	Endorsed Item 3	Did Not Endorse Item 3	
Gamers	4	5	9
Gamblers	262	105	367
	266	110	$\chi^2 = 1.92$, $p = 0.17$
PGSI Score: 5+	Endorsed Item 3	Did Not Endorse Item 3	
Gamers	21	3	24
Gamblers	664	66	730
	685	69	$\chi^2 = 0.048$, $p = 0.83$

Table 4: PGSI Item 3 endorsements in Analysis 2b: Loot Box Users vs. Non-Loot Box Users (Dataset 3)

PGSI Score: 1-2	Endorsed Item 3	Did Not Endorse Item 3	
Loot Box Use: Yes	7	11	18
Loot Box Use: No	78	72	150
	85	83	$\chi^2 = 0.64$, $p = 0.42$
PGSI Score: 3-4	Endorsed Item 3	Did Not Endorse Item 3	
Loot Box Use: Yes	7	4	11
Loot Box Use: No	43	13	56
	50	17	$\chi^2 = 0.29$, $p = 0.59$
PGSI Score: 5+	Endorsed Item 3	Did Not Endorse Item 3	
Loot Box Use: Yes	9	2	11
Loot Box Use: No	43	5	48
	52	7	$\chi^2 = 0.041$, $p = 0.84$

Figure 1: Histograms for the PGSI total score in the 4 subgroups examined in Analysis 2. For Analysis 2a, 18.8% of gamers and 27.2% of gamblers scored in the PGSI 1-2 low-risk bracket; 6.2% of gamers and 16.1% of gamblers scored in the PGSI 3-4 moderate risk bracket, and 16.7% of gamers and 32.0% of gamblers scored PGSI 5+ ('high risk'). In Analysis 2b, 21.2% of loot box users and 15.1% of non-loot box users scored PGSI 1-2; 13.1% of loot box users and 5.6% of non-users scored PGSI 3-4, and 13.1% of loot box users and 4.8% of non-users scored PGSI 5+.

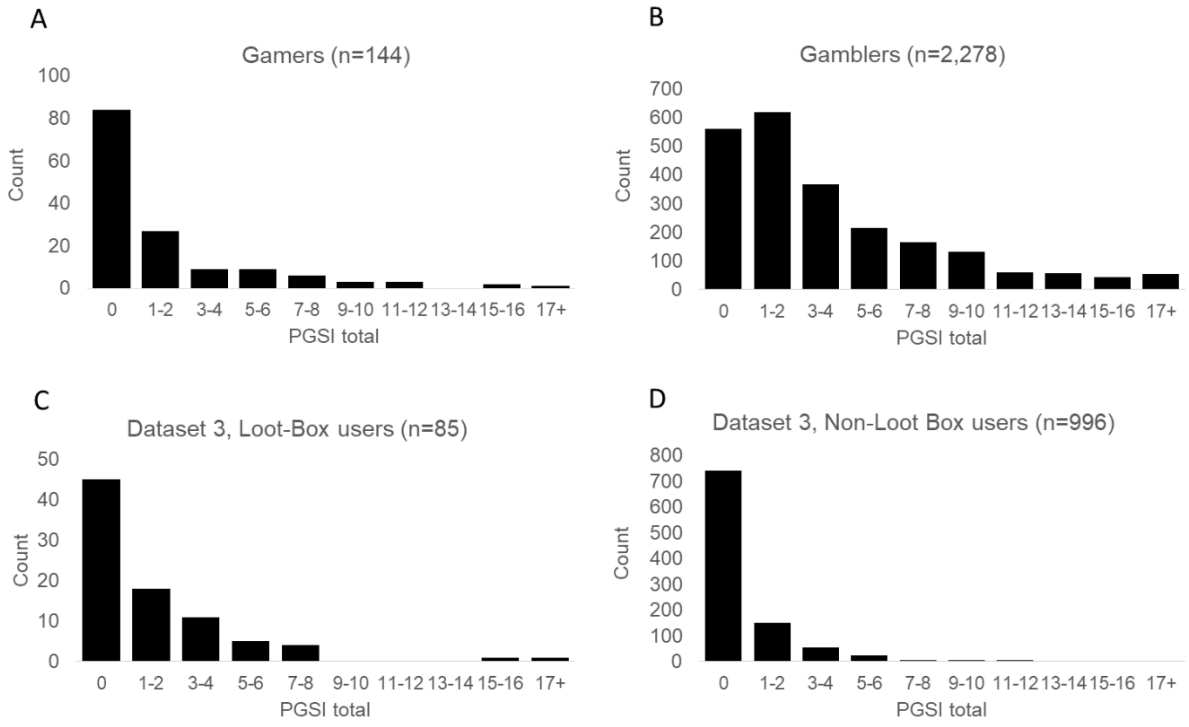


Figure 2: PGSI Item Endorsements: Gamers vs. Gamblers (Datasets 1 and 2)

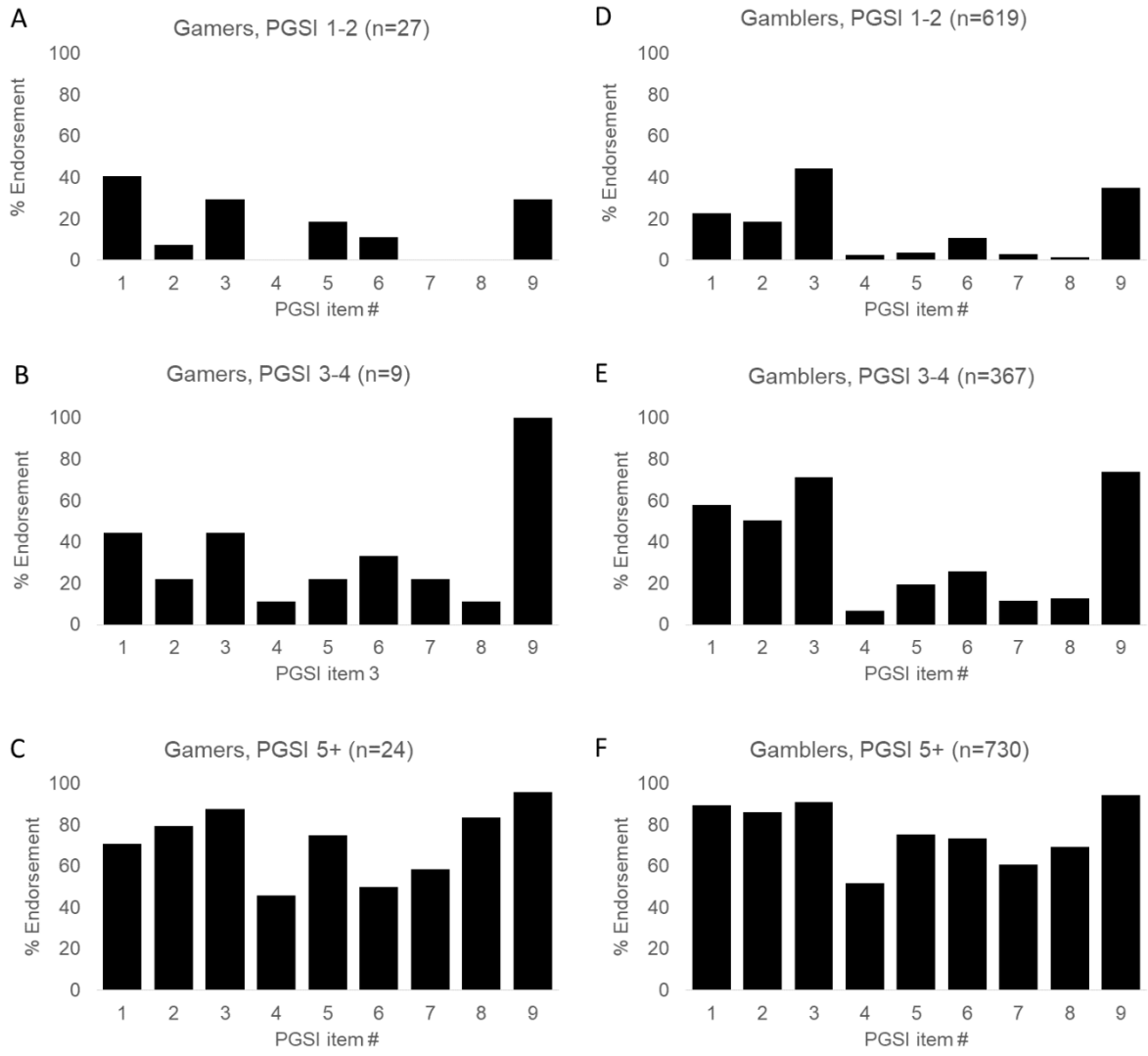
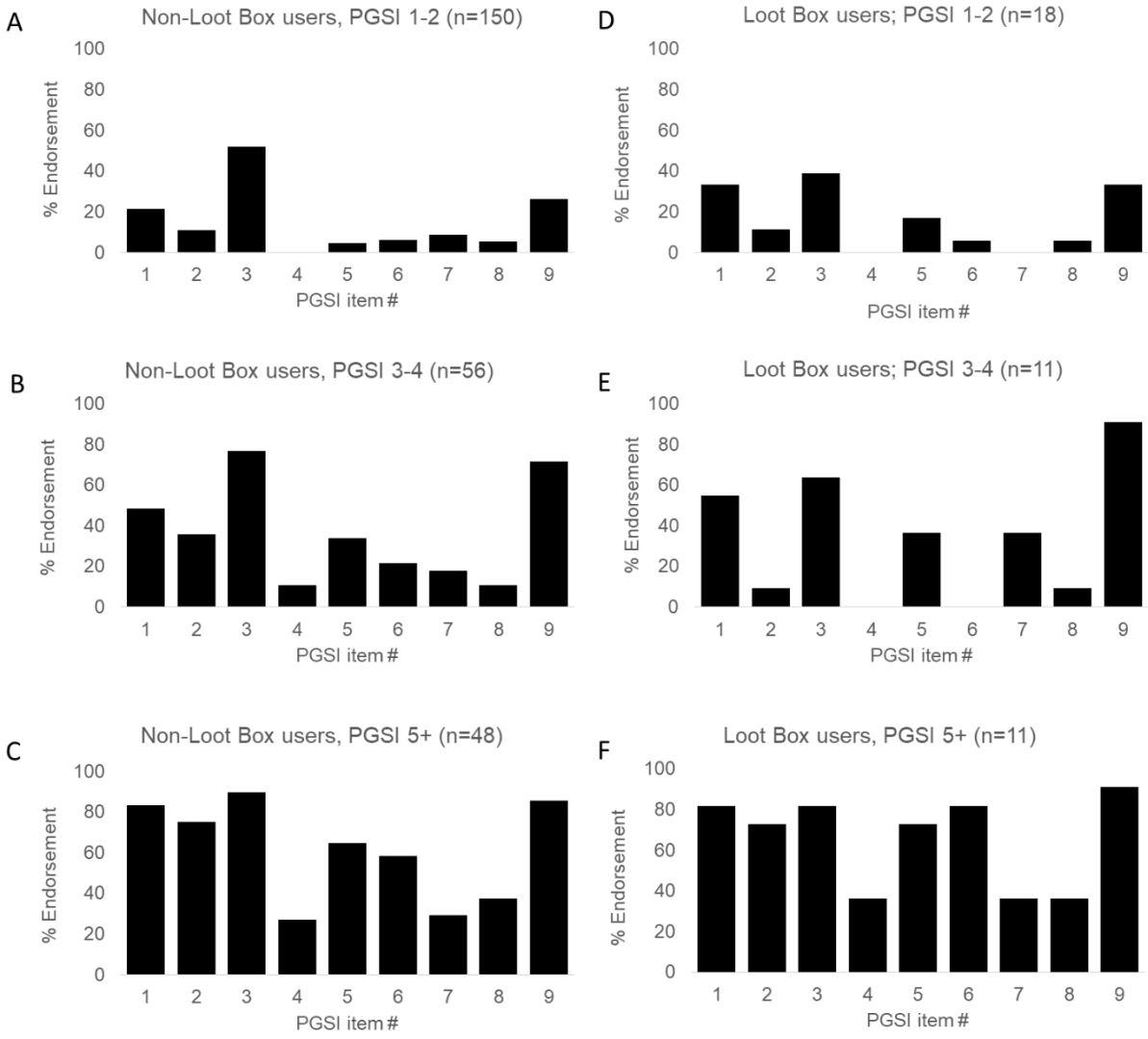


Figure 3: PGSI Item Endorsements: Loot Box Users vs. Non-Loot Box Users (Dataset 3)



Supplementary Materials for Sidloski B et al, 'Exploring the association between loot boxes and problem gambling: are video gamers referring to loot boxes when they complete gambling screening tools?'

Supplementary Methods

Dataset 1 (Brooks & Clark, 2019) comprised 144 participants recruited using Amazon Mechanical Turk (mTurk) and 116 undergraduate participants from the University of British Columbia. The mTurk data was collected in Feb - March 2018. Eligibility criteria configured in MTurk established that participants were resident in Canada or the United States and proficient in English. The university sample data was collected in March - April 2018. The title of the study used in the recruitment materials for both subsamples was *Video Games & Loot Boxes - Research Study.* For both subsamples, a short pre-screening questionnaire confirmed participants' prior experience playing video games, and familiarity with loot boxes, for eligibility. The minimum age for eligibility was 21 years old in the mTurk sample (mean = 35.6) but 19 years in the university sample (mean = 21.2), reflecting the legal minimum age for gambling in the US vs British Columbia, Canadas. The University sample also held a far greater proportion of men than women (102:14) compared to MTurk (74:70).

In Dataset 2 (Zhang & Clark, unpublished), 2,544 participants were recruited on mTurk between Feb - June 2019. Eligibility criteria configured in MTurk established that participants were resident in Canada or the United States, proficient in English, had normal or corrected to normal eyesight, minimum age 21 years (the legal minimum age in the US). A short pre-screening questionnaire established that participants had gambled in the past 12 months. The title

of the study on mTurk was *Gambling and Risk-Taking*, with the description as follows: "Answer questions regarding your gambling behaviour, demographics, and socioeconomic status, and English proficiency." From the full survey, 89 participants were excluded due to incomplete PGSI data, and 177 were excluded who displayed inconsistent responses on their past-year gambling involvement when this question was asked a second time in the main survey. The final dataset used here contained 2,278 participants. The average age (mean = 37.7 years) and gender ratio was comparable to the Dataset 1 MTurk sample, and so the Dataset 1 undergraduate sample, mostly aged 19 – 21, were excluded from Analysis 2a comparing the gamers and gamblers.

Dataset 3 (Zendle, 2020) is an open dataset available at OSF (https://osf.io/3jpey/) , comprising a demographically representative UK sample of 1,201 individuals. Data collection ran from August to September 2019 using Prolific Academic. The description of the study on Prolific was intentionally ambiguous ("In this study you will be asked to provide some demographic details, and then some information about activities that you engage in.") in order to avoid bias in respondents. The dataset was cleaned by excluding individuals who failed any of four data quality checks (two fictitious video games, and two attention checks; see Zendle, 2020), such that the final dataset comprised 1,081 participants.

Supplementary Table 1: Demographic and PGSI characteristics of the different samples

	Dataset			
	1a (mTurk, gamers)	1b (University, gamers)	2 (mTurk, Gamblers)	3 (UK survey)
Gender (men:women)	74:70	102:14	1171:1106 1 'other'	526:549 6 'other'
Age	35.6 (SD = 10.0)	21.2 (SD = 2.4)	37.7 (SD = 11.7)	44.4 (SD = 15.4)
PGSI*	1.90 (median 0, range 0 – 19)	1.24 (median 0, range 0 – 17)	3.97 (median 2, range 0 – 27)	0.87 (median 0, range 0 – 25)
Ethnicity	113 white European	41 Chinese	1751 white European	926 white
	12 Black	28 white European	189 Black	76 Asian
	3 South Asian	10 Southeast Asian	108 Latin American	38 Black
	3 Filipino	9 Korean	58 Chinese	29 mixed-race
	3 Chinese	7 South Asian	40 Southeast Asian	12 'other'
	5 'other'	13 'other'	132 'other'	

*due to skewed distribution, we also report median & range in addition to the means

Supplementary Table 2: Rates (%) of the four risk categories on the PGSI in the different datasets

	Dataset			
	1a (mTurk, gamers)	1b (University, gamers)	2 (mTurk, Gamblers)	3 (UK Survey)
No risk (0)	84 (58.3%)	65 (56%)	562 (24.7%)	787 (72.8%)
Low risk (1-2)	27 (18.8%)	30 (25.9%)	619 (27.2%)	168 (15.5%)
Moderate risk (3-4)	9 (6.25%)	13 (11.2%)	367 (16.1%)	67 (6.2%)
High risk (5+)	24 (16.7%)	8 (6.9%)	730 (32.0%)	59 (5.5%)