Associations Between Loot Box Use, Problematic Gaming and Gambling, and Gambling-related Cognitions

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Abstract

Loot boxes are virtual goods in video games that produce randomly-generated in-game rewards, and have attracted scrutiny because of a resemblance to gambling. This study tests relationships between gaming involvement, engagement with loot boxes, and their associations with disordered gambling and gambling-related cognitions. Online questionnaires were completed by 144 adults via MTurk (Study 1) and 113 undergraduates (Study 2). Gaming and loot box-related variables included estimated time spent gaming and monthly expenditure, the Internet Gaming Disorder Scale (IGDS), and questions that assessed perceptions and behaviours related to loot boxes. Most participants thought loot boxes were a form of gambling (68.1% & 86.2%). A subset of items were condensed into a unidimensional "Risky Loot-box Index" (RLI) via exploratory factor analysis. In Study 1, the RLI showed significant associations with the Problem Gambling Severity Index ($r = .491$, $p < .001$) and the Gambling Related Cognitions Scale ($r = .518$, $p < .001$). Overall, gambling-related variables predicted 37.1% ($p < .001$) of the variance in RLI scores. Findings were replicated, though attenuated, in Study 2. These results demonstrate that besides the surface similarity of loot boxes to gambling, loot box engagement is correlated with gambling beliefs and problematic gambling behaviour in adult gamers.

Key Words: Video Game; Gambling; Loot Boxes; Loot Crates; Cognition; Microtransaction

1. Introduction

1.1. Background

Loot boxes are a feature of modern video games that have been argued to represent 'predatory monetization' (King & Delfabbro, 2018) and an example of the so-called 'gamblification' of gaming. These are virtual goods that provide a randomly generated in-game prize, earned via game play, or purchased using in-game currency and/or direct cash transactions. Opening a loot box generates audiovisual feedback that often reflects the style of the game and is sometimes reminiscent of slot machines (e.g. spinning reels). The precise aesthetics and functionality of loot boxes varies widely between games (Drummond & Sauer, 2018). For example, some prizes convey functional advantages in the game while others are purely cosmetic. The common property among loot boxes is the receipt of a virtual item determined by random number generation, where some items are more desirable and/or valuable than others. The pursuit of a desired item may lead to entrapment (Karlsen, 2011) where individuals may play for longer periods, or incur financial costs beyond their means, to make their prior 'investment' worthwhile (King & Delfabbro, 2018).

To what extent does this feature represent gambling? Legal definitions of gambling focus on three properties: (i) a cost to play; (ii) the prospect of winning a prize; (iii) chance is involved in the outcome (Reber, 2012; Danish Gambling Authority, 2018). *Prima facie*, purchasable loot boxes appear to meet the first and third criteria, but the second criterion is more complex. It is often noted that all loot boxes yield a prize, only many prizes are for common items that the gamer may already possess or not want, and the valuation of virtual items is often subjective (Watkins & Molesworth, 2012). Yet, some games permit the trade or sale of loot box prizes, which enables 'cashing out' through marketplaces (Drummond & Sauer, 2018). These have

borne the brunt of recent regulatory reviews of loot boxes in contemporary games (Danish Gambling Authority, 2018; Yin-Poole, 2018).

Research to date on gaming monetization features comes primarily from work on 'social casino games' (SCGs). These are gambling-themed games on social media platforms that are free to play (initially) and provide no monetary reward, but offer in-game purchases to unlock extra features or continue play (Gainsbury et al., 2014; Wohl et al., 2017). For people with gambling problems, SCGs were associated with increased gambling urges (Gainsbury et al., 2014; Hollingshead et al., 2016), and microtransaction use predicted the transition to online gambling (Kim et al., 2015). Similarly, many video games allow free access to loot boxes, but expenditure is encouraged to increase the frequency of use. Gaming and gambling share psychological characteristics, including variable ratio schedules of reinforcement, that foster cognitive distortions such as overconfidence and illusory control (King et al., 2010). In the case of gambling, high rates of these distortions are linked to disordered behaviour (Fortune & Goodie, 2012; Yakovenko et al., 2016), but it is unclear if analogous mechanisms operate during loot box use.

The present study sought to test the associations between loot box engagement and gambling behaviour, utilizing an exploratory approach. We report analyses from two samples to establish the robustness of our observations. Our specific aims were the following research questions: **(1)** To what extent do adults who play video games engage in loot box use? **(2)** To what extent is loot box usage associated with gambling-related beliefs, disordered gambling, and problematic internet gaming? **(3)** To what extent do marketplace affiliated games influence the consumption of loot boxes among video game players?

2. Methodology

2.1. Sample & Procedure

Sample 1 was collected via Amazon Mechanical Turk (MTurk). A pre-screen questionnaire (compensation $0.15 USD) established eligibility, which included prior video game play and familiarity with loot boxes. The pre-screen completion time was three minutes and remained on MTurk until 1000 responses were collected (approx. 2 weeks). The pre-screen and full survey were described on MTurk as '*Video Games & Loot Boxes – Research Study*', with a suffix of 'pre-screen' for the former. The full survey took approximately 40 minutes to complete. Participants resided in North America, were fluent in English, and were age 21 or over. For data quality, inclusion was restricted to MTurk Workers who had completed $\geq$ 1000 MTurk tasks with >98% approval ratings. Covert attention checks were included to enhance data quality, as recommended (Goodman et al., 2013). These included removal of abnormally fast completions (< 10 minutes), endorsed play on a fictional slot machine or video game, and inconsistent responding across repetitions of the same item. Overall, 721 (84.8%) of 850 otherwise eligible respondents had video game experience and familiarity with loot boxes. The full survey, administered via Qualtrics®, was then made accessible to this subset for a month, again on MTurk (compensation $1.50 USD). The survey was presented in the following order: Consent, demographics, video game and loot box questions, non-gambling scales, then gambling-related scales/items. This order reduced contamination or demand characteristics via the gambling items. Overall, 153 individuals found and completed this survey, and 144 passed the attention checks. Full survey data was collected from February through March of 2018.

Sample 2 comprised of students from the University of British Columbia, who participated in an online survey (using the same title description as the MTurk study), for course credit. No pre-

screen was conducted; rather, those who indicated no familiarity with loot boxes on the survey were excluded. Eligibility criteria were as for Study 1, except for a lowered age requirement (19 years, legal gambling age in BC). Of 138 respondents, 113 were eligible and passed the attention checks. Data was collected from March through April of 2018.

2.2. Measures

Video Game & Loot Box Questions. Video game-related questions inquired about use, preferences, virtual item valuation, and prioritization of gaming over other activities. Loot box-specific questions were created by the research team to assess engagement with (e.g., use, purchase), beliefs about, and behaviours regarding loot boxes. These questions were vetted by researchers familiar with the topic as well as a gaming community. A clear definition was provided for loot boxes, given the variety of synonymous terms used across contemporary games. Standard demographic questions were included (e.g., age, gender, ethnicity). These questions inquired about historical use, and responses were not time restricted.

Problematic Internet Gaming. The Internet Gaming Disorder Scale (IGDS; Lemmens et al., 2015) is a dichotomous 9-item scale that aligns with the provisional criteria for Internet Gaming Disorder in the DSM-5 (American Psychiatric Association, 2013). Respondents answer these questions with the previous 12 months in mind. The scale demonstrated good internal consistency ($\alpha = 0.82$).

Risk Taking. The financial subscale of the Domain-Specific Risk-Taking (DOSPERT-F) (Weber & Blais, 2002) includes six items scored on a seven-point Likert scale related to engagement in risky investment and gambling behaviours (e.g., *"betting a day's income at the horse races"*). Internal consistency was acceptable ($\alpha = 0.79$).

Gambling Beliefs. Two questionnaires were used to measure gambling-related cognitive distortions. The Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004) uses a seven-point scale, ranging from 'strongly disagree' to 'strongly agree' to measure illusion of control, interpretive bias, predictive control, gambling-related expectancies, and perceived inability to stop gambling. Reliability was excellent (total score $\alpha = 0.95$). The Darke and Freedman Beliefs Around Luck Scale (BALS; Maltby et al., 2008) measures four aspects of luck; Good Luck (BALS-GL), Bad Luck (BALS-BL), Belief in Luck (BALS-B), and Rejection of Luck (BALS-R) using a six-point Likert scale. The reliability of these subscales was good-to-excellent ($\alpha = 0.86$-0.97).

Problem Gambling. The Problem Gambling Severity Index (PGSI) (Ferris & Wynne, 2001) was used to assess problem gambling in the previous twelve months. Items are scored 0 ('never') to 3 ('almost always'). This scale is currently considered the gold standard self-report instrument for gambling problems (Dowling et al., 2018). Our data had excellent reliability ($\alpha = 0.91$).

2.3. Analysis Plan

Initial analyses focused upon loot box user demographics and descriptive information. A composite index of risky loot box usage was derived (*see Appendix A in Supplementary Materials)*, which was correlated with the other constructs. Informed by this correlation matrix, two hierarchical linear regressions assessed the prediction of this index by gambling-related variables. Gambling-related cognitive distortions have been found to moderate the relationship between gambling frequency and expressions of gambling harm (Miller & Currie, 2008). Therefore, the two cognitive scales (GRCS and BALS) were entered first, followed by measures of disordered gambling and gambling-related risk-taking (PGSI and DOSPERT-F). Then, a 'loot box distortion' (#6 in Table 4) was incorporated because of its increased proximity to loot box

risk. Lastly, the IGDS, age, gender, and exposure to loot box-related media were added to assess incremental explanation by traditional measures of gaming harm or covariates. A second model assessed incremental explained variance of the gambling-related/loot box variables, after the IGDS and covariates. In Study 2, group difference tests were conducted, using independent samples t-tests and a chi-squared test, between those whose preferred game had an associated virtual item marketplace and those whose preferred game did not.

Analyses were conducted using IBM SPSS® 25.0. Given skew in gaming and gambling involvement, descriptive statistics report median values. Following Field (Field, 2017), outliers were first assessed with boxplots, noting cases above 3.0 times the interquartile range (IQR). The distribution of z-scores for this subset was assessed, and variables with a greater than expected number of extreme cases were thought to contain outliers. Next, normality was assessed with a series of P-P plots. Normality was not observed on the GRCS, PGSI, or the BALS-BL subscale. A log transformation was applied to the PGSI, which mitigated the skew. Bootstrapping (BCa, 2000 samples) was used to mitigate the impact of both the outliers and normality deviations for correlation and regression analyses. Missing data was excluded listwise. Collinearity diagnostics did not indicate the presence of multicollinearity within regression models. Variance inflation factors ranged from 1.23-2.81 (Study 1) and 1.05-1.70 (Study 2); and tolerance ranged from .357-.811 (Study 1) and .590-.948 (Study 2).

3. Results – Study 1

3.1. Demographic Information

See Table 1 for participant demographics. Current video game play was endorsed by 97.2% of the sample, and online play by 95.1%. The average age that participants began gaming was 8

(*SD* = 10.4), and the average gaming frequency was "6-10 hours per week". Regarding gambling behaviour, 87.4% reported past gambling experience, 53.2% were current gamblers, and 78.3% endorsed slot machine play. Median gambling frequency was "about once a year", and 39.2% reported gambling every few months. See Figure 1 for a distribution of risky gambling behaviour, measured by the PGSI.

[Insert Table 1 About Here]

[Insert Figure 1 About Here]

3.2. Loot Box Engagement and Attitudes

Table 2 provides information regarding loot box engagement. There was a high degree of heterogeneity in preferred video game to open loot boxes, with 44 titles reported. For the 45.1% who endorsed spending on loot boxes, the median expenditure was $10.00 (*SD* = 16.7) per month and this was highly skewed (6.2% spent more than $40.00; see Figure 2). Attitude towards loot boxes was generally positive ('good feature' 52.1%; 'bad feature' 33.3%; neutral response 14.6%). Regarding perceived similarity to gambling; 75.7% endorsed agreement that *"opening Loot Boxes sometimes feels like making a bet"*, and 68.1% endorsed agreement for *"I believe Loot Boxes are a form of Gambling"*.

[Insert Table 2 About Here]

[Insert Figure 2 About Here]

3.3. "Risky Loot-box" Index

Twelve loot-box items assessed problematic aspects of loot box use. These were condensed into a five-item scale using Principle axis factoring (see *Appendix A in Supplementary Materials*) that

produced a single-factor solution (α = .864), which we refer to henceforth as the Risky Loot-box

Index (RLI). Retained items included: (1) *The thrill of opening Loot Boxes has encouraged me to*

buy more; (2) *I frequently play games longer than I intend to, so I can earn Loot Boxes*; (3) *I*

have put off other activities, work, or chores to be able to earn or buy more Loot Boxes; (4) *Once*

I open a Loot Box, I often feel compelled to open another; and (5) *I have bought more Loot*

Boxes after failing to receive valuable items. This variable was correlated against surveys

assessing gambling behaviour, gambling-related cognitive distortions, and risk-taking behaviour.

Correlation matrices are reported in Tables 3 & 4. Initial validity is demonstrated via bivariate

correlations with questions 1 & 9 in Table 4, where risky use is assumed to associate with

expenditure and self-reported problematic use.

[Insert Table 3 About Here]

[Insert Table 4 About Here]

3.4. Regression Analyses

In the hierarchical regression predicting RLI, gambling cognitions explained 34.3% of the

adjusted variance, $F(4, 137) = 19.4$, $p < .001$, $R^2 = .362$, Adj. $R^2 = .34$ (see Table 5). Combined,

the variables related to gambling cognitions and problem gambling (steps 1-2) accounted for

37.1% of the adjusted variance, $F(7, 134) = 16.3$, $p < .001$, $R^2 = .398$, Adj. $R^2 = .371$; $\Delta F(2,135)$

$= 4.12$, $p = .018$. IGDS, gender, and media exposure were also significant predictors. A second

hierarchical regression was conducted to determine the incremental value of the gambling-

related variables. IGDS, age, gender, and media exposure accounted for 15.4% of the adjusted

variance, $F(4, 137) = 7.40$, $p < .001$, $R^2 = .178$, Adj. $R^2 = .154$. Following these, gambling-

related variables accounted for an additional 28.5% of adjusted variance, $F(10, 131) = 12.1$, $p <$ .001, $R^2 = .479$, Adj. $R^2 = .439$; $\Delta F(6,131) = 12.64$, $p < .001$.

[Insert Table 5 About Here]

4. Results – Study 2

4.1. Demographic Information

See Table 1 for demographic information. Current play was endorsed by 92.2% of the sample, and online play by 85.3%. The sample self-reported gaming onset at age 4 ($SD = 2.25$), with a median frequency of "6-10 hours per week". Overall, 56.9% reported past gambling experience, 15.5% were current gamblers, and 44.0% had used a slot machine. Compared to MTurk, a smaller proportion of participants engaged in problem gambling behaviour (PGSI; see Figure 1).

4.2. Loot Box Descriptives

In this sample, 60.3% endorsed spending money on loot boxes (see Table 2). The 58 individuals who reported monthly expense had a median of $17.50 ($SD = 44.2$), and 10.3% spent more than $50.00 (see Figure 2). Game preferences were less diverse (23 titles) compared to Study 1. There were mixed views on loot boxes (good = 30.2%, neutral = 38.8%, bad = 31.0%). Overall, 79.3% agreed that loot boxes can feel like betting, and 86.2% agreed that loot boxes are a form of gambling.

4.3. Correlational Analyses

The RLI had good internal consistency in Study 2 ($\alpha = .834$) and correlations matrices are reported in Table 6 (scales) & Table 7 (individual items).

[Insert Table 6 About Here]

[Insert Table 7 About Here]

4.4. Regression Analyses

The hierarchical regression predicting RLI replicated Study 1, where gambling-related variables explained a significant proportion of variance, $F(3, 109) = 4.99$, $p = .003$, $R^2 = .121$, Adj. $R^2 = .097$. Gender, age, and media exposure were not significant predictors. Inclusion of the IGDS significantly increased explained variance, $F(4, 108) = 6.01$, $p < .001$, $R^2 = .183$, Adj. $R^2 = .153$; $\varDelta F(1,108) = 8.25$, $p = .005$. Entered first, the IGDS explained a significant proportion of variance, $F(1, 111) = 12.2$, $p = .001$, $R^2 = .099$, Adj. $R^2 = .091$. Gambling-related variables, when entered after the IGDS, accounted for an additional 6.20% of adjusted variance, $F(4, 108) = 5.13$, $p < .001$, $R^2 = .183$, Adj. $R^2 = .153$; $\varDelta F(3,108) = 3.71$, $p = .013$.

4.5. Preferred Games to Open Loot Boxes

The narrower distribution of preferred games in Study 2 allowed for analysis of participants who preferred games with ($n = 35$) vs. without ($n = 50$) marketplaces, for those where marketplace presence or absence could be determined. As a manipulation check, the question, *"I buy Loot Boxes with the hope of receiving valuable items to sell"* was tested for differences between these two subgroups: participants who preferred marketplace games ($M = 2.34$, $SD = 1.37$) scored higher than participants in the latter group ($M = 1.62$, $SD = 1.03$); $t(83) = 2.64$, $p = .010$, Cohen's $d = 0.60$. On the question *"Virtual items that can be sold are better than those that cannot be"*, participants who preferred marketplace games reported higher scores ($M = 3.57$, $SD = 1.14$) than participants who preferred games without marketplaces ($M = 3.04$, $SD = 1.18$); $t(83) = 2.07$, $p = .041$, Cohen's $d = 0.46$. Within the marketplace group, 24 of 35 participants reported expense,

whereas in the non-marketplace group, 21 of 50 participants reported expense, $\chi^2(1) = 5.84$, $p = 0.016$, $\varphi = .262$.

5. Discussion

These two samples of adult gamers showed high levels of engagement with loot box features. In Studies 1 and 2, 88.9% and 94.8% had opened a loot box, respectively. Our participants encountered this feature across a wide variety of games that spanned many genres and platforms. The MTurk sample appeared to endorse a positive view of loot boxes more than the student sample (52.1% vs. 30.2%). Correlational analyses did not indicate that this was explained by the age difference between the samples, but other possible factors are game-related preferences or non-gaming demographic differences. Approximately half (49.3% and 60.3%) of each sample reported expenditure to *buy* loot boxes, and substantial variation in expenditure was seen. A similar skew was detected in the weekly hours spent earning loot boxes, implying that non-monetary risks could also arise for some individuals.

In a large survey of video gamers ($n = 7,422$), Zendle & Cairns (2018) reported that loot box expenditure was linked with problem gambling status (PGSI). The relationship between other microtransactions and problem gambling was not as strong, indicating a specific roll of loot boxes in this association. Macey & Hamari (2018) also found 'video game-gambling habits', which likely included loot boxes, moderately predicted PGSI score in a sample of video gamers. We replicated these findings in the pattern of correlations between loot box expenditure, RLI, and PGSI (see Tables 3 and 4). Within Study 1, moderate-to-strong relationships were observed for the RLI against the PGSI ($r = .491$) and GRCS ($r = .518$), and three of the BALS subscales. Similar associations were observed, although of smaller size, in Study 2. The muted effect in Study 2 likely reflects the university sample's lower level of gambling experience: only 15.5%

were current gamblers (compared to MTurk sample, 53.2%), which in turn reduced variance on the GRCS and PGSI. Distorted cognitions are implicated as an etiological factor in Gambling Disorder, and analogous cognitions have been posited in gaming (King et al., 2012; King & Delfabbro, 2014; Wu et al., 2018). These correlations indicate that gambling cognitions could be risk factor for the excessive use of loot box features.

Together, gambling-related variables accounted for 37.1% of variance in the RLI. Notably, gambling-related variables contributed an additional 28.5% over the variance attributed to problematic gaming (IGDS). Study 2 replicated these findings, though gambling involvement within the sample was lower and gambling-related variables correspondingly accounted for less total and incremental variance (9.70%; 6.20%). In other words, gambling measures were more strongly related to risky loot box use, and explained a larger share of the variance, than typical measures of problematic gaming. This could point to some differentiation between problematic loot box use and the common presentation of disordered gaming, which emphasizes excessive time spent gaming, preoccupation, and consequential functional impairment (American Psychiatric Association, 2013; Lemmens et al., 2015). Rather, problematic loot box use may emerge from financial risk-taking and cognitive distortions associated with problem gambling. This concurs with research advocating the need to investigate other harms (e.g., financial) arising from modern video games (Starcevic & Billieux, 2018).

Subsets of both samples (27.8% and 39.7%) reported selling items from loot boxes. This figure is striking because 'cashing out' requires either integrated marketplaces or trade features, which not all games allow. This feature allows gamers to enact gambling-like behaviour with loot boxes, where the monetary reward from selling could be the desired outcome. The RLI correlated moderately with questions related to item sale (see Table 4). Study 2 provided further insight,

through comparison between preferred loot box games with and without marketplaces. This is a coarse contrast, because preference for marketplace-enabled games did not preclude the player from also playing other non-marketplace games. Nevertheless, reporting monthly spending on loot boxes was associated with preference for marketplace games. Those who preferred marketplace games were more inclined to buy loot boxes specifically to sell the content, and believed that virtual items that could be sold were 'better'. Our interpretation is that marketplace features increase in-game spending and shift players' valuation of items from subjective qualities (e.g., aesthetics) to monetary worth. This is an important consideration, since loot boxes are commonly portrayed as a method of in-game customization, rather than a digital store of value.

5.1 Study Limitations

This study was exploratory and contains some limitations. The recruitment ad mentioned loot boxes, which could have influenced individual's decisions to participate. A comparison of pre-screen and full survey respondents in Study 1 indicates this could have biased our sample toward regular loot box users but not regular gamblers (see *Appendix B in Supplementary Materials*). Although we used attention checks and MTurk workers with high approval ratings to improve data quality, deliberate mischievous responding cannot be ruled out. Further variables could moderate these relationships and/or the differences between samples (e.g., the dispositions of MTurk workers or video game playing undergraduates), and we encourage further replication in other populations. Our questions assessing loot box beliefs and engagement were newly created. While effort was undertaken to reduce question ambiguity, it is possible their interpretation differed across participants and samples. For example, the statement, *"I believe loot boxes are a form of gambling"* did not correlate with the RLI, GRCS, or PGSI, but predicted more negative attitudes toward loot boxes ($r = -.408$). It is possible this question aligns more closely with a

pejorative perspective toward loot boxes, rather than gambling-related cognitions or behaviours. Similarly, further validation is warranted for the Risky Loot-box Index, although it did display adequate psychometric properties. We emphasize this should not be taken as a measure of 'loot box disorder', rather an aggregate of behaviours that could be considered risky for those who excessively engage with this feature. Additional work is required to develop questions that assess specific beliefs pertaining to loot boxes. Further, the size of the effect of the gambling-related items in predicting risky loot box use varied substantially between the two samples in this exploratory study, indicating the likely existence of moderators.

6. Conclusions

Building on recent editorials from King & Delfabbro (2018) and Drummond & Sauer (2018), this study provides empirical evidence of associations between loot boxes (i.e., risky use, expenditure) and problem gambling, as well as problem internet gaming. As cross-sectional data, these associations may indicate that individuals with risky gambling beliefs and behaviours are vulnerable to loot box features in gaming, or alternatively, risky loot box use could promote problematic gambling, as seen in the transitions from SCGs to gambling (Kim et al., 2015). The participants' high rate of agreement that loot boxes reflect betting behaviour and gambling indicates that gamers perceive loot boxes as a 'gamblified' feature of video games.

The presence of item marketplaces or player-to-player trading may be a crucial feature for the enactment of gambling behaviours, and it may shift a player's perspective toward the system's monetary aspects. Our measure for marketplace presence, though coarse, was associated with differences in virtual item valuation and monthly expenditure. Jurisdictional reviews have identified marketplace features as a key determinant of regulation of specific video games as gambling (Yin-Poole, 2018). Nevertheless, the ability to sell items constitutes a 'narrow' view of

gambling with loot boxes, and the risks that may be associated with a player's 'bound' items should not be discounted. King and Delfabbro (2018) make no such discrimination when labelling loot boxes as predatory. Beyond restrictions related to item sale or trade, additional regulations could impose limitations on the rarity of items and/or publish these probabilities, a policy already enacted in China (Hilgert, 2018). Since virtual items are typically associated with game-wide player accounts, the ability to impose spending limits (Drummond et al., 2019) or self-exclude from loot box purchases or microtransactions could also be considered.

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Author Notes

Conflict of Interest Statement

LC is the Director of the Centre for Gambling Research at UBC, which is supported by the Province of British Columbia government and the British Columbia Lottery Corporation (BCLC). The BCLC is a Canadian Crown Corporation. The Province of British Columbia government and BCLC had no involvement in the research design, methodology, conduct, analysis or write-up of the study, and impose no constraints on publishing. LC has received speaker reimbursements from the National Center for Responsible Gaming (US) and National Association of Gambling Studies (Australia), and payments for reviewing from the National Center for Responsible Gaming and Gambling Research Exchange Ontario. He has not received any further direct or indirect payments from the gambling or gaming industries or groups substantially funded by gambling or gaming. He has received royalties from Cambridge Cognition Ltd. relating to the licensing of a neurocognitive test. GB has no disclosures.

Table 1. Participant Demographics

| Demographics	Sample 1: MTurk (n = 144)	Sample 2: University (n = 113)
Median Age (SD)	34.0 (10.0)	21.0 (2.39)
Gender (% Female)	48.6%	12.1%
Ethnicity:		
Asian	8.32%	62.1%
African-American/Black	8.33	0.90
Caucasian/White	78.5	24.1
Latin American	1.40	0.90
"Other"	3.47	12.0

Note: Nine participants were removed from the MTurk sample and 22 were removed from the university sample due to failed attention checks.

Table 2. Loot Box Engagement

Questions:	Percent "Yes" Study 1 / Study 2	Median Endorsed Statement Study 1 / Study 2
Have you played a game with loot boxes?	93.8 / 97.4%	
Have you opened a loot box within a video game?	88.9 / 94.8	
Have you spent time specifically to earn loot boxes?	63.2 / 55.2	
Have you bought a loot box or "key" to unlock one?	49.3 / 60.3	
Have you sold a loot box or loot box item?	27.8 / 39.7	
Have you profited from loot boxes?	18.1 / 25.9	
Approx. age of first Loot Box Use:		"26 – 30 years old" / "14 – 17 years old"
Approx. hours spent specifically to earn Loot Boxes:		"less than an hour per week" / "less than an hour per week"

Note: 15.3% of the study 1 reported spending more than three hours per week specifically to earn loot boxes, and 5.56% spent more than six hours per week. 15.5% of study 2 reported spending three or more hours per week specifically to earn loot boxes, and 6.03% spent six or more hours per week.

Figure 1. Distribution of PGSI Scores
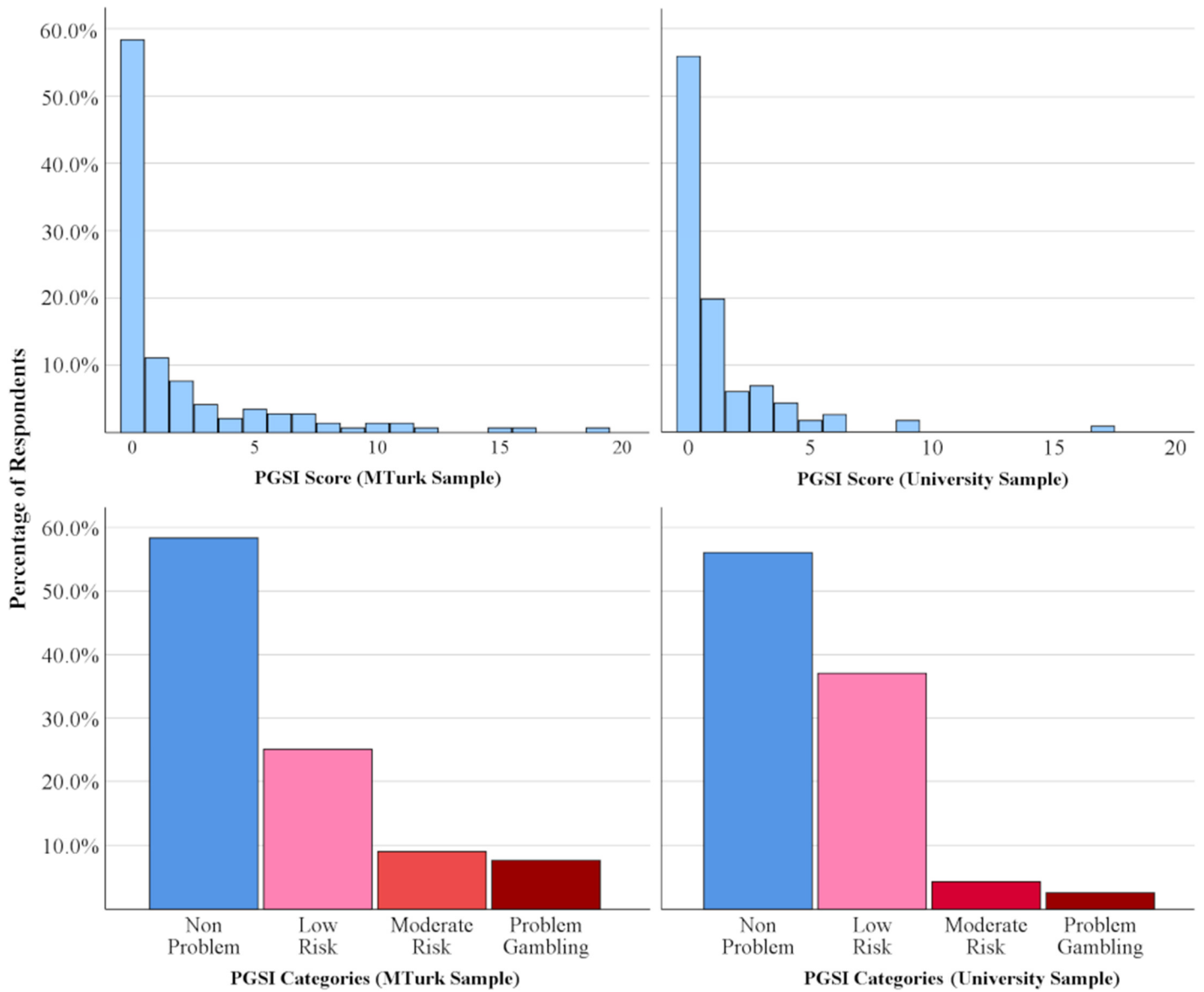
Note: Risk categories are based upon (Currie et al., 2013); Non Problem = '0'; Low Risk = '1-4', Moderate Risk = '5-7'; Problem Gambling = '8+'.

Figure 2. Monthly Expenditure on Loot Boxes
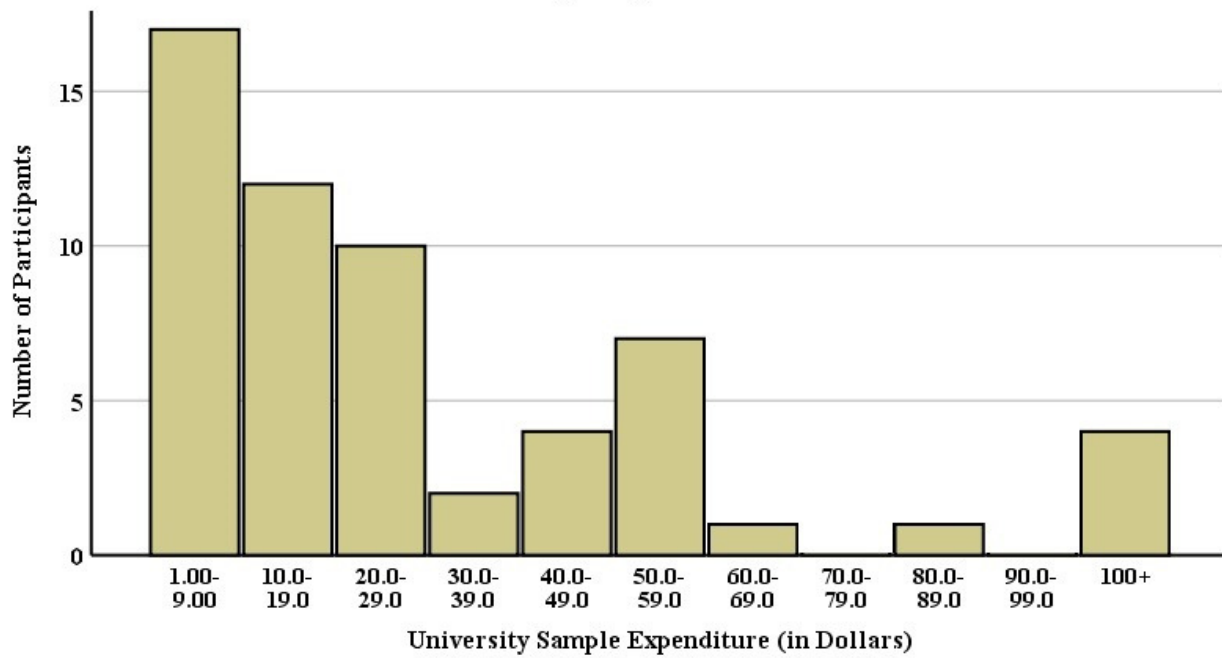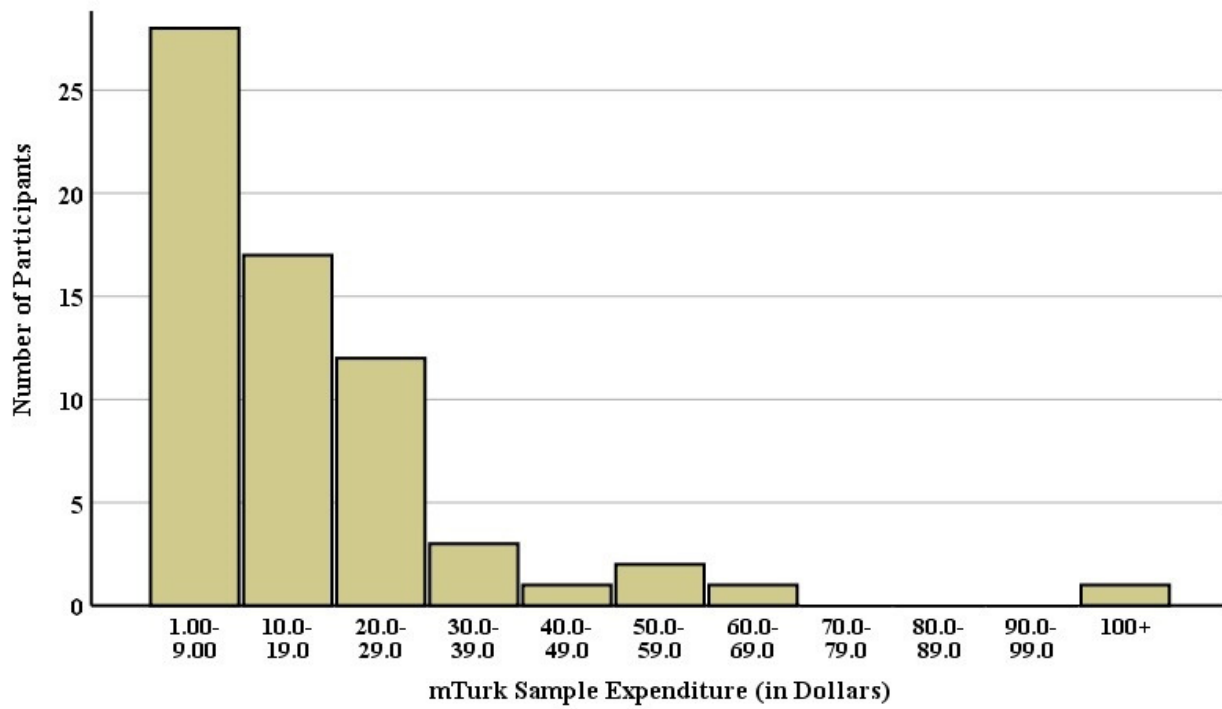
Note: Distribution reflects current monthly expenditure on loot boxes, by those who reported current expenditure, within the MTurk sample (n = 65) and the university sample (n = 58).

Table 3. Correlation Matrix of Scales – Study 1

Variables:	M	SD	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. RLI	7.86	5.70	.518**	-.066	.277**	-.462**	.329**	.491**	.355**	.240**	.006
2. GRCS	53.0	27.2	—	.062	.388**	-.363**	.461**	.697**	.340**	.441**	-.201*
3. BALS-BL	15.2	8.24		—	-.412**	-.063	.421**	.066	-.099	-.043	-.069
4. BALS-GL	17.0	7.10			—	-.155	.130	.214*	.109	.181*	-.163
5. BALS-R	17.8	4.84				—	-.375**	-.246**	-.153	-.077	.162
6. BALS-B	20.1	7.63					—	.330**	.224**	.160*	-.083
7. PGSI	1.90	3.49						—	.426**	.357**	-.140
8. IGDS	3.18	2.51							—	.157	-.146
9. DOS-F	15.5	7.01								—	-.152
10. Media	3.74	2.65									—

Note: * $p \leq .05$, ** $p \leq .01$ (two-tailed), *df* = 140; Bootstrapped correlations (2,000 samples); DOS-F = DOSPERT-F; Media = Exposure to media regarding concerns about loot boxes, answered on a sliding scale (1-9) with greater values equalling more exposure. Correlations between the RLI and GRCS subscales had a range of r = .370 for 'Inability to Stop' to r = .495 for 'Gambling Expectancies'

Table 4. Correlation Matrix of Scales & Individual Items – Study 1

Questions:	RLI	PGSI	GRCS	IGDS	Media
(1) My Loot Box use has caused me problems.	.441**	.502**	.368**	.378**	-.093
(2) Opening Loot Boxes is exciting.	.550**	.189*	.252**	.195*	.045
(3) Opening Loot Boxes sometimes feels like making a bet.	.274**	.118	.113	.212*	.129
(4) I believe Loot Boxes are a form of gambling.	-.060	-.018	-.033	-.035	-.148
(5) I buy Loot Boxes with the hope of receiving valuable items to sell.	.462**	.286**	.371**	.194*	-.069
(6) I believe obtaining items from Loot Boxes is an effective way to generate money.	.464**	.285**	.260**	.090	-.036
(7) I most enjoy games that rely heavily on randomization to determine rewards.	.377**	.167*	.278**	.119	-.036
(8) Do you believe Loot Boxes are a good or bad feature of gameplay?	.465**	.075	.190*	.005	-.043
(9) Please estimate your monthly spending on Loot Boxes or Keys in dollars.	.486**	.234**	.304**	.183*	-.021

Note: $* p \leq .05$, $** p \leq .01$ (two-tailed), $df = 141$; Bootstrapped correlations (2,000 samples). Questions 1-7 used a five-point Likert-scale (Strongly Disagree – Strongly Agree). Three responses existed for question 8 (Bad Feature, Neither Good nor Bad, Good Feature), question 9 required the input of a dollar value.

Table 5. Hierarchical Regression Predicting the Risky Loot Index in Study 1

Variables:	Step 1 β [CI]	SE	Step 2 β [CI]	SE	Step 3 β [CI]	SE	Step 4 β [CI]	SE
GRCS	.356** [.189, .523]	.084	.149 [-.070, .368]	.111	.155 [-.054, .365]	.106	.163 [-.035, .362]	.100
BAL-R	-.305** [-.455, -.156]	.076	-.311** [-.457, -.164]	.074	-.244** [-.388, -.100]	.073	-.229** [-.362, -.090]	.070
BAL-GL	.087 [-.060, .234]	.074	.104 [-.040, .248]	.073	.090 [-.047, .228]	.069	.103 [-.029, .236]	.067
BAL-B	.040 [-.117, .198]	.080	.039 [-.115, .193]	.078	.023 [-.124, .170]	.074	-.009 [-.150, .133]	.072
PGSI			.266* [.081, .450]	.093	.209* [.031, .387]	.090	.168 [-.031, .349]	.091
DOS-F			.031 [-.117, .178]	.075	.042 [-.099, .183]	.071	.058 [-.077, .193]	.068
LB-EM					.264** [.127, .401]	.069	.254** [.122, .390]	.068
IGDS							.189** [.056, .323]	.068
Age							-.019 [-.014, .010]	.006
Media							.164** [.042, .288]	.062
Gender							.150* [.040, .561]	.132
$R^2 / \Delta R^2$	.362 / .362		.398 / .037		.460 / .062		.531 / .071	
Adj. R^2	.343		.371		.432		.491	
ΔF	19.4**		4.1*		15.4**		4.90**	

Note: * $p \le .05$, ** $p \le .01$ (two-tailed), CI = Bootstrapped BCa 95% CI (2,000 samples); DOS-F = DOSPERT-F; LB-EM = "I believe obtaining items from Loot Boxes is an effective way to generate money".

Table 6. Correlation Matrix of Scales – Study 2

Variables:	M	SD	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. RLI	7.39	4.90	.287**	.059	.063	-.109	.183*	.315**	.318**	.111	.101
2. GRCS	50.9	20.9	—	.299**	.258**	-.287**	.314**	.494**	.244**	.334**	-.001
3. BAL-BL	15.9	7.06		—	-.120	-.444**	.403**	.198*	.226*	-.010	.108
4. BAL-GL	17.0	6.16			—	-.073	.270**	.098	.078	.207*	-.012
5. BAL-R	18.1	4.12				—	-.374**	-.228*	-.049	-.013	.108
6. BAL-B	21.1	6.26					—	.214*	-.009	.127	.092
7. PGSI	1.24	2.35						—	.188*	.271**	.054
8. IGDS	4.39	2.53							—	.055	.217*
9. DOS-F	17.0	6.09								—	-.027
10. Media	4.86	2.77									—

Note: * $p \le .05$, ** $p \le .01$ (two-tailed), *df* = 111; Bootstrapped correlations (2,000 samples); DOS-F = DOSPERT-F; Media = Exposure to media regarding concerns about loot boxes, answered on a sliding scale (1-9) with greater values equalling more exposure.

Table 7. Correlation Matrix of Scales & Individual Items – Study 2

Questions:	RLI	PGSI	GRCS	IGDS	Media
(1) My Loot Box use has caused me problems.	.366**	.259**	.240*	.191*	-.009
(2) Opening Loot Boxes is exciting.	.395**	-.036	-.105	.059	.069
(3) Opening Loot Boxes sometimes feels like making a bet.	.253**	.089	.141	.184	.111
(4) I believe Loot Boxes are a form of gambling.	074	.026	.051	-.013	.224*
(5) I buy Loot Boxes with the hope of receiving valuable items to sell.	.210*	.277**	.251**	.103	.038
(6) I believe obtaining items from Loot Boxes is an effective way to generate money.	.257**	.049	-.006	.018	.031
(7) I most enjoy games that rely heavily on randomization to determine rewards.	.140	.141	.075	.023	-.153
(8) Do you believe Loot Boxes are a good or bad feature of gameplay?	.162	.247**	.085	.038	-.242**
(9) Please estimate your monthly spending on Loot Boxes or Keys in dollars.	.249**	-.008	.019	-.004	.024

Note: * $p \leq .05$, ** $p \leq .01$ (two-tailed), $df = 141$; Bootstrapped correlations (2,000 samples). Questions 1-7 used a five-point Likert-scale (Strongly Disagree – Strongly Agree). Three responses existed for question 8 (Bad Feature, Neither Good nor Bad, Good Feature), question 9 required the input of a dollar value.

Supplementary Online Material

Appendix A: Development of the "Risky Loot" Index

Twelve items assessed problematic aspects of loot box use (see Supplementary Table A.1). To consolidate these items, an exploratory factor analysis was conducted ($n = 144$) with Principle axis factoring to account for measurement error among variables (Thompson, 2004). The procedure was rerun after each item removal. From the initial items, one variable was excluded due to high collinearity, and six were excluded due to low communality (< .450). The remaining five items reflected preoccupation with loot boxes, impulsive use, and chasing of losses; these remaining items were suitable for factor analysis (Determinant = .093; Kaiser-Meyer-Olkin = .821; Bartlett's Test of sphericity, $x^2 = 33.28$, $df = 10$, $p < .001$). Factors with an eigenvalue > 1 were retained, and a single factor solution was produced with an eigenvalue of 3.24. Results from the Scree Plot converged with this solution (see Supplementary Figure A.1). This factor explained 56.3% of the total variance, Supplementary Table A.2 provides factor loadings and communalities for each retained item. Cronbach's alpha indicated good internal consistency (α = .864) and the items loading on the latent factor indicated risky loot box usage scores ranging from 0-20. We recognize that this variable was not intended to assess 'disordered' or 'addictive' loot box usage, only risky behaviours that may become problematic.

Table A.1. Initial Set of Items for Factor Analysis

---

(1) I frequently play games longer than I intend to, so I can earn Loot Boxes.

(2) I believe obtaining items from Loot Boxes is an effective way to generate money.

(3) I will play for long periods of time to earn Loot Boxes.

(4) Receiving items from Loot Boxes is a primary reason why I play video games.

(5) I buy Loot Boxes with the hope of receiving valuable items to sell.

(6) I have felt guilty about the amount of time or money I have spent on Loot Boxes.

(7) I have put off other activities, work, or chores to be able to earn or buy more Loot Boxes.

(8) Once I open a Loot Box, I often feel compelled to open another.

(9) I have sometimes spent more on Loot Boxes than I could afford.

(10) I have bought more Loot Boxes after failing to receive valuable items.

(11) The thrill of opening Loot Boxes has encouraged me to buy more.

(12) My Loot Box use has caused me problems.

Note: Questions are answered on a five-point likert scale (strongly disagree – strongly agree).
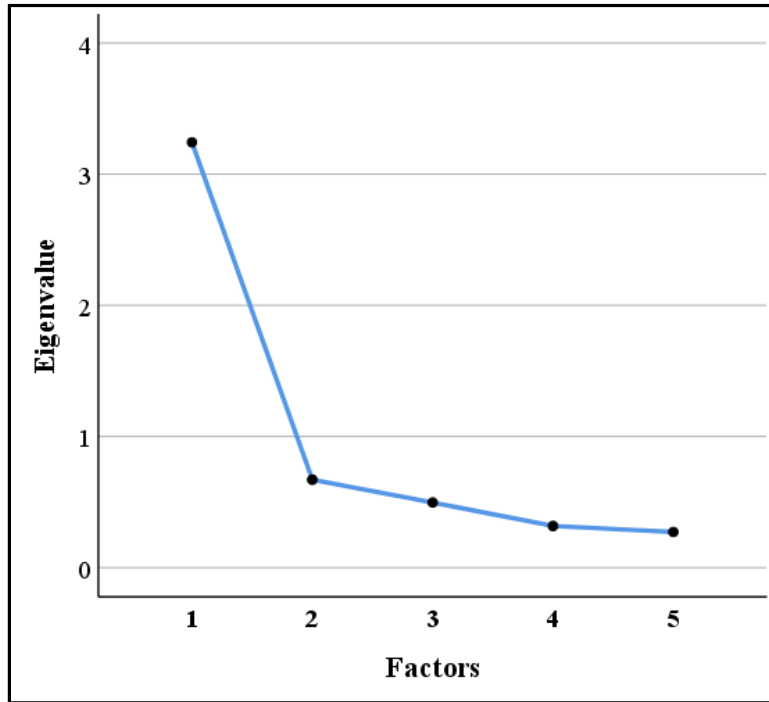
Figure A.1. Scree Plot of Risky Loot Index

Table A.2. Communalities and Factor Loading

Scale Items	Factor Loading	Communality
(1) The thrill of opening Loot Boxes has encouraged me to buy more.	.848	.718
(2) I frequently play games longer than I intend to, so I can earn Loot Boxes.	.754	.569
(3) I have put off other activities, work, or chores to be able to earn or buy more Loot Boxes.	.745	.555
(4) Once I open a Loot Box, I often feel compelled to open another.	.701	.491
(5) I have bought more Loot Boxes after failing to receive valuable items.	.695	.482

Note: Communalities listed are after extraction. Questions are answered on a five-point likert scale (strongly disagree – strongly agree).

Appendix B: Chi-Square Tests Between Pre-screen & Full Survey

Table B.1. Pre-screen & Full Survey Participants

Questions:	Pre-screen (n = 850)	Full Survey (n = 144)	Chi-Square Test	*p*-value
Do you currently gamble?			$\chi^2(1) = .316$	.574
Yes:	433	76		
No:	417	68		
Have you ever gambled?			$\chi^2(1) = .176$	.675
Yes:	754	125		
No:	96	19		
Have you opened a loot box?			$\chi^2(1) = 21.3$	.000
Yes:	599	128		
No:	251	16		