



# To screen, or not to screen: An experimental comparison of two methods for correlating video game loot box expenditure and problem gambling severity

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## ABSTRACT

Loot boxes are gambling-like products found in video games that players can buy with real-world money to obtain random rewards. A positive correlation between loot box spending and problem gambling severity has been well-replicated. Some researchers recently argued that this observed positive correlation may be due to participants incorrectly interpreting problem gambling questions as applying to their loot box expenditure because they see loot box purchasing as a form of 'gambling.' We experimentally tested this alternative explanation for the observed positive correlation ( $N = 2027$ ) by manipulating whether all participants were given the problem gambling scale, as the previous literature generally had done (the 'non-screening' approach;  $n = 1005$ ), or by 'screening' participants ( $n = 1022$ ) by only giving the problem gambling scale to those reporting recent gambling expenditure. Through the latter screening process, we clarified and calibrated what 'gambling' means by providing an exhaustive list of activities that should be accounted for and specifically instructed participants that loot box purchasing is *not* to be considered a form of 'gambling.' Results showed positive correlations between loot box spending and problem gambling across both experimental conditions. In addition, a predicted positive correlation emerged between binary past-year gambling participation and loot box expenditure in the screening group. These experimental results confirm that the association between loot box spending and problem gambling severity is likely *not* due to participants misinterpreting problem gambling questions as being relevant to their loot box spending. However, problem gambling severity was inflated in the non-screening group, meaning that future research on gambling-like products should include gambling participation screening questions; better define what 'gambling' means; potentially exclude non-gamblers from analysis; and, importantly, provide explicit instructions on whether certain activities should not be considered a form of 'gambling.'

## 1. Introduction

Loot boxes are virtual items in video games that provide randomised rewards (Xiao et al., 2021a, 2022a). Some loot boxes can be obtained through gameplay without payment of real-world money (Larche et al., 2022), but many loot boxes are purchased with real-world money (so-called 'paid loot boxes') Hereinafter, references to 'loot boxes' refer to 'paid loot boxes' unless otherwise specified. The randomised rewards found in loot boxes may also potentially possess varying real-world

monetary value (Drummond et al., 2020a), in addition to non-transferable in-game value (Nielsen and Grabarczyk, 2019). Loot boxes are prevalently implemented internationally to monetise video games: studies have repeatedly found that at least 50% (but likely close to 80%) of popular mobile games contain them (Xiao, 2023; Xiao et al., 2021b, 2022b, 2023a; Zendle et al., 2020, 2022). Loot boxes are arguably conceptually and structurally akin to gambling because the player pays real-world money to have a chance at obtaining randomly determined rewards with unknown and widely varying values (Drummond

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and Sauer, 2018; Nielsen and Grabarczyk, 2019; Xiao, 2021a). More than a dozen previously published studies have found that loot box purchasing is positively correlated with problem gambling severity: generally, the higher a player's self-reported problem gambling severity was, the more money that player self-reported spending on loot boxes (Brooks and Clark, 2019; Drummond et al., 2020b; González-Cabrera et al., 2021; Hall et al., 2021; Kristiansen and Severin, 2019; Li et al., 2019; Macey and Hamari, 2019; Rockloff et al., 2021; von Meduna et al., 2020; Wardle and Zendle, 2021; Zendle, 2019; Zendle, 2020; Zendle and Cairns, 2018; Zendle and Cairns, 2019; Zendle, Meyer, & Over, 2019; Zendle et al., 2019). This small-to-moderate correlation has been confirmed in a secondary analysis (Close et al., 2021) and two meta-analyses, which determined that the average value of the correlation is  $r = 0.27$  (Spicer et al., 2021) or  $r = 0.26$ , when certain unpublished studies were included (Garea et al., 2021).

Many countries around the world are considering whether to regulate loot boxes (Cerulli-Harms et al., 2020; Derrington et al., 2021; Evans, 2022; Leahy, 2022; Moshirmia, 2018; Xiao, 2021b) and, if so, how (Xiao et al., 2022c). The positive correlation between loot box purchasing and problem gambling severity, repeatedly identified by prior studies, has featured prominently in publications by policy advocacy groups (Close and Lloyd, 2021, pp. 15–16; Royal Society for Public Health, 2019, p. 10) and official policy documents, e.g., in the UK (Digital, Culture, Media and Sport Committee of the House of Commons UK, 2019, para. 82; Select Committee on the Social and Economic Impact of the Gambling Industry of the House of Lords (UK), 2020, paras. 432 & 436; Department for Digital, Culture, Media & Sport (UK), 2022, para. 11), Spain (Ministerio de Consumo Ministry of Consumer Affairs Spain, 2021; Ministerio de Consumo Ministry of Consumer Affairs Spain, 2022), and Australia (Senate Environment and Communications References Committee Australia, 2018). This indicates that this correlation has already been taken into account in both lobbying and policymaking. Reliance on this correlation to argue in favour of restricting loot box purchase reflects the interpretation originally proposed by Zendle and Cairns (2018) that a true conceptual link exists between loot boxes and traditional forms of gambling (hereinafter, the 'true association' hypothesis). This hypothesis could reflect one of several underlying causal models (Spicer et al., 2022) (for the present research it does not matter which one of these might be true).

However, the underpinning research methodology, specifically the survey design, using which that evidence on loot boxes was generated has not been sufficiently scrutinised. It is important not only to generate new results but also to evaluate the scientific process by which previous results were obtained. A recent secondary analysis of studies examining this correlation conducted by Sidloski et al. (2022) proposed an alternative interpretation. Sidloski et al. (2022) suggested that, because players perceive loot boxes as a form of 'gambling' (which is a statement that 68% and 86% of participants agreed with across two samples in Brooks and Clark (2019, p. 28)), they might therefore refer to loot box-related harms when answering the problem gambling severity self-assessment scale (e.g., the Problem Gambling Severity Index (PGSI) (Ferris and Wynne, 2001) that nearly all previous loot box studies used (e.g., Brooks and Clark, 2019; Drummond et al., 2020b; Hall et al., 2021; Li et al., 2019; Rockloff et al., 2021; Zendle, 2019; Zendle and Cairns, 2018, 2019; Zendle et al., 2019; Zendle, Meyer, & Over, 2019)). This was capable of occurring because many prior loot box studies did not provide a definition for 'gambling' nor listed activities that would or would not constitute 'gambling' for that study's purposes before asking participants about their problem gambling, as a review of the publicly shared survey materials for some of those studies have revealed (e.g., Drummond et al., 2020a; Hall et al., 2021; Zendle, 2020; Zendle, Meyer, & Over, 2019). (A comprehensive review of the survey materials of previous studies, including requesting authors to provide those that have not already been publicly shared, might prove fruitful but is beyond the ambit of this paper.) Of importance, these studies did *not* give the specific instruction that loot box purchasing should not be

considered a form of 'gambling' when answering the PGSI questions.

In support of their alternative interpretation of the correlation, Sidloski et al. (2022) identified the 'intriguing' phenomenon that a small minority of participants (9% in one particular dataset (Zendle, 2020)) *denied* past-year gambling participation but then would unexpectedly choose to *not* answer 'Never' to all PGSI questions, and therefore receive a 'positive,' non-0 PGSI score. This is even though the PGSI is assessed based on a 12-month window, meaning that people who have not engaged in gambling over that period should conceptually not experience any gambling-related harms over that window. To illustrate, when asked the question 'Have you felt that you might have a problem with gambling?,' participants might have considered a 'problem with loot box purchasing' to be a 'problem with gambling,' even though they never participated in 'traditional gambling' and therefore have never experienced a 'problem with *traditional* gambling.' Sidloski et al.'s alternative interpretation is hereinafter referred to as the 'broad interpretation hypothesis' because problem gambling has been broadly interpreted by participants to be inclusive of problematic loot box purchasing, contrary to the survey designers' intentions. According to this hypothesis, the positive correlation was produced in at least a partly mechanical way, as the loot box expenditure variable and the PGSI variable were both measuring the same thing. This is an alternative explanation for the correlation which contrasts with the true association hypothesis. Notably, Sidloski et al. (2022) also considered two other alternative explanations for this phenomenon that may have contributed to the observed effect but were deemed as less likely to be the sole or primary explanation: namely, that (i) participants were referring to 'legacy harms' (Rockloff et al., 2022) or 'lingering harms after the individual has ceased actual gambling' and (ii) participants provided nuisance responses (because attention checks were used to clean the data) (p. 5).

In nearly all loot box studies correlating loot box expenditure and PGSI score (cf. Coelho et al., 2023; Xiao et al., 2023b), the PGSI scale was given to *all* participants (hereinafter, the 'non-screening methodology'). Before presenting those problem gambling questions, no definition as to how the researchers wanted the participants to understand the concept of 'gambling' was provided, nor were the participants instructed to account for or disregard specific example activities (e.g., Drummond et al., 2020b; Hall et al., 2021; Zendle, 2020; Zendle, Meyer, & Over, 2019). This methodological choice enabled the broad interpretation issue identified by Sidloski et al. (2022) to arise. It could have been prevented had a definition or better instructions been provided (e.g., stating that purchasing loot boxes should not be viewed as a type of 'gambling'), as participants should then no longer be 'broadly interpreting' the questions (unless they fail to read the instructions or wilfully refuse to comply with them).

This non-screening methodology that was widely adopted by previous loot box studies contrasts with the standard methodology used for gambling prevalence studies, which aim to estimate the rate of gambling harms in a population (e.g., Harrison et al., 2020; Sturgis and Kuha, 2022; UK Gambling Commission, 2022a). In gambling prevalence studies, the problem gambling assessment scale is typically given *only* to participants who self-reported recent gambling participation after they answer a screening question (or at least one question in a series of them) in the affirmative, e.g., 'Did you participate in gambling, which we define as follows, in the past year?' or a series of 'Did you participate in [a certain gambling activity] in the past year?' (Sturgis and Kuha, 2022, p. 64) (hereinafter, the 'screening methodology'). A definition for 'gambling' would be provided (importantly, *before* the participant answers the problem gambling questions) either explicitly or implicitly through this process as such screening questions often at least list some examples of gambling activities that the researchers deem as constituting 'gambling.' Doing so resolves any linguistic ambiguities with how the concept of 'gambling' is understood by different people by providing a uniform definition, at least for the study's purposes.

Indeed, the original Ferris and Wayne work (2001, sec. 5) proposing

and validating the Canadian Problem Gambling Index (CPGI) contained an extended first section asking the participant about their gambling involvement before moving on to the second section consisting of the nine questions that are now termed the PGSI. The original survey instructions stated that the PGSI questions should be skipped if the respondent did not participate in gambling. Nearly all previous loot box studies have used the PGSI by delivering it to all participants regardless of their gambling participation (e.g., Brooks and Clark, 2019; Drummond et al., 2020b; Hall et al., 2021; Zendle, 2020; Zendle, Meyer, & Over, 2019; cf. Coelho et al., 2023; Xiao et al., 2023b; Xiao et al., 2024). Participants can, and should, also be specifically instructed alongside the gambling participation screening questions to *not* consider purchasing loot boxes as a form of ‘gambling’ as part of this process (and we present the results from the first time this has been done in the published literature). This approach could reduce the incidence of responses affecting the results as identified by Sidloski et al. (2022), because (i) a definition for ‘gambling’ (that should have excluded ‘purchasing loot boxes’) has been provided either explicitly or implicitly, which would calibrate how the participants and the researchers understand the concept of ‘gambling,’ and (ii) non-gambling participants would not be given the opportunity to misconstrue PGSI questions as applying to their loot box expenditure. Additionally, the screening methodology allows for non-gamblers (*i.e.*, those who did not participate in gambling in the last 12 months) and non-problem gamblers (*i.e.*, those who *did* participate in gambling in the last 12 months but did not experience any problem gambling issues) to be differentiated.

For clarity, when we refer to the ‘screening methodology,’ we mean both having screening questions or instructions about gambling participation before presenting the problem gambling scale and screening out non-gamblers from having to answer those problem gambling questions. The screening methodology, as we have defined, would also disregard any legacy harms (as participants who no longer gamble would not have any opportunity to later reflect on those through the problem gambling questions that they never get to answer) and not give participants the opportunity to answer the gambling participation questions in the negative but then later remember that they did gamble and experience harms when pressed to self-reflect more when answering the problem gambling questions (see Xiao et al., 2024, p. 7).

There are other alternative approaches to survey design. The first being to provide information about how the researchers understand ‘gambling’ *after* the problem gambling scale was already administered with no definitions for ‘gambling’ having been provided prior to that (e.g., Zendle, 2020). However, this is arguably no better than (and arguably the same as) the traditional non-screening methodology because the gambling definition has been provided too late to help participants avoid the broad interpretation issue when answering the problem gambling questions. However, this approach would be able to provide additional information about whether a participant was a gambler or not, which the non-screening methodology could not.

The second alternative approach, which is an improvement to the first, is to only include screening questions and instructions but *not* screen out the non-gamblers from having to answer the problem gambling questions. This has been done elsewhere either with a clear definition for how ‘gambling’ should be understood for the study, as was done in Xiao et al. (2024), or without one by merely asking a simple and undefined ‘Have you ever gambled?’ question, as was done in Brooks and Clark (2019), as explained in Sidloski et al. (2022, pp. 2, 5). This approach has potential and can be further manipulated by having the gambling participation screening questions provide different instructions (e.g., whether or not to explicitly exclude loot box purchasing). Xiao et al. (2024) recently used a variation of this approach by ‘screening’ all participants for gambling participation with a relatively detailed definition for ‘gambling’ (pp. 3–4) but without any explicit instructions to not consider purchasing loot boxes as a form of ‘gambling’ (p. 4) and then giving the problem gambling scale to all participants regardless: this allowed for the strength of the correlation

amongst gamblers and non-gamblers to be compared, which showed that the correlation existed but was weaker amongst non-gamblers ( $r = 0.11$ ) when compared to amongst gamblers ( $r = 0.27$ ) (p. 7). That a correlation existed at all amongst the non-gamblers at an effect size that is not negligible (see Ferguson, 2023, p. 3) (when they were *not* instructed to disregard loot box purchasing as a form of ‘gambling’) may be interpreted as potential support for the broad interpretation hypothesis (Xiao et al., 2024, p. 7). However, Xiao et al. (2024) could not determine whether that was the sole cause, or indeed even a cause, for the non-gamblers responding positively to problem gambling questions because this methodology does not allow for it. The present study sought to address that limitation using an experimental approach that has the advantage of randomisation and the ability to compare the strength of the evidence supporting either hypothesis.

Intriguingly, the contrasting true association and broad interpretation hypotheses would make alternative predictions when one considers experimentally manipulating the use of the non-screening and screening methodologies in a given sample. The broad interpretation hypothesis predicts that the association between loot box expenditure and problem gambling severity would be weakened under the screening methodology, as non-gambling participants would no longer have the opportunity to misconstrue PGSI questions as being relevant to their loot box expenditure and gambling participants would have been instructed not to take their loot box purchasing experience into account. In contrast, the true association hypothesis does not predict any such weakening. In fact, the ability of the screening methodology to differentiate between non-gamblers and non-problem gamblers (*i.e.*, those who participate in gambling but do not report relevant negative experiences) leads to a unique prediction that can help support this hypothesis in a new way, by showing a significantly higher rate of loot box expenditure amongst non-problem gamblers than non-gamblers. This is because if there is a conceptual link between loot boxes and gambling, then it may well be expected for non-problem gamblers to be more interested in loot boxes than non-gamblers.

To our knowledge, prior to the data collection for the present study, only two previous loot box studies screened participants for gambling participation and then exclusively asked self-identified gamblers to complete the problem gambling scale: Coelho et al. (2023) and Xiao et al.’s study in Mainland China (2023b). Coelho et al. (2023) artificially gave all non-gamblers a 0 score on the problem gambling scale and then shifted the problem gambling scores of gamblers up by 1 (meaning that a gambler who scored 0 would have received 1 as a minimum) (p. 262). Xiao et al. (2023b) used the screening methodology and found support for the aforementioned new prediction stemming from the true association hypothesis, by showing that non-problem gamblers spent more money on loot boxes than non-gamblers (p. 654). Furthermore, the screening methodology allowed Xiao et al. (2023b) to identify a surprisingly low gambling participation rate of 9.9% (compared to international rates of 40–60% (Calado and Griffiths, 2016)), which may have in part explained why that study did not find a statistically significant association between loot box expenditure and problem gambling severity (pp. 652, 657–658). This information would not have been available had the non-screening methodology been used. Indeed, another possible explanation for that extremely low gambling participation rate is how Chinese participants might have understood ‘gambling’ differently due to cultural reasons (e.g., the stigma attached with labelling an activity as ‘gambling’ (Zeng and Zhang, 2007, p. 267) causing fewer people to consider activities involving chance like purchasing loot boxes to be a form of gambling). In some languages, such as German and Danish, ‘gaming’ and ‘gambling’ are described using the same word so the delicate distinction might be understood inconsistently by different people. These cultural considerations mean that, unless explicitly instructed, the percentage of participants from different backgrounds who might consider loot boxes to be a form of gambling might vary greatly.

An experimental comparison between the non-screening

methodology and the screening methodology was therefore conducted to test whether the original Zendle and Cairns' true association hypothesis (2018) or whether Sidloski et al.'s broad interpretation hypothesis (2022) is more consistent with the evidence accumulated to date. The present study is one of the few to challenge the *status quo* of loot box research by experimentally manipulating the underlying research design and method. We sought to detect whether previous research designs may have introduced noise into the results and provide evidence on the reliability of prior results.

### 1.1. Research questions

This research was conducted in order to address the following research questions:

**Research Question 1.** Is there an association between PGSI and loot box expenditure in the non-screening methodology?

**Research Question 2.** In the screening methodology, are there differences in loot box expenditure between gamblers and non-gamblers, and is there an association between PGSI and loot box expenditure amongst gamblers?

**Research Question 3.** Is the association between loot box expenditure and gambling-related constructs stronger or weaker when using the non-screening methodology in comparison to the screening methodology?

### 1.2. Hypotheses

**Hypothesis 1.** There will be a positive correlation between loot box expenditure and PGSI in the non-screening group, to replicate the finding and methodology found in the previous literature.

**Hypothesis 2.** In the screening group, gamblers will on average spend more money on loot boxes than non-gamblers, as a replication of a previous study using this methodology (Xiao et al., 2023b), and that there will be a positive correlation between loot box expenditure and PGSI amongst gamblers.

**Hypothesis 3.** (broad interpretation hypothesis): The relationship between loot box expenditure and gambling-related constructs will become weaker when using the screening methodology, as this approach prevents some participants from broadly-interpreting PGSI questions as relating to loot box expenditure and not gambling.

We originally preregistered the null hypothesis for **Hypothesis 3** as a separate hypothesis, but that is theoretically unsound. Instead, this should be taken as us having stated that we would interpret a null result for **Hypothesis 3** as support for the true association hypothesis, *i.e.*, if the relationship between loot box expenditure and gambling-related constructs will not become weaker when using the screening methodology, then the previous findings reflect a true conceptual association between loot boxes and gambling.

The present study (including hypotheses, data collection method, survey materials, exclusion criteria, and analysis plan) was preregistered at <https://doi.org/10.17605/OSF.IO/PD23S>.

## 2. Method

### 2.1. Participants and exclusions

Participants were recruited using Prolific and pre-screened to be aged 18 years or above and currently resident in the UK. Prolific did not have a pre-screening question that allows for the identification of video game players *per se*. Therefore, following Close et al. (2022), the pre-screener of 'Which of the following types of games are you interested in playing at least occasionally?' was used to pre-screen for inclusion any participants who selected at least one of the following: 'Computer

games;' 'Console games;' 'Handheld console games;' 'Free-to-play mobile games;' 'Premium mobile games (pay to download);' 'Esports games;' and 'Virtual reality games.' The Prolific study listing was entitled 'Spending money in video games' and explicitly mentioned in its description that 'The purpose of this study is to investigate your use of video game loot boxes, and also to ask you about your current gambling behaviour.'

The preregistered exclusion criteria were applied. Incomplete responses (23) and those with missing demographic data were excluded (43). Participants who failed either of two attention checks were excluded (104). We also preregistered that any participant reporting a monthly loot box expenditure of  $\geq$  £1000 would be excluded as outliers following Close et al. (2022), but no participant was excluded on that basis. This left 2027 valid responses (out of an original total of 2197 recorded responses; 92.3%) that formed the sample. The median survey completion time was 2:43. We paid participants £0.40 each, which equated to a pro-rata payment of £8.83/hour.

Participants were randomly assigned to either the non-screening methodology ( $n = 1005$ ) or the screening methodology group ( $n = 1022$ ).

#### 2.1.1. Gambling participation screening question

Only participants in the screening methodology group were presented with a past-year gambling participation screening question: 'For the purposes of this survey, please do NOT include purchasing loot boxes in video games as a form of gambling. [...] In the last 12 months, have you spent money on any of the below?' and with a detailed list of activities that count as 'gambling,' as shown in Fig. 1. This gambling participation screening question is adapted from the UK Gambling Commission's survey questionnaire on gambling participation (2020, 2022a). Participants who responded 'yes' to any of the listed forms of gambling were then asked to complete the PGSI. The last option of 'I did not spend money on any of the above.' could not be chosen alongside other options.

#### 2.1.2. Problem gambling severity

We measured participants' problem gambling severity using the Problem Gambling Severity Index (PGSI) (Ferris and Wynne, 2001). The PGSI was given to all participants in the non-screening methodology group. In contrast, for the screening methodology group, the PGSI was only given to participants who positively endorsed the gambling participation screening question. This difference in the two groups represented the experimental manipulation. Each participant that completed the PGSI scored between 0 and 27. Participants were categorised into non-problem (0), low-risk (1–4), moderate-risk (5–7) and problem gamblers (8 or more) using the revised PGSI scoring system of Currie et al. (2013). We used these revised cut-offs, which were demonstrated to be better than the originals (Currie et al., 2013), to emulate previous loot box research (e.g., Drummond et al., 2020b; Hall et al., 2021; Zendle and Cairns, 2018, 2019) and follow the specific recommendation from Drummond et al. (2020b) (which compared the two scoring schemes) that the revised version is better as it more clearly showed the trend that loot box spending increased with each problem gambling risk category (pp. 89). Internal reliability was good in the non-screening group (Cronbach's  $\alpha = 0.88$ ) and excellent in the screening group (Cronbach's  $\alpha = 0.90$ ).

#### 2.1.3. Loot box expenditure

We provided participants with a definition of loot boxes that was previously used with UK videogame players (Lloyd et al., 2021) and then asked them how much money they spent on loot boxes in the past month as shown in Fig. 2.

#### 2.1.4. Open-ended comment box

Finally, at the end of the survey, we provided a text entry box for participants to provide any comments or feedback. Some of the open-

For the purposes of this survey, please do **NOT** include purchasing loot boxes in video games as a form of gambling.

The activities listed below when played for money are generally considered to be gambling.

When answering questions about "gambling" or "betting" in this survey, please remember that all these types of activities count as gambling.

**In the last 12 months, have you spent money on any of the below? (Select all options that apply)**

Tickets for the National Lottery draws (Lotto, EuroMillions, Thunderball, Hotpicks, Set for Life)?
Scratchcards?
Tickets for a charity lottery or other lottery?
Fruit or slot machines?
Virtual gaming machines in a bookmaker's to bet on virtual roulette, poker, blackjack or other games?
Bingo, including bingo played online?
The football pools?
Betting on horse races?
Betting on dog races?
Betting on football?
Betting on tennis?
Betting on other sports events?
Betting on the outcome of lotteries?
Betting on political events?
Betting on other events (e.g. entertainment, topical, current affairs, novelty)?
Betting on virtual dog or horse races?
Spread betting?
Online instant win games available on the National Lottery website?
Online fruit/slot machine style games or online instant win games on sites other than the National Lottery website?
Roulette in a casino or online?
Card or dice games in a casino or online?
Poker in a casino or online?
Playing poker in a pub tournament/league, or at a club?
Private betting (sweepstakes, bets between friends) or gambling (playing card games for money) with friends, family or colleagues?
I did not spend money on any of the above.

**Fig. 1.** The past-year gambling participation screening question presented to participants in the screening methodology group.

ended responses we received concerned the research methodology and are therefore relevant to the overall research aim of identifying which surveying method is superior. Accordingly, these are quoted and relied upon in the [Discussion](#) section as reflecting how individual participants felt about a particular methodology.

## 2.2. Analysis plan

Loot box expenditure is typically positively skewed, as a small number of people can spend significant amounts of money on them. Previous loot box studies therefore typically rank-transformed loot box expenditure in order to remove this skew (e.g., [Drummond et al., 2020b](#), p. 7; [Zendle, Meyer, & Over, 2019](#), p. 6; [Zendle et al., 2021](#), p. 7). Following this, we pre-registered the use of rank-transformed loot box expenditure across the entire sample for all analyses. However, there are some issues with the use of the rank transformation to be aware of. Whilst suitable for recovering main effects from data ill-suited for parametric analysis, there are issues with the identification of interactions, with evidence of both Type I and II errors (see [Zimmerman, 2012](#); [Saltelli and Sobol', 1995](#)). To alleviate this risk, the interaction effects observed using untransformed loot box spending are also reported at the data deposit link. The results were the same.

[Research Question 1](#) was tested using a Spearman's rank correlation test between PGSI and loot box expenditure among respondents in the non-screening group. This is designed to replicate the well-established findings of an association between loot box expenditure and problem gambling scores that have been previously identified in the literature.

[Research Question 2](#) was tested in two parts. Firstly, a binary logistic regression was conducted with gambling status predicted by loot box expenditure in the screening group. Then, the same Spearman's test as used for [Research Question 1](#) was applied to the respondents in the screening group to test the extent to which loot box expenditure and problem gambling are associated amongst gamblers. This was then compared against the test in [Research Question 1](#) using Fisher's  $r$  to  $z$  transformation to test whether they were significantly different from each other ([Fisher, 1950](#)), which was implemented in STATA using the 'cortesti' function ([Caci, 2000](#)).

[Research Question 3](#) was tested using a Tobit regression, with the PGSI category as the dependent variable, and loot box expenditure, condition (0 = no screen, 1 = standard gambling), and the interaction between loot box expenditure and condition as independent variables. Problem gambling severity was treated as the dependent variable here, as Tobit models work best when the censored variable is the dependent variable. For the screening condition, the data was left censored insofar as people who have not gambled in the past 12 months were considered to be below the limit of detection, i.e., they do not have any data, whereas in the non-screening condition they do. Censored data can occur because a measurement is not taken if a certain level of engagement in a behaviour is not met (e.g., not having gambled), but can also be observed at the extremes of a measure that is not sensitive (e.g., someone scoring the highest or lowest possible value).

In the screening condition, data censoring is a particular problem because the data were not missing at random. Tobit models are a form of regression analysis suited for censored data, which was the case for respondents who have been screened out of the PGSI for not gambling in the past year. Essentially, Tobit models estimate a latent variable for the outcomes outside the limit of detection. Censored regression models have been utilised in studies where experimental manipulations have prevented censoring in one level of the independent variable but not the other ([Young and McCoy, 2019](#)), as is the case in this study. It has also been shown to work better than linear or generalized linear models in situations where the data is censored ([Baba, 1990](#); [Young and Hoane, 2021](#)). Non-gamblers in the screening condition were marked as below the limit of detection and censored, whereas non-gamblers in the non-screening condition were not. [Research Question 3](#) was tested with the interaction between loot box expenditure and condition. The null

For this study, we define a “loot box” as any in-game item that can be paid for with real money, the contents of which are randomised. They might be called boxes, crates or card packs, and include many ‘gacha games’, and also includes paying real world money for an in-game currency that is used to buy loot boxes, or paying real-world money for a key that is used to open loot boxes.

### In the past month, how much money have you spent on loot boxes?

(If you did not spend any money on this, please enter 0).

Provide your answer in British pounds, *without* entering the pound sign (£)

Fig. 2. The loot box spending question presented to participants.

hypothesis for [Hypothesis 3](#) (true association) predicted that there will be no interaction between condition and loot box expenditure on problem gambling, whilst [Hypothesis 3](#) (broad interpretation) predicted that there will be an interaction, specifically that the association between loot box spending and problem gambling will be weaker in the screening condition than in the non-screening condition.

### 2.3. A priori power analysis

For the correlational analyses in [Research Question 1](#), the test is powered to detect an association of  $r = 0.25$  (based on the previous literature) with power of 0.8 with 114 participants (per condition presumably), or with power of 0.95 with 187 participants ([Kohn and Senyak, 2021](#)). This test was therefore sufficiently powered, given that there were 1000 participants in the relevant cell. The effect size of 0.25 is based on the anticipated size of the effect derived from meta-analyses ([Spicer et al., 2021](#); [Garea et al., 2021](#)).

For [Research Question 2](#), the overall level of statistical power depended upon the overall rate of gambling participation for both the logistic regression, in terms of the overall ratio of gamblers and non-gamblers to variables, and the Spearman’s test, in terms of the number of gamblers to whom the PGSI were administered. The sample recruited from Prolific, based on the screening criteria, was anticipated to likely oversample young men, who are more likely to participate in gambling and experience gambling harms ([Browne et al., 2019](#)). Based on existing gambling prevalence data (specifically, the UK Gambling Commission’s research ([2022b](#)) finding that 44% of people aged 16+ participated in gambling *in the past four weeks*), we anticipated the proportion of the sample to have gambled *in the past year* to be approximately 50%. Using the power analysis from [Research Question 1](#) as a baseline, the sampling design was robust to large deviations from anticipated prevalence or effect size. Either gambling participation would have to have been less than 20% in the proposed sample, or the effect size would have to have been substantially smaller (even with a  $r$  of 0.16, about a third smaller than expected, the test would still have had a power of 0.95 with a sample size of 500) in order for the study to have been inadequately powered.

For [Research Question 3](#), statistical power was assessed using the PowerBBK package in STATA ([Bellemare et al., 2016](#)), which calculates simulated power for Tobit models. This was estimated for a Tobit regression with varying levels of sample size to each treatment condition, the effect size varied for 0.05 to 0.25, and a small error (0.2). Regression coefficients for Tobit models are estimated in a similar manner to OLS regression, except with an additional parameter for the uncensored latent variable as well as the measured variable. For the effect of loot box expenditure on PGSI category, which has an effect size of approximately 0.25, the test is sufficient to detect this effect with

power greater than 0.8 with a sample size of 200 (100 per condition) or more. Modelling the interaction is slightly more complicated, as there is no literature on which to draw from. Assuming a small effect size of 0.05, the test would be sufficiently powered with a sample of over 800 (400 per condition) to detect the proposed effect size (power of 0.813), but would require a sample of 2000 for the study to have observed power to detect an association with power of .95.

### 2.4 Ethics approval

Ethics approval for this study was obtained from the University of Bristol’s School of Psychological Science Research Ethics Committee (#12865).

## 3. Results

### 3.1. Descriptive statistics: sample characteristics

Sample characteristics are shown in [Table 1](#). Participants were spread across various age groups and *not* predominantly young ( $M_{\text{age}} = 37.6$ ,  $SD = 12.1$ ), unlike many previous loot box studies (e.g., [Macey and Hamari, 2022](#); [Zendle and Cairns, 2018](#); [Zendle, Meyer, & Over, 2019](#)). Overall, 27.1% of participants spent money on loot boxes, and further information concerning the amounts spent is in [Table 1](#).

In the screening group, 80.9% of participants gambled in the past 12 months. The problem gambling status of participants was determined using Currie et al.’s revised PGSI scoring system ([Currie et al., 2013](#)), as the full breakdown in [Table 2](#) shows. Overall, 5.7% of self-reported gamblers in the screening group ( $n = 826$ ), and 4.5% of all participants ( $N = 2027$ ), were deemed to be problem gamblers.

### 3.2. Confirmatory analyses

**Hypothesis 1.** was supported: loot box spending was positively correlated with problem gambling severity in the non-screening group ( $r_s(1003) = .23$ ,  $p < .001$ ).

The binary logistic regression model was statistically significant ( $z = 2.53$ ,  $p = .012$ ). Higher levels of loot box expenditure (ranked) were associated with a greater likelihood of gambling in the previous 12 months (OR = 1.016, 95% CI [1.004, 1.030]). Within the subsample of gamblers in the screening condition, the association between loot box spending and problem gambling severity ( $r_s(824) = 0.26$ ,  $p < .001$ ) was similar to that found in the non-screening condition. An exploratory  $z$  test was conducted to determine whether the correlations between loot box spending and problem gambling were significantly different in the non-screening condition and among screened gamblers. The  $z$  test was non-significant ( $z = -0.669$ ,  $p = .503$ ).

**Table 1**  
Demographics (N = 2027).

Characteristic	Percentage of participants
Age	
18–24	13.2%
25–29	15.6%
30–34	18.2%
35–39	15.7%
40–45	13.0%
45+	24.3%
Sex	
Male	50.2%
Female	49.8%
Ethnicity	
White	88.1%
Asian	6.1%
Black	2.6%
Mixed	2.3%
Other	0.8%
Data not available	0.1%
Country of birth	
United Kingdom	86.6%
Poland	1.2%
Nigeria	1.0%
Italy	0.9%
Germany	0.9%
Other	9.2%
Employment status	
Full-time	55.3%
Part-time	17.1%
Not in paid work	11.6%
Unemployed	6.2%
Other	3.1%
Due to start a new job within the next month	1.0%
Data not available	5.7%
Student status	
Yes	13.0%
No	82.6%
Data not available	4.3%
Loot box spending (past month; pound sterling £)	
Mean (SD)	5.79 (28.21)
95% CI	[4.56, 7.02]
Minimum–Maximum	0–650

Research Question 3 was tested using a Tobit regression, with condition and loot box spend (ranked) as predictor variables, and an interaction term between the two. The results of this analysis (Table 3) identify a main effect of loot box spend as previously observed, with greater loot box expenditure associated with higher problem gambling classification. Greater loot box spending was associated with higher problem gambling scores irrespective of screening condition. There was also a significant effect of condition, as respondents in the non-screening condition reported higher levels of problem gambling severity in terms of PGSI categorisation. There was no evidence of an interaction between loot box spend and condition, suggesting that the effect caused by not

**Table 2**  
Problem gambling severity categories (N = 2027).

Problem gambling severity category	Percentage of all participants	Loot box spending (past month; pound sterling £); Mean (SD)	In the non-screening group		In the screening group		
			Percentage of participants (n = 1005)	Loot box spending (past month; pound sterling £); Mean (SD) (n = 1005)	Percentage of participants (n = 1022)	Percentage of gamblers (n = 826)	Loot box spending (past month; pound sterling £); Mean (SD) (n = 826)
Non-gamblers	N/A	N/A	N/A	N/A	19.2%	N/A	3.11 (9.80)
Non-problem gamblers	61.1%	3.17 (16.74)	57.9%	2.63 (8.15)	45.0%	55.7%	3.87 (25.09)
Low risk gamblers	30.0%	5.98 (20.05)	32.4%	6.52 (25.01)	27.5%	34.0%	5.36 (11.95)
Moderate risk gamblers	4.4%	18.93 (7.54)	5.2%	26.81 (92.85)	3.7%	4.6%	8.14 (14.82)
Problem Gamblers	4.5%	26.95 (7.74)	4.5%	28.02 (74.66)	4.6%	5.7%	25.91 (74.64)

screening for gambling activity was common across gamblers and non-gamblers alike.

### 3.3. Exploratory analysis

The Tobit analysis did not find an interaction between loot box expenditure and the screening condition, thus failing to support the Sidloski et al. (2022) broad interpretation account operationalised in Hypothesis 3. To test whether this can be interpreted as evidence in favour of the true association hypothesis (i.e., a null effect, rather than a null result), a Bayesian Tobit analysis was conducted using the brms package in R (Bürkner et al., 2023). The Bayes factors were estimated using the bayestestR package to model the evidence in favour of the interaction being equivalent to zero (Makowski et al., 2023). The Bayes factor showed strong evidence in favour of the interaction term being equivalent to zero (BF<sub>01</sub> = 0.048). The full result output is reported at the data deposit link.

## 4. Discussion

The positive correlation between loot box expenditure and problem gambling has been consistently replicated (Garea et al., 2021; Spicer et al., 2021). This has been interpreted as a ‘true association’ between loot boxes and traditional forms of gambling due to conceptual links (e.g., Zendle and Cairns, 2018). However, the alternative ‘broad interpretation’ explanation is that participants saw loot boxes as a form of gambling and were referring to their loot box purchasing experience when answering gambling-related questions (Sidloski et al., 2022). The present experiment manipulated whether respondents were screened or not for gambling participation before administering the problem gambling scale to test these alternative interpretations. The findings supported the true association hypothesis. In the non-screening condition, a positive correlation between loot box expenditure and problem gambling severity was observed (r = 0.23). When screened for past-year gambling activity, a positive association of the same magnitude was observed amongst gamblers (r = 0.26), as was an association between binary past-year gambling participation and loot box expenditure. The r values of the two correlations between PGSI and loot box expenditure

**Table 3**  
Tobit regression of the interaction between loot box expenditure and screening condition (N = 2027).

Parameter	b	se	t	p
Tobit m	−0.438	0.034	12.81	<.001
Tobit sd	0.868	0.028		
Condition	−0.391	0.048	−7.99	<.001
Loot box expenditure	0.014	0.002	7.00	<.001
Condition x Loot Box	0.005	0.003	1.59	.112

from the two conditions were not statistically significantly different. The strength of these correlations are very similar to estimates made in previous meta-analyses (Garea et al., 2021; Spicer et al., 2021) and support the contention there is a true association between loot box expenditure and problem gambling behaviour of an effect size that is practically meaningful for media effect contexts (Ferguson, 2009, p. 533, 2023, p. 3). A Tobit regression was used as the main test of the two interpretations' predictions, which provided further support for the true association hypothesis: there was a significant effect of loot box expenditure, and the interaction between condition and loot box expenditure was not significant. This suggested that the association between loot box expenditure and problem gambling was the same across both conditions.

The screening methodology is widely used and preferred by traditional gambling prevalence surveys (Sturgis and Kuha, 2022). The Tobit analysis revealed a main effect of condition, insofar as respondents in the non-screening condition reported higher levels of problem gambling severity in terms of PGSI categorisation. Although this does not impact the association between loot box spending and problem gambling, it does highlight some impacts on the data from screening for past year gambling activity. Some inaccurate responding by non-gambling participants in the non-screening group likely inflated the levels of problem gambling severity, but this did not fundamentally alter the relationship between loot box expenditure and problem gambling. The screening approach also yields information on the prevalence of gambling participation in the sample (which would be unavailable had the non-screening approach been used). The gambling participation rate is particularly useful when the study finds a null result because a low rate of gambling participation (thus resulting in few participants answering the problem gambling scale positively) is a potential explanation for finding no evidence. A non-screening approach does not allow a similar proposition to be put because researchers would not know whether the low problem gambling rate is genuine (despite reasonably widespread gambling participation) or caused by a low gambling participation rate. Finally, the screening approach avoids giving irrelevant problem gambling-related questions to non-gamblers, which could inconvenience (or even cause offence to) participants and plausibly lead to reductions in data quality elsewhere in the survey. This point was highlighted by at least one participant who commented:

Maybe the study should have asked if I gambled first, rather than asking many questions about "my gambling" when I don't even do it!

Sidloski et al. (2022) identified how some participants might be referring to their loot box purchasing when answering gambling-related questions because they deemed loot box purchasing to be a type of 'gambling.' This is an issue that future research should be cautious of: participants might not understand 'gambling' in the same way that the researchers intended, and different participants might understand 'gambling' to mean and include different activities. The present study did not find definitive evidence to support the contention that the Sidloski et al. idea (2022) fundamentally affected previous research results: whether respondents were screened or not did not impact on the association between problem gambling and loot box spend. However, a main effect of condition was observed (PGSI categorisation was inflated in the non-screening sample), which raises the question: if respondents are answering the PGSI differently depending on whether they are screened for gambling or not, and this does not appear to be driven by loot box purchasing, what products or processes might explain this difference? One possibility is that the screening question might exclude people who engage in gambling but who subjectively judge their behaviour not to count as 'gambling.' There is some evidence to support this argument. Gambling prevalence studies that have included a follow up question after the initial gambling screen (e.g., the Adult Psychiatric Morbidity Survey (National Health Service (NHS) (UK), 2016)) found that approximately 10% of non-gamblers subsequently endorse past year gambling when challenged. However, although this increases the

number of people endorsing gambling, it is not known whether this increase is driven by genuine gambling activity. Alternatively, it may be that, to some participants, 'gambling' encompasses a broader range of activities that may be adjacent to gambling. Indeed, one participant in the screening group who stated that they did not spend money on any of the gambling activities in the present study's exhaustive list commented that:

I do invest in crypto which is a form of gambling.

It is possible that this participant, had they not been screened and were instead given the PGSI automatically, would have returned a non-0 PGSI score because they might refer to harm experienced in relation to cryptocurrency investing (Delfabbro et al., 2021; Johnson et al., 2023; Mills and Nower, 2019). These observations suggests that more research should be done on defining 'gambling' in ways that yield broad agreement. This issue may become increasingly important over time, due to trends in the 'gamblification' of, for example, video games (Macey and Hamari, 2022) and investing (Newall and Weiss-Cohen, 2022). Although researchers are free to deviate and experiment with different surveying approaches, an uncontroversial recommendation can be made for all studies on a gambling-like activity that are attempting to assert that said activity is associated with *traditional* gambling harms: participants should be explicitly instructed to *at least* not consider that one novel gambling-like activity being studied as a form of 'gambling' when answering questions that are intended to assess *traditional* gambling harms. It may also be helpful to ask participants to disregard other gambling-adjacent activities (e.g., so-called 'investing' in cryptocurrencies), although it might be difficult to do so exhaustively. For loot box studies, this means giving specific instructions that loot boxes should not be considered a form of 'gambling.' Providing an extended list of known gambling activities as examples that should be taken into account, as we have done, is a good approach for calibrating what 'gambling' means with survey participants, as the alternative of attempting to objectively define what 'gambling' means using prose is highly difficult. Researchers could then add further gambling-like activities, potentially based on qualitative research with people from the population of interest (e.g., crypto investing as mentioned by one of our survey participants), to that list to make this 'definition' for gambling even more precise and up to date.

More studies should be done using different methodological approaches to help us better understand the relationship between loot boxes and gambling. For example, Coelho et al. (2023) used a third alternative technique of asking about gambling participation and then not asking any non-gamblers to answer the problem gambling questions but artificially giving all of them a 0 score on the problem gambling scale for analysis purposes (p. 262). That technique could increase the effective sample size (which is particularly relevant for samples with low gambling participation rates), although it disregards certain types of gambling harms that non-gamblers might still experience (e.g., legacy harms experienced by those in recovery). Further, this technique may not fully account for the distinction between non-gamblers and non-problem gamblers. Coelho et al. (2023) sought to address that point by artificially shifting the problem gambling scores of any gamblers up by 1 (such that a non-problem gambler who actually scored 0 would receive 1 instead) (p. 262). However, that may not be a perfect solution as it appears to assume that *any* recent gambling involvement is a form of minor problem gambling harms (and indeed a 1-point change for problem gambling scores is quite a large effect, given how many people would score very low). This artificial manipulation might affect any statistical analysis.

As mentioned in the Introduction, Xiao et al. (2024) found that the correlation existed amongst non-gamblers at  $r = 0.11$  (p. 7), which may be perceived as some support for the broad interpretation hypothesis. This is not inconsistent with the present results. We conclude that the true association hypothesis is to be preferred over the broad interpretation hypothesis. However, importantly, although we do not find



support for the broad interpretation *hypothesis* in the sense that it did not solely explain the positive correlation between loot box spending problem gambling, we do find support for the broad interpretation *effect*. The strength of the correlation is potentially affected through the inclusion of non-gambler: in Xiao et al. (2024), the  $r$  value was 0.11 amongst non-gamblers, 0.27 amongst gamblers, and 0.22 when the two groups are combined (p. 7). The wider methodological concerns about data quality and accuracy raised in Sidloski et al. (2022) are sound and supported by the present evidence on how arguably inaccurate problem gambling answers were provided by, presumably, non-gamblers in the non-screening sample. Future research should try to eliminate this noise by design (e.g., using the screening methodology).

Notably, the gambling participation rate in the screening group of the present experiment was 80.9%, which is very high but not unreasonable considering the data collection method used (Pickering and Blaszczynski, 2021; cf. Russell et al., 2022). It would be fair to assume that the rate in the non-screening group was similarly high given how our experimental design ensured that this stayed consistent. This means that only about 19% of participants were actually screened out in the screening group and only about 19% of participants (at most) in the non-screening group were capable of giving inaccurate responses due to the broad interpretation effect. In contrast, in Xiao et al. (2024), 35.5% of non-gamblers received a non-0 PGSI score, so the incidence rate of the broad interpretation effect potentially occurring in Mainland China was much higher. For studies conducted on populations that are significantly less likely to gamble (or at least significantly less likely to self-report doing so), e.g., in Mainland China (see Xiao et al., 2023b, 2024), the impact of inaccurate responses when using the non-screening methodology might become more pronounced because significantly more participants would be non-gamblers and therefore at risk of broadly interpreting what ‘gambling’ means when answering the problem gambling questions.

Indeed, a future study should empirically test whether the broad interpretation issue identified by Sidloski et al. (2022) is actually occurring by using the non-screening methodology (and providing no instructions to participants on whether or not they should consider loot box purchasing as a form of gambling), perhaps as one of multiple conditions, but appending the question ‘Did you consider loot box purchasing as a form of gambling when answering the previous gambling-related questions?’ after the participants finish answering the problem gambling questions. This would help to address a theoretical limitation of the present study, which is that we were motivated to test the phenomenon that Sidloski et al. (2022) suggested (with good reasons) might be occurring but did not actually empirically prove has happened.

The present study relied on crowdsourced data from paid online panels whose quality has previously been questioned (Pickering and Blaszczynski, 2021; cf. Russell et al., 2022); however, Prolific is a reliable platform (Peer et al., 2022) and preregistered exclusion criteria based on attention checks were used to increase data quality. In contrast to population-representative surveys, we did not attempt to manipulate demographic characteristics, although, as to ethnicities, the distribution was very similar to national estimates for England (Office for National Statistics (UK), 2019). This means most of our participants self-identified as White, which may have caused the study to underplay how other ethnic and cultural groups, which are known to be more vulnerable to problem gambling (Alegría et al., 2009; Caler et al., 2017), experience loot boxes (see Gentles et al., 2022; Xiao et al., 2023b, 2024). Future studies that are cross-cultural or specifically consider various minority groups (beyond ethnicities) are needed to broaden the literature and benefit all video game players who might engage with loot boxes. Our participants were on average older than those of previous loot box studies. Particular concerns have been raised about children’s engagement with loot boxes (Brooks and Clark, 2022; González-Cabrera et al., 2021, 2023; Wardle and Zendle, 2021; Zendle, Meyer, & Over, 2019). Younger individuals might understand ‘gambling’ to mean

different things compared to older people due to generational differences (Rolando and Wardle, 2023), so an attempt should be made to replicate the present study using a youth sample. Due to the study’s collection of data at a single timepoint, we cannot conclude as to why the correlation arises. Two recent longitudinal studies have presented evidence that young people who bought loot boxes were more likely to participate in traditional gamble (González-Cabrera et al., 2023) and that they are also more likely to spend more money on traditional gambling six months later (Brooks and Clark, 2022).

## 5. Conclusion

The positive correlation between video game loot box spending and problem gambling severity has been well-replicated (Garea et al., 2021; Spicer et al., 2021). Through an experiment, we demonstrated that whether or not participants are screened for past gambling participation prior to being given the problem gambling scale does not fundamentally alter the existence of the association. Loot box purchasing was positively correlated with problem gambling even when participants were told to disregard any loot box-related experience when answering gambling-related questions. The strength of correlation was not inflated when participants were not screened; however, it does appear that some of these participants provided potentially inaccurate responses that did not impact the overall effect. The screening approach has advantages for researchers considering future work on this topic, including the identification of the gambling participation rate amongst the sample; providing more accurate data on problem gambling; and saving resources by not giving participants irrelevant questions. At a minimum, future loot box studies should explicitly instruct participants to *not* consider loot box purchasing as a form of ‘gambling’ when asking them to answer questions attempting to assess harms associated with traditional gambling.

## CRedit authorship contribution statement

LYX: Conceptualisation; Data Curation; Formal Analysis; Investigation; Methodology; Project Administration; Software; Visualization; Writing – Original Draft Preparation; Writing – Review & Editing; PWSN: Conceptualisation; Methodology; Supervision; Writing - Original Draft Preparation; Writing – Review & Editing; RJEJ: Conceptualisation; Formal Analysis; Investigation; Methodology; Resources; Software; Visualization; Writing – Original Draft Preparation; Writing – Review & Editing.

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## Declaration of competing interest

L.Y.X. was employed by LiveMe, then a subsidiary of Cheetah Mobile (NYSE:CMCM), as an in-house counsel intern from July to August 2019 in Beijing, People’s Republic of China. L.Y.X. was not involved with the monetisation of video games by Cheetah Mobile or its subsidiaries. L.Y.X. undertook a brief period of voluntary work experience at Wiggin LLP (Solicitors Regulation Authority (SRA) number: 420659) in London, England in August 2022. L.Y.X. has contributed and continues to contribute to research projects that were enabled by data access provided by the video game industry, specifically Unity Technologies (NYSE:U) (October 2022 – Present). L.Y.X. has met and discussed policy, regulation, and enforcement with the Belgian Gaming Commission [Belgische Kansspelcommissie] (June 2022 & February 2023), the

Danish Competition and Consumer Authority [Konkurrence- og Forbrugerstyrelsen] (August 2022), the Department for Digital, Culture, Media and Sport (DCMS) and its successor of the UK Government (August 2022 & August 2023), PEGI (Pan-European Game Information) (January & March 2023), a member of the European Parliament (February 2023), the US Federal Trade Commission (February 2023), the Finnish Gambling Administration at the National Police Board [Poliisihallituksen arpajaishallinto / Polisstyrelsens lotteriförvaltning] (March 2023), the Danish Gambling Authority [Spillemyndigheden] (April 2023), the Netherlands Authority for Consumers and Markets [Autoriteit Consument & Markt] (May & June 2023), and the Swedish Gambling Authority [Spelinspektionen] (June 2023). L.Y.X. has been invited to provide advice to the DCMS on the technical working group for loot boxes and the Video Games Research Framework. L.Y.X. was the recipient of two AFSG (Academic Forum for the Study of Gambling) Postgraduate Research Support Grants that were derived from 'regulatory settlements applied for socially responsible purposes' received by the UK Gambling Commission and administered by Gambling Research Exchange Ontario (GREO) (March 2022 & January 2023). L.Y.X. has accepted funding to publish academic papers open access from GREO that was received by the UK Gambling Commission as above (October, November, & December 2022 & November 2023). L.Y.X. has accepted conference travel and attendance grants from the Socio-Legal Studies Association (February 2022 & February 2023); the Current Advances in Gambling Research Conference Organising Committee with support from GREO (February 2022); the International Relations Office of The Jagiellonian University (Uniwersytet Jagielloński), the Polish National Agency for Academic Exchange (NAWA; Narodowa Agencja Wymiany Akademickiej), and the Republic of Poland (Rzeczpospolita Polska) with co-financing from the European Social Fund of the European Commission of the European Union under the Knowledge Education Development Operational Programme (May 2022); the Society for the Study of Addiction (November 2022 & March 2023); and the organisers of the 13th Nordic SNSUS (Stiftelsen Nordiska Sällskapet för Upplysning om Spelberoende; the Nordic Society Foundation for Information about Problem Gambling) Conference, which received gambling industry sponsorship (January 2023). L.Y.X. has received an honorarium from the Center for Tjekspillet.dk, which is funded by the Danish Ministry of Health's gambling addiction pool (Sundhedsministeriets Ludomanipulje) (March 2023). A full gifts and hospitality register-equivalent for L.Y.X. is available via: <https://sites.google.com/view/leon-xiao/about/gifts-and-hospitality-register>. The up-to-date version of L.Y.X.'s conflict-of-interest statement is available via: <https://sites.google.com/view/leon-xiao/about/conflict-of-interest>.

P.W.S.N. is a member of the Advisory Board for Safer Gambling – an advisory group of the Gambling Commission in Great Britain, and in 2020 was a special advisor to the House of Lords Select Committee Enquiry on the Social and Economic Impact of the Gambling Industry. In the last 3 years P.W.S.N. has contributed to research projects funded by the Academic Forum for the Study of Gambling, Clean Up Gambling, Gambling Research Australia, NSW Responsible Gambling Fund, and the Victorian Responsible Gambling Foundation. P.W.S.N. has received open access fee grant income from Gambling Research Exchange Ontario.

R.J.E.J. currently holds research project funding from the Academic Forum for the Study of Gambling, whose funding comes from gambling regulatory settlements, and Gambling Research Exchange Ontario. R.J.E.J. has also received conferences expenses from the Swiss Government to attend and present research.

## Data availability

The data presented herein are publicly available in the Open Science Framework via <https://doi.org/10.17605/OSF.IO/BHJR4>. The survey materials, analysis code and results, and peer review and editorial

history are also available therein. Previous draft versions are available via: <https://doi.org/10.31219/osf.io/cefnv>.

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