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Loot boxes are again linked to problem gambling:

Results of a replication study

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## Abstract

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Loot boxes are items in video games that contain randomised contents and can

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be purchased with real-world money. Similarities between loot boxes and forms

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of gambling have led to questions about their legal status, and whether they

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should be regulated as gambling. Previous research has suggested a link

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between the amount that gamers spend on loot boxes and their problem

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gambling: The more individuals spent on loot boxes, the more severe their

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problem gambling. However, the generalisability of prior work may be limited by

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both the self-selected nature of the sample under test, and the fact that

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participants were aware of the study's aims. A large-scale survey of gamers

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( $n=1,172$ ) was undertaken to determine if this link remained when these

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limitations of previous work were taken into account. These gamers did not self-

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select into a loot box study and were not aware of the study's aims. This study

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found similar evidence for a link ( $\eta^2 = 0.051$ ) between the amount that gamers

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spent on loot boxes and the severity of their problem gambling. Previous

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research strongly suggested both the size and the direction of link between loot

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box use and problem gambling. This paper provides further support for this link.

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These results suggest either that loot boxes act as a gateway to problem

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gambling, or that individuals with gambling problems are drawn to spend more

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on loot boxes. In either case, we believe that these results suggest there is good

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reason to regulate loot boxes.

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## Introduction

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Loot boxes are a profitable mechanism in modern video games that shares

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significant psychological and structural similarities with gambling. There is

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concern that loot boxes may pose risks to gamers, and some territories have

40 already regulated them as a form of gambling. Previous research has suggested  
41 the existence of an important link between loot box spending and problem  
42 gambling. However, the self-selected and unblinded nature of the sample used in  
43 this research limits its generalisability. In the research outlined below we  
44 replicate the existence of this link with a sample where individuals are not aware  
45 of the survey's aims.

#### 46 Loot boxes are big business

47 Loot boxes are items in video games that players can buy with real-world money,  
48 but which, when opened, contain randomised contents. They are very  
49 widespread in modern video games, and a recent report by the UK Gambling  
50 Commission estimated that 31% of children aged 11-16 have opened one(1).  
51 Loot boxes are highly profitable, with some estimates stating that they will  
52 generate up to \$30 billion dollars for the video game industry in 2018 alone(2).

#### 53 Loot boxes share psychological and structural features with gambling

54 Loot boxes all share one common feature: When players purchase one, they do  
55 not know what specific thing they will receive in return for their money. For  
56 example, players of the first-person shooter *Counter-Strike: Global Offensive* can  
57 pay real-world money to unlock sealed weapon cases, which have randomised  
58 contents. Players do not know what a weapon case's contents are when they pay  
59 to unlock it. It might contain items that are both rare and valuable: For example,  
60 a case might contain the *Dragon Lore* gun skin(3), which carries enormous value  
61 on secondary markets - indeed, it can be resold to other players for over  
62 \$4000(4). On the other hand, a weapon case might contain an ugly or common  
63 item that is of little or no value.

64 The chance-based nature of loot boxes has led to questions over similarities  
65 between them and gambling. Gambling experts have noted that loot boxes share

66 several key formal features with traditional forms of gambling. For example, both  
67 when wagering at the roulette wheel, and when buying a loot box, players are  
68 risking the loss of real-world money for the chance of obtaining a valuable  
69 reward (5).

70 These structural similarities have led to questions over whether loot boxes might  
71 pose similar risks to gambling. More specifically, there is concern that spending  
72 on loot boxes might form a gateway to problem gambling amongst gamers.

73 Problem gambling is an excessive and involuntary pattern of gambling activity  
74 which causes serious problems in an individual's personal, family, and vocational  
75 life (6). It is thought to often be caused by conditioning from arousing features of  
76 gambling (7). Drummond and Sauer(8) analysed 22 games featuring loot boxes  
77 to determine if they shared the characteristics of gambling necessary for them to  
78 lead to the development of problem gambling amongst gamers. They concluded  
79 that many loot boxes shared "important structural and psychological similarities  
80 with gambling" and recommended their regulation lest they create a "ripe  
81 breeding ground" for problem gambling.

82 Some bodies have concluded that loot boxes should be regulated as  
83 gambling

84 Indeed, some regulators have formally investigated whether loot boxes share  
85 enough similarities with forms of gambling, and determined that they should  
86 legally be regulated as gambling themselves. Early in 2018 Belgian and Dutch  
87 authorities ruled that some loot boxes violated national gambling legislation, and  
88 ordered that they be removed from video games. (9,10)

89 This hard stance on loot box regulation is, however, far from universal. A recent  
90 Australian Senate investigation into loot boxes did not declare them illegal as a  
91 form of gambling, but instead ordered that a "comprehensive review" of national

92 gambling legislation should take place in order to ensure that it was still current  
93 (11). French gambling authorities have ruled that because loot box items lack  
94 direct real-world monetary value, purchasing them cannot be classified as  
95 gambling (12). Similarly, the UK Gambling Commission determined that loot  
96 boxes do not legally constitute gambling because “the prizes unlocked in loot  
97 boxes are usable only in the games in which they’re won.”(13). It is important to  
98 note that this perspective on loot boxes does not take into account well-known  
99 secondary markets such as *OPSkins*(14), on which loot box winnings are  
100 regularly ‘cashed out’ by gamers for real-world money through a resale process.  
101 This is a common feature of many games that feature loot boxes (8). Further  
102 information on the different approaches to legislating loot boxes are available in  
103 (5,15,16).

104  
105 Recent data suggests an important link between loot box spending and  
106 problem gambling

107 Criticism of loot boxes has been roundly rebuffed by the games industry. Loot  
108 boxes do not represent the first time that consumers have been given  
109 randomised rewards in return for spending real-world money. Indeed, collectible  
110 card games like *Magic: The Gathering* have employed a similar mechanic for  
111 decades (a full review of the history of these ‘randomised reward mechanisms’ in  
112 games is available in (17)). This has resulted in industry pressure groups and  
113 representatives repeatedly equating the effects of loot boxes with these other  
114 forms of entertainment, which are themselves perceived to be harmless. For  
115 example, the ESRB have recently claimed that there is insufficient evidence that  
116 loot boxes had negative consequences for gamers (18). They instead declared  
117 that “we do not consider loot boxes to be gambling for various reasons ... loot

118 boxes are more comparable to baseball cards, where there is an element of  
119 surprise and you always get something.” (18). Similarly, The IGEA is the industry  
120 body responsible for representing the business and public policy interests of  
121 gaming companies in Australia and New Zealand. They liken loot boxes to  
122 harmless Kinder Surprise chocolates and state that “When you purchase a Kinder  
123 Surprise, you might receive a prize you already own or one that you do not. Loot  
124 boxes operate in the same way, as they too offer a variety of different  
125 items.”(19).

126 However, in contrast to these statements, recent data has suggested an  
127 important behavioural association between loot box spending and problem  
128 gambling. In (15), researchers found that purchasing loot boxes was associated  
129 with problem gambling in a sample of eSports spectators; in a recent large scale  
130 survey (n=7,422) (20), researchers polled a group of gamers and found that the  
131 problem gambling of gamers had a significant ( $\eta^2 = 0.054$ ) relationship with their  
132 loot box spending.

133 It is important to point out that this research is potentially limited by the nature  
134 of the samples under test: In (15), eSports spectators rather than gamers were  
135 polling, limiting the generalisability of results. Similarly, in (20), gamers were  
136 recruited by asking whether they would like to take part in a survey on loot  
137 boxes and gambling. Whilst they may not have been aware of the specific aims  
138 of the study, they would certainly have been aware of the general issues it  
139 examined and would have self-selected into the survey on the basis of their  
140 interest in these issues. This may also limit the generalisability of this research –  
141 indeed, in the conclusions of both studies, authors explicitly called for further  
142 work to be conducted which addressed these limitations and confirmed the  
143 robustness of their findings.

144 The research that we present below directly addresses this gap in the literature.  
145 We conducted a similar survey to (21), and measured both gamers' problem  
146 gambling, and their spending on loot boxes. However, crucially, in the research  
147 presented here, gamers did not self-select into a study about loot boxes; and any  
148 gamers who showed suspicion that the study itself might be about loot boxes  
149 and gambling were removed from our sample. Our results support the  
150 robustness of previous findings on the effects of loot boxes. More specifically  
151 they confirm the size and positive correlation of the relationship between loot  
152 box spending and problem gambling that was previously observed. This  
153 information is of direct and urgent relevance to ratings boards and gambling  
154 regulators.

## 155 Method

156 This research was approved by the Cross-School Research Ethics Committee for  
157 the Schools of Art, Design & Computer Science; and Performance & Media  
158 Production at York St. John University

### 159 Design

160 We conducted an online survey with a sample of gamers aged 18 or older.  
161 Participants were recruited via an advertisement on Amazon Mechanical Turk  
162 order to answer a survey about their spending habits in games. In contrast to  
163 previous research, the recruitment message specifically did not mention loot  
164 boxes. Instead it read "We are conducting a survey about the different things  
165 that gamers spend money on, and how much they spend on each of these  
166 things."

167 Participants were screened before beginning the survey to ensure that they  
168 regularly played one of the 10 most globally popular games that feature loot  
169 boxes: *Player Unknown's Battlegrounds*, *League of Legends*, *Hearthstone*,

170 *Overwatch, Counter-Strike: GO, FIFA 18, Rocket League, DOTA 2, Team Fortress*  
171 *2, and Tom Clancy's Rainbow Six Siege.* At the end of the study, for the purposes  
172 of screening, they were asked these questions again to ensure consistency in  
173 their responses

174 This study was designed to measure problem gambling and loot box spending in  
175 a sample of gamers from the USA. For extensibility to other studies, all measures  
176 of spending in this study relied on participants reporting spending in the  
177 currency of their home country. For example, if a participant listed their  
178 nationality as 'Australian' it would ask for their spending in Australian Dollars  
179 rather than USA Dollars. 2 participants that took part in the study were not from  
180 the USA, but rather from India and Australia. They therefore reported their  
181 spending in Indian rupees and Australian dollars respectively. However, both of  
182 these participants did not spend any money on either loot boxes or other  
183 microtransactions. Therefore, conversion into US dollars was not necessary as all  
184 measurements were essentially in US dollars already (i.e. 0 Indian rupees is the  
185 same as 0 US dollars, which is the same as 0 Australian dollars).

186 **Loot box spend** was measured by asking participants to state approximately  
187 how much money they had spent on loot boxes in the past month. In order to  
188 blind participants to the aims of the study, they were also asked a variety of  
189 other questions about their spending habits: How much money they spent on  
190 physical copies of video games; how much money they spent on virtual copies of  
191 video games; and how much money they spent on in-game items.

192 **Problem gambling** was measured using the Problem Gambling Severity Index  
193 (PGSI) (22). The PGSI consists of a series of 9 questions which each ask the  
194 participant how frequently they engage in some behaviour that is related to  
195 problem gambling. For example, one question asks participants how often over



196 the past month “Has your gambling caused any financial problems for you or  
197 your household?”. Each of these questions is answered on a 4-point scale, with  
198 the following scoring pattern: (0) Never; (1) Sometimes; (2) Most of the time; (3)  
199 Almost always. The sum of scores over all 9 questions gives a total PGSI score  
200 that ranges from 0 (i.e. all questions answered as ‘Never’) to 27 (i.e. all  
201 questions answered as ‘Almost always’).

202 Participants were presented with the 9 items from the PGSI within a larger series  
203 of questions which they were informed related to impulsiveness. Participants  
204 were then classified as either ‘non problem gamblers’ (Score: 0), ‘low-risk  
205 gamblers’ (Score: 1-4), ‘moderate-risk gamblers’ (Score: 5-7), or ‘problem  
206 gamblers’ (Score: 8+) using the revised scoring system for the PGSI (23). This  
207 scoring scheme separates gamblers into classification bands on the basis of how  
208 extreme and frequent the problems are that their gambling has caused, rather  
209 than the absolute amount that they have spent. Thus, an individual who reports  
210 several gambling-related problems occurring frequently within their life might be  
211 classified as a problem gambler, whilst an individual who reported a lack of  
212 gambling-related problems would not, regardless of how much money each of  
213 these gamblers spent.

214 Each item was scored on a 4-point scale, giving a total score of 0-27.

215 At the conclusion of the survey, participants were asked what they thought the  
216 survey was about. Any participants who gave answers that contained both ‘loot  
217 boxes’ and ‘gambling’, or any variants of these words, were removed from the  
218 sample. This is in contrast to previous research, in which participants were aware  
219 that the study concerned both loot boxes and gambling.

220 The survey itself took an average time of 4 minutes and 38 seconds to complete.  
221 Participants were paid \$0.60 for their time, equivalent to \$7.80/hour.

## Participants

1,545 responses were collected in total from gamers from the USA. 245 respondents gave more than one inconsistent answer to the ten screening questions when they were repeated at the end of the study and were removed from the sample. 119 participants mentioned both loot boxes and gambling when asked what they thought the study was about and were removed from the sample. 7 participants listed their gender as a number. They were deemed non-serious and removed from the sample. This left a total of 1,174 responses. 1,172 participants listed their nationality as 'United States'. One participant listed their nationality as Indian, and one participant listed their nationality as Australian. The intention with this study was to recruit gamers solely from the USA, and it was determined that these two gamers should be removed from the study, leaving a sample of 1,172 gamers.

751 participants (64%) described themselves as male. 372 participants (31%) described themselves as female. The remaining 50 participants (4%) gave other answers.

237 participants (20%) were aged 18-24. 342 (29%) were aged 25-29; 300 (25%) were aged 30-34; 148 (12%) were aged 35-39; 150 (12%) were aged 40 or over.

## Data Availability

The data that support the findings of this study are available in a fixed and frozen form in the following online repository: <https://psyarxiv.com/u5dmr>

## Results

Reported spending on loot boxes over the past month ranged from \$0 to \$2300. Means and 95% confidence intervals of loot box spending when split by problem gambling severity are presented below as Table 1.

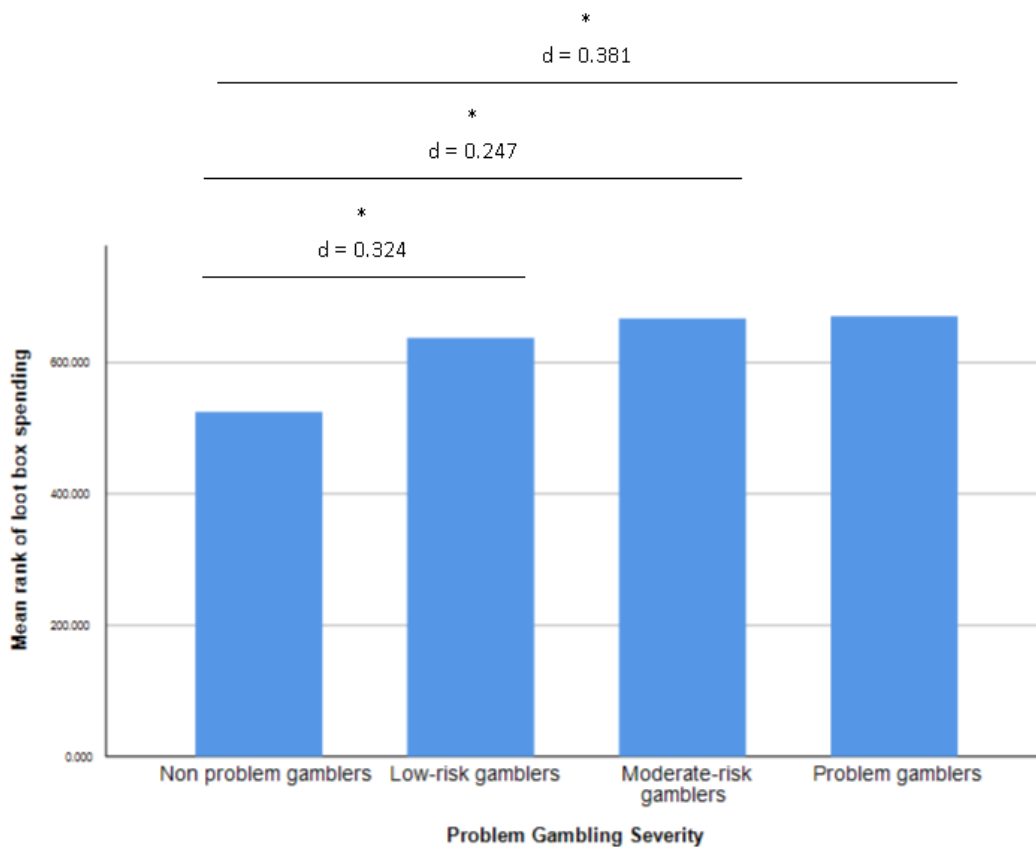
	Loot box spend	N
Non problem gamblers	\$11.14 (95% CI: \$4.19 - \$18.09)	596
Low-risk gamblers	\$21.87 (95% CI: \$7.10 - \$36.64)	313
Moderate-risk gamblers	\$27.55 (95% CI: \$1.64 - \$53.46)	56
Problem gamblers	\$38.24 (95% CI: \$16.66 - \$59.82)	207
Total	\$19.58 (95% CI: \$12.94 - \$26.21)	1172

Table 1: Means and 95% confidence intervals for player spending on loot boxes, split by problem gambling severity

The effects of problem gambling (non problem gamblers, low-risk gamblers, moderate-risk gamblers, problem gamblers) on loot box spend were tested via Kruskal Wallis H Test. In order to support the robust, diverse interpretation of tests, we present both the commonly used parametric measures of effect size,  $\eta^2$  and  $d$ , alongside the common language effects sizes of Vargha and Delaney (2000), namely Absolute Average Deviation (AAD) and stochastic superiority  $A$ . Results indicated that there was a statistically significant effect of problem gambling on loot box spending,  $\chi^2(3) = 62.850$ ,  $p < 0.001$ ,  $\eta^2 = 0.051$  AAD = 0.081. Pairwise comparisons were then conducted via a series of 6 Mann-Whitney U tests. Bonferroni corrections were applied to the results of these tests, raising the alpha level of the tests to 0.05/6, or 0.008. The results of these comparisons are reported below as Table 2, and depicted visually as Figure 1.

Pairwise comparison groups	U	p-value	Cohen's d	Vargha and Delaney's A'
Non problem gamblers vs. low-risk gamblers	75140.00	<0.001*	0.429	0.597
Non problem gamblers vs. moderate-risk gamblers	12467.00	<0.001*	0.568	0.622
Non problem gamblers vs. problem gamblers	46432.00	<0.001*	0.548	0.623
Low-risk gamblers vs. moderate-risk gamblers	8228.00	0.416	0.102	0.526
Low-risk gamblers vs. problem gamblers	30287.00	0.163	0.121	0.531
Moderate-risk gamblers vs. problem gamblers	5756.50	0.932	0.023	0.506

Table 2: Pairwise comparisons of the effects of problem gambling on loot box spending. Effects that are significant at the  $p < 0.008$  level are marked with a \*.



265

266 *Fig 1: Barchart representing pairwise comparisons of the effects of problem gambling on loot box*  
 267 *spending. Significant effects at the  $p < 0.008$  level are shown with lines, and annotated with effect*  
 268 *sizes in Cohen's d*

269

## Exploratory analyses

270

In order to clarify whether the strength of the relationship between problem gambling and loot box spending observed above was specific to loot boxes,

271

exploratory analyses were conducted on players' responses to the question

272

exploratory analyses were conducted on players' responses to the question

273

"During the last month, approximately how much money in dollars would you

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say that you have spent on in-game items per month? (Excluding loot boxes)".

275

As noted in the design subsection of our method, this question was initially asked

276

solely as a way of blinding participants to the purpose of the study. Means and

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95% confidence intervals of spending on in-game items when split by problem

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gambling severity are presented below as Table 3.

	Spending on in-game items other than loot boxes	N
Non problem gamblers	\$40.12 (95% CI: \$-0.38 - \$80.62)	596
Low-risk gamblers	\$30.98 (95% CI: \$11.49 - \$50.48)	313
Moderate-risk gamblers	\$36.07 (95% CI: \$18.55 - \$53.58)	56
Problem gamblers	\$78.83 (95%CI: \$19.59 - \$138.07)	207
Total	\$44.32 (95% CI: \$20.67 - \$67.98)	1172

Table 3: Means and 95% confidence intervals for player spending on other in-game items, split by problem gambling severity

The effects of problem gambling (non problem gamblers, low-risk gamblers, moderate-risk gamblers, problem gamblers) on spending on in-game items other than loot boxes were tested via Kruskal Wallis H Test. Results indicated that there was a statistically significant effect of problem gambling on spending on in-game items, though with what appeared to be a smaller effect size than the relationship between problem gambling and loot box spending observed above,  $\chi^2(3) = 32.470$ ,  $p < 0.001$ ,  $\eta^2 = 0.025$ ,  $AAD = 0.071$ .

Exploratory pairwise comparisons were then conducted via a series of 6 Mann-Whitney U tests. Bonferroni corrections were applied to the results of these tests, raising the alpha level of the tests to 0.05/6, or 0.008. The results of these comparisons are reported below as Table 4.

Pairwise comparison groups	U	p-value	Cohen's d	Vargha and Delaney's A
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Non problem gamblers vs. low-risk gamblers	78292.00	<0.001*	0.300	0.580
Non problem gamblers vs. moderate-risk gamblers	11829.00	<0.001*	0.527	0.639
Non problem gamblers vs. problem gamblers	51755.00	<0.001*	0.298	0.579
Low-risk gamblers vs. moderate-risk gamblers	7592.00	0.099	0.217	0.561
Low-risk gamblers vs. problem gamblers	31646.00	0.642	0.036	0.510
Moderate-risk gamblers vs. problem gamblers	6364.00	0.243	-0.160	0.455

Table 4: Pairwise comparisons of the effects of problem gambling on spending on in-game items other than loot boxes. Effects that are significant at the  $p < 0.008$  level are marked with a \*.

The Spearman rank correlation matrix for loot box spending, other microtransaction spending, and problem gambling categorisation was computed. This is shown below as Table 5.

	<b>Problem gambling classification</b>	<b>Loot box spending</b>	<b>Other microtransaction spending</b>
<b>Problem gambling classification</b>			
<b>Loot box spending</b>	0.228		
<b>Other microtransaction spending</b>	0.155	0.454	

Table 5: Correlation matrix for Spearman rank correlations between problem gambling classification, loot box spending, and other microtransaction spending. All correlations are significant at the  $p < 0.001$  level.

The same analysis was then conducted on the relationship between raw problem gambling scores (i.e. scores ranging from 0 to 27) and the spending variables

305 outlined above. The Spearman rank correlation matrix for these variables is  
306 displayed below as Table 6.

	<b>Problem gambling classification</b>	<b>Loot box spending</b>	<b>Other microtransaction spending</b>
<b>Problem gambling classification</b>			
<b>Loot box spending</b>	0.238		
<b>Other microtransaction spending</b>	0.164	0.454	

307 *Table 6: Correlation matrix for Spearman rank correlations between raw problem gambling scores,*  
308 *loot box spending, and other microtransaction spending. All correlations are significant at the*  
309 *p<0.001 level.*

310  
311 We then conducted a series of exploratory analyses to investigate whether the  
312 relationship between other microtransactions and problem gambling was  
313 significantly weaker than the relationship between loot box spending and  
314 problem gambling. In order to assess the difference between these relationships,  
315 they were entered into statistical analyses which allowed the testing of  
316 interactions between different kinds of spending and problem gambling severity.

317 A mixed-model ANOVA was first conducted, with problem gambling (non problem  
318 gamblers, low-risk gamblers, moderate-risk gamblers, problem gamblers) as a  
319 between-participants factor and type of spending (loot box spending, spending  
320 on in-game items other than loot boxes) as within-participants factor. Results  
321 gave no evidence for either an effect of problem gambling categorisation  
322 ( $F(3,1168) = 1.135, p = 0.333$ ), a main effect of type of spending ( $F(1,1168) =$   
323  $1.761, p = 0.184$ ), or an interaction between these factors ( $F(3,1168) = 0.327, p$   
324  $= 0.805$ ).

325 However, It is important to note that the data that are under test are non-normal  
326 with the data for both loot box and microtransactions spend exhibiting long tails  
327 in all categories of problem gambling: for example, whilst the mean spending on



328 loot boxes was \$19.58, this data ranged from \$0 to \$2300, indicating the  
329 presence of extreme outliers. A Shapiro-Wilk test for normality on each variable  
330 in each problem category supported this with  $W < 0.6$  and  $p < 0.001$  in all cases.

331 We therefore ran a follow-up nonparametric analysis whose assumptions did not  
332 require data to be normally distributed. More specifically, an Aligned Rank  
333 Transform test, analogous to a nonparametric ANOVA, was conducted according  
334 to (24), with problem gambling (non problem gamblers, low-risk gamblers,  
335 moderate-risk gamblers, problem gamblers) as a between-participants factor and  
336 type of spending (loot box spending, spending on in-game items other than loot  
337 boxes) as within-participants factor. Results indicated a significant effect of  
338 problem gambling categorisation ( $F(3,1168) = 18.68$   $p < 0.001$ ), a main effect of  
339 type of spending ( $F(1,1168) = 232.40$  , $p < 0.001$ ), and an interaction between  
340 these factors ( $F(3,1168) = 46.80$ ,  $p < 0.001$ ).

341 To confirm the presence of this effect, a robust 5% trimmed mixed-model  
342 ANOVA was conducted according to (25), with problem gambling (non problem  
343 gamblers, low-risk gamblers, moderate-risk gamblers, problem gamblers) as a  
344 between-participants factor and type of spending (loot box spending, spending  
345 on in-game items other than loot boxes) as within-participants factor. Results  
346 indicated a significant effect of problem gambling categorisation ( $F(3,1168)$   
347  $12.28$ ,  $p < 0.001$ ), a main effect of type of spending ( $F(1,168) = 19.60$ , $p < 0.001$ ),  
348 but no interaction between these factors ( $F(3,1168) = 1.18$ ,  $p = 0.319$ ).

## 349 Discussion

### 350 Loot box spending is linked to problem gambling

351 The results of this study provides further evidence of a potentially important  
352 relationship between problem gambling and loot box spending. Overall, there

353 was a significant link between participants' scores on the Problem Gambling  
354 Severity Index and their loot box spending ( $p < 0.001$ ,  $\eta^2 = 0.051$ ). Individuals  
355 who did not have gambling problems spent significantly less money on loot  
356 boxes than those who were problem gamblers, or at risk of problem gambling.

357 Subgroup analyses revealed that on average, non problem gamblers spent  
358 significantly less money per month on loot boxes (mean = \$11.14) than either  
359 low-risk gamblers (mean = \$21.87), moderate-risk gamblers (mean = \$27.55), or  
360 problem gamblers (mean = \$38.24).

361 Not only does the direction of these effects tally with those seen in Zendle and  
362 Cairns' (20) previous investigation of the effects of loot boxes, but the effect sizes  
363 associated with these relationships align closely with this previous work too. In  
364 (20), an overall relationship between loot box spending and problem gambling  
365 was observed that was of magnitude  $\eta^2 = 0.054$ . Here, the overall relationship  
366 we see is of magnitude  $\eta^2 = 0.051$ . Zendle and Cairns' subgroup analyses found  
367 differences between non-problem gamblers and other subgroups of magnitudes  
368 ranging from Cohen's  $d = 0.277$  to Cohen's  $d = 0.368$ . Here, our subgroup  
369 analyses revealed ranges in effect size from Cohen's  $d = 0.429$  to Cohen's  $d =$   
370  $0.568$ .

371 However, when it comes to analysing differences between other subgroups, it is  
372 interesting to note that whilst differences were observed between non problem  
373 gamblers and both low-risk, moderate-risk, and problem gamblers, no significant  
374 differences were observed within these groups. Our results gave no evidence to  
375 support the idea that low risk, moderate risk, and problem gamblers differed  
376 from each other in terms of their spending on loot boxes, in contrast to (21).

377 There are several reasons why this might be the case. Firstly, it may be the case  
378 that real differences exist in the world, but our sample was not large enough to

379 observe these effects. It is worth noting that in this dataset, for instance, only 56  
380 moderate risk gamblers formed part of the sample.

381 It is possible that there are other explanations for this lack of an effect.

382 Differences are thought to exist between individuals who are categorised as  
383 either low-risk, moderate-risk, and problem gamblers. For example, problem  
384 gamblers have been observed to gamble more, and have higher levels of debt  
385 than moderate-risk gamblers(26). However, as noted in (23), demographic and  
386 behavioural differences between low and moderate risk categories are often  
387 small and statistically insignificant. Indeed, in some studies, these classification  
388 categories are collapsed into each other (e.g. (27,28)). Further studies are  
389 needed with larger numbers of gamers that fall into these categories in order to  
390 determine whether the lack of an effect observed here between these subgroups  
391 is simply a Type II error, or whether it really does represent a meaningful facet of  
392 the relationship between loot box spending and problem gambling amongst  
393 gamers.

394 It is important to note that the overall relationship between problem gambling  
395 and loot box spending that was observed is of small-to-medium size. This  
396 suggests that the relationship between problem gambling and loot box spending  
397 may be comparable in strength to the relationship between problem gambling  
398 and known risk factors in the gambling literature. For instance, the relationship  
399 between problem gambling and current alcohol dependence is estimated at  
400 approximately  $\eta^2 = 0.0625$  (equivalent Cohen's  $d = 0.516$ ) (29). Interestingly,  
401 other factors that relate to technology use have been estimated to have similarly  
402 strong links with problem gambling. For example, exposure to gambling content  
403 in social media has been shown to share a moderate-strength relationship with  
404 problem gambling(30), as has engagement with simulated gambling in digital  
405 and social media (31). It may therefore be the case that the links between loot

406 boxes and problem gambling that we see here are not an isolated phenomenon.  
407 They may instead be a single indicator of a phenomenon, as new forms of  
408 communication and entertainment technology allow audiences easy access to  
409 novel gambling-like and gambling-related experiences.

#### 411 Other microtransaction spending and problem gambling

412 In (21), the relationship between problem gambling and other microtransaction  
413 use appeared trivially small ( $\eta^2 = 0.004$ ). However, a much stronger relationship  
414 was observed here, of magnitude  $\eta^2 = 0.025$ . Though the picture of loot box  
415 spend is consistent, the complexity of the microtransaction spend indicates how  
416 important it is to gather more data in this area. Exploratory follow-up analyses  
417 painted an inconsistent picture: An aligned rank transform revealed a significant  
418 interaction between types of spending and problem gambling, indicating that the  
419 relationship between other microtransactions spending and problem gambling is  
420 inferior to the relationship between loot box spending and problem gambling.  
421 However, this effect was not consistently seen during exploratory analyses, and  
422 did not appear in either a mixed ANOVA, or a robust 5% trimmed ANOVA. Much  
423 more work is needed first to understand the structure of the data in order to  
424 determine which more sophisticated modelling approaches might be appropriate  
425 to its analysis. In particular, based on our data here we might propose a  
426 generalized linear model of the spend data that could then be used as the  
427 foundation for future studies and their analysis. This further opens up the  
428 opportunity for Bayesian analysis that can consider robust parameter estimation  
429 of such models. It would be premature to do such analysis on our current data  
430 because until this study, we had no conception of what the data might look like  
431 and therefore what might be suitable models.

## 432 Limitations

433 An additional note must be made about the sample that was used in this study.

434 An unusually large number of participants in this study identified as problem  
435 gamblers. Overall, 207 individuals from within our 1172 participant sample  
436 scored 8 or higher on the PGSI. This indicates a much higher level of problem  
437 gambling in our sample than in the population at large, in which problem  
438 gambling is relatively rare (23). It seems likely that the prevalence of problem  
439 gamblers in our sample is due to the data collection method we employed: In  
440 this study, we recruited participants via Amazon Mechanical Turk, a popular  
441 microwork platform. It may be the case that microworkers are more likely to  
442 suffer from problem gambling than the general population. This point is  
443 supported by previous research on gambling amongst microworkers. For  
444 example, in (32), researchers examined the usefulness of the Crowdfunder  
445 microwork platform for recruiting individuals with gambling problems. They  
446 found that as many as 24% of the participants that they recruited were problem  
447 gamblers. The data collection method we employed here may therefore have  
448 allowed us a good opportunity to study the behaviours of problem gamblers who  
449 are also gamers. Similarly, previous studies on loot boxes have seen a large  
450 gender imbalance amongst participants: In (15), only 5.5% of participants were  
451 female; in (21) only 9%. By contrast, in the sample used here, almost a third of  
452 participants identified as female. Again, the difference between these samples  
453 may be due to the data collection method employed. The fact that similar  
454 patterns of results were replicated in this study despite the different composition  
455 of the sample under test suggests that the link between problem gambling and  
456 loot box spending may generalise widely across different groups of gamers.  
457 Further work is necessary to confirm that this is the case.

458 Finally, it is key to note that the specific methodology followed during this study  
459 itself carries inherent limitations. In order to assess the level of gamers'  
460 spending on loot boxes, we asked them to self-report how much they had spent  
461 on these things over the past month. It may be the case that these estimates are  
462 imprecise, and that taking a direct measure of actual spending would allow a  
463 more precise evaluation of the strength of any link between problem gambling  
464 and loot box spending. Additionally, this work is primarily concerned with the  
465 replication of previous work on links between the amount that individuals spend  
466 on loot boxes and their problem gambling severity. Therefore, it does not focus  
467 on factors such as the frequency of loot box opening, how long it takes gamers  
468 to open loot boxes, or individuals' exposure to loot box opening videos on  
469 websites like YouTube. However, all of these factors may be of importance when  
470 it comes to any relationship between loot box spending and problem gambling.

## 471 Conclusions

472 This research provides further evidence of a potentially important link between  
473 problem gambling and the amount that individuals spend on loot boxes. It  
474 directly addresses the limitations of previous research, in which a similar link was  
475 seen in an unblinded and self-selected sample. This research replicates that  
476 relationship and suggests that it remains in existence even when a sample is  
477 unaware of the fact that research concerns loot boxes and gambling, and have  
478 not self-selected into a loot box-related study.

479 However, it is key to note that the causal direction of this relationship is unclear.  
480 It may be the case that loot boxes cause individuals to become problem  
481 gamblers. It may also be the case that pre-existing gambling problems cause  
482 individuals to spend more money on loot boxes.

483 If this is the case, the presence of loot boxes in video games would not be  
484 creating a 'breeding ground' for problem gambling. They would instead be  
485 providing an opportunity for games companies to exploit serious pre-existing  
486 psychological problems amongst their customers for massive monetary gains.  
487 The correlational nature of this study makes it impossible to determine which of  
488 these pictures of the effects of loot boxes is true.

489 However, regardless of the direction of causality, the games industry faces a  
490 crisis of conscience. Industry bodies such as the ESRB and IGEA are finding it  
491 increasingly difficult to claim in good faith that there is little evidence of a link  
492 between problem gambling and loot box use. Loot boxes are a novel  
493 phenomenon, and game developers may understandably be wary of the  
494 association of their products with gambling. However, as noted in (33), in this  
495 case the "emphasis for all parties, be they government, industry, or consumer, should be on  
496 the need for self-education and due diligence in understanding the complexity and nuance of  
497 games and gambling." We strongly believe that this encompasses the need for  
498 continual reflection on the potential effects of loot boxes on the behalf of  
499 industry stakeholders

500  
501 It is our view based on the findings of this study that ratings agencies should  
502 consider incorporating additional parental advisories into games that persist in  
503 featuring loot boxes. In (34), King and Delfabbro outline a broad variety of  
504 different ways that loot box related harm may be mitigated by employing social  
505 responsibility measures. In light of the results seen here, we believe that many of  
506 the suggestions that are suggested in that document are appropriate. Most  
507 importantly, we follow them in their suggestion that appropriate content  
508 descriptors are added to games that feature loot boxes. We recommend that

509 games with loot boxes are restricted to players of legal gambling age. It is also  
510 our opinion that the severity of the link seen here suggests that relevant  
511 authorities should seriously consider restricting access to loot boxes as if they  
512 were a form of gambling.



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