Paying for loot boxes is linked to problem gambling, regardless of specific features like cash-out and pay-to-win: A preregistered investigation of the relationship between loot box features and problem gambling

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Abstract

Loot boxes are a common element of many video games. The defining feature of loot boxes is the element of chance. Players can buy loot boxes for real-world money, but they do not know a loot box's content or value until they have opened it. Due to similarities between loot boxes and gambling, various countries are considering regulating them to reduce gambling-related harm. Indeed, prior research demonstrates a robust correlation between loot box purchases and problem gambling. However, loot boxes differ from each other in significant ways. For example, some loot boxes contain items that can be re-sold to other players, whilst others do not; some loot boxes contain items which give a gameplay advantage to players, whilst others do not. A key problem facing regulators is determining which types of loot boxes should be regulated to mitigate gambling-related harm. In this study, we specify a variety of different features that loot boxes may have. We then use a large-scale preregistered correlational analysis (n=1200) to determine if any of these features strengthen the link between loot box spending and problem gambling. Our results indicate that some loot box features may weakly strengthen the relationship between loot box spending and problem gambling. However, our main conclusion is that regardless of the presence or absence of specific features of loot boxes, if they are being sold to players for real-world money, then their purchase is linked to problem gambling.

Introduction

Loot boxes are a common but controversial feature of many popular video games. They are items in video games that contain hidden and ostensibly randomised contents. Many loot boxes can be bought with real-world money, though some can be bought through 'unpaid openings' that do not involve paying real-world money. Selling loot boxes to players generates enormous amounts of money for the video game industry. One industry report estimates that they may create up to $30 billion dollars in revenue in 2018 alone, with this amount almost doubling over the next four years [1].

The value of loot box contents varies enormously, and players are not aware of what a loot box contains until they have opened it. Some loot box contents afford gameplay advantages; others give players social benefits; some may even be traded on marketplaces for real-world money, and therefore have financial value. For instance, a player of *Counter-Strike: Global Offensive* in 2017 might pay to open a 'Weapon Case' and receive an almost worthless 'Briar' skin for their pistols - or they might receive the 'Dragon Lore' gun skin, which could be resold to another player for upwards of $4000 on an external marketplace [2].

There are clear similarities between paying for loot boxes and gambling. For example, both when paying to buy a loot box and when playing blackjack in a casino, individuals stake real-world money

in the uncertain hope of receiving a valuable reward. These similarities have raised concerns that loot boxes may either encourage or exploit problem gambling – a pattern of gambling-related behaviour which is so disordered and excessive that it leads to problems in a gambler's personal, work, and family life <CIT>.

Indeed, in a recent comment to *Nature: Human Behavior*, Drummond and Sauer hypothesise that some kinds of loot boxes share so many features with gambling that they may be considered "psychologically akin to gambling", and provide a gateway for gamers to just that: problem gambling and gambling-related harm [3]. Recent research supports these claims, demonstrating a clear correlation between buying loot boxes and problem gambling. This research has shown that that the more money players spend on loot boxes, the more severe their problem gambling [4], [5].

Loot boxes' potential for gambling-related harm has not been lost on legislators. Regulators in the Netherlands have decided that loot boxes break national gambling laws if their contents have 'market value', and can be cashed-out for real-world money on either in-game or external marketplaces [6]. Video game developers in the Netherlands have therefore been ordered to remove loot boxes from their games – or face criminal prosecution. Similarly, the Belgian Gambling Commission has ruled loot boxes which are paid for with real-world money are in violation of gambling legislation and should be removed from games [7]. Their government is reportedly launching a criminal investigation into video game manufacturers who have failed to comply with this ruling [8].

In contrast, some countries have ruled that loot boxes should not be regulated. For example, the UK Gambling Commission states that loot boxes are not gambling because they consider that in-game items have no value outside of the game itself. As [9] notes, this stance is controversial as "there are many websites that allow players to trade in-game items and/or virtual currency for real money".

Many countries have not yet determined how they should legislate loot boxes. Sixteen gambling regulators from around the world have recently signed an agreement to investigate the risks associated with loot boxes [10]. The Finnish government is currently carrying out an investigation into the potential for gambling-related harm present in loot boxes [11], as is the Australian Senate [12].

A key problem facing these regulators is that loot boxes come in a variety of forms. For example, some loot boxes are paid for with real-world money, whilst others are not. Some loot boxes allow players to trade their contents, and sell them to each other for real-world money, whilst others do not. It is currently unclear which of these kinds of loot boxes might be most harmful to gamers, and it is therefore also unclear which should be regulated. In the words of Jordon Steele-John, the chair of the Australian Senate's inquiry into loot boxes and gambling-related harm, this knowledge constitutes the "critical piece of clarifying information" when it comes to the regulation of loot boxes.

In the present study, we specify several key features that distinguish between different types of loot boxes (Table 1). These features may cause them to become more or less harmful. In a preregistered empirical study, we then examine the relationship between these features and problem gambling.

Features of Loot Boxes

Here we identify and define 7 potentially important ways that loot boxes in video games vary: Paid and unpaid openings; opportunities for cashing out; paying to win; using in-game currency; crate and key mechanics; showing near-misses; containing exclusive items.

Paid and unpaid openings

One of the most important distinctions to make when it comes to loot boxes is their cost. The price of some is very real. For example, players of *Counter Strike: Global Offensive* cannot open loot boxes without spending actual money. However, the majority of games that contain loot boxes also offer their players the option to take part in so-called 'unpaid openings', where no real-world money is exchanged for the loot box itself. For example, whilst players of *Overwatch* may choose to pay for loot boxes, they also 'earn' them for playing the game itself: They are rewarded with a loot box each time they level up [13].

Similarly, players of *Clash Royale* can either buy chests that contain randomised rewards from an in-game shop, or earn them as a reward for winning battles [14]. Furthermore, these chests will either open after a set period of time, or their opening can be hastened by paying further real-world money. In the same vein, players of *League of Legends* can either buy the game's equivalent of loot boxes outright for real-world money, or earn them at a slower rate by achieving high in-game mastery scores [15].

In contrast, a relatively small number of games offer loot boxes that cannot be purchased. For example, *Star Wars: Battlefront II* contains loot boxes which cannot be paid for with real-world money under any circumstances. They are instead solely "earned via daily login bonuses, milestone completions, or timed challenges"[16].

It is reasonable to suggest that whether players pay for loot boxes may be one of the most important factors in determining the relationship between loot box purchases and problem gambling. As noted in [9], one of the key features that typically differentiates gambling from other activities is that it involves the exchange of money or valuable goods. Accordingly, The amount that individuals spend on loot boxes has been repeatedly linked to problem gambling in empirical research [4], [5], [17].

Cashing out: In-game marketplaces, Externally-hosted marketplaces, and the ability to trade items

Another major distinction when it comes to loot boxes is the ability to make money from their contents. In some games, the rewards that are gained from loot boxes are bound to a player's account. They cannot be traded or sold to other players. There is no way to make money from these loot boxes short of a player selling their entire account. Examples of games like this are *Overwatch* and *Destiny 2*.

However, in strong contrast to this, the contents of loot boxes in some games are not immediately bound to a player's account. This creates the potential for items to be sold to other players – either in return for other in-game items or rewards, or in return for real-world money.

Indeed, some games incorporate the ability to 'cash out' into the game itself. For example, players of *Counter Strike: Global Offensive* and *Player Unknown's Battlegrounds* can buy and sell the in-game rewards that they receive from opening loot boxes for real money via these games' integration with the Steam marketplace. Once this money has been made on the Steam marketplace, it can then be spent on other games, or other in-game items.

In many cases, selling loot box items is not built into the game itself, but is still possible via an externally-hosted marketplace. For example, players of *Rocket League* are not officially able to sell the items that they gain from loot boxes 'in-game'. However, these items are not locked to players' accounts and can therefore be traded between accounts. A variety of external marketplaces have sprung up which take advantage of this ability to buy and sell the contents of loot boxes for real-

world money. Sales on these so-called 'grey markets' can be extremely lucrative. Many items can be sold for hundreds, or even thousands of dollars[18].

Researchers have noted that whether the rewards that loot boxes offer are "embedded" in the real-world's economy may be an important factor in determining their effects[19]. They have further pointed out that if loot boxes can be sold for real-world money, they effectively have market value - a key feature of gambling [9]. This importance ascribed to the ability to 'cash out' is also reflected in movements to legislate against loot boxes: In Netherlands, for example, only loot boxes that can be sold for real-world money have been deemed gambling and made illegal[20].

Paying to win: Loot box items that give players gameplay advantages

In some games, the items that are contained within loot boxes can afford players a distinct advantage when playing the game itself. For example, in *Fire Emblem Heroes*, stronger units are available in loot boxes than elsewhere in the game. Similarly, players of *Hearthstone* can obtain powerful cards with unique abilities by opening sealed packs of cards with randomised contents.

By contrast, in many games, loot box contents are purely cosmetic and give no competitive advantage at all. No matter how much money players of these games pay, they cannot pay to increase their likelihood of winning. Examples of games like this include *Path of Exile*, *Overwatch*, *Rocket League*, and *Counter Strike: Global Offensive*.

Competitiveness is well-known as an important factor when it comes to gambling. Not only are competitive individuals more likely to engage in gambling [21], [22], but competitiveness itself has been cited as a risk factor for problem gambling [23]. Tying competitive advantage to loot box rewards may well therefore strengthen the link between problem gambling and loot box spending. Similarly, whilst the loot boxes outlined in previous subsections varied in terms of financial reward, allowing players to 'pay to win' might add additional value to loot box contents, altering their effects on problem gambling.

Using In-Game Currency

In some games, loot boxes are bought directly with real-world currency: For example, in *Overwatch* and *Hearthstone* loot boxes can be bought directly for cash.

However, in many more games, loot boxes are not bought directly for real-world money, but are instead paid for using a form of scrip: a 'middleman' in-game currency. This currency may itself be bought directly for real-world money, or earned by players in-game.. For example, in *Fire Emblem Heroes*, players can pay a certain number of 'orbs' for the chance to randomly receive a new character. These orbs can themselves be bought for real-world money.

One could speculate that the use of in-game currencies may be linked to gambling-related harm as a product of valuation biases. For example, previous studies have indicated that individuals tend to spend more when they are spending scrip rather than cash [24]. Similarly, poker players have been shown to gamble more money if they are using chips than if they are using cash [25]. It seems possible that these effects might influence players to spend in a disordered fashion when using in-game currency.

Crate and key mechanics

The loot boxes in some games are built around a 'crate and key' mechanic. In this system, players typically earn loot boxes themselves through the course of playing the game but must obtain a key in order to open these boxes. Obtaining a key usually involves the transfer of real-world money.

For example, in *Star Trek Online*, loot boxes are earned by players as a reward for defeating in-game enemies. However, in order to open a loot box, players require a 'master key'. These keys can be bought from an in-game exchange for real-world money. Similarly, in *Counter Strike: Global Offensive*, players can obtain loot boxes as 'random drops' from playing the game itself. However, the keys that are required to open these loot boxes must either be purchased for real-world money via an in-game store or traded for with other players.

There are various reasons why the presence of crate and key systems might strengthen the effects of loot box spending on problem gambling. One example of this is sunk cost effects. The sunk cost effect is "a greater tendency to continue an endeavor once an investment in money, effort, or time has been made"[26]. Sunk cost effects are thought to be key to the psychology of gambling and are often used to explain why individuals continue gambling even after large losses have been made. If players perceive that they have already made an investment of money or time to acquire a loot box, they may be more likely to try to open it due to their attempt to recoup this sunk cost.

Crate and key systems might also capitalize on illusions of control, false beliefs that one is some way in control of chance outcomes [27]. Much research has suggested that illusions of control play an important role in traditional gambling (e.g. [28], [29]). A players' perception that their skill has earned them a crate and key loot box might lead to an illusion of control, which in turn might impact spending on these items. Indeed, similar effects to these have been posited in the literature on fruit machine gambling[30].

Showing near-misses

A further key distinction to make between different kinds of loot boxes is whether they show 'near misses' or not. Some loot boxes – for instance, those in *Path of Exile* - simply show players the contents of a loot box after they have opened it. However, others show players a variety of rare items that players might have won by opening that loot box. Typically, this display implies that players have almost received these valuable items from opening the loot box – in other words, that they are 'near misses'. For example, when opening loot boxes in *DOTA 2*, players are shown a spread of spinning rewards of varying rarity. These rewards gradually disappear over time, until only a single, more likely less valuable, reward remains. Often, the very last rewards to disappear are extremely rare. Similarly, *Counter Strike: Global Offensive* shows players a spinning, roulette-wheel-like reel of various items. This reel gradually slows over time until it eventually stops. The item in the centre of the screen at this point is received by the centre – but often a rare item is displayed right next to it.

Near-misses feature in a variety of different kinds of gambling. For example, slot machine designers deliberately include mechanisms in their machines where players who have lost are deliberately shown 'losing' combinations of symbols that are close to those required to win large amounts[31].

Research on gambling demonstrates that near-misses in games of chance lead to cognitive distortions whereby the player believes they are more likely to win in the future [32]. Players are more likely to continue taking risks after a near-miss [33], [34]. Furthermore, near-misses may be particularly potent for problem gamblers, who show distinct patterns in neural activity in reward-related brain regions and who may consequently show enhanced motivation to gamble (for review, see [28]). It therefore seems possible that the presence of near misses in loot boxes might strengthen the relationship between loot box spending and problem gambling.

Containing exclusive items

Most loot boxes contain exclusive items – things that can be found in loot boxes and nowhere else in the game. For example, loot boxes in *Counter Strike: Global Offensive* and *Rocket League* contain unique cosmetic items. These items only appear in loot boxes and can only be obtained by either opening a loot box or by trading with another player for the contents of a loot box that *they* have opened.

However, this is not the case in all games. In some games, loot boxes contain items that are obtainable elsewhere in game. Often these items can be directly purchased using an in-game currency. For example, in *Path of Exile*, 1 month after a loot box is released, all possible items within that loot box become available for direct purchase via an in-game store.

As noted above, loot boxes can be associated with both financial and competitive value. However, it seems reasonable that the worth of loot boxes is not only bound to these dimensions. Loot boxes also contain content that carries significant value within the world of the game. The value of some loot boxes quite possibly lies in the fact that their content isn't available anywhere else in the game.

It should be clear from the above discussion that not all loot boxes are created equal. Some may be more likely to elicit or capitalize on problem gambling than others. However, it is not clear from extent research which features are worth further research or regulation. Accordingly, we conducted a preregistered, empirical study. Our first goal was to replicate prior findings that people who purchase loot boxes are more likely to score high on a measure of problem gambling behaviour [4], [5]. We then sought to extend those findings by exploring the moderating relationship of each of the abovementioned factors on this relationship.

Method

Design

We conducted an online survey with a sample of gamers aged 18 or older. Participants were recruited via an advertisement on Amazon Mechanical Turk order to answer a survey about their spending habits in games. The recruitment message did not mention loot boxes.

Participants were screened before beginning the survey to ensure that they have previously been involved with loot boxes. They were therefore asked the following Yes/No question: "Have you opened a loot box in a video game within the past month?". Only those who answered 'Yes' were able to proceed with the survey.

Participants were then asked a series of questions regarding their loot box spending and problem gambling. Ten of these questions were repeated at the end of the study in order to check that participants were giving reliable answers. Participants who answered more than one of these questions differently were screened out from the sample as unreliable. Screening questions are marked in the list of variables measured below with an asterisk (*).

Variables

At the beginning of the survey, players were asked "Over the past month, which game have you most frequently opened loot boxes in?"*. The text result of this question was stored as a string named $GAME, which was used in several further questions described below. The following variables then were measured during the survey in order to carry the confirmatory analyses:

Var1. **Problem Gambling**

Measurement: Measured via the Problem Gambling Severity Index (PGSI) [35]. Participants were presented with the items from the PGSI within a larger series of questions which they were informed related to impulsiveness. This nine-item instrument contains a series of questions about how frequently individuals have engaged in a variety of gambling-related behaviours in the past 12 months (e.g. 'Have you needed to gamble with larger amounts of money to get the same feeling of excitement?', 'Have you borrowed money or sold anything to get money to gamble?'). Individuals must indicate how frequently they engage in these activities on a four-point scale ranging from 'Never' to 'Almost Always'. These responses are each scored from 0 – 3, with their sum forming a total score ranging from 0 to 27.

Variables that relate to paid and unpaid openings

Var2. Whether a player pays for loot boxes

Measurement: The following question will be asked of players, with two possible responses (No/Yes): "Thinking about $GAME, have you paid real-world money for opening loot boxes over the past month? This includes paying real world money for an in-game currency that is used to buy loot boxes, or paying real-world money for a key that is used to open loot boxes."

Var3. How much money players spend on loot boxes

Measurement: The following question will be asked of players, with a free numeric response: "Thinking about $GAME, how much money have you paid for loot boxes during the past month? This includes paying real world money for an in-game currency that is used to buy loot boxes, or paying real-world money for a key that is used to open loot boxes (If you have not paid any money for loot boxes, just put 0)". It is important to note that this variable was rank-transformed prior to all analyses in order to mitigate the effects of extreme outliers on our inferences.

Variables that relate to cash out

Var4. Being able to cash out via an in-game marketplace*

Measurement: The following Yes/No question will be asked of players: "In $GAME, can the contents of loot boxes be sold on an in-game marketplace?"

Var5. Being able to cash out via an externally-hosted marketplace*

Measurement: The following Yes/No question will be asked of players: "In $GAME, can the contents of loot boxes be sold on an externally-hosted marketplace?"

Var6. Being able to cash out via an in-game marketplace OR an externally hosted marketplace

Measurement: It is important to note that this variable is not measured by asking an additional question. Instead, Var6 is calculated as "Yes" if either Var4 OR Var5 have been answered "Yes". Otherwise, Var6 is calculated as "No".

Var7. Being able to trade loot box items with other players in-game*

Measurement: The following Yes/No question will be asked of players: "In $GAME, can you trade any of the items that you get in loot boxes with other players, instead of them all being bound to your account?"

Var8. How much money players make from selling loot boxes

Measurement: Players will be asked the following question, with a free numeric response: "How much money have you made by selling items from loot boxes during the past month? (If you have not made any money by selling loot boxes, just put 0).

Please give your answer in US Dollars.". It is important to note that this variable will be rank-transformed prior to all analyses in order to mitigate the effects of extreme outliers on our inferences.

Variables that relate to pay to win

Var9. **Being able to use loot box contents for a gameplay advantage**

Measurement: The following Yes/No question will be asked of players: "In $GAME, can the contents of loot boxes give you a gameplay advantage?"

Variables that relate to near misses

Var10. **Showing near-misses when buying loot boxes***

Measurement: The following Yes/No question will be asked of players: "In $GAME, are you shown 'near-misses' of rare items that you theoretically could have won (e.g. on a roulette wheel)?"

Variables that relate to in-game currency

Var11. **Being able to use in-game currency to buy loot boxes***

Measurement: The following Yes/No question will be asked of players: "In $GAME, can you only buy loot boxes with an in-game currency (e.g. gems, shards)?"

Variables that relate to crate and key

Var12. **The presence of 'crate and key' mechanics when buying loot boxes***

Measurement: The following Yes/No question will be asked of players: "Does $GAME feature a 'crate and key' system, where a key is necessary in order to open a loot box?"

Variables that relate to exclusive items

Var13. **The presence of exclusive items when buying loot boxes***

Measurement: The following Yes/No question will be asked of players: "Does $GAME feature items in its loot boxes that cannot be bought or found anywhere else in the game?"

Hypotheses

This study involves the preregistered testing of 13 specific hypotheses about the relationship between loot box spending and problem gambling. The preregistration details for these hypotheses (and all other details of this study) are available at [36]. These hypotheses (and their preregistered analysis plan) are presented below. It is important to note that all hypotheses tested and variables measured are in exact accordance with this plan. However, the *ordering of these variables and hypotheses* has been changed in order to make this document read more easily: For example, **H9** here was listed as **H5** in the preregistration document.

Hypotheses that relate to paid and unpaid openings of loot boxes

H1. There will be a significant positive correlation between the extent of an **individual's problem gambling** and their **spending on loot boxes**.

H2. There will be a significant relationship between **whether a player pays for loot boxes or engages only in unpaid openings** and their **problem gambling**.

Hypotheses that relate to cash out

H3. Being able to **cash-out in an in-game marketplace** will strengthen the relationship between **loot box spending** and **problem gambling**.

H4. Being able to **cash-out in an externally-hosted marketplace** will strengthen the relationship between loot box spending and problem gambling.

H5. Being able to **cash out in either an in-game marketplace OR an externally-hosted marketplace** will strengthen the relationship between **loot box spending** and **problem gambling**.

H6. The **ability to trade loot box items** in a video game will strengthen the relationship between **loot box spending** and **problem gambling**.

H7. **Making money by selling loot box items** will strengthen the relationship between **loot box spending** and **problem gambling**.

H8. There will be a significant positive correlation between the extent of an **individual's problem gambling** and the **amount of money they make by selling loot box items**.

Hypotheses that relate to pay to win

H9. Being able to **use lootbox contents for gameplay advantages** will strengthen the relationship between **loot box spending** and **problem gambling**.

Hypotheses that relate to near misses

H10. **Showing near-misses** will strengthen the relationship between **loot box spending** and **problem gambling**.

Hypotheses that relate to in-game currency

H11. Being able to **use-in game currency to buy loot boxes** will strengthen the relationship between **loot box spending** and **problem gambling**.

Hypotheses that relate to crate and key mechanics

H12. The presence of **crate and key mechanics** will strengthen the relationship between **loot box spending** and **problem gambling**.

Hypotheses that relate to exclusive items

H13. The **presence of exclusive items in loot boxes** will strengthen the relationship between **loot box spending** and **problem gambling**.

Participants

As documented in the preregistration information for this study [36], participants were recruited incrementally until there were exactly 1200 valid responses to the survey overall.

1607 full responses were collected in total from Amazon Mechanical Turk workers. Of these 1607, 329 were removed from the sample as unreliable due to answering more than 1 of the 10 screening questions inconsistently. 1 participant listed their age as '1987' and was removed from the sample as non-serious. A further 74 participants did not list a recognisable game when asked which game they had opened loot boxes in within the last month and were removed from the sample (example responses include 'Video game', 'yes', 'foot ball', and '6'). This left 1203 responses overall, of which chronologically the first 1200 were taken.

729 participants (60.8%) described themselves as male and 445 as female (37.1%). 237 participants (19.8%) were aged 18-24; 328 (27.3%) were aged 25-29; 302 (25.2%) were aged 30-34; 161 (13.3%) were aged 35-39; and 173 (14.4%) were aged 40 or over.

Results

Preregistered Confirmatory Analyses

All hypotheses were tested according to our preregistered analysis plan, available at [36].

As noted in our preregistration document, Var3 (How much a player spends on loot boxes) and Var8 (How much money a player makes from selling loot box items) were rank-transformed prior to analysis. There were 58 unique ranked values for player spending, ranging from $0 (Rank 1) to $1500 (Rank 58). There were 51 unique ranked values for how much money players made by selling loot boxes, ranging from $0 (Rank 1) to $1500 (Rank 50). Furthermore, one individual indicated that they earned a purported $1,000,000 (Rank 51).

First, **H1** ("There will be a significant positive correlation between the extent of an individual's problem gambling and their spending on loot boxes") was tested via calculating the Spearman Rank Correlation between Var1 (Problem gambling) and Var3 (How much a player spends on loot boxes). Results indicated a significant positive correlation between loot box spending and problem gambling, **supporting H1**, $p<0.001$, Spearman's Rho = 0.304, equivalent to $r^2 = 0.092$.

Next, **H2** ("There will be a significant relationship between whether a player pays for loot boxes and their problem gambling") was tested via a Mann-Whitney U test, with Var2 (Whether a player pays for loot boxes) as a quasi-independent variable, and Var1 (problem gambling) as dependent variable. Results indicated a significant relationship between paying for loot boxes and problem gambling, **supporting H2,** ($U=122117$, $p<0.001$, $\eta^2 = 0.60$), with individuals who did not pay for loot boxes having a lower median rank, and mean rank for problem gambling than those who did. A bar-chart showing this relationship is depicted below as Figure 1. Means and 95% confidence intervals between groups is depicted below as Table 1.

Loot box purchasing behaviour	Problem gambling severity	N
Gamers who only engage in unpaid openings	2.190 (95%CI: 1.789 – 2.591)	451
Gamers who pay to open	5.407 (95%CI: 4.914 – 5.899)	749
Total	4.198 (95%CI: 3.845 – 4.551)	1200

Table 1: Means and 95% Confidence Intervals of problem gambling, split by whether gamers pay to open loot boxes

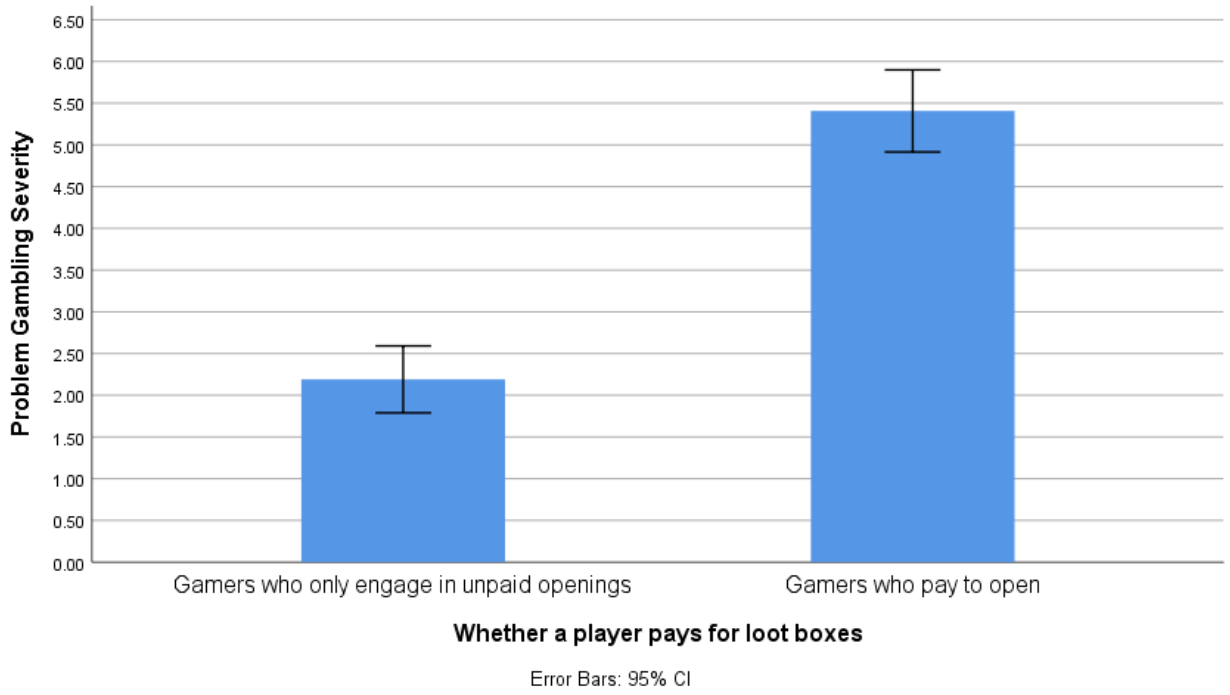

Figure 1: Problem gambling severity of gamers, split by whether they pay for loot boxes

H8 ("There will be a significant positive correlation between the extent of an individual's problem gambling and the amount of money they make by selling loot box items.") was tested via calculating the Spearman Rank Correlation between Var1 (Problem gambling) and Var8 (How much money players make from selling loot boxes). Results indicated a significant positive correlation between loot box spending and problem gambling, **supporting H8**, $p<0.001$, Spearman's Rho = 0.460, equivalent to $\eta^2 = 0.211$.

H3-13 (Excluding H8) were tested via moderation analysis. Moderation analysis was run using PROCESS v3 for SPSS, and conducted according to [37]. Moderation was conducted under PROCESS Model 1, with X=Var3 (How much money players spend on loot boxes), and Y=Var1(Problem gambling) in each case. The moderating variable under test, W, varied for each analysis. However, in each case, when relevant, 'Yes' was coded as 1 and No was coded as 0. A positive coefficient for b_3 was predicted in each case (i.e. the moderating variable increasing the strength of the relationship between loot box spending and problem gambling). Each moderation analysis was conducted with 10,000 bootstrap samples. The results of these analyses are presented below as Table 2. Overall, 8 significant moderations were observed, **supporting H3, H4, H5, H6, H7, H9, H10,** and **H11.** For additional stringency, and in addition to the preregistered analyses, we subjected the results of these tests to Bonferroni corrections for the testing of 13 hypotheses (i.e. $p<0.05/13$, or $p<0.0038$). Following this, the analyses supporting **H3, H5, H6, H7, H10,** and **H11** remained significant.

Confirmatory moderation analyses				Spotlight analyses		Additional information	
H under test	**Moderating variable (W)**	**Moderating effect of X*W on Y (b_3)**	**Significance of moderating effect of X*W on Y (b_3)**	**Effect of X on Y when W = 0 (equivalent to b_1)**	**Effect of X on Y when W = 1**	**Effect of W on Y when X = 0 (b_2)**	**Overall model of the ability of X, W, and X*W to predict Y**
Cashing Out							
H3	Var4 (being able to cash out via an in-game marketplace)	b_3 = 0.868 t(1196)= 4.003, r^2 change = 0.011, p=0.0001	p=0.0001**	b_1 = 0.052 t(1196) =3.497, p=0.0005	0.139 t(1196) =8.954 p<0.0001	b_2 = 2.084 t(1196) = 4.064, p=0.0001	F(1196) =88.541, p<0.0001, r^2 =0.181
H4	Var5 (being able to cash out via an externally-hosted marketplace)	b_3 = 0.049 t(1196) = 2.099, r^2 change = 0.002, p=0.036	p=0.036*	b_1 = 0.063 t(1196) = 5.003 p<0.0001	0.112 t(1196) = 5.701 p<0.0001	b_2 = 4.252 t(1196) = 6.853, p<0.0001	F(1196) = 119.411, p<0.0001, r^2 =0.230
H5	Var6 (Being able to cash out via an in-game OR externally-hosted marketplace)	b_3 = 0.084 t(1196) = 3.870 r^2 change = 0.010 p=0.0001	p=0.0001**	b_1 = 0.052 t(1196) = 3.302 p=0.001	0.137 t(1196) = 9.149 p<0.0001	b_2 = 1.836 t(1196) = 3.639, p=0.0003	F(1196) = 80.479, p<0.0001, r^2 =0.168
H6	Var7 (being able to trade loot box items with other players)	b_3 = 0.090 t(1196) = 4.146 r^2 change = 0.011 p<0.0001	p<0.0001**	b_1 = 0.060 t(1196) = 4.261 p<0.0001	0.150 t(1196) = 9.036 p<0.0001	b_2 = 2.081 t(1196) = 3.928, p=0.0001	F(1196) =90.858, p<0.0001, r^2 =0.185

H7	Var8 (Amount of money made from selling loot box items)	b_3 = -0.005 t(1196) = -4.188 r^2 change = 0.010 p<0.0001	p<0.0001**	b_1 = 0.063 t(1196) = 5.541 p<0.0001	0.058 t(1196) = 5.226 p<0.0001	b_2 = 0.497 t(1196) = 9.873, p<0.0001	F(1196) = 147.056, p<0.0001, r^2 =0.269
Paying to Win							
H9	Var9 (being able to use loot box contents for a gameplay advantage)	b_3 = 0.069 t(1196) = 2.855, r^2 change = 0.006 p=0.0044	p=0.0044*	b_1 = 0.065 t(1196) = 3.168 p=0.001	0.134 t(1196) = 10.42 p<0.0001	b_2 = 1.154 t(1196) = 2.179, p=0.0295	F(1196) =57.553, p<0.0001, r^2 =0.126
Near Misses							
H10	Var10 (showing near-misses when buying loot boxes)	b_3 = 0.064 t(1196) = 2.902 r^2 change = 0.005 p=0.0038	p=0.0038**	b_1 = 0.065 t(1196) = 4.871 p<0.0001	0.129 t(1196) = 7.39 p<0.0001	b_2 = 3.206 t(1196) = 5.774, p<0.0001	F(1196) =103.115, p<0.0001, r^2 =0205.
In-Game Currency							
H11	Var11 (Being able to use in-game currency to buy loot boxes) (Pay to win)	b_3 = 0.068 t(1196) = 3.08, r^2 change = 0.006 p=0.002	p=0.002**	b_1 = 0.072 t(1196) = 4.279 p<0.0001	0.141 t(1196) = 10.015 p<0.0001	b_2 = 1.408 t(1196) = 2.809, p=0.005	F(1196) = 64.776, p<0.0001, r^2 =0.139.
Crate and Key							

H12	Var12 (the presence of 'crate and key' mechanics)	b_3 = 0.040 t(1196) = 1.877 r^2 change = 0.002 p=0.060	p=0.060	b_1 = 0.084 t(1196) = 5.729 p<0.0001	0.125 t(1196) = 7.949 p<0.0001	b_2 = 2.633 t(1196) = 5.158, p<0.0001	F(1196) =77.977, p<0.0001, r^2 =0.163
Exclusive Items							
H13	Var13 (the presence of exclusive items)	b_3 = 0.008 t(1196) = 0.310 r^2 change = 0.0001 p=0.756	p=0.756	b_1 = 0.114 t(1196) = 4.890 p<0.0001	0.122 t(1196) = 9.773 p<0.0001	b_2 = 0.9305 t(1196) = 1.558, p=0.119	F(1196) =42.878, p<0.0001, r^2 =0.097

Table 2: Moderation of the relationship between loot box spending and problem gambling by various factors. Analyses are further split by headlines indicating groups of variables that all tap a feature of interest (e.g. many variables are used to measure the effects of cash out). Moderation that is significant at the 0.05 level is marked with a single asterisk (*). Moderation that remains significant when Bonferroni corrections for the testing of 13 hypotheses are taken into account (i.e p<(0.05/13) or. p<0.0038) are marked with two asterisks (**)

Exploratory analyses

The analyses detailed above are preregistered tests of specific hypotheses. However, given the potential impact of our results, a number of subsequent exploratory tests were made in an attempt to probe the robustness of the effects that were observed through these analyses.

To begin with, we investigated the games that individuals within our sample played. From the 1200 responses, 1013 individuals responded with a single, unambiguous reference to a game which contained loot boxes when asked "Over the past month, which game have you most frequently opened loot boxes in?". The other 187 cases were ambiguous or referred to games whose loot system we could not categorise. For instance, some respondents would state 'FIFA' without stating which game from the *FIFA* franchise they were playing – and different games within the same series may differ greatly in the features of their loot boxes. This investigation revealed that 10 games accounted for 570 participants, almost half of our sample of 1200. The frequency counts for these games are presented below in Table 4.

We then investigated whether players reliably reported the same features in the same games. The data collected for our preregistered confirmatory analyses were based on players reporting the features of the games that they play, and then conducting analyses on the basis of this reporting. However, some games may offer features that players are not aware of. For instance, players of *Counter Strike: Global Offensive* may not be aware of the game's externally-hosted marketplaces. Therefore, players might who said that they most frequently opened loot boxes in *Counter Strike: Global Offensive* might have indicated that this game did *not* contain this feature, due to ignorance of this feature. Furthermore, whilst our questions about the features of games themselves seemed face-valid, it is unclear whether players were able to reliably interpret them in the way that we intended – or whether there might be misunderstanding of the questions themselves. Analysis of key variables amongst players of the 10 most frequently-named games showed a marked degree of unreliability in the reporting of in-game features within each game (See TableX). For example, 48 of the 240 players of *Overwatch* indicated that they believed you could trade loot-box items with other players of the game, which is not the case.

Game	Frequency of game in dataset	Showing 'near misses' (Yes / No)	Ability to trade loot-box items with other players (Yes / No)
Overwatch	240	44 / 196*	48 / 192*
Fortnite	130	36 / 94*	60* / 70
Player Unknown's Battlegrounds	42	16 / 26*	16 / 26*
League of Legends	40	10 / 30*	12 / 28*
Star Wars Battlefront II	26	6 / 20*	13 / 13*
Counter Strike: Global Offensive	25	18* / 7	23* / 2
Rocket League	20	14* / 6	15* / 5
Clash Royale	17	7* / 10	12* / 5
Call of Duty: WWII	15	2 / 13*	1 / 14*
Destiny 2	15	4 / 11*	2 / 13*

Table 3: Exploratory analysis of the reliability of reported loot box features. Asterisks indicate which features were actually present or absent in any specific game (e.g. Overwatch does not show near misses)

In order to investigate whether the moderating effects that we found during our confirmatory analyses remained robust when the effects of unreliable responding were taken into account, we created an alternative, top-down, coding scheme for the 10 most frequently-mentioned games: *Overwatch, Fortnite, Player Unknown's Battlegrounds, League of Legends, Star Wars Battlefront II, Counter Strike: Global Offensive, Rocket League, Clash Royale, Call of Duty: WWII,* and *Destiny 2*. In total, 570 respondents played one of these 10 games. This coding scheme, and the frequency counts for each game, is presented below as Table 4. It is important to note that this coding scheme differs from the one used in our preregistered analyses as it is imposed on the data 'top-down' by the researchers, rather than 'bottom-up' from the responses of the players themselves. For example, if a player stated that they most frequently opened loot boxes in *Counter Strike: Global Offensive*, we would code them as most frequently opening loot boxes in a game which shows 'near misses', as we know that *Counter Strike: Global Offensive* affords this feature.

As shown in Table 4, only two of the games played by our reduced dataset of 570 participants featured the ability to cash out via an in-game marketplace. It was therefore impractical to use this dataset to test **H3,** and testing **H4** would be rendered almost equivalent to testing **H5**. Similarly, all but one of these 10 games featured exclusive items in loot boxes. It was therefore impractical to use this dataset to test **H13**.

In order to more severely **test H5, H6**, and **H9-H12**, moderation analysis on this subgroup was conducted in the same fashion as with the confirmatory analyses above but using our newly-recoded features as moderating variables. Amongst our sample of 10 games, every game that allowed players to trade items also allowed them to sell loot box items on an external marketplace. One single moderation analysis assessed these hypotheses as the variables associated with **H4, H5,** and **H6** were identical. The results of these analyses are shown below as Table 5.

These analyses indicated significant moderating effects that supported **H5, H6, H10** and **H12,** with comparable or larger r^2 change effect sizes to those shown in in Table 2**.** Their results did not support **H11** ("Being able to use-in game currency to buy loot boxes will strengthen the relationship between loot box spending and problem gambling") as the moderating effects of the alternatively-coded ability to use in-game currency were not significant.

	Alternative coding scheme							
Game	Frequency	Being able to cash out via in-game marketplace	Being able to use loot box contents for gameplay advantage	In-game currency used to pay for loot boxes	Showing 'near misses'	'Crate and key' mechanics	Exclusive items in loot boxes	Ability to trade loot box items with other players
Overwatch	240	N	N	N	N	N	Y	N
Fortnite	130	N	Y	Y	N	N	Y	Y
Player Unknown's Battlegrounds	42	Y	N	Y	N	Y	Y	N
League of Legends	40	N	N	Y	N	Y	Y	N
Star Wars Battlefront II	26	N	N	Y	N	N	Y	N
Counter Strike: Global Offensive	25	Y	N	N	Y	Y	Y	Y
Rocket League	20	N	N	N	Y	Y	Y	Y
Clash Royale	17	N	Y	Y	Y	N	Y	Y
Call of Duty: WWII	15	N	N	N	N	N	N	N
Destiny 2	15	N	N	N	N	N	Y	N

Table 4: Alternative coding scheme for exploratory analyses

Exploratory moderation analyses				Spotlight analyses		Additional information	
H under Severe test	**Moderating variable (W)**	**Moderating effect of X*W on Y (b_3)**	**Significance of moderating effect of X*W on Y (b_3)**	**Effect of X on Y when W = 0 (equivalent to b_1)**	**Effect of X on Y when W = 1**	**Effect of W on Y when X = 0 (b_2)**	**Overall model of the ability of X, W, and X*W to predict Y**
H5, H6	Alternatively-coded ability to trade loot box items with other players / being able to cash out via an externally-hosted marketplace	b_3 = 0.067 t(566) = 2.534 r^2 change = 0.010 p=0.011	p=0.011	b_1 = 0.078 t(566) = 4.492 p<0.0001	0.146 t(566) = 7.199 p<0.0001	b_2 = -0.845 t(566) = -1.377 p=0.169	F(566) = 24.867 p<0.0001 r^2 =0.116
H9	Alternatively-coded ability to use loot box contents for a gameplay advantage	b_3 = -0.012 t(566) = -0.399 r^2 change = 0.0003 p=0.689	p=0.689	b_1 = 0.111 t(566) = 7.214 p<0.0001	0.099 t(566) = 3.835 p=0.0001	b_2 = 0.173 t(566) = 0.248 p=0.804	F(566) = 22.289 p<0.0001 r^2 =0.105
H10	Alternatively-coded showing of near-misses	b_3 = 0.116 t(566) = 3.981 r^2 change =0.024 p=0.0001	p=0.0001	b_1 = 0.073 t(566) = 4.760 p<0.0001	0.189 t(566) = 7.604 p<0.0001	b_2 = -1.054 t(566) = -1.500 p=0.134	F(566) = 30.331 p<0.0001 r^2 =0.138
H11	Alternatively-coded ability to use in-game currency to buy loot boxes	b_3 = -0.017 t(566) = -0.346 r^2 change = 0.0002 p=0.729	p=0.729	b_1 = 0.109 t(566) = 7.956 p<0.0001	0.092 t(566) = 1.885 p=0.059	b_2 = 0.172 t(566) = 0.157 p=0.875	F(566) = 22.289 p<0.0001 r^2 =0.105
H12	Alternatively-coded presence of 'crate and key' mechanics	b_3 = 0.111 t(566) = 3.685 r^2 change = 0.020 p=0.0003	p=0.0003	b_1 = 0.077 t(566) = 5.125 p<0.0001	0.189 t(566) = 7.212 p<0.0001	b_2 = -1.099 t(566) = -1.490 p=0.136	F(566) = 30.331 p<0.0001 r^2 =0.138

Table 5: Exploratory moderation of the relationship between loot box spending and problem gambling by various alternatively-coded factors.

Discussion

The relationship between loot box spending and problem gambling

These results provide clear evidence for a link between loot box spending and problem gambling (**H1**). Preregistered correlational analysis showed that the greater the level of an individual's spending on loot boxes, the more severe their problem gambling was. Furthermore, the effect size associated with this relationship was of medium-to-large magnitude ($r^2 = 0.092$): More than 9% of the variation in gamers' problem gambling was accounted for by measuring the extent to which they spent money on loot boxes. This relationship seems extremely reliable: All previous studies which have measured these variables have consistently reported its existence (i.e. [4], [5], [17]). Its replication in a preregistered analysis also strongly suggests its robustness. Lending extra weight to the importance of this link is the effect size associated with this analysis. Previous estimates have placed this effect at approximately $\eta^2 = 0.05$. In this analysis we see an effect of almost double this size. This strongly supports the potential importance of spending when it comes to gambling-related harm.

In a similar vein, these results support **H2** ("There will be a significant relationship between whether a player pays for loot boxes and their problem gambling"). When it came to our measure of problem gambling severity, individuals who paid for loot boxes scored more than twice as high, on average, than those who did not (M=2.190 for those who did not pay, M = 5.407 for those who did).

When taken together, both the results of **H1** and **H2** clearly point to one thing: Paying money for loot boxes is linked to problem gambling. The causal direction of this relationship is unclear. It may be the case that loot boxes share so many formal features with gambling that they act as a gateway to problem gambling itself. It may also be the case that loot boxes share so many formal features with gambling that they are particularly attractive to problem gamblers, leading individuals with higher levels of problem gambling to spend more money on them and driving the $30 billion dollars in annual revenue that the games industry makes from loot boxes. In either case, it is our opinion that harm may be done when loot boxes are paid for.

The tests associated with **H3-H5** nuance this picture. In each case, spotlight analyses were conducted that measured what the effect of loot box spending was on problem gambling, both when a potentially important feature was present in a game and when that feature was absent.

When players could use loot box contents for gameplay advantage, loot box spending was significantly linked to problem gambling; when they could *not* use loot box contents for gameplay advantage, this link was weaker but still remained.

When loot boxes could be sold on in-game or external marketplaces, loot box spending was significantly linked to problem gambling ($p<0.0001$); when they could *not* be sold on these markets, the link between problem gambling and loot box spending was weaker but still remained ($p<0.0001$).

When loot boxes showed 'near misses' of items, spending on them was significantly linked to problem gambling ($p<0.0001$); when they did not show these near-misses, the link was weaker but still remained ($p<0.0001$).

In fact, throughout all analyses of all features of games (i.e. all spotlight tests associated with **H3-H5**), whether or not a specific loot box feature was present, loot box spending remained significantly

linked to problem gambling. The sole exception to this was a single exploratory spotlight analysis, which indicated that loot box spending was *not* significantly linked to problem gambling when players *could* buy loot boxes with in-game currency. However, it is important to note that this lack of a significant link under spotlight analysis was not the case in our initial confirmatory analyses.

The message here is clear: regardless of the presence or absence of individual loot boxes features, spending money on them was linked to gambling-related harm.

The moderating effects of loot box features

Whilst these analyses therefore strongly suggest that removing any single feature from loot boxes will not render them harmless while they are paid for with real-world money, the preregistered moderation analyses do, however, provide some evidence for specific features of loot boxes which may be more likely to strengthen this relationship than others. Overall, between **H3** – **H5**, 7 significant moderations were observed, **supporting H3, H4, H9, H11, H10, H6,** and **H5.** After subjected the results of these tests to unplanned Bonferroni corrections for the testing of 13 hypotheses (i.e. $p<0.05/13$, or $p<0.0038$), the preregistered analyses associated with five hypotheses remained significant: **H3, H11, H10, H6,** and **H5**. These results are summarised and contextualised below as Table 6.

Loot box feature	Potential mechanisms	Variables under test	Description	Effect size and associated p-value
Cash out	Value of goods	Ability to sell items on an in-game marketplace (Var4)	Players are able to buy and sell loot box items on marketplaces integrated with the game itself (e.g. in *Counter-Strike: Global Offensive*)	r^2 change = 0.011 p=0.0001
		Ability to sell items on an external marketplace (Var5)	Players are able to buy and sell loot box items on external websites (e.g. in *Rocket League*)	r^2 change = 0.002 p=0.036
		Ability to sell items on either an external or an in-game marketplace (Var6)	Either of the above	r^2 change = 0.010 p=0.0001
		Ability to trade loot box items with other players (Var7)	Players can trade items with each other, opening up the possibility for the creation of external marketplaces (e.g. in *Fortnite*)	r^2 change = 0.011 p<0.0001
Pay to win	Value of goods, Competitiveness	Being able to use loot box contents for gameplay advantage (Var9)	The items that players get from loot boxes give advantages during gameplay (e.g. in *Hearthstone*)	r^2 change = 0.006 p=0.0044
Near-misses	Near-miss effects	Showing of near-misses in game (Var10)	Players are shown (typically rare) items that they did not win during the course of opening a loot box (e.g. in *DOTA 2*)	r^2 change = 0.005 p=0.0038
In-game currency	Valuation biases	Being able to use in-game currency to buy loot box items (Var11)	Players can pay for loot boxes using an in-game currency (e.g. in *Fire Emblem Heroes*)	r^2 change = 0.006 p=0.002
Crate and key	Sunk cost effects, Illusion of control	Presence of 'crate and key' mechanics (Var12)	Players obtain loot boxes themselves (typically by earning them through playing the game), but need a key to unlock them, which is typically paid for (e.g. in *Star Trek Online*)	r^2 change = 0.002 p=0.060
Exclusive contents	Value of goods	Presence of exclusive items in loot boxes (Var13)	Loot boxes contain items that are not available elsewhere in the game (e.g. in *League of Legends*)	r^2 change = 0.0001 p=0.756

Table 6: Summary of loot box features, associated variables, and the moderating effects of these features on the relationship between loot box spending and problem gambling

Two of these hypotheses deal with the ability for specific features of loot boxes to strengthen the relationship between loot box spending and problem gambling. **H11** predicts that being able to use an in-game currency to buy loot boxes will strengthen the relationship between loot box spending and problem gambling. **H10** predicts that showing 'near misses' will strengthen this relationship. Three of these hypotheses (**H3, H5, H6**) deal with the idea that being able to cash out loot box items for real-world money will strengthen relationships between loot box spending and problem gambling.

Our analyses provide some support for these hypotheses. When we conducted moderation analyses, these factors significantly strengthened links between loot box spending and problem gambling. However, the results of our statistical tests also indicate that caution should be used in their interpretation. It is key to note that whilst these moderating relationships were statistically significant, the effect sizes associated with them were typically very small. For example, the effect size associated with **H11** ("being able to use in-game currency to buy loot boxes") was placed at r^2 change = 0.006. In other words, when we incorporated this feature into our model of the effects of loot box spending on problem gambling, its moderating effect was only able to predict an additional 0.6% of players problem gambling. The practical importance of this difference is unclear. Other effect sizes were similarly small, with the largest r^2 change observed in our preregistered analyses placed at only $r^2 = 0.011$. If we had observed a larger effect size associated with a single factor here, it would have suggested that said factor might be of immediate practical importance in determining the effects of loot boxes. No such 'smoking gun' was seen here.

Finally, it is key to note that a similar magnitude of effects was seen again in our exploratory analyses. The sole exception to this was the moderation analysis of the alternatively-coded presence or absence of near misses. In that case, the effect size that was seen was of magnitude $r^2 = 0.237$, indicating that this feature may be of interest in future research. However, it is important to note that this was an unplanned exploratory analysis, and therefore carries less weight than our preregistered confirmatory analyses.

It is further important to note important properties of the sample on which our data was collected which make the replicability and the generalisability of these results unclear. Exploratory analyses indicated that a large proportion of our sample was based on two games: *Overwatch* (240 players) and *Fortnite* (130 players). Overall these games accounted for 30% of our data. The fact that such a large proportion of our sample was drawn from relatively few games makes it difficult to determine how the moderating effects of different loot box features generalise beyond our sample: What appears to be the moderating effects of any single in-game features may in fact just reflect variation between players of *Overwatch* and *Fortnite*.

Additional caution is also warranted due to the observed unreliability in the reporting of moderating features that we discovered during our exploratory analyses. Players of a single game often reported very different features for the loot boxes within that game. Some of this may be due to ignorance of in-game features; some of it may be due to a lack of clarity in the question itself; some of it may even be due to the complexity of these games themselves. *Clash Royale*, for example, does not typically show near-misses when players open loot boxes. However, a specific kind of loot box in the game (called the 'Fortune Box') is able to display to players the different things that they might get from the box prior to opening. So, does *Clash Royale* show near misses? Players of the game were unsure – 7 of them indicated that it did, whilst 10 indicated that it did not.

In sum total, our analyses provide some weak support for specific hypotheses that suggest that cash out, in-game currency, and near misses strengthen the link between loot box spending and problem gambling. However, much more experimental and longitudinal work across a wide variety of gamers and games is needed in order to determine whether these effects are either robust or of practical importance.

The relationship between problem gambling and selling loot box items for money

A final note must be made about **H7,** the hypothesis that "making money by selling loot box items will strengthen the relationship between loot box spending and problem gambling". As shown in Table 2, the amount of money that players made by selling loot box items did significantly moderate the relationship between loot box spending and problem gambling. However, contrary to predictions, the more money an individual made selling loot box items, *the weaker their relationship between loot box spending and problem gambling*. This result might indicate several different things. It might indicate, for instance, the presence of a group of gamers who tactically buy specific kinds of loot boxes in order to sell their contents at a profit on external marketplaces. Further work is needed to determine whether this relationship is either robust or of practical importance.

Conclusions

One conclusion that can be drawn from this study is clear: Paying real-world money for loot boxes is linked to gambling related harm, regardless of the features of loot boxes themselves. This suggests that companies that allow their players to pay money for loot boxes may well be enabling gambling-related harm.

Our preregistered analysis of the link between loot box spending and problem gambling shows that the more gamers spend on loot boxes, the more severe their problem gambling. Furthermore, gamers who paid for loot boxes (rather than engaging solely in unpaid openings) scored more than twice as high on measures of problem gambling than those who did not.

It may be the case that buying loot boxes literally causes increases in problem gambling amongst gamers. Alternatively, it may be the case that problem gambling causes increases in buying loot boxes, and that games companies are using pre-existing problem gambling amongst their customers to drive the massive revenues associated with loot boxes. Both relationships are potentially damaging.

It is important to note that this is not the first time this relationship has been demonstrated in the literature. It is not even the third time it has been demonstrated. This relationship seems both reliable, robust, and real. Furthermore, the effect that we saw here was almost twice as large as previous estimates of the strength of the relationship between these factors, indicating that the potential for harm present in loot boxes may be even stronger than was previously thought.

Further preregistered analyses painted an even starker picture. Regardless of the individual features of loot boxes themselves, the link between spending money on them and problem gambling remains. Regardless of whether or not loot boxes gave players gameplay boosts, allowed them to trade items for real world money, allowed cash-out, or showed near-misses, we still observed a link between loot box spending and problem gambling. None of these features caused this link to disappear. We therefore find no evidence to support the argument that any specific type of loot box is harmless. Our research suggests that if players pay real money for a loot box, then it is linked to problem gambling, and still potentially capable of causing gambling-related harm.

Loot boxes may make up to $30 billion this year alone [1]. The social cost of this profit may be far higher. Given the potential harm of loot boxes, ratings agencies should consider restricting access to

games with paid loot boxes to players who are of legal gambling age. Relevant national and federal authorities should further consider restricting access to these loot boxes in the same way that they would if they fulfilled the technical requirements necessary to be considered a form of gambling.

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