ORIGINAL PAPER

To Pay or Just Play? Examining Individual Differences Between Purchasers and Earners of Loot Boxes in Overwatch

Chanel J. Larche[1] · Katrina Chini[1] · Christopher Lee[1] · Mike J. Dixon[1]

Abstract

Video-game loot boxes are a popular form of microtransaction that have been widely criticized for their structural similarities to gambling. Recent research linking loot box expenditure to gambling activity has illuminated potential harms associated with loot box use. However, whether the harms differ between earning loot boxes through gameplay versus acquiring loot boxes through purchasing remains understudied. This pre-registered study explores gambling, gaming and loot box-related harms between loot box purchasers and earners in the scope of the game Overwatch. To our knowledge, this is the first study to assess loot box-related harms in a single game. We found that loot box purchasers experienced greater video-game related expenditure harms, risky loot box use, impulsivity related to planning and reward reactivity in comparison to loot box earners. Surprisingly, Overwatch loot box *earners* displayed greater gambling-related harms and there were no differences in general problem video-gaming between the two groups. Our results suggest that the relationship between loot box purchasing and gambling is in need of refined examination. Particularly, our results indicate that potential harms stemming from loot box engagement should be assessed on a game-by-game basis in order to better understand the potentially problematic nature of loot box use.

Keywords Loot boxes · Impulsivity · Gambling · Gaming · Reward sensitivity · Individual differences · Ethical game design

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Introductions

Loot boxes are a chance-based form of microtransaction featured in several video-games. Although primarily a means of generating revenue for game companies, the use of loot boxes in games has been widely criticized for their structural similarities to gambling—a traditionally regulated activity (Drummond & Sauer, 2018; Larche et al., 2019). Recent research has shown that increased expenditure on loot boxes specifically has been associated with increased problem gambling severity (Zendle & Cairns, 2018; Macey & Hamari, 2019) as well as problem video-gaming and psychological distress (Brooks & Clark, 2019; Li et al., 2019). Although most games feature purchasable loot boxes, some games also allow players to engage with loot boxes without spending money. For example, in games like *Overwatch* and *League of Legends*, in addition to purchasing them for money, players can also earn loot boxes directly through game-play (e.g., by achieving a new level rank, or winning three consecutive games in the so-called *Arcade Mode*). In this case loot boxes serve as rewards for successful gameplay.

From a harm perspective, although purchasing loot boxes has been consistently linked to financial harms (Brooks & Clark, 2019), what has yet to be ascertained is whether playing to obtain loot boxes might be related its own unique subset of harms (e.g., spending more time than intended trying to earn them). Zendle et al. (2020) directly contrasted a subset of harms for those who engage in unpaid loot box openings (n = 451) and those who engage in paid openings (n = 749) at the group level. In this study, the authors collected data from players engaging in a myriad of games, with a plethora of loot box types that could vary dramatically in terms of their intrinsic and perhaps 'addictive' appeal. Like Zendle et al. (2019), we contrasted the harms that may accrue from paying for loot boxes, versus earning loot boxes through play. Rather than considering loot boxes from different games, we focused on a single game (*Overwatch*) that offers loot boxes for pay or through play. In this way we hold constant the loot boxes under investigation and can focus solely on the differences between players who pay for, versus play for these same loot boxes.

Looking at different forms of loot box engagement has implications for how loot boxes should be regulated (Xiao, 2020). There has been a marked inconsistency in the way loot boxes have been regulated attributable to many differences in legal definitions of gambling and cultural perceptions of gambling and gaming. Globally, regulatory approaches have ranged from "banning" of loot boxes, to simply imposing age restrictions and the requirement of probability disclosures for relevant games (Xiao, 2020). Despite these marked differences, the regulatory approaches are unified in focusing on regulating loot boxes for pay (those that involve microtransactions), despite the fact that earning loot boxes through gameplay also incurs a cost to the player (e.g., time). Even without the financial component, unpaid loot boxes may have the potential to normalize gambling for younger players—a similar argument proposed for other videogames that feature simulated gambling activities such as *Grand Theft Auto* or *Red Dead Redemption* (King et al., 2012; Xiao, 2020). Hence, missing from the overall loot box gambling debate is whether the loot box format itself may contribute to harms, even if they are earned through play without any financial transactions.

Thus, the current study aims to empirically investigate the different arrays of harms and individual differences that may accompany the two distinct modes of loot box acquisition: purchasing loot boxes, versus earning them through gameplay without expenditure. To investigate this question the current research will focus on the highly popular

multiplayer first-person shooter game *Overwatch* since players can acquire loot boxes either through play or by paying for them.

Harms Associated with Paying Versus Playing for Loot Boxes

Loot boxes can be considered particularly appealing and potentially reinforcing regardless of how they are acquired. The contents of loot boxes are unknown to the player, and the items are randomly determined. The main appeal of loot boxes lies in the chance to obtain rare items—the rarer the items the more valuable the loot. In a study where players viewed videos of loot box openings, Larche et al. (2019) demonstrated that loot boxes containing the rarest items were the most inducing of arousal and the urge to open more loot boxes. Such findings parallel winning and losing outcomes in traditional gambling games. In slots, losses are the most frequently occurring outcome, small wins less frequent, while large wins are exceedingly rare, and trigger high excitement-induced arousal (Dixon et al., 2013; Baudinet & Blaszcynzski, 2013). Rare loot box items, like large wins in slots, can be seen as occurring on a variable ratio schedule. Such variable-ratio reinforcement schedules lead to more persistent behavior in gambling, video-gaming and presumably loot box use (Madden et al., 2007; Charlton & Danforth, 2007; Larche et al., 2019). As loot box purchasers and loot box earners engage with loot boxes in distinct ways, the reinforcing nature of the variable reinforcement schedule may impact the behaviours of these two groups differently. For purchasers, the primary behaviour of loot box engagement involves the use of money to obtain the reward, whereas for players who earn loot boxes, the primary behaviour involves gameplay. Thus, while purchasing loots is known to be associated with expenditure-related harms, those who earn loots through gameplay may instead experience problems predominantly related to excessive time playing the game for the purposes of gaining more boxes.

Studies conducted by Zendle et al. (2019, 2020) showed that those who paid for loot box openings had higher problem gambling severity scores than those who engaged in unpaid openings (i.e., earners). Importantly, in this study the only measure of harm was the Problem Gambling Severity Index (PGSI). Based on these findings we can reasonably expect to see a similar pattern of greater gambling harms for those who pay for loot boxes in Overwatch. It is less clear, however, whether loot box earners might incur different kinds of harms—namely problematic video-game play. At the time that this study was conducted, only a small handful of studies have looked at loot boxes and problematic game play (Drummond et al., 2020; Li et al., 2019), yet a contrast between those who purchased loot boxes versus those who never purchased or used loot boxes has yet to be made. Since for loot box earners, the expenditure is time, not money, there is a potential that this subgroup might experience problematic *gaming* harms as opposed to problematic gambling harms.

Brooks and Clark (2019) found that loot box expenditure was not only associated with greater problem gambling and gaming severity, but also with higher scores on The Risky Loot box Index—a newly developed measure of problematic loot box use. A goal of this study was to assess whether there would be differences in this measure based on whether players paid or earned loot boxes.

Impulsivity and Reward Processing Between Purchasing and Playing for Loots

Arguably the most salient difference between earning loot boxes versus paying for loot boxes is the time it takes for the onset of reward delivery. Paying affords immediate access

to the loot box, whereas earning loots requires far more time invested in the game. The immediacy of paying for loots may be of particular appeal to players with impaired decision-making traits like impulsivity since impulsivity is characterized as the tendency to make rapid decisions without forethought; the inability to inhibit responses and a preference for immediate rewards (Hodgins & Holub, 2015). In the gambling literature impulsivity is strongly related to problem gambling severity (Alessi & Petry, 2003; Benson et al., 2012). As those who purchase more loot boxes tend to report more problematic behaviors related to their loot box use (Brooks & Clark, 2019), we would expect more expenditure or gambling related harms for those who pay, versus those who earn loots.

For loot box earners, there is both time, and effort involved in gaining loots. In situations of goal pursuit people tend to assign greater value to objects and rewards where considerable effort was involved to obtain them (Bijleveld et al., 2012; Inzlicht et al., 2018; Yi et al., 2020). In fact, consumers are willing to pay more for items if they perceive themselves to have worked harder to obtain them compared to identical items for which no effort was expended (Mochon et al., 2012; Norton et al., 2012). At the neural level, people tend to experience enhanced emotional affect to hedonic rewards involving greater investments of effort (Hernandez et al., 2014; Ma et al., 2014; Johnson & Gallagher, 2011; Yi et al., 2020). As such, players who play for loot boxes may value them more than those who pay for the same loot boxes.

Recall that the rarity of the items in a loot box is correlated with how exciting they are and how much urge they induce to open another loot box (Larche et al., 2019). From the gambling literature we know that exposure to gambling cues has been shown to induce greater arousal and craving in those with heightened impulsivity (Antons et al., 2020; Wulfert et al., 2009, 2016). If paying for loot boxes is associated with greater impulsivity, then we would expect that those who pay for loot boxes may experience greater arousal and urge to open more loot boxes than those who play for loot boxes.

Overview of the Current Study

In line with previous research, our pre-registered hypotheses specified that loot box purchasers in Overwatch would report experiencing more symptoms of problematic loot box use, as well as more negative consequences related to expenditures (e.g., greater PGSI and game-related purchase harms) compared to loot box earners (Pre-registered on the Open Science Framework: https://osf.io/pkmnd). Moreover, we predicted that loot box earners would report more issues related to problem video-gaming due to the nature of attaining loot boxes being tied to successful gameplay. As purchasing allows for immediate access to loot box rewards, we expect purchasers to have higher levels of impulsivity.

We also had pre-registered hypotheses for the expected differences in reward processing in response to loot box openings between the two types of loot box engagement. Specifically, if loot box purchasers experience heightened impulsivity specifically, we would expect higher arousal and urge to open more loot boxes for purchasers compared to loot box earners. We also had hypotheses regarding emotion and value judgments for loots that were not pre-registered and more exploratory in nature. For loot box purchasers, we expected their loot box value judgments to be tightly titrated to how much they would actually be willing to pay for the loots in a real purchasing scenario. Based on previous research that indicates that we value that which we have worked hard for, we would expect earners to attribute greater value to the loots that they had earned. In consequence they would also show greater positive affect after seeing the fruits of their

labours. We therefore expect those who earn loot boxes to positively value loot box rewards more so than loot box purchasers. We employed a similar methodological paradigm to Larche et al. (2019) to assess such differences in reward processing. In this way, we expect to replicate our findings from Larche et al. (2019) such that the rarer loots will be rated as more valuable, rewarding and urge-inducing compared to more common loots regardless of whether players purchase loot boxes or not.

Methods

Participants

Two samples were collected separately using the online survey platform Amazon Mechanical Turk (MTurk). The first sample consisted of 218 players (135 valid cases; 54 female; age range of 19 to 61) who paid for loot boxes in Overwatch at least once in the past four weeks. The second sample consisted of 220 players (117 valid cases; 42 female; age range of 18 to 57) who had not purchased an Overwatch loot box in the past 4 weeks, but have obtained and opened a loot box in Overwatch in the past 4 weeks (criteria adapted from Zendle et al., 2020). All potential participants must have played Overwatch at least once in the past 4 weeks regardless of loot box purchasing status. Eligibility was established for both samples via a separate prequalification questionnaire on Mturk. To maximize the quality of responses, study availability was limited to predominantly English speaking countries (e.g., Australia, Canada, Ireland, New Zealand, Great Britain and the US) and to MTurk workers with at least a 96% approval rating and who had completed a minimum of 1000 tasks to date.

Eligible participants were redirected to the study's HIT with the Qualtrics survey link. The full study required approximately 30 min to complete, for which participants were compensated US $4.50.

The current study's protocol was reviewed and approved by [institution retracted for peer review] Research Ethics Committee. All participants were provided sufficient information about the study prior to participating by means of an information letter and consent form. Participants were given the choice to agree to participate or not, and were advised that they could withdraw at any point in the study without loss of remuneration.

Apparatus

Loot Box Stimuli

The stimulus set used in Larche et al. (2019) was used. This set comprised 49 videos of actual Overwatch loot box openings presented in randomized order for all participants. Each loot box was assigned an objective credit value (predetermined by the game) and sorted into one of three categorical tiers (Rare, Epic and Legendary) based on the increasing rarity of the items in the box (see Table 1 for loot box categories and associated values). As can be seen in this table, the less common items are worth far more. See Larche et al. (2019) for a full explanation of how loot boxes were objectively valued and classified.

Table 1 Loot box tiers and value ranges

Tier	Criteria	n	Value range (net worth of all items in box)
Rare	Box contains at least one "Blue" item	29	150–225 credits
Epic	Box contains at least one "Magenta" item	15	325–500 credits
Legendary	Box contains at least one "Gold" item	5	1075–1325 credits

Materials

The questionnaire following each loot box presentation consisted of subjective ratings of arousal, valence, urge to open another box, disappointment, loot box worth and loot box value.

Subjective Arousal and Positive Affect Ratings

Subjective arousal and degree of positive affect were measured using Self-Assessment Manikins (SAM; Bradley & Lang, 1994). Five manikins depicting various levels of arousal and positive/negative affect were presented to participants after each loot box event. Participants indicated their arousal level and affect level by selecting the manikin that best matched their current state (see Fig. 1). Manikins were translated to a 1–5 scale by assigning numbers to Manikins (leftmost = 1, rightmost = 5).
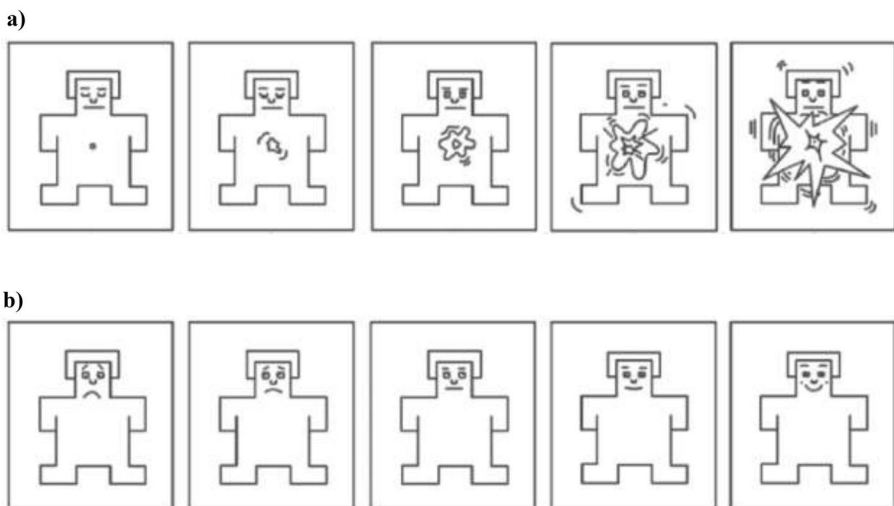
Fig. 1 a Self-assessment manikins depicting levels of arousal. **b** Self-assessment manikin, with leftmost picture depicting negative valence, rightmost more positive valence

Subjective Urge, Disappointment, Worth and Value Ratings

All other subjective ratings except loot box value were assessed via 100-point line scales. When rating urge to open another box, 0 would represent 'no urge' and 100 would represent 'high urge'. When rating disappointment, 0 would represent 'no disappointment' and 100 would represent 'high disappointment'. Worth was measured by asking how much each loot box outcome was worth to the participant whereby 0 represented 'no worth' and 100 represented 'high worth'. Loot box value was assessed by asking how many in-game credits the participant would willingly spend on each box. Value was measured on a 4000-pixel line scale where 0 represented '0 game credits' and 4000 represented '4000 game credits'. See Larche et al. (2019) for more detailed explanations of each item.

Gambling-Related Measures

The Canadian Problem Gambling Index (CPGI) and its Problem Gambling Severity Index (PGSI) component were used to assess gambling activity frequency and problem gambling severity respectively (Ferris & Wynne, 2001). The CPGI assesses frequency of engagement with 22 different gambling modes (e.g. slot machines, poker, lottery etc.). Items asked participants how frequently they engaged with a particular mode of gambling within the past 12 months using an eight-point scale with response options of 'daily', '2–6 times/week', 'about once/week', '2–3 times/month', 'about once/month', 'between 6 and 11 times/year', 'between 1 and 5 times/year', and 'never'.

The PGSI component of the CPGI consists of a nine-item survey that assesses gambling status and potential problem gambling within the last 12 months. An example item includes 'In the last 12 months, have you bet more than you could really afford to lose?'. Responses are made on a 4-point scale ranging from 'never', 'sometimes', 'most of the time' to 'almost always'. Gambling status is assessed via the cumulative totals of participants' item scores whereby 'never' corresponds to 0 and 'almost always' corresponds to 3. Participants with an overall score of 0 are considered non-problem gamblers, scores of 1–2 are considered low-risk gamblers, 3–7 are moderate risk gamblers, and 8 + constitutes high risk problem gamblers (Wynne, 2002).

Problem Video-Gaming

The Problem Video Game Playing Questionnaire (PVPQ) is a nine-item measure that assesses problem video gaming status or video game addiction (Tejeiro-Salguero & Morán, 2002). An example item includes 'I spend an increasing amount of time playing video games' for which participants respond '*yes*' or '*no*' to each item. Items are summed ('*yes*' is scored as 1 and '*no*' is scored as 0) to create a total PVPQ score. Higher overall PVPQ scores are indicative of more video game related problems. We also included an additional item on this scale to capture the harm of game-related purchasing: "I have been spending an increasing amount of money on games (e.g., hardware, software, in-game items, etc.)".

Loot box-Related Measures

The Risky Loot box Index (RLI) is a 5-item measure assessing problematic use of loot boxes (Brooks & Clark, 2019). The measure utilizes a 5-point Likert scale with response options of 'strongly disagree', 'somewhat disagree', 'neither agree nor disagree', 'somewhat agree' and 'strongly agree'. An example item includes 'Once I open a loot box, I often feel compelled to open another'. Items were summed to create a final RLI score, where 'strongly disagree' was scored as '1' and 'strongly agree' was scored as '5'. Hence, RLI scores ranged from 5 (non-risky loot box user) to 25 (high-risk loot box user).

Impulsivity Measures

The Barratt Impulsivity Scale (BIS-11) is a 30-item measure assessing impulsivity consisting of three subscales: attentional, motor, and non-planning impulsivity (Patton et al., 1995). The attention domain (8 total items; 2 reverse-coded items) assesses attention and cognitive instability (e.g., "I concentrate easily'). The motor domain (11 total items) assesses motor components of impulsivity and perseverance (e.g., 'I do things without thinking'). The non-planning domain (11 total items) measures self-control and cognitive complexity (e.g., 'I plan tasks carefully'). All items are scored on a 4-point scale where responses include 'never/rarely', 'occasionally', 'often' and 'almost always/always'. 'Never/rarely' scored as 1 and 'almost always/always' scored as 4. Participants' scores on each subscale were summed respectively.

Procedure

The survey began with the presentation of the loot box stimuli. A subjective response survey (e.g., arousal, valence, urge, etc.) followed each loot box opening. Following the last loot box, the final survey components were presented as follows: Attention check 1, demographics (age and gender), attention check 2, gambling related measures, video game and loot box related measures, impulsivity measures. The gambling, video-game and impulsivity measures were presented in a randomized order.

Data Reduction and Analysis Strategy

Two attention check items were included within the study. The first item required participants to read a block of text and respond per the specified instructions amid a set of plausible distractors. The second explicitly asked if participants had been randomly responding at any point during the study. Participants who failed either attention check were excluded from further analyses. Participants who failed to complete the majority of the survey were also excluded. The Van-Selst and Jolicoeur (1994) trimming method was used to identify and remove outliers.

For all subjective responses pertaining to loot box openings (e.g. arousal, urge, etc.), loot boxes were sorted into their respective tiers (Rare, Epic or Legendary), and an outlier-free average was calculated. These averages were used as input data for a mixed analysis of variance (ANOVA) with tier (Rare, Epic, Legendary) as the repeated factor, and loot

box route (Purchasers, Earners) as the between-subjects factor. Any violations of sphericity were rectified using Greenhouse–Geisser corrections. Fisher's Least Significant Difference (LSD) post hoc comparisons were used to analyze any significant main effects.

Results

The aforementioned data cleaning procedures left us with a final sample of 135 purchasers, and 117 loot box earners.
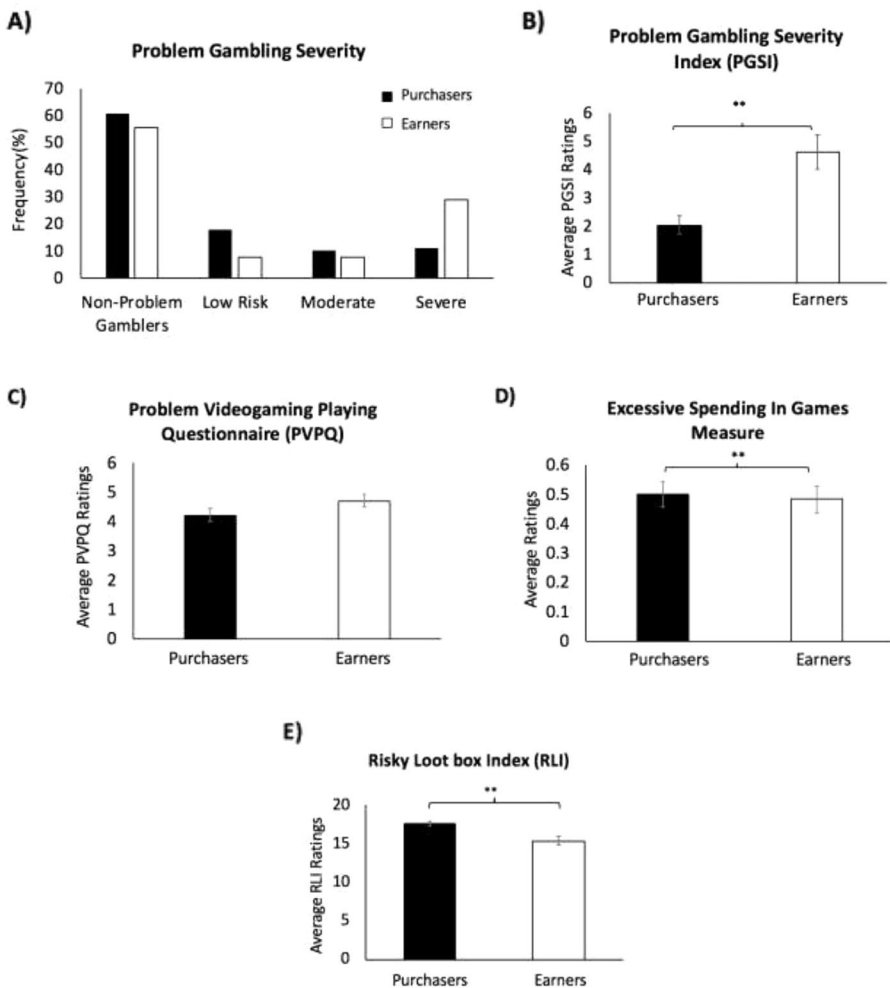
Fig. 2 **a** Distribution of purchasers and earners across the various levels of gambling severity. **b** Average problem gambling severity (PGSI) scores for purchasers and earners. **c** Average problem video gaming (PVPQ) scores for purchasers and earners. **d** Average ratings for our excess spending in games measure, **e** Average risky loot box (RLI) scores for purchasers and earners

## Problem Gambling, Problem Video-Gaming and Risky Loot Box Use

Average ratings of problem gambling severity, problem video gaming severity and risky loot box use between purchasers and earners are depicted in Fig. 2.

Contrary to our predictions, players who purchased loot boxes were shown to have *lower* problem gambling severity compared to loot box earners, $t(179.29) = 3.70$, $p < .001$, $d = 0.447$. Figure 3 displays percentages of purchasers and earners who endorsed having engaged in certain gambling activities over the past 12 months. Chi-square tests assessing the average percentages between earners and purchasers revealed that earners seem to be more avid gamblers compared to loot box purchasers (see Table 2 for statistics). Specifically, a significantly greater percentage of earners endorsed participating in traditional gambling games such as Horse betting, Bingo, Blackjack, Keno, Craps and Video Lottery Terminals (VLTs; marginally significant) compared to purchasers (Table 2).

There was no statistical difference between purchasers and earners on problem video-gaming severity, $t(250) = 1.53$, $p = .127$, $d = 0.193$. In line with our hypotheses, purchasers broadly reported experiencing more harm related to excessive video-game expenditures (e.g., purchasing in-game items, gaming hardware, etc.) compared to earners, $t(247.08) = -2.42$, $p = .016$, $d = 0.306$. Players who purchased loot boxes in Overwatch endorsed significantly more items related to risky loot box use compared to earners, $t(202.96) = -3.58$, $p < .001$, $d = 0.458$.

Impulsivity

For impulsivity, we compared purchasers and earners for each subscale on the BIS (see Fig. 4). Loot box purchasers did not statistically differ from earners on measures of attentional impulsivity, $t(250) = 1.13$, $p = .260$, $d = 0.142$. However, purchasers reported lower motor impulsivity compared to earners, $t(205.48) = 2.69$, $p = .008$, $d = 0.341$. In line with
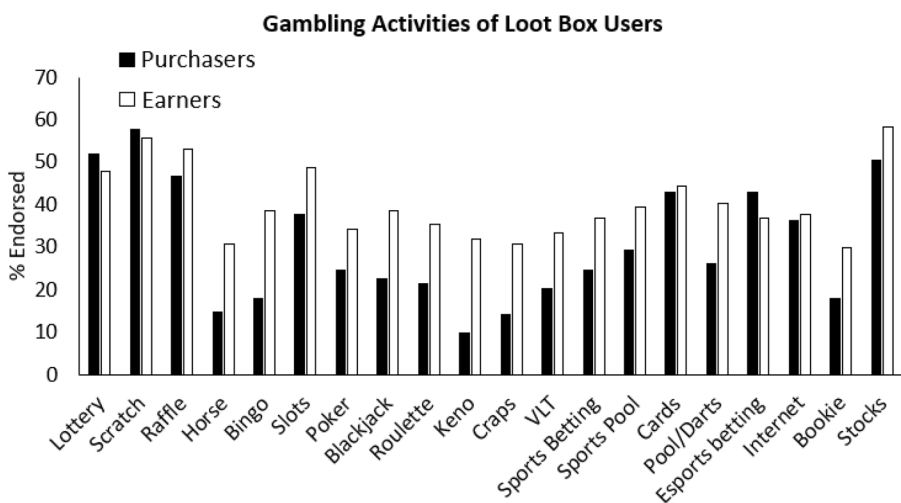

Fig. 3 Percentage of Purchasers and Earners having endorsed engaging in various gambling activities in the past 12 months

Table 2 Chi-Square tests of homogeneity for gambling activities by purchasing status

Gambling Game	χ^2	p
Lottery tickets	0.2	0.718
Scratch cards	0.05	0.887
Raffle	0.50547692	0.532
Horse Betting	7.17948718	0.010*
Bingo	9.79331104	0.002*
Slots	1.79958703	0.185
Poker	2.05416228	0.188
Blackjack	5.40068886	0.025*
Roulette	4.14974359	0.055
Keno	15.281641	0.0002**
Craps	8.00456876	0.0071*
Video Lottery Terminal (VLT)	4.12901402	0.052
Sports betting	3.14817814	0.097
Sports Pool	2.02045249	0.189
Pool Darts	3.90869293	0.061
Esports	0.60324956	0.497
Internet	0.02917011	1
Bookie	3.94341591	0.063
Stocks	0.6974359	0.454

*N.B. Df* 1 for all tests

*p < 0.05, **p < 0.001
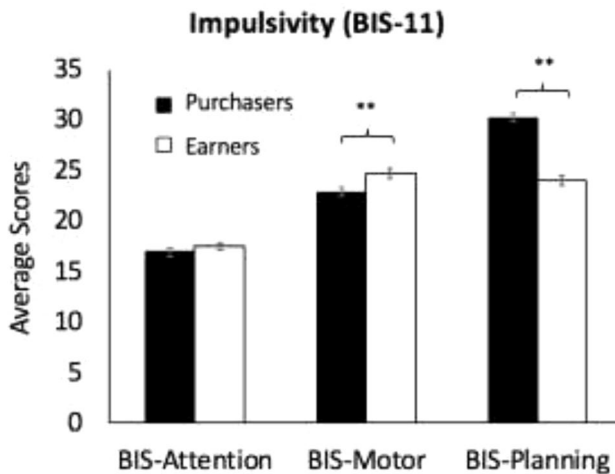
Fig. 4 Average attentional, motor and non-planning impulsivity scores for purchasers and earners

our hypotheses, purchasers reported greater impulsivity related to executive functions such as planning compared to earners, $t(250) = -9.59$, $p < .001$, $d = 1.213$. Of particular note, however, the effect size of the executive function contrast is over 3.5 times the effect size of

the motor impulsivity contrast. This larger effect size suggests a more meaningful role of the non-planning aspect of impulsivity for the purchasers. As written the contrasts are different in sign—the purchasers are LOWER in motor impulsivity, but HIGHER in Executive impulsivity—while the latter finding makes intuitive sense the motor impulsivity finding is puzzling and needs further empirical investigation.

Reward Reactivity to Loot Box Stimuli

Average arousal scores for purchasers and earners are depicted in panel A) of Fig. 5. A mixed ANOVA revealed a significant main effect of reward tier, $F(1.32, 331.18) = 308.92$, $p < .001$, $\eta_p^2 = .553$, no main effect of loot box route, $F(1, 250) = .278$, $p = .598$, $\eta_p^2 = .001$, but a significant reward tier by loot box route interaction, $F(1.32, 331.18) = 4.41$, $p = .026$, $\eta_p^2 = .017$. For the main effect of reward tier, Fisher's LSD comparisons revealed that players experienced the least arousal for rare tier loots, greater arousal for the epic tier loots, and the most arousal for legendary tier loots (all $ps < .001$). For the interaction simple effects analyses using independent t-tests showed a marginal effect of purchasers' greater arousal for the legendary loots compared to earners, however this comparison fell short of significance (p = .067). Comparisons of arousal scores between purchasers and earners for rare and epic loots were non-significant (p > .10). To further unpack the interaction, we calculated difference scores between arousal ratings for the two extremes of the reward tier. Specifically, we calculated the difference in arousal ratings for legendary versus rare loots for purchasers (M = 1.47, SD = 1.09) and earners (M = 1.15, SD = 1.09). The reward tier by loot box route interaction was driven by greater difference scores for purchasers
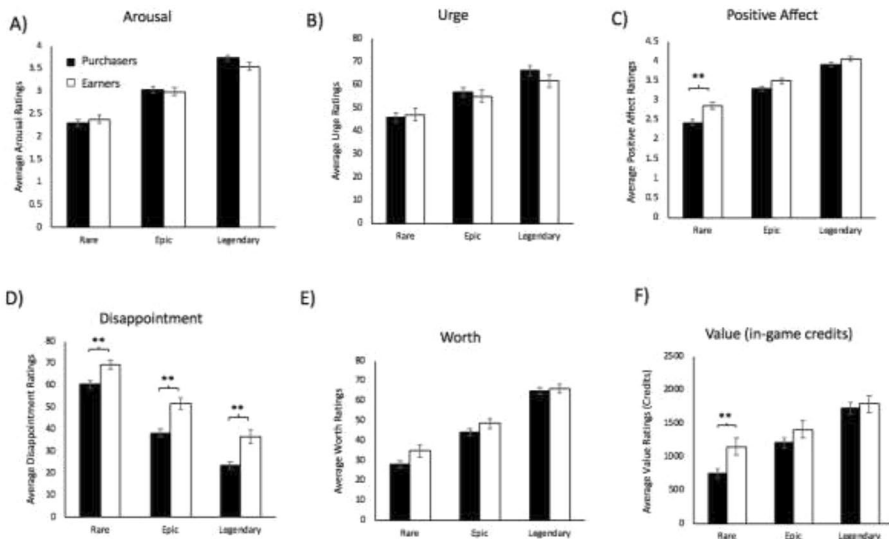
Fig. 5 Subjective responses for loot boxes across reward tiers for purchasers and earners. **A** Average subjective arousal ratings. **B** Average subjective urge to open more loot boxes ratings. **C** Average subjective positive affect ratings. **D** Average subjective disappointment ratings. **E** Average subjective worth ratings. **F** Average subjective loot box value in in-game credits

(e.g., greater reactivity when progressing from rare to legendary loots) compared to earners, $t(250) = -2.27$, $p = .024$, $d = .293$.

Average urge scores are depicted in panel B) of Fig. 5. A mixed ANOVA indicated a significant main effect of reward tier, $F(1.32, 332.32) = 103.84$, $p < .001$, $\eta_p^2 = .293$, no main effect of loot box route, $F(1, 250) = .442$, $p = .507$, $\eta_p^2 = .002$, but a significant reward tier by loot box route interaction, $F(1.32, 332.32) = 3.54$, $p = .048$, $\eta_p^2 = .014$. Fisher's LSD comparisons indicated that rare loots were the least urge inducing, epic loots slightly more urge-inducing, and legendary loots being the most urge inducing (all $ps < .001$). For the interaction, simple effects analyses using independent t-tests did not yield any statistical differences in urge between purchasers and earners for rare loots ($p = .739$), epic loots ($p = .526$), or legendary loots ($p = .123$). Difference scores between urge ratings for the two extremes of reward tier were calculated to further unpack the interaction. Specifically, we calculated the difference in urge ratings between legendary and rare loots for purchasers (M = 21.10, SD = 27.87) and earners (M = 14.51, SD = 22.74) respectively. The interaction appeared to be driven by greater difference scores for purchasers (e.g., greater urge when progressing from rare to legendary loots) compared to earners, $t(250) = -2.03$, $p = .043$, $d = .259$.

Average positive affect scores by loot box route are depicted in panel C) of Fig. 5. A mixed ANOVA revealed a significant main effect of reward tier, $F(1.41, 354.84) = 291.28$, $p < .001$, $\eta_p^2 = .538$, a main effect of loot box route, $F(1,250) = 9.23$, $p = .003$, $\eta_p^2 = .036$, and a significant reward tier by loot box route interaction, $F(1.41, 354.84) = 3.45$, $p = .049$, $\eta_p^2 = .014$. For the main effect of reward tier, Fisher's LSD comparisons revealed that all players exhibited lower positive affect scores for rare tier loots, slightly greater positive affect scores for the epic loots, and the highest positive affect for legendary tier loots (all $ps < .001$). The main effect of loot box route was due to purchasers' lower valence scores across the three reward tiers of loots. Finally, simple effects analyses unpacking the reward tier by loot box route interaction revealed the interaction was driven by purchasers' lower valence for rare loots compared to earners, $t(250) = 3.52$, $p < .001$. Comparisons of valence scores between purchasers and earners for epic and legendary loots were non-significant ($p > .05$).

Average disappointment scores are depicted in panel D) of Fig. 5. A mixed ANOVA revealed a significant main effect of reward tier, $F(1.42, 356.03) = 332.97$, $p < .001$, $\eta_p^2, = .571$, a main effect of loot box route, $F(1,250) = 21.21$, $p < .001$, $\eta_p^2 = .571$ but a marginally significant reward tier by loot box route interaction, $F(1.42, 356.03) = 3.28$, $p = .055$, $\eta_p^2 = .013$. Fisher's LSD comparisons revealed rare loots to be the most disappointing, followed by epic loots, and legendary loots being the least disappointing (all $ps < .001$). The main effect of loot box route was due to earners' greater disappointment on average for all loots regardless of tier (all $ps < .001$).

Panel E) of Fig. 5 depicts average scores for subjective worth between purchasers and earners. A mixed ANOVA revealed a significant main effect of reward tier, $F(1.33, 334.50) = 319.42$, $p < .001$, $\eta_p^2 = .561$, no main effect of loot box route, $F(1,250) = 1.95$, $p = .163$, $\eta_p^2 = .008$, and no reward tier by loot box route interaction, $F(1.33, 334.50) = 3.19$, $p = .062$, $\eta_p^2 = .013$. Fisher's LSD comparisons indicated low subjective worth for rare loots, greater worth for epic loots, and the legendary loots having the greatest subjective worth (all $ps < .001$).

Panel F) of Fig. 5 depicts average scores for subjective value measured in terms of how many in-game credits players would be willing to pay for the obtained loot box items. A mixed ANOVA revealed a significant main effect of reward tier, $F(1.27, 317.69) = 196.80$, $p < .001$, $\eta_p^2 = .440$, no main effect of loot box route, $F(1, 250) = 2.60$, $p = .108$,, $\eta_p^2 = .010$

but a significant reward tier by loot box route interaction, $F(1.27, 317.69) = 9.66$, $p = .001$. For the main effect of reward tier, rare loots were valued the least, followed by epic loots, and legendary loots being valued the most (all $ps < .001$). Simple effects analyses revealed the significant reward tier by loot box route interaction was driven by earners willingness to (theoretically) pay more for rare loots compared to purchasers, $t(179.89) = 2.77$, $p = .006$. Comparisons between purchasers and earners for epic and legendary loots were not significant ($ps > .1$).

To determine whether purchasers generally undervalue loots compared to earners, we examined the average discrepancy between objective and subjective values for loots (Fig. 6). To do this we took the absolute difference between subjective and objective scores (with scores closer to 0 indicating a more accurate gauge of the loot's objective value). A mixed ANOVA revealed a significant main effect of reward tier, $F(1.3, 325.68) = 25.89$, $p < .001$, $\eta_p^2 = .094$, a main effect of loot box route, $F(1,250) = 9.41$, $p = .002$, $\eta_p^2 = .036$, but no reward tier by loot box route interaction, $F(1.3, 325.68) = 2.93$. $p = .076$, $\eta_p^2 = .012$. As can be seen in Fig. 6 the main effect of loot box route was attributable to the earners overvaluing loots more than purchasers. For the main effect of reward tier, Fisher's LSD post-hoc comparisons revealed rare loot boxes to have the least discrepancy compared to epic and legendary loots (all $ps < .001$) indicating that participants overvalued the less frequent loots. However, epic and legendary loots were overvalued to the same extent ($p = .221$).

Discussion

The current research aimed to characterize loot box users who primarily pay for loot boxes (purchasers) and those who only gain loot boxes through gameplay (earners). As per our pre-registered hypotheses, loot box purchasers reported greater risky loot box use as well as greater video-game expenditure related harms. Surprisingly, loot box purchasers in *Overwatch* reported *less* severe problem gambling in comparison to loot box earners—with earners participating in more gambling activities over purchasers. Moreover, there was no difference in problem video-gaming between the two groups. In Overwatch specifically,
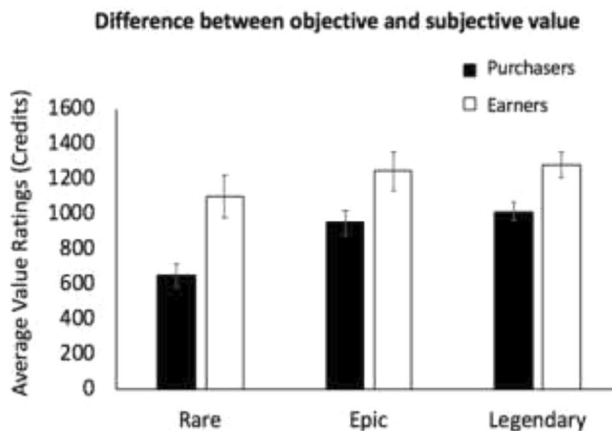
Fig. 6 Difference between objective and subjective values of loot boxes for purchasers and earners

purchasers seem to express negative consequences related to game expenses as opposed to other gambling-related harms and neither group seemed to differ in their problem video-gaming severity. The negative consequences related to game expenses experienced by purchasers include buying more loot boxes in order to gain desired game items and forgoing paying for other activities in order to further engage with loot boxes. This suggests that in Overwatch, loot box purchasing is associated with expenditure-related harms within the scope of the game, and only associated with low harm severity related to gambling expenditures outside of Overwatch.

The finding that earners reported significantly greater problem gambling severity than loot box purchasers is theoretically counterintuitive in light of previous study results. A potential reason for this seemingly opposing finding may be due to small differences in how purchasers and earners were operationally defined between studies. Our study defined earners as players who regularly play for loot boxes but have not purchased a loot box in Overwatch in the past four weeks. By contrast, Zendle et al. (2020) defined earners as video-game players who have not purchased any loot boxes in the past four weeks in any game. Hence, our study did not take into account whether Overwatch earners have purchased loot boxes in other games, while other studies have not looked at loot box purchasing in single-game contexts. While the overall relationship between loot box expenditure and gambling is unclear, one certain takeaway of the current study is that purchasing in Overwatch specifically does not seem to be associated with heightened problem gambling severity. This finding however should not detract from efforts to regulate loot boxes as a feature, given the association between purchasing and problems related to loot box use within the scope of the game.

Our results suggest that the relation between spending on loot boxes and problem gambling is not as clear cut as previously thought. Prior work demonstrating the relation between loot box expenditures and gambling collapsed loot box expenditure across multiple game types and loot box systems, while our study examined loot box engagement in a single game. Comparing all loot box users may be problematic considering the presentations of loot boxes between games are structurally heterogeneous. For example, at the time of data collection for the current study, Rocket League players could earn loot boxes through gameplay but needed to *purchase* keys to open such rewards. Some games offer pay-only structures for loot boxes, while other games only allow players to earn loots through gameplay with no purchase option. Moreover, the contents of a loot box may be purely cosmetic (e.g., Overwatch) or may confer an advantage to gameplay (e.g., mystery decks in Hearthstone). All of these structural differences in loot box features may lead to unique harms or may uniquely impact players' behaviours related to gambling and gaming. Hence, our finding that earners had more gambling problems than purchasers (which contradicts previous research) highlights the need to examine loot box impacts on a game-by-game basis.

In our pre-registered hypotheses we also aimed to establish a psychological profile of purchasers and earners in terms of impulsivity—a trait that is directly related to the severity of other forms of behavioural addictions including problem video-gaming and gambling (Hodgins & Holub, 2015; Metcalf & Pammer, 2014). Our hypotheses for impulsivity were supported in part as purchasers scored higher on impulsivity reflecting deficits in planning compared to earners. This suggests that purchasers generally struggle with decision making that requires future oriented thinking, closely mirroring impulsivity characteristics in problem gamblers (Alessi & Petry, 2003; Gullo & Potenza, 2014; Hodgins & Holub, 2015). Hence the negative consequences experienced by those who pay for loot boxes may be related to the lack of foresight related to future financial needs—leading to more

negative outcomes due to spending more on loot boxes than one can afford to lose. Interestingly, purchasers did not demonstrate heightened impulsivity across all dimensions represented in the BIS. Specifically, earners were actually more impulsive than purchasers in the motor domain. This particular dimension of impulsivity encompasses behavioural inhibition (e.g., 'acting' without thinking in the moment). Increased motor impulsivity is a common characteristic among frequent players also at risk of video-gaming addiction in first-person shooter games like Overwatch (Metcalf & Pammer, 2014). This may suggest that loot box earners have a deeper involvement in gameplay and skill development than their purchaser counterparts. However, in the context of this study more information about play frequency between the two groups is warranted to determine this. Importantly, the effect size for executive planning deficits among purchasers compared to earners was more than 3.5 times larger than the effect size for greater motor-planning impulsivity among earners compared to purchasers. Thus, the impulsivity in planning among purchasers appears to play a far more meaningful role in problem loot box use.

We successfully replicated previous results of reward and emotional reactivity to loots of varying values demonstrated in Larche et al. (2019). Additionally, there were notable differences in how loot boxes were valued and treated psychologically by loot box purchasers and earners. Specifically, purchasers demonstrated higher reactivity in terms of arousal and urge compared to earners, such that they exhibited less arousal and urge for the rare loots, and much greater arousal and urge for legendary loots. The converging patterns of arousal and urge in purchasers suggests that this group is more sensitive to the magnitude of reward in loot box cues. This motivational state titrated to the value of loot box cues among purchasers is a promising indicator of their attribution of incentive salience to the visual and auditory components of loot box cues (Berridge & Robinson, 2003). This strongly complements the finding that the central problematic behavior reported by purchasers in Overwatch relates to loot box use in Overwatch specifically.

In stark contrast, those who typically play for loot boxes (i.e., earners) illustrated more emotional value to loot boxes overall, including greater positive affect, and the assignment of greater credit values for loots. Of particular significance is how earners even assigned greater value and more positive affect to the more common loot openings than the purchasers, as well as earners' heightened absolute difference between the objective and subjective values for all loots. It may be that purchasers' value judgments are based on how much they would typically spend if they were to actually purchase the loots, whereas earners assigned a more theoretical credit value of worth that was dissociated from monetary value. This finding also strongly suggests that players who habitually invest more time and effort in gameplay upon attaining these rewards imagine these experiences upon exposure to these reward cues—thereby assigning greater emotional attachment to them. Overall this enhanced emotional value of loot box openings by earners strongly favors our initial hypotheses.

An unusual finding involves the loot box earners amplified disappointment in loots in tandem with their heightened positive affect scores compared to purchasers. One potential explanation for their enhanced positive *and* negative affect relative to purchasers may reside in how they strongly value their loots overall (Inzlicht et al., 2018). The co-activation of positive and negative affect titrated to their subjective value of the loots attests to how loot box openings may not be an exclusively pleasant or unpleasant experience. For instance, receiving a loot box may be a generally positive experience for players, especially for earners since they are being rewarded for their in-game efforts. But in attaching greater value to their loot due to their efforts, these players might simultaneously experience enhanced disappointment by not getting an item that they initially desired. This would

align with similar scenarios where there may be discord between an event's outcome and the counterfactual comparisons of what 'should' have been, such as when people receive a raise for their hard efforts (a pleasant experience) that was less than what they felt they deserved (Ortony, Clore, & Collins, 1988; McMullen, Markman, & Gavanski, 1995; Roese & Olson, 1995). Importantly, earners' enhanced disappointment compared to purchasers for their loots is negatively related to their positive affect—they find common loots to be less pleasant and more disappointing, and the legendary loots to be the most pleasant and the least disappointing. Although an intriguing finding with respect to reward processing, such patterns of emotional reactivity involved with playing for loot boxes does not seem to be associated with problematic loot box use or playing behavior compared to purchasing loots.

As aforementioned, one limitation of this study is the lack of data collected about purchasing and earning behaviours in games outside of Overwatch. While our methods allowed us to explore loot box engagement within the context of a single game, players purchasing behaviours in Overwatch may be affected by different loot box structures and interactions with loot boxes in other games. Research exploring the impact and harms conferred by different game-types and loot box structures is crucial for better understanding the relationship between loot boxes and problematic gambling and gaming. Furthermore, for purchasers specifically, our study did not account for varying degrees of loot box expenditure. That is, we did not distinguish between higher-expenditure purchasers and lower-expenditure purchasers. As such, there may be differences in gambling and game-related harms for high spenders and low spenders. These differences should be accounted for in future studies. Overall, these limitations, coupled with our study's findings suggest that the relationship between purchasing and gambling is in need of further study. Previous research supporting this link has speculated that loot boxes may act as a 'gateway' to gambling—however, evidence for this link remains mixed, in addition to the lack of direct, longitudinal evidence for this assumption (Delfabbro & King, 2020). In light of our current study results, loot box expenditure and gambling-related harms may not apply to every game or loot box structure. Future research should aim to compare whether some loot box structures are more harmful or confer different harms than others across games, as well as determine whether game-type or degree of expenditure contribute to such harms.

Conclusion

In summary, the current findings provide further insight into the nature of negative consequences and reward processing characteristics between those who purchase loot boxes and those who strictly opt to play for loot boxes. Those who purchase loot boxes report more problematic loot box use specifically as well as problems related to in-game expenditures than those who play for loots. Paying for loot boxes is also associated with greater impulsivity tied to deficits in future thinking, whilst playing for loot boxes was related to impulsivity tied to motor inhibition. Subsequently, loot box purchasers demonstrated greater sensitivity to the magnitude of loot box rewards in terms of their greater reactivity difference scores in urge and arousal to loot box cues. For players who gain loot boxes as rewards for their successful gameplay, these players tended to assign greater value and experienced enhanced emotional responsivity to the loots—attributed to the result of their greater investment of time and effort.

A surprising yet important finding from our results includes the fact that loot box purchasers expressed less problem gambling severity pertaining to gambling outside the scope of the game. This finding indicates that the relation between problem gambling and loot box purchasing is not as clear as once thought, highlighting the potential importance of studying problematic loot box use on a game-by-game basis. To reiterate, this finding however does not detract from the need to regulate loot boxes as a feature, as loot boxes in themselves were affiliated with specific problems related to purchasing.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Standards All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

Antons, S., Brand, M., & Potenza, M. N. (2020). Neurobiology of cue-reactivity, craving, and inhibitory control in non-substance addictive behaviors. *Journal of the Neurological Sciences, 415*, 116952.

Alessi, S. M., & Petry, N. M. (2003). Pathological gambling severity is associated with impulsivity in a delay discounting procedure. *Behavioural Processes, 64*(3), 345–354.

Baudinet, J., & Blaszczynski, A. (2013). Arousal and gambling mode preference: A review of the literature. *Journal of Gambling Studies, 29*(2), 343–358.

Benson, L. A., Norman, C., & Griffiths, M. D. (2012). The role of impulsivity, sensation seeking, coping, and year of study in student gambling: A pilot study. *International Journal of Mental Health and Addiction*, *10*(4), 461–473.

Berridge, K. C., & Robinson, T. E. (2003). Parsing reward. *Trends in Neurosciences*, *26*(9), 507–513.

Bijleveld, E., Custers, R., & Aarts, H. (2012). Adaptive reward pursuit: How effort requirements affect unconscious reward responses and conscious reward decisions. *Journal of Experimental Psychology: General, 141*(4), 728.

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

Charlton, J. P., & Danforth, I. D. W. (2007). Distinguishing addiction and high engagement in the context of online game playing. *Computers in Human Behaviour, 23*, 1531–1548.

Delfabbro, P., & King, D. L. (2020). Gaming-gambling convergence: evaluating evidence for the 'gateway' hypothesis. *International Gambling Studies, 14*, 1–13.

Dixon, M. J., MacLaren, V., Jarick, M., Fugelsang, J. A., & Harrigan, K. A. (2013). The frustrating effects of just missing the jackpot: Slot machine near-misses trigger large skin conductance responses, but no post-reinforcement pauses. *Journal of Gambling Studies*, *29*(4), 661–674.

Drummond, A., Sauer, J. D., Ferguson, C. J., & Hall, L. C. (2020). The relationship between problem gambling, excessive gaming, psychological distress and spending on loot boxes in Aotearoa New Zealand, Australia, and the United States: A cross-national survey. *PLoS ONE, 15*(3), e0230378.

Drummond, A., & Sauer, J. D. (2018). Video game loot boxes are psychologically akin to gambling. *Nature Human Behaviour, 2*(8), 530–532.

Ferris, J. A., & Wynne, H. J. (2001). *The Canadian problem gambling index* (pp. 1–59). Canadian Centre on Substance Abuse.

Gullo, M. J., & Potenza, M. N. (2014). Impulsivity: mechanisms, moderators and implications for addictive behaviors. *Addictive Behaviors*, *39*(11), 1543–1546.

Hernandez Lallement, J., Kuss, K., Trautner, P., Weber, B., Falk, A., & Fliessbach, K. (2014). Effort increases sensitivity to reward and loss magnitude in the human brain. *Social Cognitive and Affective Neuroscience, 9*(3), 342–349.

Hodgins, D. C., & Holub, A. (2015). Components of impulsivity in gambling disorder. *International Journal of Mental Health and Addiction, 13*(6), 699–711.

Inzlicht, M., Shenhav, A., & Olivola, C. Y. (2018). The effort paradox: Effort is both costly and valued. *Trends in Cognitive Sciences, 22*(4), 337–349.

Johnson, A. W., & Gallagher, M. (2011). Greater effort boosts the affective taste properties of food. *Proceedings of the Royal Society B: Biological Sciences, 278*(1711), 1450–1456.

King, D. L., Ejova, A., & Delfabbro, P. H. (2012). Illusory control, gambling, and video gaming: An investigation of regular gamblers and video game players. *Journal of gambling studies*, *28*(3), 421–435.

Larche, C. J., Chini, K., Lee, C., Dixon, M. J., & Fernandes, M. (2019). Rare loot box rewards trigger larger arousal and reward responses, and greater urge to open more loot boxes. *Journal of Gambling Studies, 12*, 1–23.

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

Ma, Q., Meng, L., Wang, L., & Shen, Q. (2014). I endeavor to make it: Effort increases valuation of subsequent monetary reward. *Behavioural Brain Research, 261*, 1–7.

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

Madden, G. J., Ewan, E. E., & Lagorio, C. H. (2007). Toward an animal model of gambling: Delay discounting and the allure of unpredictable outcomes. *Journal of Gambling Studies*, *23*(1), 63–83.

McMullen, M. N., Markman, K. D., & Gavanski, I. (1995). Living in neither the best nor worst of all possible worlds: Antecedents and consequences of upward and downward counterfactual thinking. *What Might Have Been: the Social Psychology of Counterfactual Thinking, 85*, 133–167.

Metcalf, O., & Pammer, K. (2014). Impulsivity and related neuropsychological features in regular and addictive first person shooter gaming. *Cyberpsychology, Behavior, and Social Networking, 17*(3), 147–152.

Mochon, D., Norton, M. I., & Ariely, D. (2012). Bolstering and restoring feelings of competence via the IKEA effect. *International Journal of Research in Marketing*, *29*(4), 363–369.

Ortony, A., Clore, G. L., & Collins, A. (1990). *The cognitive structure of emotions*. Cambridge University Press.

Roese, N. J., & Olson, J. M. (1995). Outcome controllability and counterfactual thinking. *Personality and Social Psychology Bulletin, 21*(6), 620–628.

Tejeiro Salguero, R. A., & Morán, R. M. B. (2002). Measuring problem video game playing in adolescents. *Addiction*, *97*(12), 1601–1606.

Wulfert, E., Harris, K., & Broussard, J. (2016). The role of cross-cue reactivity in coexisting smoking and gambling habits. *Journal of Gambling Issues, 32*, 28–43.

Wulfert, E., Maxson, J., & Jardin, B. (2009). Cue-specific reactivity in experienced gamblers. *Psychology of Addictive Behaviors, 23*(4), 731.

Wynne, H. J. (2002). *Gambling and problem gambling in Saskatchewan*. Canadian Centre on Substance Abuse.

Xiao, L. Y. (2020). Which implementations of loot boxes constitute gambling? A UK legal perspective on the potential harms of random reward mechanisms. *International Journal of Mental Health and Addiction*, 1–18.

Yi, W., Mei, S., Zhang, M., & Zheng, Y. (2020). Decomposing the effort paradox in reward processing: Time matters. *Neuropsychologia, 137*, 107311.

Zendle, D., Cairns, P., Barnett, H., & McCall, C. (2020). Paying for loot boxes is linked to problem gambling, regardless of specific features like cash-out and pay-to-win. *Computers in Human Behavior, 102*, 181–191.

Zendle, D., Meyer, R., & Over, H. (2019). Adolescents and loot boxes: Links with problem gambling and motivations for purchase. *Royal Society Open Science, 6*(6), 190049.

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