Gambling-Related Cognitive Distortions: Their Associations, Measurement, and Utility to Assess Gamblification in Video Games

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Abstract

Gambling-related cognitive distortions (GRCDs) are central to the cognitive model of gambling, and through these lenses, gamblers may perceive themselves as being able to predict or influence randomly determined outcomes. Chapter 2 explored the associations between schizotypy, GRCDs, and problematic gambling via three cross-sectional samples. Schizotypal personality (schizotypy) is a cluster of traits in the general population, including alterations in belief formation that may underpin delusional thinking. Small-to-moderate associations were detected between components of schizotypy and gambling-related variables, pointing to shared biases relating to belief formation and decision-making. Chapter 3 sought to develop a scale to assess state-activated GRCDs during slot machine gambling. Scale items were developed and refined across three samples and underwent exploratory factor analysis. This produced a 17-item scale comprising 4 factors: Magical Thinking, Personal Illusion of Control, Hot Hand Fallacy, and Experienced Luck. Initial reliability and validity was established. This instrument increases accessibility to state-activated gambling beliefs. Chapters 4 & 5 focused upon the gamblification of video games by investigating ‘loot boxes’, virtual items in video games that generate a randomized in-game reward of varying desirability. Chapter 4 was among the first studies to establish a cross-sectional link between loot boxes and gambling. Loot boxes were perceived as gambling by a majority of participants. Loot box expenditure, and their risky use, was moderately linked to GRCDs and problematic gambling. The gambling-related variables were also a stronger predictor of risky loot box use than a measure of disordered gaming. These results underline a psychological similarity between loot boxes and gambling and implicate each behaviour as a risk factor for the other, although these cross-sectional data do not establish directionality. Chapter 5 clarified the directional relationship between loot boxes and gambling
behaviour, via a longitudinal study. In a sample of non-gamblers, ‘migration’ to gambling was predicted by loot box expenditure and risky use six months later, whereas non-loot box microtransaction expenditure did not. In an exploratory resorting of participants, baseline GRCD endorsement also predicted migration to loot box use. These results are consistent with a bi-directional temporal relationship and support regulatory action on loot boxes.
Lay Summary

Inaccurate beliefs about gambling are related to problematic gambling, and I explored three properties of these gambling beliefs relating to their stable (trait) and state nature during gambling, and their generalization to video games. First, a personality dimension called schizotypy is linked to inaccurate gambling beliefs. The more one endorses items related to schizotypy the more likely they have inaccurate gambling beliefs. Second, I developed a tool to measure the strength of these state beliefs during slot machine play, when they might be ‘switched on’. Lastly, I explored a payment feature of video games called ‘loot boxes’, which look a lot like gambling. Engagement with loot boxes also related to inaccurate beliefs about gambling and problematic gambling, and in a further study conducted over six months, loot box use predicted future gambling behaviour. These results support the call for regulation of loot boxes, because of their similarities to gambling.
Preface

I am the primary contributor to the work presented in this dissertation. The research presented in Chapter 2 received ethics approval from the UBC Behavioural Research Ethics Board (H16-03028). I was the primary researcher responsible for survey design and study procedure. I collected data from the 3 participant samples via the UBC Psychology Department’s Human Subject Pool and Amazon’s Mechanical Turk, I completed the statistical analyses, and I completed the manuscript drafting. Luke Clark contributed to the survey design and provided manuscript revisions. A version of Chapter 2 appears in the Journal of Behavioral Addictions:


The research presented in Chapter 3 received ethics approval from from the UBC Behavioural Research Ethics Board (H16-03028). I designed the study and validity experiment. The items included in all versions of the Gambling State Cognitions Scale were either newly developed or adapted from existing gambling cognitions measures by me. Data collection was completed by me and with the support of research assistants: Josie Horn, Lauren Abramson, Muhammad Ali, and Benjamin Sidloski. Participants gambled on real slot machines housed in a laboratory at the Centre for Gambling Research. I completed data analyses and the manuscript drafting. Luke Clark contributed to the scale item development, validity experiment, and provided manuscript revisions. A version of Chapter 3 will be prepared for publication:

The research presented in Chapter 4 received ethics approval from the UBC Behavioural Research Ethics Board (H17-03571). I was the primary researcher responsible for the survey design, question creation, study procedure. I collected data for the 2 participant samples via the UBC Psychology Department’s Human Subject Pool and Amazon’s Mechanical Turk. I completed the statistical analyses and the manuscript drafting. Luke Clark contributed to the survey and question design, provided guidance for statistical analyses, and provided manuscript revisions. A version of Chapter 4 appears in the journal Addictive Behaviors:


The research presented in Chapter 5 received ethics approval from the UBC Behavioural Research Ethics Board (H20-02830). I was the primary researcher responsible for survey design, question creation, and study procedure. I collected data for the participant Sample via Prolific, completed the statistical analyses, and manuscript drafting. Luke Clark contributed to the study design and provided manuscript revisions. A version of Chapter 5 appears in the journal Computers in Human Behavior:

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List of Abbreviations

BALS – Darke and Freedman Beliefs Around Luck Scale
BIGLS – Belief in Good Luck Scale
CBT – Cognitive Behavioural Therapy
DOSPERT – Domain-Specific Risk-Taking Scale
DPM – Direct Purchase Microtransaction
EFA – Exploratory Factor Analysis
GBQ – Gambler’s Beliefs Questionnaire
GEQ – Game Experience Questionnaire
GRCD – Gambling-Related Cognitive Distortion
GRCS – Gambling Related Cognitions Scale
GSCS – Gambling State Cognitions Scale
IGDS – Internet Gaming Disorder Scale
MTurk – Amazon’s Mechanical Turk
OR – Odds Ratio
PDI-21 – Peters et al. Delusions Inventory
PGSI – Problem Gambling Severity Index
RLI – Risky Loot Box Index
SPQ-B – Schizotypal Personality Questionnaire – Brief
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Dedication

To my wife, Negar Jalali, you have been my constant in this ever-changing world, and this journey would not have been possible without you.
Chapter 1. Introduction

1.1 Problem Gambling

Gambling is a common pastime across societies and evidence of this activity dates back at least six thousand years (McMillen, 2005). Numerous situations, events, and games can be considered as gambling as long as three necessary components are present: 1) a cost to play, known as the wager; 2) the prospect of winning a prize valued more than the cost; and 3) an element of chance that determines, in part or in whole, the outcome (Reber, 2012). Thus, one may gamble on the outcome of horse races, card games, sports, political outcomes, whether it will snow on a particular day, or, more recently, on electronic slot machines. There is also a long history of prohibition and regulation of gambling because of the harms associated with this behaviour (Miers, 2004; Orford, 2012; Smith, 2014). Contributing to the societal concern surrounding gambling, these harms are not limited to the individual gambler and can extend to their families, friends, and the broader community (Browne, Goodwin, & Rockloff, 2018). Financial harm may be the most identifiable, but excessive gambling can also lead to relationship dysfunction, emotional and psychological distress, deteriorated physical health via neglect of selfcare and cardiovascular distress, impaired work or school functioning, and broader societal issues (Langham et al., 2016). At the same time, most individuals that gamble do so without issue, and it is important to identify those most prone to problem use to mitigate risk of harm.

Recent decades have seen improvements in our understanding of problematic gambling, evidenced by the evolution of disordered gambling across editions of the Diagnostic and Statistical Manual of Mental Disorders (DSM). This has coincided with the regulatory shift from
prohibition toward the expansion of commercialized gambling (Hodgins & Petry, 2016), which has generally resulted in both greater access to legal gambling and the development of harm-reduction and treatment programs. Problematic gambling was first introduced in the Third Edition of the DSM (DSM-III), in 1980, under the category of Impulse Control Disorders Not Elsewhere Classified, and labeled as “Pathological Gambling” (American Psychiatric Association, 1980). This placed gambling alongside historical “monomanias” such as pyromania and kleptomania, then likened to singular “irresistible impulses” experienced by individuals (Rosenthal, 2020). In 2013, with the release of the fifth edition of the DSM (DSM-5), the disorder was renamed to “Gambling Disorder” and became the inaugural entry into the newly formed classification of “Non-Substance-Related Disorders” within the category of Substance-Related and Addictive Disorders (American Psychiatric Association, 2013).

Similar to substance-related disorders, a diagnosis of Gambling Disorder was defined by the presence of persistent and recurring problematic usage, resulting in distress, during the past 12-months. Criteria associated with Gambling Disorder include: 1) increased tolerance (e.g., needing to gamble with more money); 2) inability or difficulty to stop or limit gambling; 3) preoccupation about gambling; 4) inability to reduce gambling; 5) attempts to recoup losses through more gambling (‘loss chasing’); 6) use of gambling to regulate mood; 7) concealed gambling behaviour; 8) impaired relationships or work performance; 9) and reliance on other’s money due to financial duress caused by gambling. This recategorization removed the “illegal acts” criterion from Gambling Disorder, nevertheless there is evidence that such an association exists (Mitzner, Whelan, & Meyers, 2011). Many of these criteria overlap with substance use disorders, whereas some, such as loss chasing, are arguably unique to gambling behaviour. Both substance use and gambling behaviour incur public stigma (Hing, Russell, Gainsbury, & Nuske,
2016), and the degree of stigma varied by gambling type (Peter, Li, Pfund, Whelan, & Meyers, 2019). The reclassification as a non-substance-related disorder reflected a shift in our understanding, that behaviours can result in similar consequences to those historically associated with substances (Clark, 2014), and that addiction can occur outside the context of chemical dependence.

The prevalence of problematic gambling is comparable to the problematic use of many substances (American Psychiatric Association, 2013), and these behaviours regularly co-occur (e.g., alongside cannabis use; Winters & Whelan, 2020). The lifetime occurrence of Gambling Disorder is estimated to be 0.4 – 1.0% of the general population (American Psychiatric Association, 2013; Kessler, Hwang, LaBrie, et al., 2008). However, these estimates only reflect those who meet diagnostic criteria, and gambling harms occur upon a continuum. A worldwide meta-analysis of prevalence studies estimated 2.4% of adults are at-risk of problematic gambling behaviour (Gabellini, Lucchini, & Gattoni, 2022). Locally, a survey of British Columbian’s engagement with gambling identified that 72.5% of residents had gambled in the past year, 7.9% were at a ‘low-risk’ of problem gambling (i.e., some minimal negative gambling-related consequences), 2.6% at a ‘moderate-risk’, and 0.7% at a ‘high-risk’ (R.A. Malatest & Associates Ltd., 2014), meaning about 1 in 10 British Columbia residents experience some degree of harm from gambling. Modern technology has also increased accessibility to gambling, through both legal and illegal online gambling platforms. Although fewer individuals gamble online (approximately 22.0% of the population), those who do so appear to be at higher risk of problematic gambling (Gainsbury, Russell, Wood, Hing, & Blaszczynski, 2015), a finding that has also been reported in BC (Ipsos & Strategic Science, 2020). The characteristics between internet and non-internet at-risk and problem gamblers also appear to differ, with the former
typically of younger age and more likely to be male (Gainsbury, Russell, Hing, Wood, & Blaszczynski, 2013). There is a need to understand the impact of gambling-internet convergence, with both online gambling platforms and other gambling-like mechanisms, such as simulated gambling games or randomized features within video games.

1.2 Similarities to Substance Use

In addition to symptom overlap, similarities between the neurobiological underpinnings of gambling behaviour and substance use are well documented. The dopaminergic system is associated with initial motivation to move toward a reward stimuli, and the reinforcement of reward-seeking behaviours after obtaining the reward (Wise, 2004). Certain substances, such as the stimulant cocaine, act directly upon dopamine, in addition to other neurotransmitters, by preventing reuptake at the synapse, allowing more dopamine to remain in the system (Kohno, Dennis, McCready, & Hoffman, 2022). Across substances, lowered dopamine activity in the mesolimbic system is associated with substance use dependence, and this has been attributed to withdrawal symptoms (Diana, 2011; Spiga, Lintas, Migliore, & Diana, 2010). A blunted dopaminergic reward response toward substances has also been found (Trifilieff, Ducrocq, van der Veldt, & Martinez, 2017; Volkow, Fowler, Wang, Baler, & Telang, 2009). Further, stimuli associated with substance use can become conditioned to trigger dopamine activity, and prompt motivation toward use (Leyton, 2007). The dopaminergic system has also been linked in disordered gambling, although this relationship does not appear to be identical to the described relationship with substance use (Clark, 2014), and this possibly reflects the absence of direct chemical consumption. Using positron emission tomography, no evidence of reduced baseline dopamine activity among those with gambling disorder was found (Boileau et al., 2013; Clark et
al., 2012), nor has consistent evidence of reduced dopamine activity during gambling been found (Linnet, Møller, Peterson, Gjedde, & Doudet, 2011). However, gambling increased dopamine release in both winning and non-winning conditions, and problem gambling severity correlated with greater dopamine release within problematic gamblers (Joutsa et al., 2012). This latter finding is consistent with a lack of baseline dopamine reduction among problematic gamblers. Further, gamblers display heightened anticipatory dopamine responses to gambling reward cues, similar to the conditioned cues that occur with substance use (Boileau et al., 2014; Linnet, 2020).

The presence of heightened dopamine release in response of gambling reward cues and gambling outcomes could implicate Kapur’s Aberrant Salience Hypothesis (2003) as one mechanism for the formation of erroneous gambling beliefs. This hypothesis posits that heightened dopaminergic activity promotes the attribution of exaggerated meaning to otherwise meaningless or neutral stimuli. This process, in turn, can facilitate the formation of delusional beliefs, as these benign stimuli are incorporated as meaningful elements into the individuals understanding of the world. Kapur (2003) proposed this framework as a potential explanation for the latency between anti-psychotic medications that reduce dopamine activity and reduction in delusional thought. Specifically, he argued that these medications do not directly disrupt delusional beliefs, but through a reduction of the moderating effects of dopamine, individuals start to ascribe less meaning to the neutral stimuli incorporated into delusions, and eventually their preoccupation with these thoughts reduces to tolerable levels. Translating this to gambling behaviour, individuals who experience heightened dopamine release when gambling could more readily form erroneous beliefs about gambling by associating meaningless gambling-related behaviours to desired outcomes (e.g., a slot machine jackpot being attributed to a particular betting style). It is also well established in operant conditioning that random-ratio reward
schedules produce a high degree of engagement and encourage dopamine release (Laskowski, Dorchak, Ward, Christensen, & Euston, 2019). This reward uncertainty, an intrinsic component of gambling, may be crucial to anticipatory dopamine release (Clark, Boileau, & Zack, 2019), meaning gambling could be particularly suited to evoking aberrant salience.

Another shared feature between substance use and gambling is the personality trait of impulsivity, characterized by risk-taking, sensation seeking, non-planning, and disinhibition (Acton, 2003). A review by DeVito et al. (2020) demonstrated robust links between greater impulsivity, measured behaviourally and by self-report, and increased clinical severity of substance use in both males and females across multiple substances. In adolescents, a 3-year longitudinal study linked increasing scores of impulsivity with greater tobacco use, problematic alcohol use (in males but not females), and cannabis use (Martinez-Loredo, Fernandez-Hermida, De La Torre-Luque, & Fernandez-Artamendi, 2018). A cross-sectional relationship between problematic gambling and impulsivity has also been observed (Blaszczynski, Steel, & Mcconaghy, 1997), across several dimensions of the trait such as faster behavioural activation toward stimulus cues, greater preference for stimulation, and less inhibition control (Ginley, Whelan, Meyers, Relyea, & Pearlson, 2014). Individuals that experienced problematic gambling were more likely to perform worse on delay discounting (a behavioural measure of impulsivity) than non-problem gamblers (Ledgerwood, Alessi, Phoenix, & Petry, 2009). In a review by Chowdhury et al. (2017), motor impulsivity, or the ability to prevent behavioural responses, was specifically linked to an inability to inhibit gambling urges, also across both behavioural and self-report measures. However, the authors noted that little research has been conducted to disentangle the role of Attention-Deficit / Hyperactivity Disorder in this relationship, and that motor impulsivity is only one of many potential pathways toward problematic gambling.
Impulsivity and gambling has been longitudinally linked. A 7-year longitudinal study of adolescents from a median age of 12.6 found that self-reported impulsivity predicted later onset of gambling behaviour (Auger, Lo, Cantinotti, & O’Loughlin, 2010). However, this effect was only present among children that experienced lower socioeconomic conditions, and both low parental education and material deprivation were additional strong risk factors for subsequent gambling onset who reported high impulsivity. Auger et al. (2010) did note that their measure of impulsivity was not limited to a specific dimension (e.g., motor impulsivity), and that gambling information was only collected once participants were adults, and therefore the precise time of onset could have been retrospectively misremembered. Slutske et al., (2012) utilized the 30-year prospective Dunedin cohort study to investigate whether different childhood temperaments at 3-years of age could predict disordered gambling at ages 21 and 32. These authors found that children identified as having an “Undercontrolled Temperament” (inclusive of impulsive behaviour) at age 3 were over twice as likely to experience problematic gambling (defined by meeting at least one symptom associated with Gambling Disorder) at both later ages, and this was not explained by covariates such as childhood intelligence measurement score or, diverging from Auger et al. (2010), family socioeconomic status. Thus, as a general vulnerability factor, impulsivity may explain some of the co-occurrence of problem gambling and substance use (Ledgerwood et al., 2009), although moderators of this association require clarification.

1.3 Cognition and Gambling

It is no secret that commercial gambling games are designed to produce a net loss for the average gambler so that the venue or gambling operator can produce a profit. Slot machines and other electronic forms of gambling are programmed with return rates below 100%, and table
games and sports betting have odds that are biased toward the establishment or, like poker, incorporate a ‘house rake’ (the proportion of the winning taken by the organizers). Given this, what encourages continued gambling in the face of statistically expected losses, and how might these behavioural tendencies escalate to problematic levels? One prominent explanation emphasizes cognitions that shift the gambler’s perception toward more favourable odds. These erroneous beliefs, termed gambling-related cognitive distortions (GRCDs), have routinely been implicated in problematic gambling (Leonard, Williams, & Vokey, 2015). In a treatment-seeking group, gamblers who scored higher on a measure of GRCDs were more likely to experience a relapse of problem gambling (Oei & Gordon, 2008). This is consistent with structural equation modelling that demonstrated gambling cognitions predicted of subsequent gambling behaviour (Yakovenko et al., 2016). These distortions have been documented during both the gambling state (Gaboury & Ladouceur, 1989; Ladouceur & Walker, 1996) and as trait beliefs held outside of gambling sessions (McInnes, Hodgins, & Holub, 2014; Raylu & Oei, 2004). State-related beliefs may promote continued gambling, whereas trait (i.e., dispositional) beliefs could encourage the individual’s decision to gamble or return to gambling.

A possible foundation for the development of certain gambling cognitions is found in our predisposition to think heuristically (Leonard et al., 2015). As mental shortcuts for estimating outcomes, heuristics have the potential to be adaptive by reducing the effort required in judgement and decision-making. Typically, heuristic thinking involves attending to fewer cues, simplifying the values attributed to cues, recalling less information, attending to less information, or reducing the use of alternative sources of information (Shah & Oppenheimer, 2008). Yet, this process can also lead to systematic errors when situations differ from the environments that these shortcuts were developed within (Gilovich & Griffin, 2012).
Tversky & Kahneman (1974) identified three commonly utilized heuristics: representativeness, availability, and anchoring and adjustment. The representativeness heuristic is evoked when estimating the probability whether one object or event is related to another, through judging the presence of a relationship by the perceived similarity between the two. For example, assuming two people are related because they share similar physical features. This heuristic fails to incorporate several sources of information, including base rate probabilities, the greater variability produced by small samples, the tendency to regress toward mean values, and is prone to the misconception that small sequences of events will reflect expected distributions. Within gambling, this heuristic can be actively encouraged by displaying a series of the most recent outcomes, as this often encourages gambler’s to bet on the outcomes thought to be not sufficiently represented (i.e., the Gambler’s fallacy, see Section 1.3.1 for an elaboration). The availability heuristic occurs when the frequency of an event is estimated by the ease relevant information is recalled. Misappraisals can occur when there are differences in the retrievability of information, one set of events is more readily imaginable than another, or the method to recall one set is more effective. For example, gambling ‘jackpot’ wins may be more memorable than the much more common encounters of gambling losses, leading to a biased perception about the frequency of positive outcomes. Their third heuristic, anchoring and adjustment, occurs when the initial estimate is made, and subsequent information prompts incremental changes to the estimate. Tversky & Kahneman (1974) showed how these later adjustments are often insufficient to produce an accurate prediction. The United Kingdom-based Behavioural Insights Team recently demonstrated that many online gambling platforms use default values for daily deposit limits that can then act as an anchor (Behavioural Insights Team, 2021). When higher deposit amounts were presented as options (ranging from £5 - £100,000), gamblers selected a
significantly higher daily limit than when lower default options were presented (upper limit £250) alongside a textbox to enter a desired amount (maximum $100,000). While the application of these heuristics to describe the formation gambling-related cognitions has been described as a broad and incomplete explanation (Ayton & Fischer, 2004), gambling games nevertheless appear to be particularly prone to heuristic-related errors.

1.4 Specific Gambling-Related Cognitive Distortions

Fortune & Goodie (2012) discuss the relationship between Tversky & Kahneman’s (1974) heuristics and gambling-related cognitive distortions (GRCDs), and highlight both the representativeness and availability heuristics in the formation of certain GRCDs. In this section, specific cognitions are outlined, informed by Fortune & Goodie’s (2012) taxonomy alongside the taxonomies developed by Toneatto (1999), Leonard, Williams, & Vokey (2015), and elsewhere. The cognitions captured by the Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004) are also incorporated into this review because this scale is the primary measure of GRCDs used in the data chapters of this thesis. Two factors from the GRCS, “Gambling Expectancies” and “Inability to Stop”, do not strictly reflect distorted thinking, but metacognitive perceptions about gambling (see Section 1.4.9). I note that while specific cognitive distortions are discussed separately, some overlap does exist, and this is evidenced by the moderate-to-large correlations between gambling cognitions on measures (see Steenbergh, Meyers, May, & Whelan, 2002 or Raylu & Oei, 2004 for examples).
1.4.1 The Gambler’s Fallacy

The Gambler’s fallacy, also commonly referred to as the Monte-Carlo fallacy, reflects the inaccurate belief that deviations from a statistical average will self-correct (Leonard, Williams, & Vokey, 2015). For example, when the Gambler’s fallacy is active, a roulette wheel that produces three ‘red’ outcomes is expected to have an increased probability to produce a ‘black’ outcome next. Such a belief fails to consider the independence of events present in roulette and other games of chance, where prior events have no impact on future outcomes (Croson & Sundali, 2005). This bias is linked to the representativeness heuristic because the expected correction to this distribution (i.e., landing on black) would make the sequence of events more representative of expected probabilities (Fortune & Goodie, 2012; Tversky & Kahneman, 1971), and results from the misconception that even small sequences should reflect the overall probability distributions (Tversky & Kahneman, 1974). Indeed, casinos often leverage this faulty belief in roulette by displaying recent outcomes on a monitor above the roulette wheel.

1.4.2 The Hot Hand Fallacy

The hot hand fallacy relates to the erroneous belief that a series of wins is predictive of continued wins, because the gambler perceives the winning streak as evidence of personal skill (Leonard, Williams, & Vokey, 2015) and continued wins are representative of this skill. Fortune & Goodie (2012) note the apparent inconsistency in the representative heuristic because it can be attributed to these seemingly opposite expectations produced by the Gambler’s fallacy and hot hand fallacy. They reconcile this with findings from Ayton & Fischer (2004), who described how gamblers might first decide whether the physical device that is generating the outcomes should conform to randomness (e.g., a roulette wheel or coin toss; prompting a Gambler’s fallacy) or individual skill (e.g., a basketball player taking shots; prompting the hot hand).
1.4.3 Illusion of Control

The perception of control can be separated into primary control, which relates to the sense that one can directly influence gambling outcomes, and secondary control, where this influence is evoked via supernatural forces (Ejova, Delfabbro, & Navarro, 2015). In primary control, gamblers expect that their actions will produce desirable outcomes at a frequency greater than chance (Fortune & Goodie, 2012). Picking lottery numbers compared to random number generation, adjusting the line or bet settings on a slot machine, or using specific betting patterns in roulette are all examples of primary control. Notably, gambling games often include structural characteristics that increase the perception of control, such as slot machine ‘stopper’ buttons that act as a brake on the reel spin (Chu, Limbrick-Oldfield, Murch, & Clark, 2018; Robert Ladouceur & Sevigny, 2005). Even in games that allow a degree of skill (e.g., poker, sports betting), primary control may be perceptually inflated to distorted levels (MacKay, Bard, Bowling, & Hodgins, 2014).

Secondary control relates to gambler’s perceptions about the influence of supernatural forces, the use of rituals, and can also incorporate elements of luck (Ejova et al., 2015). Although rituals often refer to an action taken by the gambler, these differ from primary control because the effect of the ritual is perceived to be mediated by supernatural forces. Wearing specific clothing or bringing ‘lucky items’ (e.g., a rabbit’s foot) to influence gambling outcomes are considered talismanic superstitions (Toneatto, 1999). Other examples of secondary control include verbal or nonverbal behaviours that lack a clear connection to the gamble (e.g., talking to the machine; tapping the machine, clapping, rubbing dice), appeal for intervention from deities, or for the person to only gamble when they perceive their luck to be at a cyclical high (Ejova, Delfabbro, & Navarro, 2015). Secondary control can arise from operant conditioning, where
positive gambling outcomes become mistakenly linked to ritualistic behaviours and supernatural beliefs. Such conditioning may be maintained by the availability heuristic because rituals or beliefs paired with wins could be more easily recalled than those paired with losses (Fortune & Goodie, 2012).

The Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004) contains two factors that incorporate these elements of control. In reviewing the specific items, its “Illusion of Control” factor appears to be an amalgamation of primary and secondary control, emphasizing the latter (e.g., item 18: “I have specific rituals and behaviours that increase my chances of winning”). The GRCS “Predictive Control” factor relates closely to the Gambler’s fallacy and hot hand fallacy (e.g., item 14: “When I have a win once, I will definitely win again”), as well as cyclical luck (e.g., item 19: “There are times that I feel lucky and thus, gamble those times only”). This emphasizes the use of these as cues to strategically (although incorrectly) inform gambling decisions. This conceptualization is similar to the cognitive distortion of “predictive skill” outlined by Toneatto (1999).

1.4.4 Belief in Luck

Perceptions about luck are multifaceted. Leonard, William, & Vokey, (2015) described “dispositional luck” as a gambling-related cognitions, where luck is thought to consistently favour certain people, places, colours, or numbers over others. This version of luck can also emerge from the availability heuristic through illusory correlations, due to memorable positive, but erroneous, associations between these things and outcomes (Fortune & Goodie, 2012). Conversely, individuals may believe that luck is not a constant or something that can be manipulated, but a cyclical force (Ejova, Delfabbro, & Navarro, 2015). In this case, good luck is something to be capitalized upon (e.g., by gambling), whereas gambling during periods of bad
luck is to be avoided. This has some overlap with the hot hand fallacy but emphasizes the influence of supernatural forces rather than individual skill. Others may view luck as controllable via talismans or as contagious, where positive or negative outcomes elsewhere in life influence gambling outcomes (Toneatto, 1999). One limitation in the measurement of luck-related beliefs has been an emphasis on good luck (Leonard, Williams, & Vokey, 2015), although at least one measure assesses four separate aspects of luck: the general belief in luck, rejection of luck, belief in good luck, and belief in bad luck (Maltby et al., 2008).

1.4.5 Interpretive Bias

This is another factor found in the Gambling Related Cognitions Scale (Raylu & Oei, 2004), and it relates to reframing gambling outcomes to encourage continued use. Aspects of this appear to relate to the availability heuristic, such as the item “Remembering how much money I won last time makes me continue gambling” (item 20), as significant wins will be more memorable than less exciting losses (Fortune & Goodie, 2012). Other aspects involve attributing positive outcomes to individual skill and negative outcomes to external forces (e.g., item 15: “Relating my losses to probability makes me continue gambling”).

1.4.6 Anthropomorphism

Anthropomorphism involves ascribing human characteristics to non-humans, and in the case of gambling, to non-living gambling-related objects (Toneatto, 1999). This provides a means to assign order to otherwise random events, by relating outcomes to the temperament of the object. For example, gamblers using a slot machine may be more inclined to continue if the machine’s outcomes are viewed as intentional, rather than resulting from an algorithm (Riva, Sacchi, & Brambilla, 2015). Anthropomorphism also provides another lever for illusion of
control. Kim & McGill (2011) found that individuals with a greater sense of control over others more willingly engaged with an anthropomorphized slot machine and found it less risky. The anthropomorphism of gambling games as a gambling-related cognitive distortion remains understudied and will benefit from further exploration.

1.4.7 Availability of Other’s Wins

This is a cognitive distortion that arises from the availability heuristic (Fortune & Goodie, 2012). Other gambler’s wins capture attention and are more memorable than their losses because wins are often accompanied by cheering, excitement, and in the case of electronic gambling products like slot machines, enticing audio-visual cues that can be heard throughout the venue. Lottery winners are also regularly made public, increasing the salience of positive outcomes. This can have the overall effect of encouraging continued gambling (Griffiths, 1994).

1.4.8 Fallacies Related to Mathematical & Statistical Properties

Leonard, Williams, & Vokey (2015) identified two errors in mathematical and statistical reasoning that can increase gambler’s vulnerability to certain gambling cognitions. The first, “insensitivity to sample size”, refers to the assumption that small samples should represent long-term statistical probability. Such a belief fails to consider that statistical deviations should be expected, and that such deviations are more likely in small samples. This is related to Tversky & Kahneman's (1974) representativeness heuristic, and may be seen as an intermediary between the heuristic and the Gambler’s fallacy. As Leonard, Williams & Vokey (2015) state, this means that gamblers are less likely to win over prolonged (i.e., a larger sample of) sessions because the average negative expected rate of return becomes increasingly likely. The second fallacy, “base rate neglect”, refers to the inclination to misjudge or ignore base rates in favour of alternative
information (Bar-Hillel, 1980), such as that derived from the representativeness heuristic (Tversky & Kahneman, 1973). In gambling, this can manifest as a belief that winning a slot machine jackpot is more common than the base-rate probability (i.e., the ‘return to player’ of the slot machine) because more salient information is preferentially attended to (e.g., the frequency of visually similar and more probable near-miss outcomes).

1.4.9 Gambling Expectancies & Inability to Stop

Raylu & Oei’s (2004) Gambling Related Cognitions Scale (GRCS) contains two factors that relate to metacognitions about gambling that do not necessarily correspond to distorted thinking about gambling mechanisms. The “Gambling Expectances” factor asks about the gambler’s perceived impact that gambling will have upon their mood. An example item is: “Gambling makes the future brighter” (item 11). Beliefs such as this could be the byproduct of the distortions discussed above, where misperceptions about the likelihood of winning result in distorted expectations about how one will feel during and afterward. Gambling Expectancies may also derive from the experience of flow, triggered during gambling activity, which correlates was demonstrated to positively associate with positive affect (Murch, Chu, & Clark, 2017). The GRCS’ “Inability to Stop” relates to the gambler’s perception about their dependence upon, and difficulty to control, gambling behaviour (e.g., item 21: “I will never be able to stop gambling”). Perceived difficulty in controlling one’s gambling behaviour is not necessarily an erroneous belief, but could be influenced by such distortions, as well as traits such as impulsivity or sensation seeking (Raylu & Oei, 2002).
1.5 Cognitive Treatment for Problem Gambling

The cognitive model of gambling provides a foundation for the treatment of problematic gambling based on targeting gambling-related cognitive distortions. Cognitive-behavioural therapy (CBT) is an empirically validated and dominant treatment approach for many difficulties associated with mental health. CBT-informed treatments have historically placed emphasis on either the behavioural or cognitive components. Behavioural approaches have focused on identifying gambling triggers, increasing pleasant activities, behavioural planning to minimize gambling, developing assertiveness and gambling refusal skills, and coping with relapse, and coping with urges to gamble (Petry et al., 2006; Petry, 2009), with some focus also upon identifying irrational beliefs. Whereas, cognitive approaches have emphasized the restructuring of these irrational beliefs, specifically applied to gambling-related cognitive distortions (Bujold, Ladouceur, Sylvain, & Boisvert, 1994; Sylvain, Ladouceur, & Boisvert, 1997). Ladouceur et al. (1998) sought to determine whether targeting these erroneous beliefs alone was a sufficient component of treatment. Participants identified with a diagnosis of Pathological Gambling (DSM-IV terminology) were provided once or twice weekly sessions, for up to 20 hours of treatment. Correction of gambling-related cognitive distortions focused upon increasing the understanding of chance and randomness (i.e., independence of events, no strategies are effective; no meaningful control is possible), learning about commonly held beliefs (i.e., an illusion of control), how these relate to misconceptions of randomness, increasing awareness about inaccurate perceptions during gambling, and active correction of the specific erroneous beliefs expressed by the gambler (e.g., elicited via the ‘think aloud’ procedure; see Section 3.1 for a thorough description of this procedure). After treatment, participant’s perception of control
over their gambling behaviour significantly increased and their reported desire to gamble decreased, and this persisted to 1 and 6-month follow-ups. (Ladouceur et al., 1998).

Subsequent studies have continued to provide some support for treatment of gambling-related cognitive distortions (GRCDs). Ladouceur and colleagues (2001) conducted a follow-up randomized controlled trial, and incorporated relapse prevention that emphasizes identification of GRCDs. Compared to the control group, the treatment group met significantly fewer diagnostic criteria for Pathological Gambling (DSM-IV), had an increased perception of control over gambling behaviour, greater self-efficacy, and a reduced desire to gambling. This treatment approach remained effective in a group format, and improvements were maintained up to 24-months post-treatment (Ladouceur et al., 2003). More broadly, Petry et al. (2006) compared the treatment efficacy of individual CBT, a formulation that included a module targeting cognitive distortions, to a Gamblers Anonymous (GA) condition. GA is a 12-step program that remains the only available form of treatment for problematic gambling within some states in the USA. Petry and colleagues found that CBT treatment was significantly more likely to reduce symptom severity than GA alone, although the specific contribution of the cognitive component of this treatment was not measured.

Cognitive treatment is not the only effective form of therapeutic intervention for problematic gambling. While remaining efficacious, it did not perform better than alternatives in a study by Toneatto & Gunaratne (2009). In this study, cognitive treatment was compared to: 1) behavioural interventions that focused on avoidance of gambling venues and associated stimuli, gambling urge management, and reinforcement non-gambling behaviours; 2) motivational interviewing, a directive, client-centred, therapy style that encourages ambivalence resolution, fostering intrinsic motivational to change behaviour, and aligning change with personal values
(O’Neill, 2017); and 3) a minimal, advice oriented intervention that was administered in a single session. A dose-dependent effect between the number of sessions and strength of the therapeutic effect could also account for some of the benefits of CBT, which typically includes a greater quantity of treatment sessions (Pfund et al., 2020). Supporting a role for the treatment of gambling distortions, lower levels of gambling-related cognitions at pre-test predicted symptom reduction at post-test among individuals receiving residential treatment for problematic gambling (Ledgerwood et al., 2020). Overall, the literature suggests targeting these cognitions is conceptually sound and possibly a sufficient form of treatment, and that the cognitive model of gambling is an essential component of gambling behaviour.

1.6 Gamblification of Video Games

Gamblification refers to the integration of gambling-like features into other systems (Macey & Hamari, 2022), and the gamblification of video games has led to increasing concerns among gamers, researchers, and regulatory bodies (Drummond & Sauer, 2018; King & Delfabbro, 2018; Zendle & Cairns, 2018). These concerns involve whether: 1) additional harm exists due to gamblification within a video game, and 2) if playing gamblified video games encourages subsequent gambling behaviour. The characteristic of randomization has long been included within video games, and underpins many of the systems found enjoyable (e.g., rewards, in-game encounters, and outcomes) by producing greater variability or adding an element of uncertainty to the game (Moore, 2011). Many games also directly replicate gambling games or casino atmospheres (i.e., “The Four Kings Casino & Slots”, released 2015). King et al. (2015) describe gaming as principally defined by interactivity, skill-based play, and indicators of progression and success; whereas central features of gambling games are the wagering
mechanics (often chance-determined), risk, and the prospect of monetary reward. Thus, a key
distinction is between gambling-like systems that do not allow expenditure of real money
(instead relying on valueless and unexchangeable in-game currency) versus those that permit in-
game purchases, referred to as microtransactions. The latter allows game mechanisms to link this
expenditure to those core features of gambling, creating the risk for financial harm.

Several cognitive factors have been associated with problematic internet gaming. In a
review, King & Delfabbro (2014) highlighted a four factor model for video gaming cognitions:
1) overvaluing video game rewards, 2) maladaptive and inflexible rules about gaming, 3)
excessive use of gaming to support self-esteem, and 4) use of gaming to gain social acceptance
as principal cognitions associated with online gaming. King & Delfabbro (2016) then assessed a
large group of adolescents (n = 824), and found that those who met criteria for Internet Gaming
Disorder were significantly more likely to hold these gaming cognitions. Bernaldo-de-Quiros et
al. (2022) designed a refined scale to capture the four cognitions outlined by King & Delfabbro
(2014). The authors found that these cognitions accounted for an additional 7.9% of variance in a
measure for Internet Gaming Disorder, when entered after a measure for video game engagement
in a hierarchical regression (total variance explained = 59.3%), within a sample of students aged
12-22. Thus, like gambling, there also appear to be specific cognitions that facilitate problematic
gaming, and in cases where video games undergo gamblification, additional cognitions typically
associated with gambling (see Section 1.4) could also influence video game engagement.

1.6.1 Social Casino Games

Social casino games are video games that replicate common online gambling games, such
as slot machines or roulette. These are effectively a form of simulated online gambling that do
not require monetary wagers or offer monetary prizes – although these games do typically offer
and encourage players to purchase additional credits with real money, for example to continue gameplay beyond a daily limit (Gainsbury, Russell, & Hing, 2014). This ability to ‘pay-to-play’ closely resembles the wager property that definitions of gambling often require. Gainsbury et al. (2016) found that paying social casino games (SCGs) players typically played longer, more regularly, and had greater engagement with the social interaction features than non-payers. Payers were also more likely to score higher on the Kessler 6 measure of psychological distress (King, Russel, Gainsbury, Delfabbro, Nerilee, 2016). A six-month longitudinal study found SCG players who completed microtransactions were significantly more likely to migrate to online gambling (OR = 8.16) than those who did not make microtransactions (Kim et al., 2015).

Similarly, Gainsbury et al. (2016) asked about the relationship between social casino games and gambling in a sample of 521 adult players, and 19.4% believed SCGs directly influenced their decision to gamble for money. Further, trait impulsivity has been linked to the decision to gamble for money after playing these games (Kim et al., 2019). Another concern about social casino games is the integration of advertising for gambling websites (Gainsbury et al., 2016), which could be especially potent because the player has demonstrated interest in gambling-like behaviour. Given SCGs similarities to gambling, gambling-related cognitive distortions would be another strong candidate for a predictor of migration, although this has yet to be tested.

1.6.2 ‘Skins’ Betting

Skins are virtual goods that change the cosmetic design of an in-game item and are present in many popular competition-oriented games. Some games allow players to trade these virtual items, and this capability permits the items to be treated as a commodity on online marketplaces. Similarly, platforms have been developed that allow skins to be wagered as a currency for online gambling games or for eSports betting (Grove, 2016). In a sense, skins
betting represents a hijacking of a video game system that allowed virtual items to have a monetary value. Motivations to engage in skins betting were reportedly similar to those of traditional gambling (i.e., financial gain, to improve mood) in a study of 180 participants who engaged in skins betting (Greer, Hing, Rockloff, Browne, & King, 2022). Many jurisdictions have deemed these platforms to be illegal gambling venues (Thorhauge & Nielsen, 2021), although the activity remains accessible for those determined to engage with it.

1.6.3 ‘Loot Boxes’

Loot boxes represent another, increasingly prominent, gambling-like feature in video games (Zendle & Cairns, 2018), and the aspect of gamblification that I focus on in Chapters 4 and 5. Zendle et al. (2020) surveyed the 50 most-played games on Steam, a video game platform, and found that loot boxes were present in 36% of these, and in 59% of the highest earning mobile games. A more recent survey conducted in 2022 survey noted that the prevalence in mobile games was 77%, when more obscured variations of loot boxes were considered (Xiao, Henderson, & Newall, 2022). Loot boxes are virtual items that may either be earned or purchased via microtransactions in video games, and these produce a randomized reward once “opened”. The resulting items vary in desirability, but the most desirable rewards are often the rarest. The probability of obtaining specific items has historically not been provided, although some governments (e.g., in China) have started to require such information be published (Tang, 2018). Such a reward system, relying on a random-ratio schedule, can encourage continued purchasing behaviour. Thus, loot boxes have been described as a predatory system of monetization (King & Delfabbro, 2018), and some jurisdictions have proposed regulation to curb their likeness to gambling (Danish Gambling Authority, 2018; Gerken, 2018).
Certain video games are also associated with virtual item marketplaces (e.g., Counter Strike: Global Offensive). When present, this allows players to have the option to ‘cash out’ the awarded loot box items for money, similar to that described above for skins betting. When a game includes both purchasing and cash out functions, this effectively means loot boxes exhibit the three properties associated with gambling (Reber, 2012): 1) a cost to play (when loot boxes are bought); 2) an outcome partly determined by chance; and 3) the prospect of winning a prize valued more than the initial cost (i.e., an item that can sell for more than the price of a loot box).

I note that this is a strict definition and does not take into account the subjective value that many players place upon virtual items, such as that for social signalling (Watkins & Molesworth, 2012), which may also perpetuate loot box use. Nevertheless, when present, this does provide the opportunity to treat the feature as a mechanism to gamble for money.

The consequences of loot boxes are unclear but can be speculated upon. If loot boxes are “psychologically akin” to gambling (Drummond & Sauer, 2018), then it becomes possible for players to unknowingly develop problematic gambling behaviours. This could be informed through the relationship between loot boxes, video game-related cognitions, and gambling-related cognitive distortions. It is possible that expenditure on loot boxes could promote a migration to gambling, similar to the findings by Kim et al. (2015) and Gainsbury et al. (2016) regarding social casino games, as discussed in Section 1.5.2. Alternatively, gamblers may be attracted to loot box features in video games because of their similarity to gambling games, and therefore be at a disproportionate risk of harm due to this feature. Notably, the proposed criteria for Internet Gaming Disorder (American Psychiatric Association, 2013) does not discuss the potential for harms associated with financial expenditure via in-game purchases. Thus, microtransactions broadly, and loot boxes specifically, represent an increasingly important facet
of video game behaviour that may currently be overlooked in the clinical assessment and
treatment of problematic video gaming.

1.7 Summary

In 2013, Gambling Disorder was classified as a “Non-Substance-Related Disorder”
within Substance-Related and Addictive Disorders (American Psychiatric Association, 2013),
and “Internet Gaming Disorder” was listed as a disorder requiring further study for the same
classification. More recently, the broader conceptualization of “Gaming Disorder”, not specific
to online formats, entered the eleventh edition of the International Classification of Diseases
(ICD-11; (World Health Organization, 2019). The similarities between Gambling Disorder and
substance-related disorders are found at the neurobiological, individual trait, and behavioural
levels. A cognitive model has been developed for gambling that can explain, at least in part, the
development and maintenance of gambling behaviour. This model pays specific attention to the
role of gambling-related cognitive distortions (GRCDs). Gambling cognitions can be thought of
as both dispositional traits and state-activated beliefs during gambling behaviour. The
significance of GRCDs in Gambling Disorder is emphasized by the efficacy of cognitive
treatments that have been developed. More recently, there is increased concern about the
incorporation of gambling-like elements into video games. Unlike conventional gambling,
gamblified video games have received less regulatory scrutiny, despite the possible exposure to
gambling-related harms. The relationship between these gamblified elements and gambling itself
requires clarity, and gambling-related cognitions provide one approach to assess psychological
similarities.
1.8 Dissertation Overview

This work emerged through a desire to explore two facets of gambling: gambling-related cognitive distortions and the gamblification of video games via loot boxes. These are studied through four data chapters, which are presented here as individual manuscripts. This means the research focus between chapters differs, although the common thread of gambling cognitions is found throughout, with varying emphasis. Each data chapter contains a more specific literature review to inform its study goals (Chapters 2-5). The introduction of Chapter 4 is intentionally limited to the discussion and research available at the time that study was completed (early 2019), and Chapter 5 offers a continuation through review of the literature that emerged afterward until its completion (late 2022). Chapter 6, the final chapter, provides a broad concluding discussion and highlights possible future directions that may be gleaned from this work as a whole.

1.8.1 Data Chapter Summaries

Chapter 2 explores the relationship between the personality spectrum of schizotypy, gambling-related cognitive distortions, and problematic gambling behaviour. Individuals high in schizotypy are predisposed to delusional beliefs and unusual perceptual experiences, disorganized thought, and interpersonal deficits. I hypothesized that these traits, especially delusion proneness and disorganization, would correlate positively with: 1) endorsements of erroneous gambling beliefs, given their apparent similarity; and 2) problem gambling. This was tested across three participant samples with varying degrees of gambling engagement. The results demonstrate that schizotypy is related to these gambling-related variables, and the effect size is comparable to the associations found with other research on impulsivity - the personality trait that is most often implicated in substance and non-substance addictions.
Chapter 3 develops and validates a scale, the Gambling State Cognitions Scale (GSCS) to assess state-activated gambling cognitions during gambling behaviour. This attempts to reconcile the divergence between existing scales, which focus upon trait beliefs, and the evidence that individuals with rational beliefs about gambling may still experience erroneous cognitions during gambling, perhaps due to emotional amplification (e.g., via excitement or desperation). This state scale was refined across three samples where participants engaged in a gambling task with credited money wagered, then completed the scale immediately afterward. A measure that comprised four factors was produced, and this underwent a variety of validation analyses. This measure will allow for an expansion of research focused upon common gambling cognitions activated during the state of slot machine use.

Chapter 4 shifts focus toward the gamblification of video games by studying the associations between loot boxes and gambling. This was one of the first studies to scientifically explore this relationship, and the primary questions were: 1) to determine how individuals who play video games engage with loot boxes; 2) to explore how loot box use relates to gambling behaviour; and 3) to examine whether risky loot box use can be predicted by gambling-related cognitions. This study developed a brief five-item measure called the Risky Loot Box Index (RLI) to evaluate these study questions. For robustness, two participant samples are used to explore these questions. The results demonstrated most gamers are familiar and have engaged with loot boxes, and that loot box expenditure and their risky use moderately correlate with problematic gambling behaviour. Further, moderate associations between loot box use and gambling cognitions suggest that the similarities between loot boxes and gambling extend to a psychological level. Broadly, this latter finding emphasizes the utility of gambling-related cognitions for informing the discussion about gamblification.
Chapter 5 extended the findings of Chapter 4 by examining the hypothesis that loot box engagement increases the likelihood of migration to gambling, using a preregistered six-month longitudinal design. In a sample of self-identified non-gamblers at baseline, both expenditure on loot boxes and their risky use at baseline was predictive of migration to self-identified gambler status and gambling expenditure by follow-up. This study also tested an alternative explanation for the correlational effects seen in Chapter 4, that current gamblers could be disproportionately attracted to loot box features, due to their similarity to gambling. In a sample of loot box non-users at baseline, the tests of this ‘reverse pathway’ demonstrated that gambling-related cognitive distortions were predictive of subsequent engagement with this feature at follow-up. As the first study to explore these questions longitudinally, the overall results continue to support concern and the call for regulation of loot box features.
Chapter 2. Gambling Along the Schizotypal Spectrum: The Associations between Schizotypy, Gambling Cognitions, and Problem Gambling

2.1 Introduction

Schizotypal personality (henceforth schizotypy) refers to a set of multidimensional traits that lie on a continuum with Schizotypal Personality Disorder (SPD) and Schizophrenia, but vary across the general population (Ettinger et al., 2014; Raine, 1991; Compton et al., 2007; Woodward et al., 2011). The term includes cognitive-perceptual features, interpersonal difficulties, and disorganized thought. Schizotypy is a core dimension in neurobiologically-informed models of human personality, including the Eysenck 3-factor model in which it is termed Psychoticism (Eysenck, 1992). Endorsement of traits on this continuum can range from those that may be minimally impairing (e.g., the perception that one is aloof or vague, see Appendix J for the Schizotypal Personality Questionnaire – Brief items; Raine & Benishay, 1995) to significantly impairing (e.g., meeting the criterial for SPD outlined in the DSM-5; American Psychiatric Association, 2013). Typically, a greater endorsement of schizotypal traits corresponds to worsening psychological adjustment (Lenzenweger, 2018). *Prima facie,* key aspects of schizotypy correspond with erroneous beliefs and biases in decision-making and reasoning that occur in gambling, known as gambling-related cognitive distortions (Ejova & Ohtsuka, 2020; Goodie, Fortune, & Shotwell, 2019; Leonard, Williams, & Vokey, 2015). For

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1 A version of Chapter 2 has been published: Brooks & Clark (2022). Gambling along the schizotypal spectrum: The associations between schizotypal personality, gambling-related cognitions, luck, and problem gambling, *Journal of Behavioural Addictions, 11*(2), 406-416.
example, gambling rituals or beliefs in personal luck are instances of magical thinking. Endorsement of these cognitions is reliably observed in disordered gambling (see Chapter 1; Griffiths, 1990; Kloosterman & Summerfeldt, 2015; Ladouceur et al., 1998; Moore & Ohtsuka, 1999), as are broader beliefs around luck (Chiu & Storm, 2010). There is a recognized comorbidity between schizophrenia and disordered gambling (McIntyre et al., 2007; Potenza & Chambers, 2001). However, schizotypy, as a source of individual differences throughout the population, has received limited empirical attention in relation to gambling.

In one of the few studies to consider this question, Abdollahnejad, Delfabbro, & Denson (2014, 2015) investigated the correlations between delusion-proneness (overlapping with the cognitive-perceptual facet of schizotypy), gambling-related cognitive distortions (GRCDs), and problematic gambling. Gamblers (n = 140) were assessed with the Peters et al. Delusions Inventory, Drake Beliefs about Chance Inventory (Wood & Clapham, 2005) and Gambling Related Cognitions Scale (Raylu & Oei, 2004). The authors found moderate correlations ($r = 0.40 – 0.48$) between delusion-proneness and these scales. Notably, the strength of these associations indicates that delusional thinking relates to gambling-related cognitions as strongly as the more widely-studied traits such as impulsivity (associated with gambling cognitions $r = 0.41$ to $0.49$ in Del Prete et al., 2017; Michalczuk et al., 2011), and stronger than the “Big Five” facets ($r = -.12$ to $-0.23$; MacLaren, Ellery, & Knoll, 2015). Yet, delusion-proneness, and by extension schizotypy, has received minimal attention in relation to gambling.

As a clinical syndrome, schizophrenia is associated with an array of changes in cognition and information processing, including judgment and decision-making. Balzan et al. (2012) found individuals with schizophrenia were prone to a reasoning bias of “jumping to conclusions” by making decisions with premature evidence, and that this persisted when accounting for study
task miscomprehension. Jumping to conclusions has been linked more specifically to delusion formation (Freeman et al., 2008). Individuals with schizophrenia were also more likely to select non-diagnostic positive hypothesis tests (i.e., directed toward the hypothesis) over diagnostic negative tests (i.e., directed toward an alternative), as were healthy controls who scored higher on the Peters et al. Delusions Inventory, indicative of a bias toward evidence-hypothesis matches (Balzan, Delfabbro, Galletly, & Woodward, 2013a). Further, both individuals with schizophrenia and delusion-prone individuals weighted confirmatory evidence more strongly (Balzan et al., 2013a). In another study by Balzan and colleagues (2013b), individuals with schizophrenia and healthy controls who scored higher on the delusions scale were more likely to make illusory correlations. These biases are similar to those found in gambling cognitions. For example, the task Balzan et al. (2012) used to measure jumping to conclusions involved watching beads being drawn from a jar with either 90% red beads or 90% green beads. The participant’s task is to sample information until they can decide whether the jar is predominantly red or green. Those prone to delusional thinking tended to make a judgement with fewer revealed beads, effectively relying upon the representativeness heuristic with a small sample. The representativeness heuristic’s insensitivity to sample size may also contribute to the Gambler’s Fallacy (see Section 1.4.8). Likewise, the task used to assess illusory control, judging whether button presses turned on a light across different levels of contingency (Balzan et al., 2013b), is comparable to gambler’s judgements about the outcome of slot machine games based upon their use of the stopper button (Chu et al., 2018). These similarities, alongside the work of Abdollahnejad et al., (2014, 2015) support the hypothesis that schizotypy and gambling cognitions could positively associate.
Schizophrenia has an established comorbidity with Gambling Disorder. In patients with Gambling Disorder, Granero et al. (2021) found that 4.40% met criteria for schizophrenia, compared to the approximately 1.10% baseline prevalence, and noted that variables associated with this comorbidity included: being single, lower education, unemployment, lower socioeconomic status, early onset of gambling problems, and worse psychopathological state. Similarly, in a sample of treatment-seeking individuals with Gambling Disorder, 7.2% met the criteria for psychosis, also approximately 4 times higher than the general population (Cassetta et al., 2018). Conversely, in a sample of 337 outpatients with either schizoaffective disorder or schizophrenia, 19.0% of individuals diagnosed also met the criteria for past-year problem or Pathological Gambling (the DSM-IV-TR diagnosis now replaced with Gambling Disorder; Desai & Potenza, 2009). Comorbid gambling was predicted by alcohol use, a greater degree of depression, and more use of outpatient mental health care. A qualitative study by Yakovenko et al. (2016) found themes of gambling as a means to fill a need for activity or as a means to connect with society were unique to their participants with schizophrenia or a schizoaffective disorder, and not typical of gamblers more broadly. Further, Yakovenko et al. (2016) noted that some participants ascribed an exacerbating effect on symptoms of schizophrenia to gambling, and Yakovenko et al. (2018) reported that loss chasing predicted gambling frequency among individuals with psychotic disorders, a behaviour associated with gambling cognitions. Thus, the changes in decision-making within schizophrenia and delusion-proneness conceptually overlap with these beliefs, and this could be an additional factor that explains the heightened rate of co-occurrence between schizophrenia and.

There is also emerging evidence for neurobiological links between gambling and psychosis. According to the aberrant salience hypothesis (Kapur, 2003), elevated dopamine
transmission drives attribution of salience to neutral or irrelevant stimuli, resulting in delusion formation. Such amplified dopaminergic activity has also been described in disordered gambling (Boileau et al., 2014) and this could promote gambling-related cognitive distortions through a similar mechanism, amplifying attention to chance events (Zack, St. George, & Clark, 2020).

The modern conceptualization of schizotypy is organized into three factors that align with key symptoms of schizophrenia: cognitive-perceptual features, interpersonal deficits, and disorganized thought (Compton et al., 2009; Raine, 1991; Raine & Benishay, 1995). Of these, the most obvious candidate to relate to gambling cognitions is the cognitive-perceptual facet, which includes magical/supernatural beliefs and broader delusional thought. Yet, the other facets may also relate to gambling behaviour; for example, disorganization could impair understanding of gambling probabilities. In healthy gamers, the interpersonal and disorganized facets of schizotypy decreased when participants thought about their ‘virtual selves’ within an online video game (Schimmenti et al., 2017). By analogy, gambling could provide a similar source of coping and escape for those with high trait schizotypy, resulting in increased engagement.

2.1.1 The Present Study

In the present study, Hypothesis 1 (H1) sought to replicate the association between delusion-proneness and gambling-related cognitions initially reported by Abdollahnejad et al. Second, I test an overarching hypothesis (H2) that schizotypy is correlated with gambling-related cognitions, beliefs about luck, and problem gambling. Third, I explore the hypothesis (H3) that the three facets of schizotypy will each positively correlate with specific gambling distortions, as measured with the Gambling Related Cognitions Scale subscales. Lastly, I hypothesize (H4) that the relationship between schizotypy and problem gambling will be attenuated after controlling for gambling-related cognitions. For robustness, Results are reported from three samples that
relied upon both undergraduate (Sample 1) and crowdsourced recruitment (Samples 2 & 3), each sampling a different range of gambling involvement.

2.2 Methodology

2.2.1 Sample & Procedure

Sample 1 consisted of university students with minimal levels of gambling involvement who completed an online survey for course credit. Despite their lack of or reduced degree of gambling engagement, this sample was included to determine whether results from convenience samples such as this can be relevant to examine questions about gambling cognitions, by observing their ability to generalize to samples of regular gamblers. Participants were pre-screened for English fluency and were over 19 (British Columbia’s legal gambling age). The survey was titled as ‘Gambling & Personality’ on the UBC Psychology Department’s Human Subject Pool for course credit, and took approximately 30 minutes to complete on Qualtrics®. Covert attention checks were used to promote data quality (recommended by Goodman, Cryder, & Cheema, 2013): i) abnormally fast survey completion (< six minutes), ii) endorsed use of a fictional slot machine, and iii) inconsistent responses to a repeated item. Participants failing any check were excluded and 104 participants (77.6%) passed. After consent, demographics were administered, then the scales outlined below (randomly presented per participant), followed by study debriefing. Data was collected between February to April 2017.

Samples 2 comprised North American adults (USA & Canada) with gambling experience collected via Amazon’s Mechanical Turk (MTurk), a crowdsourcing platform often used for research (Kim et al., 2017; Mishra et al., 2019; Newall, Walasek, & Ludvig, 2020). A pre-screen
questionnaire (compensation $0.15 USD) established eligibility: i) English fluency, ii) age 21 or over (legal gambling age in USA), iii) and an endorsed gambling frequency statement of “once every few months” or greater. Those eligible were given the option to complete the survey described above (compensation $1.50 USD). For data quality, only MTurk respondents that had completed ≥ 1000 MTurk tasks with a > 98% approval rating were eligible. Overall, 332 participants completed the questionnaire and 277 passed the attention checks (83.4%). Data was collected from September to October 2017.

Sample 3 was a secondary dataset comprised of North American adults (USA & Canada) collected via MTurk, originally collected between February and March 2018 for an unrelated study question about video gaming (see Brooks & Clark, 2019 and Chapter 4), and titled “Video Games & Loot Boxes – Research Study”. In including Sample 3 here, I aimed to replicate findings from Samples 1 & 2 among a group of participants with a broader range of gambling experience (from non-gamblers to frequent gamblers), and to further explore the association between schizotypy and luck. A pre-screen questionnaire (compensation $0.10 USD) established eligibility: i) English fluency, ii) age 21 or over (the legal gambling age in the United States), iii) and familiarity with video game “loot boxes” (unrelated to the present question). The full survey provided compensation of $1.50 USD. As with Sample 2, all MTurk respondents had completed ≥ 1000 MTurk tasks with a > 98% approval rating. Overall, 154 individuals completed the questionnaire and 144 passed the attention checks (94.1%).

2.2.2 Measures

A summary table of the measures, their acronyms, and a description of the constructs each measure assesses is found in Appendix A, Table A.1.
2.2.2.1 Delusion Proneness

The Peters et al. Delusions Inventory (PDI-21; Peters, Joseph, Day, & Garety, 2004) comprises 21 items about unusual beliefs (e.g., thought disturbances, references to the self, supernatural beliefs) to measure delusional ideation in the general population. Participants endorse each item as “Yes” or “No”, and for each endorsed item, rate their degree of conviction, preoccupation, and level of distress, on a 5-point scale, giving a total score from 0 to 336. Internal consistency was good ($\alpha = .86$) and excellent ($\alpha = .92$) in Sample 1 & Sample 2, respectively. This survey was not included in Sample 3.

2.2.2.2 Schizotypal Personality

The Schizotypal Personality Questionnaire-Brief (SPQ-B; Raine & Benishay, 1995) is an abbreviated, 22-item version of the SPQ (Raine, 1991), on which respondents answer “Yes” or “No”. This scale provides a dimensional assessment of schizotypy within the general population. Although this scale has no diagnostic threshold, those who endorse more traits on the SPQ/SPQ-B are at increased risk of meeting the criteria for schizophrenia and Schizotypal Personality Disorder (Raine, 1991; Compton et al., 2009). Therefore, the SPQ/SPQ-B may act as a pre-screen to determine suitability for a subsequent psychiatric evaluation. Greater scores on this measure have also associated with heightened dopamine release, one of the neurotransmitters associated with the cognitive-perceptual features of psychosis (Woodward et al., 2011). Good total score internal consistency was demonstrated in Sample 1 ($\alpha = .80$), Sample 2 ($\alpha = .85$), and Sample 3 ($\alpha = .89$). The scale comprises three factors of Cognitive-Perceptual Features ($\alpha = .55$;
α = .74; α = .82), Interpersonal Deficits (α = .80; α = .81; α = .82), and Disorganized Thought (α = .75; α = .74; α = .81; Compton et al., 2009).

2.2.2.3 Gambling Beliefs

Gambling-related cognitive distortions were assessed with three scales: 1) the Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004), which consists of 23 items scored on a seven-point scale ranging from ‘strongly disagree’ to ‘strongly agree’. This measure has five subscales that assess Illusion of Control, Interpretive Bias, Predictive Control, Gambling Expectances, and Inability to Stop gambling. For further elaboration upon these factors, see Section 1.4. Internal consistency was acceptable-to-good in Sample 1 (α = .78 - .83), and acceptable-to-excellent in Samples 2 (α = .77 - .93) and 3 (α = .83 - .90). 2) The Belief in Good Luck Scale was used in Samples 1 & 2 (BIGLS; Darke & Freedman, 1997). This scale assesses the respondent’s belief in good luck in Samples 1 & 2 (α = .84; α = .89). To examine a broader range of luck-related cognitions in Sample 3, the BIGLS was replaced with the 3) Beliefs Around Luck Scale (BALS; Maltby et al., 2008), comprising four subscales that measure belief in Personal Good Luck, Personal Bad Luck, General Belief in Luck, and Rejection of Luck. Internal consistency was good-to-excellent (α = .86 - .97).

2.2.2.4 Problem Gambling

The Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001) was used to assess problematic gambling in the past year. Items are scored 0 (“never”) to 3 (“almost always”), giving a max score of 27. This scale is considered the gold standard self-report instrument for gambling problems (Dowling et al., 2018). Scores are categorized “non-problem gambler” (0),
“low-risk” (1-4), “moderate-risk” (5-7), and “problem gambler” (8+; Currie et al., 2013). Internal consistency was good (α = .84) in Sample 1, and excellent (α = .93; α = .91) in Samples 2 & 3.

2.2.3 Analysis Plan

The delusions inventory (PDI-21) was included as a direct replication of Abdollahnejad and colleagues (H1). To investigate H2, that the broader construct of schizotypy is related to gambling-related cognitive distortions, beliefs about luck, and problem gambling, correlations were conducted between the schizotypy (SPQ-B), gambling cognitions (GRCS), and the luck-related scales (BIGLS or BALS). For H3, correlations between the separate facets of schizotypy and specific distortions were computed. Age, gender, and ethnicity were assessed as potential confounds with multiple linear regressions using R 4.1.2. For H1-H3, Pearson bivariate correlations (two-tailed) were conducted with IBM SPSS® 28.0, and the detected potential confounds were partialled. Partial correlations were used to assess H4, by recalculating the correlations between schizotypy and problem gambling while controlling for the GRCS. Following Cohen (1988), effect sizes for $r$ values are classified as “small” (> 0.30), “medium” (0.30 ≤ $r$ < 0.50), and “large” ($r$ ≥ 0.50). Boxplots with cases above 3.0 times the interquartile range (IQR) were considered outliers (Field, 2017). Normality was assessed with P-P plots and histograms and log transformations were applied to reduced skew, where appropriate. Spearman rank-order correlations were computed to reassess the results under different assumptions.

2.2.4 Ethics

The procedures for this study were carried out in accordance with the Declaration of Helsinki. Surveys began with a consent form about study procedures, and participants could either consent to participate or decline participation at the bottom of this page. The survey ended
with a debriefing form that discussed the purpose of the study, and provided participants with information about mental health resources. Study approval was provided by the University of British Columbia’s Behavioural Research Ethics Board (H16-03028)

### 2.3 Results

See Table 2.1 for demographics. Median endorsed gambling frequency: “less than once a year” for Sample 1, “about once a month” for Sample 2, and “about once a year” for Sample 3.

<table>
<thead>
<tr>
<th>Table 2.1 Participant Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Mean Age $(SD)$</td>
</tr>
<tr>
<td>Gender (% Female)</td>
</tr>
<tr>
<td>Ethnicity:</td>
</tr>
<tr>
<td>Asian</td>
</tr>
<tr>
<td>African/Black</td>
</tr>
<tr>
<td>Caucasian/White</td>
</tr>
<tr>
<td>Latin American</td>
</tr>
<tr>
<td>Other Ethnicity</td>
</tr>
<tr>
<td>Gambling Frequency:</td>
</tr>
<tr>
<td>Ever Gambled</td>
</tr>
<tr>
<td>“never”</td>
</tr>
<tr>
<td>“less than once a year”</td>
</tr>
<tr>
<td>“about once a year”</td>
</tr>
<tr>
<td>“once every few months”</td>
</tr>
<tr>
<td>“about once a month”</td>
</tr>
<tr>
<td>“every few weeks”</td>
</tr>
<tr>
<td>“every week”</td>
</tr>
<tr>
<td>“a few days a week”</td>
</tr>
<tr>
<td>“most days of the week”</td>
</tr>
</tbody>
</table>

Note: Descriptive statistics were calculated using untransformed values. Sample 2 was required to have at least “once every few months” of gambling engagement.
2.3.1 Multiple Linear Regressions

Multiple linear regressions tested for possible confounding effects of the demographic variables age, gender, and ethnicity, by using these to predict the gambling-related variables. Across samples, some demographic variables were significant predictors, and the analyses are presented in Appendix B in Tables B.1 – B.3. As a result, partial correlations were used to mitigate for the confounding effects these variables, and the specific partialled variables are stated in the appropriate table notes.

2.3.2 Pearson Bivariate Correlation Analyses

Table 2.2 summarizes full-scale correlations between delusion proneness (PDI-21), schizotypal personality (SPQ-B), gambling cognitions (GRCS), luck beliefs (BIGLS or BALS), and problem gambling (PGSI). Table 2.3 summarizes the correlations between the SPQ-B and GRCS subscales, and their associations with problematic gambling in Samples 1 & 2. Table 2.4 summarizes this for Sample 3, with the inclusion of the BALS’ luck scales.

As expected, the gambling cognitions (GRCS) and its subscales demonstrated small-to-large positive correlations with problematic gambling (PGSI) across all samples, except for the GRCS’ Gambling Expectancies subscale in Sample 1. Likewise, luck beliefs (BIGLS) were positively associated with gambling cognitions (GRCS) and problematic gambling (PGSI). The narrower measure of delusion proneness (PDI-21) and broader schizotypy (SPQ-B) were also moderately-to-strongly intercorrelated. Overall, these associations support construct validity of the measures within these three samples.
Table 2.2 Full-scale Pearson Bivariate Correlations

<table>
<thead>
<tr>
<th>Sample 1: Student (n = 104)</th>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PDI-21</td>
<td>50.2</td>
<td>33.3</td>
<td></td>
<td>.570***</td>
<td>.348***</td>
<td>.338***</td>
<td>.212*</td>
</tr>
<tr>
<td>2. SPQ-B</td>
<td>8.20</td>
<td>4.48</td>
<td></td>
<td></td>
<td>.283**</td>
<td>.109</td>
<td>.235*</td>
</tr>
<tr>
<td>3. GRCS</td>
<td>40.9</td>
<td>18.6</td>
<td></td>
<td></td>
<td></td>
<td>.409***</td>
<td>.336***</td>
</tr>
<tr>
<td>4. BIGLS</td>
<td>36.3</td>
<td>9.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.239*</td>
</tr>
<tr>
<td>5. PGSI</td>
<td>0.53</td>
<td>1.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Sample 2: MTurk (n = 277)</th>
<th>Variable</th>
<th>M</th>
<th>SD</th>
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<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PDI-21</td>
<td>44.8</td>
<td>35.6</td>
<td></td>
<td>.366***</td>
<td>.175***</td>
<td>.086</td>
<td>.199***</td>
<td></td>
</tr>
<tr>
<td>2. SPQ-B</td>
<td>8.04</td>
<td>4.95</td>
<td></td>
<td></td>
<td>.203***</td>
<td>.023</td>
<td>.205***</td>
<td></td>
</tr>
<tr>
<td>3. GRCS</td>
<td>75.9</td>
<td>25.8</td>
<td></td>
<td></td>
<td>.588***</td>
<td>.537***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. BIGLS</td>
<td>38.0</td>
<td>11.0</td>
<td></td>
<td></td>
<td></td>
<td>.155*</td>
<td></td>
<td></td>
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<tr>
<td>5. PGSI</td>
<td>4.64</td>
<td>5.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Sample 3: MTurk (n = 144)</th>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SPQ-B</td>
<td>9.03</td>
<td>5.71</td>
<td></td>
<td>.321***</td>
<td>-.051</td>
<td>.320***</td>
<td>.420***</td>
<td>-.145</td>
<td>.295***</td>
</tr>
<tr>
<td>2. GRCS</td>
<td>53.2</td>
<td>27.2</td>
<td></td>
<td>.368***</td>
<td>.130</td>
<td>.502***</td>
<td>-.345***</td>
<td>.666***</td>
<td></td>
</tr>
<tr>
<td>3. BALS-GL</td>
<td>17.1</td>
<td>7.13</td>
<td></td>
<td>-.336***</td>
<td>.147</td>
<td>-.180*</td>
<td>.199*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. BALS-BL</td>
<td>15.2</td>
<td>8.24</td>
<td></td>
<td>.369***</td>
<td>-.042</td>
<td>.117</td>
<td></td>
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<tr>
<td>5. BALS-GB</td>
<td>20.0</td>
<td>7.63</td>
<td></td>
<td>-.356***</td>
<td></td>
<td>.370***</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6. BALS-RL</td>
<td>17.8</td>
<td>4.85</td>
<td></td>
<td>-.296***</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>7. PGSI</td>
<td>1.90</td>
<td>3.49</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Note: * p ≤ .05, ** p ≤ .01, *** p ≤ .001 (two-tailed); partial correlations reported to control for Caucasian/White ethnicity and gender in Sample 1, Asian ethnicity, gender, and age in Sample 2, and gender in Sample 3. PDI-21 = Peters et al. Delusions Inventory; SPQ-B = Schizotypal Personality Questionnaire-Brief; GRCS = Gambling Related Cognitions Scale; BIGLS = Belief in Good Luck Scale; BALS-GL = Belief in Good Luck; BALS-BL = Belief in Bad Luck; BALS-GB = General Belief in Luck; BALS-RL = Rejection of Luck.; PGSI = Problem Gambling Severity Index; to reduce skew, the PGSI and GRCS in Sample 1, the PDI-21 and PGSI in Sample 2, and the PGSI, GRCS, and BALS-BL in Sample 3 were log transformed.
For H1, positive correlations were detected between delusion proneness (PDI-21) and gambling cognitions (GRCS) (Sample 1, \( r = .348 \); Sample 2, \( r = .175 \)) and between the PDI-21 and problem gambling behaviour (PGSI) (Sample 1, \( r = .212 \); Sample 2, \( r = .199 \)), supporting Abdollahnejad et al. (2014; 2015). Supporting H2, there were small-to-moderate, positive associations between the schizotypal personality (SPQ-B) and gambling cognitions (GRCS) (Sample 1, \( r = .283 \) in; Sample 2, \( r = .203 \); Sample 3, \( r = .321 \)) and between the SPQ-B and problematic gambling (PGSI) (Sample 1, \( r = .235 \); Sample 2, \( r = .205 \); Sample 3, \( r = .295 \)). However, this positive relationship did not extend to beliefs about good luck in Samples 1 & 2, as the BIGLS did not correlate with schizotypy total score or subscales, except for the cognitive-perceptual facet in Sample 1 (\( r = .307; p = .002 \)). Switching from the BIGLS to the BALS, to assess a wider range of beliefs about luck in Sample 3, schizotypy (SPQ-B) moderately correlated with a belief in personal bad luck (\( r = .320 \)) and a general belief in luck (\( r = .420 \)), but not with good luck. Thus, while no sample demonstrated a link between ‘good luck’ and schizotypy, Sample 3 indicates schizotypy could relate with other facets of luck cognitions.

Broadly, the SPQ-B Cognitive-Perceptual Features subscale most strongly associated with various gambling cognitions (GRCS subscales) and problematic gambling (PGS), yet associations with the other facets of schizotypy were also detected across all samples (see Tables 2.3 & 2.4), particularly for disorganized thought. In Sample 3, the BALS General Belief in Luck subscale correlated small-to-moderately with all facets of schizotypy, and bad luck demonstrated moderate correlations with the schizotypy facets of disorganized thought and interpersonal difficulties (see Table 2.4).
Table 2.3  Subscale Pearson Bivariate Correlations for Samples 1 & 2

<table>
<thead>
<tr>
<th></th>
<th>Sample 1: Student ((n = 104))</th>
<th></th>
<th>Sample 2: MTurk ((n = 277))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(M)</td>
<td>(SD)</td>
<td>2.</td>
</tr>
<tr>
<td>1. PDI-21</td>
<td>50.2</td>
<td>33.3</td>
<td>.614***</td>
</tr>
<tr>
<td>2. SPQ-CP</td>
<td>2.74</td>
<td>1.83</td>
<td>—</td>
</tr>
<tr>
<td>3. SPQ-IP</td>
<td>3.74</td>
<td>2.50</td>
<td>—</td>
</tr>
<tr>
<td>4. SPQ-DS</td>
<td>1.72</td>
<td>1.80</td>
<td>—</td>
</tr>
<tr>
<td>5. GRCS-GE</td>
<td>6.74</td>
<td>3.69</td>
<td>—</td>
</tr>
<tr>
<td>6. GRCS-IC</td>
<td>7.36</td>
<td>4.40</td>
<td>—</td>
</tr>
<tr>
<td>7. GRCS-PC</td>
<td>12.4</td>
<td>6.59</td>
<td>—</td>
</tr>
<tr>
<td>8. GRCS-IS</td>
<td>6.34</td>
<td>3.16</td>
<td>—</td>
</tr>
<tr>
<td>9. GRCS-IB</td>
<td>8.12</td>
<td>4.70</td>
<td>—</td>
</tr>
<tr>
<td>10. PGSI</td>
<td>0.53</td>
<td>1.77</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: * \(p \leq .05\), ** \(p \leq .01\), *** \(p \leq .001\) (two-tailed); partial correlations reported to control for Caucasian/White ethnicity and gender in Samples 1, and Asian ethnicity, gender, and age in Sample 2. PDI-21 = Peters et al. Delusions Inventory; Subscales: SPQ-CP = Cognitive-Perceptual Features; SPQ-IP = Interpersonal Deficits; SPQ-DS = Disorganized Thought; GRCS-GE = Gambling Expectancies; GRCS-IC = Illusion of Control; GRCS-PC = Predictive Control; GRCS-IS = Inability to Stop; GRCS-IB = Interpretive Bias; PGSI = Problem Gambling Severity Index. To reduce skew, the SPQ-DS, GRCS subscales, and PGSI values in Sample 1, and the PDI-21, SPQ-DS, GRCS-IC, GRCS-IS, and PGSI values in Sample 2 were log transformed.
Table 2.4 Subscale Pearson Bivariate Correlations for Sample 3

Sample 3: MTurk (n = 144)

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SPQ-CP</td>
<td>2.43</td>
<td>2.43</td>
<td>.403***</td>
<td>.471***</td>
<td>.262**</td>
<td>.338***</td>
<td>.287***</td>
<td>.214*</td>
</tr>
<tr>
<td>2. SPQ-IP</td>
<td>4.26</td>
<td>2.55</td>
<td>—</td>
<td>.620***</td>
<td>.114</td>
<td>.141</td>
<td>.185*</td>
<td>.041</td>
</tr>
<tr>
<td>3. SPQ-DS</td>
<td>2.34</td>
<td>2.09</td>
<td>—</td>
<td>—</td>
<td>.214*</td>
<td>.270**</td>
<td>.231**</td>
<td>.134</td>
</tr>
<tr>
<td>4. GRCS-GE</td>
<td>10.3</td>
<td>6.30</td>
<td>—</td>
<td>—</td>
<td>.585***</td>
<td>.703***</td>
<td>.594***</td>
<td></td>
</tr>
<tr>
<td>5. GRCS-IC</td>
<td>8.09</td>
<td>5.58</td>
<td>—</td>
<td>—</td>
<td>.690***</td>
<td>.618***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. GRCS-PC</td>
<td>16.3</td>
<td>8.31</td>
<td>—</td>
<td>—</td>
<td>.481***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. GRCS-IS</td>
<td>7.88</td>
<td>5.03</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. GRCS-IB</td>
<td>10.8</td>
<td>6.39</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. BALS-GL</td>
<td>17.1</td>
<td>7.13</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. BALS-BL</td>
<td>15.2</td>
<td>8.24</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. BALS-GB</td>
<td>20.0</td>
<td>7.63</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. BALS-RL</td>
<td>17.8</td>
<td>4.85</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. PGSI</td>
<td>1.90</td>
<td>3.49</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * p ≤ .05, ** p ≤ .01, *** p ≤ .001 (two-tailed); partial correlations reported to control for gender. Subscales: SPQ-CP = Cognitive-Perceptual Features; SPQ-IP = Interpersonal Deficits; SPQ-DS = Disorganized Thought; GRCS-GE = Gambling Expectancies; GRCS-IC = Illusion of Control; GRCS-PC = Predictive Control; GRCS-IS = Inability to Stop; GRCS-IB = Interpretive Bias; BALS-GL = Belief in Good Luck; BALS-BL = Belief in Bad Luck; BALS-GB = General Belief in Luck; BALS-RL = Rejection of Luck; PGSI = Problem Gambling Severity Index. To reduce skew, correlations with the SPQ-CP, SPQ-DS, GRCS subscales, BALS-BL, and PGSI values were log transformed.
To assess the final hypothesis (H4), partial correlations were conducted between schizotypy (SPQ-B) and problem gambling (PGSI), while controlling for gambling-related cognitions (GRCS). In this scenario, the correlation between the full-scale SPQ-B and PGSI was no longer significant when gambling cognitions were controlled for in Sample 1 ($r = .155; p = .122$), Sample 2 ($r = .116, p = .055$), and Sample 3 ($r = .115; p = .173$). Significant associations between the SPQ-B’s Cognitive-Perceptual Features subscale and problem gambling were retained in Samples 1, 2, & 3 ($p < .05$), although the coefficients visually reduced when compared to the unpartialled values reported in Tables 2.3 & 2.4 ($r = .250$ vs. $r = .296$ for Sample 1; $r = .116$ vs. $r = .233$ for Sample 2; $r = .204$ vs. $r = .366$ for Sample 3).

2.3.3 Spearman Rank-Order Correlations

To assess robustness of the results, correlations matrices were recalculated with Spearman rank-order correlations (see Appendix C, Tables C.1 – C.3). Overall, few differences emerged. Schizotypy (SPQ-B) was not significantly associated with the problem gambling in Sample 1, but the SPQ-B subscale pattern did not change. The delusions measure (PDI-21) now correlated with the GRCS’ Gambling Expectancies subscale. In Sample 2, the PDI-21 exhibited a positive association with belief in good luck, the GRCS’ Gambling Expectancies subscale no longer correlated Interpersonal Deficits, whereas Predictive Control did correlate. In Sample 3, the Disorganized Thought subscale now negatively correlated with the rejection of luck, and the perceived inability to stop gambling positively linked with belief in personal bad luck. The SPQ-B and problematic gambling (PGSI) ($r_s = .125, p = .039$) remained significantly associated in Sample 2, when controlling for gambling cognitions to assess H4.
2.4 Discussion

Our analysis plan began with a replication of an earlier finding by Abdollahnejad et al. (2014; 2015) in which delusion-proneness (on the PDI-21) was associated with both erroneous gambling beliefs (GRCS) and degree of problem gambling (PGSI). H1 was supported: Both the university students (Sample 1) and experienced gamblers (Sample 2) demonstrated links between the delusion-proneness and gambling-related cognitions (see Table 2.2). The PDI-21 also demonstrated small correlations with the more range-restricted PGSI in both samples. Following this initial step, I examined if the broader construct of schizotypy associated with gambling cognitions and problem gambling (H2), and then, to further explore relationships between individual facets of schizotypy and specific cognitive distortions captured by the GRCS (H3). Supporting H2, I found small-to-moderate positive correlations between the schizotypy (SPQ-B) total score and the two gambling scales (GRCS and PGSI) within each sample (see Table 2.2). This was strongest in Sample 3, likely because of a wider range of gambling experience that spanned non-gamblers to experienced gamblers.

Hypothesis 2 also tested the link between schizotypy and trait-like beliefs in luck. Our results across the three samples provide some novel insights about this relationship. When luck is operationalized as “good luck” via the BIGLS, minimal associations were detected. However, a more nuanced understanding emerged in Sample 3 using the BALS luck measure, which deconstructs luck cognitions into four factors reflecting personal good luck, personal bad luck, a general belief in luck, and rejection of luck. Consistent with the null results relating to good luck in Samples 1 & 2, full-scale schizotypy did not associate with the BALS’ Belief in Good Luck, but moderate, positive correlations were observed with personal bad luck and a general belief in luck (see Table 2.2). Notwithstanding the possibility of psychometric differences between these
luck scales, one interpretation is that individuals scoring highly on schizotypal traits may endorse beliefs in luck with the expectation that this force will work against them (i.e., bad luck). The Belief in Bad Luck and General Belief in Luck subscales were also some of the strongest correlates with the Interpersonal Deficits and Disorganized Thought factors of schizotypy (see Table 2.4). Future research may expand on these links between good and bad luck in the context of the full range of schizotypal personality traits.

The three subscales of the schizotypy measure (SPQ-B), reflecting well-established facets of schizotypy rooted in the clinical syndrome of schizophrenia, all displayed some significant correlations with the gambling-related variables (see Tables 2.3 & 2.4). In the samples comprising more experienced gamblers, the cognitive-perceptual facet, which largely consists of delusional thinking traits, displayed small-to-moderate correlations with Predictive Control and Illusion of Control on the gambling cognitions measure (GRCS), which reflect faulty assumptions about randomness (e.g., that runs of losses signify a win is due) and causality (e.g., superstitious rituals). It also positively associated with the GRCS’ Interpretive Bias and Inability to Stop subscales. These describe the tendency to reframe gambling outcomes to support continued gambling (e.g., attributing wins to the self and explaining away losses) and perception that one’s gambling behaviour is hard to control, respectively.

Expanding on the earlier study by Abdollahnejad et al (2014; 2015), delusion proneness (PDI-21) demonstrated small-to-moderate correlations with Predictive Control, Illusion of Control, and Interpretive Bias on the GRCS (see Table 2.3). Overall, these results bolster the notion that subclinical psychosis-like experiences and delusion-proneness is clearly associated with levels of problem gambling and several specific forms of gambling distortions.
Nevertheless, the relationship between schizotypy and gambling extended to other facets of schizotypy – particularly Disorganized Thought -- that has not been previously examined in this context. This factor displayed small associations with the GRCS’ Illusion of Control and Interpretive Bias subscales across all samples, in addition to the Predictive Control subscale in Samples 2 & 3 (see Tables 2.3 & 2.4). This finding suggests that otherwise healthy individuals who score highly on this trait may struggle to conceptualize randomness and causality. In Samples 2 & 3, Disorganized Thought was also linked to problem gambling (PGSI). Although Interpersonal Deficits exhibited small associations with three of the gambling-related cognitive distortions captured by the measure of gambling cognitions (GRCS) and problem gambling amongst experienced gamblers, this finding did not replicate across all samples and thus should be treated with caution. Overall, these results partially support H3 and indicate that future research on schizotypy’s relationship to gambling should look beyond the narrow focus on delusion-proneness.

Given that the overall pattern of bivariate relationships was consistent with the hypotheses H1-H3, H4 tested for attenuation of the relationship between full-scale schizotypy and problem gambling (PGSI) when controlling for gambling cognitions (GRCS) via partial correlation. For all samples, this relationship was no longer statistically significant after controlling for shared variance with these cognitions. The association between the cognitive-perceptual features of schizotypy and problem gambling was visually attenuated but remained significant. This pattern is compatible with the idea that schizotypy could act as a risk factor for disordered gambling behaviour via elevated levels of erroneous gambling beliefs. Although cross-sectional data cannot be used to assert directionality, I note that longitudinal research also exists to support the notion that gambling cognitions can act as a precursor to
gambling problems (Leonard & Williams, 2016; Leonard, Williams, & McGrath, 2021; Nicholson et al., 2016; Yakovenko et al., 2016).

The overall pattern of the observed associations is congruent with Kapur’s (2003) aberrant salience hypothesis, which implicates heightened dopamine activity (seen in both schizophrenia and gambling disorder) in the attribution of meaning to otherwise unconnected stimuli, as a mechanism for abnormal belief formation. In the context of gambling games, aberrant salience may take the form of erroneous associations between one’s actions and random wins, resulting in ritualistic behaviour and misappraisal of skill. As a means for treatment, Metacognitive Training (MCT) is demonstrated as effective for symptom reduction of schizophrenia (Erawati et al., 2014; Moritz et al., 2014) and improved insight (Lam et al., 2015). MCT targets cognitive biases associated with the formation and maintenance of delusions (e.g., ‘jumping to conclusions’). Recently, MCT has also been piloted for problem gambling (Gehlenborg et al., 2020). By linking schizotypy and gambling, this study both supports the continued development of MCT for problem gambling and also suggests targeting those broader information processing biases (e.g., jumping to conclusions, hyper salience to evidence-hypothesis matches; Balzan et al., 2012; Balzan et al., 2013b), in addition to the more specific gambling-related cognitive distortions.

2.4.1 Study Strengths and Limitations

As strengths of this study, the use of three samples allowed for internal replication of effects and increased the robustness of results, given that the number of correlational tests inflated the risk of type-1 errors. The replication of Abdollahnejad et al. (2014, 2015) further mitigates against this. At the same time, there are limitations inherent to these groups, survey design, and analyses. The demographics of the student sample includes a relatively high rate of
Asian (or Asian Canadian) ethnicities, which have some further cultural links to gambling behaviour that I do not explore (Raylu & Oei, 2004b; Fong, Law, & Lam, 2014; Ji et al., 2015). They were also disproportionately female, nearly half of the student sample had never gambled, and range restriction was especially evident on the continuous measure of problem gambling. These demographics consistent with findings about the differences of psychology undergrads compared to those recruited online (Gainsbury, Russell, & Blaszczynski, 2014). Yet, the similar pattern of results with the crowdsourced samples of experienced gamblers suggests that data from non-gamblers can be relevant for addressing questions about gambling-related cognitions. Sample 2, recruited via MTurk, also suffered an intentional range-restriction by focusing recruitment on experienced gamblers. Consistent with other research using crowdsourcing samples (Angus et al., 2021; Kim & Hodgins, 2017; Mishra & Carleton, 2017; Walters, Christakis, & Wright, 2018), Sample 3 oversampled the moderate risk (9.00%) and problem gambling (7.60%) PGSI categories at much higher rates than the estimated prevalence of these categories (Currie et al., 2013), possibly indicating that those who gamble frequently are more likely to engage in a gambling-related survey. I also explained results using the longstanding effect size convention of Cohen (1988), and this considers most of the effects as small. However, individual differences research often has small effect sizes and alternative guidelines exist. Gignac & Szodorai (2016) analyzed 708 correlations from 87 meta-analyses within individual differences research. These authors suggested $r = .11$ (small), $r = 0.20$ (medium), and $r = 0.29$ (large) because these values represented the 25th, 50th, and 75th percentiles of reported correlations. Further, this study’s effect sizes were comparable to those reported for impulsivity (Del Prete et al., 2017; Michalczuk et al., 2011), an extensively studied trait within gambling.
literature. Thus, while many of these effects are “small” they can be considered meaningful within individual differences contexts.

2.5 Conclusions

This study demonstrates that the previously documented links between the schizophrenia and gambling problems are not limited to clinical diagnoses, but also exist within the general population as a function of trait schizotypy. The relationships between the “traditional” gambling-related cognitive distortions found in the GRCS of Predictive Control, Illusion of Control, and Interpretive Bias (Devos et al., 2020) were most pronounced with the schizotypy factors of Cognitive-Perceptual Features and Disorganized Thought. Whereas, the broader conceptualization of luck, and a specific belief in personal bad luck, but not in good luck, exhibited a moderate relationship with the schizotypal factor of Interpersonal Deficits. Whilst cross-sectional, these results support the need for future studies testing the longitudinal hypothesis that high trait schizotypy may be a risk factor for disordered gambling. These findings thus implicate the nexus between delusional and magical thinking, and decision-making distortions as candidate psychological mechanisms for understanding the comorbidity between schizophrenia and gambling disorder (Potenza & Chambers, 2001).
Chapter 3. The Gambling State Cognitions Scale (GSCS): Development and Validation for Slot Machine Gambling

3.1 Introduction

The relationship between the act of gambling and gambling-related cognitive distortions (GRCDs) is well documented (Baboushkin et al., 1989; Ladouceur, 2004; Ladouceur & Walker, 1996; Langer, 1975), as discussed in Chapters 1 & 2. This has prompted development of numerous measures to assess these beliefs, such as the Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004) and the Gambler’s Beliefs Questionnaire (Steenbergh et al., 2002). Both of these are commonly used, well validated, and considered comprehensive measures because they assess a range of GRCDs. Other measures focus on more specific beliefs like luck or superstitious rituals (Darke & Freedman, 1997; Joukhador, Blaszczynski, & Maccallum, 2004; Maltby et al., 2008). Leonard, Williams, & Vokey (2015) reviewed 18 gambling-related cognitions scales, and a common theme across these is their emphasis upon the dispositional (“trait”) nature of gambling beliefs, that is their measurement outside a direct gambling context. This focus is evidenced by the scale or item wording. For example, the GRCS item “Praying helps me win”, or the Gambler’s Beliefs Questionnaire item “Gambling is more than just luck” do not target a specific gambling experience. A trait-based approach can increase a measure’s flexibility, and dispositional beliefs are important to quantify in relation to the vulnerability to gambling problems, as evidenced by treatments for problem gambling that target these (Smith et al., 2018). Yet inherently, trait-related measures are unlikely to capture contextually driven, transient, state-activation of erroneous cognitions during gambling behaviour.
One of the first experimental approaches to identify gambling-related cognitions was intrinsically state-related. The ‘think-aloud’ method, first used by Gaboury & Ladouceur (1989), required a gambler to verbalize all thoughts, without self-censorship, during a period of gambling. This monologue was recorded and then coded for gambling-related distortions. Gaboury & Ladouceur (1989) found that participants verbalized distortions significantly more frequently than accurate perceptions during gambling (70.0% to 30.0%). The think-aloud method has demonstrated particularly high rates of erroneous verbalizations among gamblers playing their preferred game (Walker, 1992), and such verbalizations were more commonly expressed by regular or problematic gamblers than by less frequent, casual gamblers (Baboushkin et al., 2001; Griffiths, 1994). However, the think-aloud technique has largely fallen from favour in gambling research. Two criticisms of think-aloud were: 1) verbalizing an entire gambling session is overly intrusive, and could alter the experience; and 2) the verbalized statements could reflect rationalizations about behaviour rather than the cause of behaviour (Dickerson & O’Connor, 2009; Ladouceur & Walker, 1996). In the modern field of gambling studies, the relative ease and speed of data collection via trait-based questionnaires may also be preferable for many. Thus, much of our understanding about gambling cognitions is derived from research targeting participant’s dispositional beliefs, without consideration to current or recent gambling behaviour.

State-activated gambling distortions do not necessarily correspond to the presence of trait-based cognitions, a finding that was evident in Gaboury & Ladouceur (1989). In their study, the same participants that verbalized a majority of erroneous beliefs during the game endorsed accurate perceptions both before (98.0%) and after (91.0%) gambling. This inconsistency was later defined by Sevigny & Ladouceur (2003) as ‘double-switching’, an apparent tendency for rational beliefs about gambling to ‘switch on’ outside of gambling, then switch off during the
behaviour of gambling, and then on again after gambling has stopped. Sevigny & Ladouceur (2003) found 82.3% of their participants exhibited behaviours suggestive of erroneous gambling cognitions, despite stating accurate beliefs about chance-based gambling prior to the study. After the session, 23.5% re-endorsed their previous rational beliefs, suggesting that for most gamblers, accurate perceptions do not switch back immediately. This effect could stem from selective application of cognitive biases that promote gambling cognitions in personally motivating (e.g., a desire for money) or emotionally evocative situations (Delfabbro, Lahn, & Grabosky, 2006).

Biner and colleagues (1995) demonstrated that the perception of skill increased with participants’ greater sense of need (for either food in a food draw, or money in a lottery). Consistent with this, Bonnaire & Billieux (2022) postulate that double-switching could relate to the shift between the “cold” (rational and objective) and “hot” (affectively driven) cognitive states (see also the ‘dual systems’ model of decision making, e.g., Kahneman, 2011). Therefore, the double-switching concept highlights the need to research state-activated cognitions to have a more rounded understanding of how gamblers relate to gambling games. Measurement of the gambling state may also provide psychometric benefits by providing a similar and recent gambling experience to measure from, reducing between participant variability.

One scale has specifically assessed state-activated gambling-related cognitive distortions. Riva, Sacchi, & Brambilla (2015) developed a measure for slot machine anthropomorphism, which can be considered a specific form of erroneous perception. In some other cases, trait scales have been re-deployed as state measures. Sagoe et al. (2018) used the Gambling Beliefs Questionnaire (Steenbergh et al., 2002) as a state measure by administering this after a gambling task that manipulated the frequency of losses disguised as wins (LDWs; a payout less than the wager). The authors found null results and concluded that the rate of LDWs does not influence
gambling cognitions. Yet, this could also be explained by the dispositional focus of this measure, that it was not designed for state sensitivity. There are other state measures used in gambling research that do not specifically assess gambling-related cognitions. The “in-game” module of the Game Experience Questionnaire (IJsselsteijn et al., 2015) was developed to assess aspects of video gaming, and has been used as a gambling measure (Murch et al., 2017). Two further scales, the Gambling Craving Scale (Canale et al., 2019; Young & Wohl, 2009) and the Gambling Craving Experience Questionnaire (Cornil et al., 2019) have been developed and validated to assess state-induced cravings. Thus, a measure specifically designed to assess state-activated gambling cognitions remains needed to close this research gap.

The development of a state measure for gambling distortions could offer a more nuanced exploration of how emotional or psychological states (e.g., those associated with impulsivity and schizotypy) contribute to the activation of distorted cognitions during gambling behaviour. Delusion-proneness appears to be a strong contender for such research, as individuals with this trait are predisposed to jump to conclusions, (Balzan et al., 2012) make evidence-hypothesis matches (Balzan et al., 2013), and are more likely to endorse trait-level gambling cognitions (Brooks & Clark, 2022; see Chapter 2). Further, individuals with schizophrenia have approximately a fourfold increase in risk to meet criteria for Gambling Disorder (Granero et al., 2021), and individuals with a Bipolar I diagnosis are over twice as likely to experience problematic gambling (McIntyre et al., 2007). This, combined with the results from Chapter 2, suggest delusional thinking could be especially prone to state-activation of GRCDs, and therefore a strong candidate for future research of this kind. Although this question is not investigated in the present thesis, it does provide a compelling example of the utility a state measure for gambling distortions could provide.
3.1.1 The Present Study

The study sought to develop a scale, the Gambling State Cognitions Scale (GSCS), to assess state-activated GRCDs, and to demonstrate initial validity through multiple methods. Slot machine games were specifically targeted to increase item specificity and because this form of gambling is widely regarded as among the most harmful forms of gambling (Marionneau, Mandolesi, Rolando, & Nikkinen, 2022). Six GRCDs were identified as candidates for state measurement in the context of slot machine gambling: Gambler’s fallacy, hot hand fallacy, personal illusion of control, supernatural illusion of control, experienced luck, and machine anthropomorphism (see Section 1.4 for a review of these). The decision to separate illusion of control into personal (i.e., direct; primary) and supernatural (i.e., secondary) components was based upon work delineating these as distinct constructs (see Section 1.4.3; Rothbaum, Weisz, & Snyder, 1982; Ejova, Delfabbro, & Navarro, 2015). Collectively, these distortions are staples of the literature regarding erroneous beliefs about gambling (Ejova et al., 2015; Griffiths, 1994; Ladouceur, Sylvain, Letarte, Giroux, & Jacques, 1998; Langer, 1975; Leonard et al., 2015; Raylu & Oei, 2004; Riva et al., 2015; Toneatto, 1999). These beliefs were also considered likely to manifest during gambling, and could be clearly identified as distorted cognitions (i.e., directly linked to heuristics or magical thinking). Thus, two of the gambling fallacies identified by Leonard, Williams, & Vokey (2015): base rate neglect and insensitivity to sample size are excluded, as these are more distal contributors to GRCDs; as are two of the factors identified by Raylu & Oei (2004): Gambling Expectancies and Inability to Stop, which reflect metacognitive constructs rather than distortions.
Version 1 & 2 of the proposed state scale (GSCS) incorporated a multidimensional structure to assess three aspects the targeted cognitions: 1) strength of belief in the distortion (i.e., conviction); 2) the frequency the belief was experienced (i.e., preoccupation); and 3) the amount of emotional reactivity. Existing scales sometimes include items that assess both conviction (i.e., the strength of the belief, as in a delusion) and preoccupation (i.e., the frequency of a thought), in a way that may be conflated. For example, the Belief in Good Luck Scale (Darke & Freedman, 1997) asks: “I believe in luck” (item 4) and “I often feel like it’s my lucky day” (item 5). The first question targets conviction, while the latter relates to preoccupation. Thus, one could strongly believe in luck but have those thoughts on a relatively infrequent basis; or conversely, one might regularly think about being lucky without holding a strong conviction in the supernatural basis of luck per se. This approach was initially modelled after the Peters et al. Delusions Inventory (PDI-21; Peters et al., 2004; see Section 2.2.2.1) which includes these three dimensions. Whereas the PDI-21, focuses solely on the distress caused by specific beliefs, the GSCS attempted to capture positive or negative emotion due to gambling, by querying both distress and excitement. Unfortunately, the examination of these distinct dimensions proved challenging, and in Version 3 of the scale I shifted to a singular focus on the conviction component of for state-activated cognitions.

3.1.2 Chapter Organization

This chapter is organized into three study sections: the Pilot Study (Section 3.3), Study 2 (Section 3.4), and Study 3 (Section 3.5). These focus upon the development and evaluation of

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2 I am using the term ‘multidimensional’ here to refer to different ratings taken for each distortion (i.e., conviction, preoccupation, and emotional reactivity). This differs from factors or subscales that might be investigated with factor analysis, which represent the specific distortions.
this state scale (GSCS) across three primary datasets: the Pilot Sample, Sample 2, and Sample 3. Each study section includes scale design, results, and discussion subsections. The Pilot Study trialed the initial GSCS Version 1 to assess the overall study procedure and review item response patterns. These results informed the development of the second version of the state scale, which was evaluated with Study 2, which further informed scale adjustments to produce the final GSCS rendition (Version 3). Study 3 comprised the factor analysis and validity testing for Version 3, and this incorporated a fourth sample to experimentally test whether state-activated cognitions are measured by the scale. By organizing the chapter in this manner, the methodological decisions and scale adjustments made between the GSCS versions are discussed in chronological order. These study sections are presented after the General Methodology.

3.2 General Methodology

3.2.1 Sample & Procedure

Three samples of university students were collected to develop the GSCS, via the UBC Psychology Department’s Human Subject Pool. The pilot also included participants recruited from UBC Paid Studies. Pre-screen criteria were: English fluency and ≥ 19 years old (the legal gambling age in British Columbia). No gambling-related inclusions were specified, meaning that many participants would be gambling novices or playing a slot machine for the first time, as is typical for psychology student samples in gambling studies (Gainsbury, Russell, & Blaszczynski, 2014). A target of \( n = 40 \) was set for the pilot, Sample 2 targeted \( n = 100 \), informed by the empirical relationship between sample size, item-to-factor ratio, and estimated communalities
The estimated communality\(^3\) values were informed by those presented by Raylu & Oei (2004) during the development of their trait-based gambling cognitions scale (GRCS) \((n = 968;\) communality range = .505 - .852). Sample 3 targeted \(n = 150\), due to the wide communality values \((M = .608,\) range = .315 - .843) that were observed in Sample 2 (MacCallum et al., 1999). A fourth sample was also collected, for the purposes of a validity testing experiment (further discussed in Section 3.5.2.1). Overall, 41 participants were recruited for the Pilot (May – July 2017), 88 for Sample 2 (October 2017 – March 2018), 149 for Sample 3 (January – October 2019), and 33 for Sample 4 (November 2019 – January 2020). Participant demographics for every sample are found in Table 3.1.

Eligible participants were invited to the Centre for Gambling Research at UBC’s laboratory to complete the 30-minute study (titled: Perceptions of Gambling). Upon arrival, informed consent was obtained, and age was confirmed via government ID. Consenting participants were screened for problem gambling behaviour via the Problem Gambling Severity Index (see Section 3.2.3.3; Ferris & Wynne, 2001). Individuals with scores indicative of problem gambling (8+; Currie, Hodgins, & Casey, 2013) were excluded from continuing \((n = 1)\), provided resources for problematic gambling, and credited with participation or paid. The study procedure comprised: 1) trait scale administration, 2) slot machine play, and 3) state scale administration (see Figure 3.1). Upon completion, participants received a verbal debriefing, resources for problem gambling, and a pamphlet outlining common erroneous beliefs about slot machine gambling. Remuneration comprised of 0.5 course credits for the 30-minute study or $5.00 for paid participants. This procedure was consistent across samples.

\(^3\) Communalities reflect the proportion of variance in a variable that is considered common variance to a subset of items (Field, 2017).
3.2.2 Gambling Experience

Participants were introduced to slot machines and game mechanics, using a script for consistency (see Appendix D). The slot machine used, *Buffalo Spirit*, permitted adjustment of the bet size per line (1-5 cents) and the number of betting lines (1-40), which allowed the total wager to vary from $0.01 to $2.00. Participants were free to modify their line and bet style to encourage a naturalistic slot machine experience, acknowledging that these features promote a sense of

Table 3.1 Participant Demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample 1 (n = 41)</th>
<th>Sample 2 (n = 88)</th>
<th>Sample 3 (n = 149)</th>
<th>Sample 3b (n = 33)</th>
<th>Sample 4 (n = 133)</th>
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<td>20.5 (2.38)</td>
<td>21.1 (3.12)</td>
<td>21.2 (2.12)</td>
<td>20.5 (1.58)</td>
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<td>78.4%</td>
<td>75.3%</td>
<td>87.9%</td>
<td>81.8%</td>
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<td>21.6</td>
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<td>12.1</td>
<td>18.2</td>
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<td>0.00</td>
<td>0.00</td>
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<td></td>
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</tr>
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<td>56.8%</td>
<td>52.7%</td>
<td>54.54%</td>
<td>51.51</td>
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<td></td>
</tr>
<tr>
<td>Ever Gambled</td>
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<td>66.7%</td>
<td>45.5%</td>
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<td>63.6</td>
<td>42.4</td>
</tr>
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<td>“Less than once a year”</td>
<td>“Less than once a year”</td>
<td>“Less than once a year”</td>
<td>“Less than once a year”</td>
</tr>
<tr>
<td>Statement</td>
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</tr>
</tbody>
</table>

*Note: Sample 1 = Pilot Scale data; Sample 2 = Version 2 data; Sample 3 = Version 3 data; Sample 3b corresponds to the 33 participants from Sample 3 matched to Sample 4 participants for a validity experiment. EGM = Slot Machine.*
control (Harrigan, MacLaren, Brown, Dixon, & Livingstone, 2014). Participants were credited with $60.00 and directly handled this cash, to increase their sense of ownership (Limbrick-Oldfield et al., 2022). They received 1/6th of the displayed balance after 10 minutes of gambling, to a maximum of $15.00 (given the possibility of large jackpot wins that would be unethical to honour). Although players could set their own pace of gambling, they were required to play for the full 10 minutes, which began upon first bet.

3.2.3 Measures

3.2.3.1 Trait-based Gambling Beliefs

Two scales were included to assess trait-based gambling-related cognitions for validity purposes. The 23-item Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004) that contains 5 subscales targeting: Illusion of Control, Predictive Control, Interpretive Bias, Gambling Expectances, and the Inability to Stop gambling. Items use a 7-point bipolar Likert scale (strongly disagree – strongly agree). For the Pilot, full-scale reliability (i.e., internal consistency) was good (α = .883), subscale reliability ranged from acceptable-to-good (α = .746 -
.899), except for Predictive Control ($\alpha = .560$). For Sample’s 2 & 3, full-scale reliability was excellent ($\alpha = .907$ and $\alpha = .926$, respectively), subscale reliability ranged from acceptable-to-good ($\alpha = .735 - .816$ and $\alpha = .753 - .811$). The Belief in Good Luck Scale (BIGLS; Darke & Freedman, 1997) was included to measure the construct of perceived good luck (for oneself or others) as a construct that is under-represented in the GRCS. This 12-item scale uses a 6-point bipolar Likert scale (strongly disagree – strongly agree). Reliability was acceptable for the Pilot ($\alpha = .659$), and good for Samples 2 & 3 ($\alpha = .824$ and $\alpha = .817$, respectively).

### 3.2.3.2 The Game Experiences Questionnaire (GEQ)

The GEQ comprises modular scales designed to assess player experiences with video games (IJsselsteijn et al., 2015). The “in-game” module, has been successfully used as a state-related gambling measure (Murch et al., 2017). This was included for validity purposes. The 14-item scale uses a 5-point unipolar Likert scale with the options of: Not at all, Slightly, Moderately, Fairly, and Extremely (scored 1-5). Items pair into 7 factors: Competence, Sensory and Imaginative Immersion, Flow, Tension, Challenge, Negative Affect, and Positive Affect. Murch et al. (2017) report that Sensory and Imaginative Immersion more closely represents “Game Interest” and the Flow subscale better captures “Player Immersion”, and these labels are used henceforth. Across samples, Competence demonstrated poor internal consistency ($\alpha = .469 - .524$) and was excluded from analyses. Game Interest was acceptable ($\alpha = .668 - .724$), Immersion was acceptable-to-good ($\alpha = .760 - .807$), Tension was acceptable-to-good ($\alpha = .681 - .804$), Challenge was acceptable-to-good ($\alpha = .667 - .841$), and both Positive and Negative Affect were acceptable ($\alpha = .652 - .754$; $\alpha = .664 - .733$). Lower reliability could also result from the 2-item structure (Raubenheimer, 2004), which is known to produce conservative estimations.
3.2.3.3 **Problem Gambling Severity Index (PGSI)**

The PGSI (Ferris & Wynne, 2001) was included to screen for problematic gambling behaviour among participants. Items are scored 0 (‘never’) to 3 (‘almost always’), giving a maximum score of 27. Scores are categorized “non-problem gambler” (0), “low-risk” (1-4), “moderate-risk” (5-7), and “problem gambler” (8+; Currie et al., 2013). This measure was used to screen for problem gambling behaviour and was directly tested as another means to assess validity in Sample 3. This scale is considered a gold-standard for the assessment of problematic gambling behaviour (Miller, Currie, Hodgins, & Casey, 2013).

3.2.3.4 **Gambling State Cognitions Scale (GSCS)**

There were two primary considerations that guided the development of candidate items for the GSCS: 1) I wanted a short duration of the overall scale, to encourage data capture while gambling cognitions remained activated (managed by item count and wording); and 2) to focus upon specifically erroneous gambling beliefs most suitable for state-activated measurement in the context of slot machine gambling. Across all revisions of the proposed state scale, an initial statement was presented that requested participants respond with the completed gambling session in mind. Specific item development was based on a combination of modifying existing items found in trait scales (i.e., modified to target state-cognitions) and new items developed by the author. The six cognitions targeted by the GSCS are described in Table 3.2. Following Raubenheimer (2004), I aimed to identify 3+ acceptable item loadings per factor. See Sections 3.3 – 3.5 for version specific scale design choices.
3.2.4 Analysis Plan

3.2.4.1 Item Evaluation

A pilot study was conducted using Version 1 of the scale to assess the feasibility of incorporating the three dimensions, and to assess for item-specific floor or ceiling effects (i.e., lack of sensitivity). Between dimension bivariate correlations tested for their ability to capture...
distinct information. Informed by Samuels’ (2016) guidance for individual item removal in exploratory factor analyses, an absolute threshold of $r \geq .800$ (64.0% shared variance) was set to warrant removal or revision. I note these analyses would produce different $r$-values if conducted after exploratory factor analysis (and therefore on a subset of the items). However, this approach was deemed necessary to provide an initial glimpse of the state scale’s functionality to guide broad changes prior to larger data collection. Floor and ceiling effects were assessed with individual item histograms to guide adjustment, with the goal of developing a set of items that produce response variability. These steps were repeated for the GSCS Version 2 and Version 3. Scale skew was also evaluated in these versions, using retained items after factor analysis.

3.2.4.2 Exploratory Factor Analysis (EFA)

Exploratory factor analyses were first conducted on data collected for Version 2 and again using the refined state scale items of Version 3. Principle axis factoring and direct oblimin rotation were utilized because multivariate normality and orthogonal factors were not assumed (Fabrigar et al., 1999; Field, 2017). The latter assumption also informed the trait-based measure developed by Raylu & Oei (GRCS; 2004). The target sample size and EFA procedure were guided by Costello & Osborne (2005), Field (2017), MacCallum et al. (2001), MacCallum et al. (1999), and Yong & Pearce (2013). First, an initial EFA produced factor loadings for all items. Items with no or few correlations above $r = .300$ (absolute) were noted for possible removal due to poor fit, and items with correlations above $r = .900$ (absolute) were noted for potential collinearity and removal, if scale-wide multicollinearity was also deemed unacceptable (i.e., a determinant $\leq .00001$). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was reviewed to assess the suitability of sample size (i.e., a KMO value $\geq .600$), as was item-specific sampling adequacy (via the anti-image matrix diagonal). Bartlett’s test of sphericity assessed for
suitable correlations between scale items (Bartlett’s \( p < .05 \)). The optimal number of factors was calculated using parallel analysis (O’Connor, 2000), a statistically based approach deemed more appropriate than fixed eigenvalue thresholds (e.g., the greater-than-one rule) or scree plot evaluation. This procedure calculated eigenvalues from 5,000 sets of random data to compare against the sample derived eigenvalues. Factors with eigenvalues greater than the 95th percentile of those randomly generated were retained.

While factor analyses commonly use correlation matrices, these are not sensitive to non-normal data dispersion (Tinsley & Tinsley, 1987), and non-normal distributions were anticipated for certain individual items (e.g., items relating to supernatural beliefs). Covariance matrices are sensitive to such data and can produce a more interpretable factor structure, under these circumstances. To establish the most suitable approach, Sample 2 data was used to produce results from both methods. That which produced the most interpretable factor structure was then utilized for the Version 3 factor analysis. Item removal followed a procedure adapted from Costello & Osborne (2005), Field (2017), and Samuels (2016): 1) Item communality was < .200 and no acceptable factor loading was present; 2) no absolute factor loading > .400 was observed; 3) a cross-loading > 75.0% was present, this was done to avoid non-factor-specific items; or 4) the item specific KMO value was < .600. The retained items and factors were deemed acceptable if total explained variance was \( \geq 50.0\% \), the KMO tests were \( \geq .600 \) (scale-wide and item-specific), Bartlett’s test was not significant (\( p < .05 \)), and item multicollinearity was not deemed problematic (determinant \( \geq .00001 \)). Conceptual coherence between items and factors was also reviewed. The Exploratory Factor Analysis was recalculated after every item removal.
3.2.4.3 Reliability and Validity Testing

Internal consistency, as a measure of reliability for the state scale (GSCS), was calculated for the full-scale and individual factors using Cronbach’s alpha, and $\alpha \geq .600$ were considered as the lower threshold of acceptable (Janssens, Wijnen, DePelsmacker, & VanKenhove, 2008). Initial convergent validity was assessed on the Version 2 scale by correlating the resulting factors with GRCS (Raylu & Oei, 2004) and BIGLS (Darke & Freedman, 1997), with the expectation that the resulting state scale factors would positively associate with their trait-based counterparts. This was done to guide item adjustments to Version 3. A comprehensive overview of the varied approaches to validity testing for the final Version 3 factor-derived scale is found in Study 3 (Section 3.5.2).

3.2.5 Ethics

The procedures for this study were carried out in accordance with the Declaration of Helsinki. Participants were first provided with a consent form about study procedures and their age was verified. Participants had the opportunity to ask questions and either consent to participant or decline. Active steps were taken to reduce participant risk to problematic gambling. The study debriefing included education about the randomness of slot machines, and resources for problematic gambling were provided. Study approval was provided by the University of British Columbia’s Behavioural Research Ethics Board (H16-03028).
3.3 Pilot Study

3.3.1 Pilot Scale Design

The initial scale design employed a 7-point Likert scale across 34 items. Wording was only present alongside the response anchors of 1 & 7, and each item began with the preamble “At any time during the task, did you feel...” to attempt to encourage recollection of the gambling state. Following the design of the Peters et al. Delusions Inventory (Peters, Joseph, Day, & Garety, 2004), each item comprised of three dimensions to assess the respondent’s: 1) conviction (i.e., strength) in the belief; 2) preoccupation with (i.e., frequency of) the belief; and 3) the associated emotional reactivity. See Figure 3.2 for an example item.

Figure 3.2 Pilot Scale Example Item

Note: Pilot Study.
3.3.2 Results – Pilot Scale

3.3.2.1 Dimension Correlations

Bivariate correlations were conducted between dimensions ($df = 39$). Conviction and preoccupation dimensions shared 87.8% variance ($r = .937, p < .001$), conviction and emotional reactivity shared 71.9% ($r = .848, p < .001$), and emotional reactivity and preoccupation shared 70.6% ($r = .840, p < .001$).

3.3.2.2 Floor and Ceiling Effects

Individual item histograms were reviewed for floor and ceiling effects (see Figure 3.3 for examples). The floor value of ‘1’ was the modal response for every item on every dimension, except two. Of the 34 items that comprised scale Version 1, most participants (> 50%) endorsed the floor response for 16 conviction items, 15 preoccupation items, and 24 emotional reactivity items. No ceiling effects were present.

3.3.3 Discussion – Pilot Scale

The pilot study demonstrated that Version 1 of the scale required significant revision. Correlation analyses provided evidence of severe multicollinearity between the three ratings of conviction, preoccupation, and emotional reactivity. Almost every item demonstrated some degree of floor effect. While the presence of floor effects do not necessarily prevent a scale from functioning effectively (see the PGSI, the gold standard measure of problematic gambling), it does reduce sample variance and therefore can reduce sensitivity. A possible explanation for the range restriction was the reliance upon a psychology undergraduate sample, who are known to, on average, engage in less gambling than the general population (Gainsbury, Russell, & Blaszczynski, 2014). This also corresponds with Griffiths (1994) finding that fewer distorted
verbalizations were made by less frequent gamblers. Nevertheless, undergraduate convenience samples represent an intended target of the GSCS. Thus, revision to encourage greater variability at this stage of development was deemed prudent.

Figure 3.3  Example Response Distributions for 4 Items on the Pilot Scale

![Histograms of response distributions for 4 items on the Pilot Scale.](image)

Note: Pilot Study; \( n = 41 \); Item 3 = “At any time during the task, did you feel that certain actions helped or might have helped create a win (e.g., hold a lucky coin, cross fingers, etc.)?”; Item 16 = “At any time during the task, did you feel that the machine’s outcome was the result of an overall lucky or unlucky day?”; Item 15 = “At any time during the task, did you feel that the machine wanted you to lose?”; Item 21 = “At any time during the task, did you feel that probability would eventually be on your side?”.
3.4 Study 2

3.4.1 Adjustments to Scale Design

Version 2 saw the preoccupation dimension removed, due to the multicollinearity detected in the pilot. The presentation of the remaining conviction and emotional reactivity ratings was also adjusted. The degree of conviction about the distortion became the default target of the Likert scale that was presented immediately after the item. Emotional reactivity became a follow-up question that was preceded by the statement “...and this distressed or excited me:” in an attempt to clearly differentiate between the two dimensions, and to provide a brief pause between responses.

Version 2 also trialed adjustments to reduce the floor effects. The 7-point bipolar scale was replaced with a 5-point unipolar scale, to mimic the Game Experience Questionnaire’s design (IJsselsteijn et al., 2015), which has produced distributed item responses (Johnson, Gardner, & Perry, 2018). Specific changes to the item format included descriptions for every response, to increase the salience of the values between anchors. Items were rewritten in the first person and shortened to improve readability (see Figure 3.4 for an example). The scale’s introduction was reduced from 51 to 15 words, and eight pilot items were removed because of poor conceptual fit. This decreased overall completion time, allowing answers to be in closer proximity to the gambling experience.

3.4.2 Results – GSCS Version 2

3.4.2.1 Correlation Matrix Exploratory Factor Analysis

Principle axis factoring with direct oblimin rotation was performed on the 26-item Version 2 questionnaire using the conviction dimension (n = 88), with the procedure outlined in
A 13-item scale with 4 factors (eigenvalues 4.22, 1.46, 1.07, 0.536) was produced using the correlation matrix, after item removal. From the original set, 1 item was removed for low communality (< .200), 6 items for low factor loadings (< |.400|), 4 items for > 75.0% cross-factor loadings, and 2 items for poor individual Kaiser-Meyer-Olkin (KMO) values (< .600). The four retained factors appeared to assess ‘Experienced Luck’ (4 items, mean loading = .570), the ‘Hot Hand’ Fallacy (3 items, mean loading = .827), a ‘Personal Illusion of Control’ (3 items, mean loading = .782), and ‘Magical Thinking’ (a mix of anthropomorphism and supernatural control items; 3 items, mean loading = .523). The total explained variance was 58.4%, the overall (.758) and item specific (.632 - .888) KMO values were acceptable. Inter-item correlations were suitable (Bartlett’s test $p < .001$), as was item multicollinearity among items was not problematic (determinant = .002).

Figure 3.4  Version 2 Scale Example Item

**Scale Version 2:**

1. When wins occurred, more seemed to follow:

Not at all  Slightly Agree  Moderately Agree  Fairly Agree  Extremely Agree

...and this distressed or excited me:

Not at all  Slightly Agree  Moderately Agree  Fairly Agree  Extremely Agree

**Note:** Study 2.

**3.4.2.2  Covariance Matrix Exploratory Factor Analysis**

Using the covariance matrix, a 10-item scale with 3 factors resulted (eigenvalues 3.79, 1.18, 0.871). Of original the 26-items, 3 items were removed for low communality, 6 for low
factor loadings, 5 for > 75.0% cross-factor loadings, 1 for a poor item specific KMO value (< .600), and the item “I felt confident in my skill” was removed for poor conceptual fit with the factor (luck) and low communality. This produced a 3-factor solution that reflected Personal Illusion of Control (4 items, mean loading = .772), Hot Hand Fallacy (3 items, mean loading = .815), and Experienced Luck (3 items, mean loading = .683). These explained 60.8% of the total variance. KMO values (overall = .759, item specific = .660 - .836), inter-item correlations (Bartlett’s test $p < .001$) and multicollinearity were acceptable (determinant = .007). The covariance matrix produced a marginally stronger solution than the correlation matrix, by explaining 2.4% more of the item variance. Thus, coupled with the fact that covariance-derived solutions are typically more robust for non-normally distributed variables (see Section 3.2.4.2), this 3-factor solution was used for subsequent analyses (see Table 3.3 for factor structure).

3.4.2.3 Scale Dimension & Factor Correlations

Pearson bivariate correlations were conducted between the conviction and emotional reactivity dimensions ($df = 86$). The full-scale dimensions correlated strongly ($r = .800, p < .001$), as did Experienced Luck ($r = .815, p < .001$), Hot Hand Fallacy ($r = .711, p < .001$), and Personal Illusion of Control ($r = .740, p < .001$). Within dimensions, between factor correlations were calculated. These displayed moderate correlations for the conviction dimension and strong correlations for emotional reactivity (see Table 3.4).

3.4.2.4 Reliability Analysis

Internal consistency was calculated for the factors using the conviction scale. Full-scale Cronbach’s alpha was good ($\alpha = .834$), and acceptable-to-good for the factors of Experienced Luck ($\alpha = .740$), the Hot Hand Fallacy ($\alpha = .861$), and Individual Illusion of Control ($\alpha = .823$).
### Table 3.3  GSCS Version 2 Exploratory Factor Loadings

<table>
<thead>
<tr>
<th>Items</th>
<th>Personal IC</th>
<th>Hot Hand Fallacy</th>
<th>Experienced Luck</th>
<th>Communalities (after extraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>23. I learned some techniques that increased my odds</td>
<td>.919</td>
<td>.166</td>
<td>.057</td>
<td>.315</td>
</tr>
<tr>
<td>22. There seemed to be some winning strategies</td>
<td>.791</td>
<td>.043</td>
<td>-.046</td>
<td>.621</td>
</tr>
<tr>
<td>14. My skill improved throughout the game</td>
<td>.666</td>
<td>-.154</td>
<td>-.106</td>
<td>.626</td>
</tr>
<tr>
<td>2. Certain actions or behaviours could have improved my outcome</td>
<td>.512</td>
<td>-.154</td>
<td>.100</td>
<td>.780</td>
</tr>
<tr>
<td>26. Sometimes, the wins would just keep on coming</td>
<td>-.064</td>
<td>-.935</td>
<td>-.024</td>
<td>.617</td>
</tr>
<tr>
<td>1. When wins occurred, more seemed to follow</td>
<td>.013</td>
<td>-.782</td>
<td>.005</td>
<td>.611</td>
</tr>
<tr>
<td>13. Sometimes, it felt as if my wins wouldn’t stop</td>
<td>.064</td>
<td>-.728</td>
<td>-.067</td>
<td>.843</td>
</tr>
<tr>
<td>20. During the game, my lucky or unlucky nature displayed itself</td>
<td>.063</td>
<td>-.111</td>
<td>-.807</td>
<td>.351</td>
</tr>
<tr>
<td>10. Luck played an important role in my outcome</td>
<td>-.078</td>
<td>.037</td>
<td>-.624</td>
<td>.546</td>
</tr>
<tr>
<td>12. I felt particularly lucky or unlucky</td>
<td>.191</td>
<td>-.070</td>
<td>-.619</td>
<td>.766</td>
</tr>
<tr>
<td>Eigenvalues (sample derived)</td>
<td>3.79</td>
<td>1.18</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>Parallel analysis eigenvalues (95%ile value)</td>
<td>0.90</td>
<td>0.64</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>% variance</td>
<td>38.4%</td>
<td>12.5%</td>
<td>9.86%</td>
<td></td>
</tr>
<tr>
<td>Cronbach’s alpha (α)</td>
<td>.823</td>
<td>.861</td>
<td>.740</td>
<td>.834 (full-scale)</td>
</tr>
</tbody>
</table>

*Note:* Study 2; *n* = 88. Factor loadings ≥ .400 are bolded. Factor analysis applied to the covariance matrix and convictions dimension. Communalities, explained variance, and factor loadings are rescaled for standardization (raw value divided by variable’s SD). Parallel analysis eigenvalues (*n* = 88; 5,000 samples) are provided to indicate the cut-off threshold. IC = illusion of control.

### Table 3.4  GSCS Version 2 Factor Correlations

<table>
<thead>
<tr>
<th>Factors:</th>
<th>Conviction Dimension</th>
<th>Emotional Reactivity Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
</tr>
<tr>
<td>1. Experienced Luck</td>
<td>—</td>
<td>.344**</td>
</tr>
<tr>
<td>2. Hot Hand Fallacy</td>
<td>—</td>
<td>.371**</td>
</tr>
<tr>
<td>3. Personal Illusion of Control</td>
<td>—</td>
<td>.702**</td>
</tr>
<tr>
<td>1. Experienced Luck</td>
<td>—</td>
<td>.396**</td>
</tr>
<tr>
<td>2. Hot Hand Fallacy</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3. Personal Illusion of Control</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*Note:* Study 2; *n* = 88. Pearson bivariate correlations are displayed.
3.4.2.5 Floor and Ceiling Effects

Histogram review revealed floor effects across several items. The floor response (“not at all”) was the modal answer for 9 of 10 items on the conviction dimension, and 8 of 10 items on the emotional reactivity dimension. Over 50.0% of respondents answered “not at all” for 6 conviction and 4 emotional reactivity items. Skew was also calculated for the derived full-scale and factors as a means to assess the overall response distributions. Consistent with individual the item review, significant positive skewness was present for the full-scale (skewness = 1.02; $p \leq .05$), Personal Illusion of Control (skewness = 1.13; $p \leq .05$), and Hot Hand Fallacy (skewness = 1.34; $p \leq .05$), but not for Experienced Luck. See Figure 3.5 for response patterns.

Figure 3.5 Version 2 Full-scale and Individual Factor Response Distributions

Note: Study 2; $n = 88$. All except Experienced Luck are positively skewed ($p < .05$).
3.4.2.6 Validity Testing

Initial convergent validity was assessed by correlating the state scale (GSCS) Version 2 factors to the trait gambling cognitions scales (GRCS and BIGLS). Given the presence of significant positive skew, Spearman rank-order correlations were utilized. These results are summarized in Table 3.5.

As expected, GSCS Version 2 full-scale displayed significant moderate and positive correlations with the three trait scale factors that measure distorted thinking: Illusion of Control, Predictive Control, and Interpretive Bias, and the good luck measure. The state scale’s factor of Experienced Luck moderately and positively correlated with trait good luck, Illusion of Control, and Predictive Control. Likewise, the GSCS’ Personal Illusion of Control moderately associated with trait Illusion of Control and Predictive Control but did not correlate with the two trait metacognitions: Gambling Expectancies or Inability to Stop. The state scale’s Hot Hand Fallacy related most to the trait-based GRCS factor of Predictive Control, in addition to Interpretive Bias and the metacognitive subscale of Gambling Expectancies.

Table 3.5 Version 2 Spearman Rank-Order Correlations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total Score (Full-scale)</th>
<th>Exp. Luck (Factor 1)</th>
<th>P. Control (Factor 2)</th>
<th>Hot Hand (Factor 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BIGLS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Full-scale (Single Factor)</td>
<td>.358**</td>
<td>.441**</td>
<td>.292**</td>
<td>.101</td>
</tr>
<tr>
<td><strong>GRCS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Gambling Expectancies</td>
<td>.272*</td>
<td>.277**</td>
<td>.137</td>
<td>.247*</td>
</tr>
<tr>
<td>2. Illusion of Control</td>
<td>.397**</td>
<td>.396**</td>
<td>.353**</td>
<td>.194</td>
</tr>
<tr>
<td>3. Predictive Control</td>
<td>.449**</td>
<td>.436**</td>
<td>.359**</td>
<td>.283**</td>
</tr>
<tr>
<td>4. Interpretive Bias</td>
<td>.304**</td>
<td>.186</td>
<td>.293**</td>
<td>.235*</td>
</tr>
<tr>
<td>5. Inability to Stop</td>
<td>.185</td>
<td>.177</td>
<td>.147</td>
<td>.124</td>
</tr>
</tbody>
</table>

Note: Study 2; n = 88, df = 86; * p ≤ .05, ** p ≤ .01 (two-tailed). BIGLS = Belief in Good Luck Scale; GRCS = Gambling Related Cognitions Scale; Exp. Luck = Experienced Luck; P. Control = Personal Illusion of Control; Hot Hand = Hot Hand Fallacy.
3.4.3 Discussion – GSCS Version 2

This EFA demonstrated acceptable inter-item correlations and sampling adequacy could be achieved with an empirically supported, but heuristically small, sample size. From the covariance matrix, item communalities ranged from .315 - .843 (Table 3.3), and this was a wider spread than estimated from Raylu & Oei (2004). This prompted increased sampling for Sample 3 ($n = 150$), informed by MacCallum et al. (1999). Comparison of correlation and covariance matrix solutions suggested the latter was marginally preferable for data such as these, indicated by the additional explained variance and non-normal distributions. The results also showed that the pilot-informed changes did not sufficiently address issues with the dimensionality structure or floor effects. Conviction and emotional reactivity remained strongly correlated ($r = .800$) despite the simplifications made in Version 2. Emotional reactivity shared significant variance (25.5% - 49.3%) between factors, reducing conceptual distinction (see Table 3.4), while this was much lower for the conviction dimension (11.8% - 15.7%). This difference is partly explained by use of the conviction dimension as the target of the factor analysis, meaning emotional reactivity did not undergo analysis to produce its own factor structure - which could have comprised different items. I note the dimensions of the PDI-21 similarly do not appear to have received independent factor analysis (Peters et al., 2004; Peters, Joseph, & Garety, 1999). These results speak to the psychometric challenges of developing a multidimensional scale that separates different elements of single distortions.

Most of the GSCS Version 2 factors positively associated with the cognitive distortion-related measures of the trait scales (Table 3.5), given moderate-to-strong correlations between its factors (see Table 3.4) and trait gambling cognitions factors (GRCS; see Raylu & Oei, 2004). GSCS’ Experienced Luck (EL) correlated most strongly with trait luck ($r_s = .441$), demonstrating
convergence between these measures. Trait GRCS’ Illusion of Control, centred on control via
behaviour, decision-making, and lucky objects, moderately related to state experienced personal
control \( (r_s = .353) \) and luck \( (r_s = .396) \), but not with the prediction oriented state-activated Hot
Hand Fallacy \( (r_s = .194, \text{ ns}) \). Trait Predictive Control, containing elements of control, the hot
hand, and luck related to all state factors \( (r_s = .283 - .449) \). Trait GRCS’ Interpretive Bias, which
taps into perceived skill and situational contexts to explain outcomes, positively correlated state-
activated perceived control \( (r_s = .293) \) and the hot hand \( (r_s = .235) \). Conversely, only weak or
nonsignificant associations were detected between the state scale and the trait metacognitions:
Gambling Expectancies and Inability to Stop. Overall, The factors of Version 2 of the state scale
appear to align with the target constructs.

### 3.5 Study 3

#### 3.5.1 Adjustments to Scale Design

The emotional reactivity rating was removed due to the continued dimensional overlap
and high degree of between factor shared variance, resulting in a single dimension tapping
conviction (i.e., strength of belief in the distortion). In response to continued floor effects,
evidenced by the significant positive skew in Version 2 (Figure 3.5), two further adjustments
were made for Version 3 of the state scale: 1) Reincorporation of a seven-point Likert scale with
bimodal responses (strongly disagree – strongly agree) and 2) reworded items to increase
sensitivity by adding qualifiers (e.g., “sometimes”). Items that were not retained in the factor
analysis solution of Sample 2 were reviewed and either revamped or replaced, to attempt to
expand the range of assessed GRCDs, increase item retention, and improve factor response
distributions. Table 3.6 presents the 26 items used in Version 3, and were again based upon an *a priori* 6 factor structure.

Table 3.6  GSCS Version 3 Full Item List Prior to Removals

<table>
<thead>
<tr>
<th>Items:</th>
<th>Targeted Distortion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When wins occurred, more seemed to follow:</td>
<td>Hot hand fallacy</td>
</tr>
<tr>
<td>2. Some actions or behaviours could have improved my outcome:</td>
<td>Personal IC</td>
</tr>
<tr>
<td>3. Some lucky objects might have influenced my outcome:</td>
<td>Experienced luck</td>
</tr>
<tr>
<td>4. After several losses, I felt a win was due to happen:</td>
<td>Gambler’s fallacy</td>
</tr>
<tr>
<td>5. The machine was either friendly or mean toward me:</td>
<td>Machine Anthro</td>
</tr>
<tr>
<td>6. I was able to predict wins after losses:</td>
<td>Gambler’s fallacy</td>
</tr>
<tr>
<td>7. My success depended upon the machine’s mood:</td>
<td>Machine Anthro</td>
</tr>
<tr>
<td>8. I think I increased my chances of winning:</td>
<td>Personal IC</td>
</tr>
<tr>
<td>9. I learned strategies from winning streaks:</td>
<td>Gambler’s fallacy</td>
</tr>
<tr>
<td>10. Luck played an important role in my outcome:</td>
<td>Experienced luck</td>
</tr>
<tr>
<td>11. I felt confident in my skill:</td>
<td>Personal IC</td>
</tr>
<tr>
<td>12. I felt particularly lucky or unlucky:</td>
<td>Experienced luck</td>
</tr>
<tr>
<td>13. Sometimes, it felt as if my wins wouldn’t stop:</td>
<td>Hot hand fallacy</td>
</tr>
<tr>
<td>14. My outcome was guided by my prayers and wishes:</td>
<td>Supernatural IC</td>
</tr>
<tr>
<td>15. I felt my skill improve throughout the game:</td>
<td>Personal IC</td>
</tr>
<tr>
<td>16. There was a certain magic surrounding the machine:</td>
<td>Supernatural IC</td>
</tr>
<tr>
<td>17. I was competing against the machine:</td>
<td>Machine Anthro</td>
</tr>
<tr>
<td>18. I could tell when the machine was ready to pay out:</td>
<td>Gambler’s fallacy</td>
</tr>
<tr>
<td>19. There were unknown, almost mystical, forces present:</td>
<td>Supernatural IC</td>
</tr>
<tr>
<td>20. I felt at the mercy of the machine:</td>
<td>Machine Anthro</td>
</tr>
<tr>
<td>21. I was my typical lucky or unlucky self:</td>
<td>Experienced luck</td>
</tr>
<tr>
<td>22. The machine was out to get me:</td>
<td>Machine Anthro</td>
</tr>
<tr>
<td>23. There seemed to be some winning strategies:</td>
<td>Personal IC</td>
</tr>
<tr>
<td>24. I discovered some techniques that increased my odds:</td>
<td>Personal IC</td>
</tr>
<tr>
<td>25. The machine felt blessed or cursed:</td>
<td>Supernatural IC</td>
</tr>
<tr>
<td>26. Sometimes, the wins would just keep coming:</td>
<td>Hot hand fallacy</td>
</tr>
</tbody>
</table>

*Note:* Study 3. Scale introduced with the statement: “Thinking about the game that you just finished, please answer the following questions:”. IC = Illusion of Control; Machine Anthro = Machine Anthropomorphism. Items answered with a 7-point Likert scale (strongly disagree, moderately disagree, slightly disagree, neither agree nor disagree, slightly agree, moderately agree, strongly agree). Items were completed in the order presented above.
3.5.2 Analysis Plan for Validity Tests

Scale validity was tested with procedures that correspond to convergent, concurrent, and comprehensive validity. Table 3.7 provides a brief overview of these methods, and Table 3.8 provides the specific approaches, statistical tests, and variables used to assess validity of the GSCS Version 3 scale after exploratory factor analysis. For further review, an outline of approaches to establish validity is provided by Svensson (2011).

Table 3.7 Validity Overview

<table>
<thead>
<tr>
<th>Validity Approaches:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Convergent</td>
</tr>
<tr>
<td>How well a scale correlates with existing measures of the same construct, this is part of the broader category of construct validity.</td>
</tr>
<tr>
<td>2. Concurrent</td>
</tr>
<tr>
<td>Whether the scale presently relates to behaviours or other beliefs that are expected to associate with the targeted construct, this is part of the broader category of criterion validity.</td>
</tr>
<tr>
<td>3. Comprehensive</td>
</tr>
<tr>
<td>The scale’s ability to assess the full range of the content deemed important within the area targeted (e.g., a breadth of GRCDs), this is part of the broader category of content validity.</td>
</tr>
</tbody>
</table>

3.5.2.1 Validity Experiment

A fourth ‘watcher’ sample was used to assess validity via experimental design. These participants viewed a 10 minute recording of slot machine gambling and did not handle physical cash. These manipulations were conducted to decrease engagement with the slot machine and ownership of the wager. Screen recordings were obtained from participants in Sample 3, whom they were matched to for comparison. The administered scales and cash bonus were equivalent to that provided to the matched Sample 3 participants. Recruitment was not concurrent with Sample 3 because the active participants needed to precede watchers in order to create the videos. The script, adapted for observation, contained the same details about slot machine.
mechanics. Mean state scale differences between Sample 4 and the paired Sample 3 participants were assessed. Power analysis (G*Power 3.1.9.7; moderate effect, independent samples $t$-test, $\alpha = .05$, $1-\beta = .80$, two-tailed) targeted $n = 51$, but due to the COVID-19 pandemic, recruitment terminated early (November 2019 – January 2020) with $n = 33$.

**Table 3.8  GSCS Version 3 Specific Validity Tests**

<table>
<thead>
<tr>
<th>Validity Tests:</th>
<th>Correlations between GSCS (full-scale and individual factors), GRCS (full-scale and individual factors) and BIGLS were evaluated.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Convergent</strong></td>
<td><em>Anticipated Outcome:</em> GSCS cognitions are expected to correlate positively with similar trait-based cognitions.</td>
</tr>
<tr>
<td>2. <strong>Concurrent</strong></td>
<td><em>Anticipated Outcome:</em> GSCS cognitions relating to prediction and control will positively associate with GEQ Game Interest, Immersion, Challenge, and Positive Affect, and not with Negative Affect.</td>
</tr>
<tr>
<td>3. <strong>Concurrent</strong></td>
<td>GSCS scores were compared between groups receiving an active vs. passive gambling experience, assessed with independent samples $t$-tests. <em>Anticipated Outcome:</em> The active gambling condition will produce higher GSCS scores, due to greater engagement with the slot machine.</td>
</tr>
<tr>
<td>4. <strong>Concurrent</strong></td>
<td>Participant qualitative experiences were coded for themes of ‘positive’ and ‘negative’ affect, and differences in GSCS scores between these two groupings were evaluated with independent samples $t$-tests. <em>Anticipated Outcome:</em> Themes of ‘positive’ affect will associate with higher GSCS scores, when compared to themes of ‘negative’ affect.</td>
</tr>
<tr>
<td>5. <strong>Concurrent</strong></td>
<td>PGSI (past 12-month gambling behaviour) was used to predict GSCS beliefs via multiple linear regressions, controlling for age and gender. <em>Anticipated Outcome:</em> PGSI will predict GSCS cognition activation.</td>
</tr>
<tr>
<td>6. <strong>Comprehensive</strong></td>
<td>The retained GSCS factors were compared to the targeted state beliefs, to assess if a comprehensive range of distortions were captured.</td>
</tr>
</tbody>
</table>

*Note:* GSCS = Gambling State Cognitions Scale; GRCS = Gambling Related Cognitions Scale; BIGLS = Belief in Good Luck Scale; GEQ = Game Experience Questionnaire; PGSI = Problem Gambling Severity Index. Themes of interest, excitement, or engagement coded as ‘positive’ affect; themes of disinterest, boredom, irritability, or helplessness coded as ‘negative’ affect.
3.5.3 Results – GSCS Version 3

3.5.3.1 Exploratory Factor Analysis

The procedure outlined in Section 3.2.4.2 was applied to Version 3 (n = 149), using the covariance matrix. This produced a 17-item scale with 4 factors (eigenvalues = 6.20, 1.85, 1.05, 0.86). Of the initial 26-items, 1 was removed for low communality, 7 for small loadings, and 1 for a > 75.0% cross-factor loading. This reproduced Personal Illusion of Control (PIC) (4 items; mean loading = .780), Hot Hand Fallacy (HH) (3 items; mean loading = .715), and Experienced Luck (EL) (3 items; mean loading = .636). A factor that I term, ‘Magical Thinking’ (MT) also emerged, as a mix of items designed to assess machine anthropomorphism and supernatural control distortions (7 items; mean loading = .701). Item factor loadings and communalities are found in Table 3.9. In total, these four factors explained 58.6% of variance, Kaiser-Meyer-Olkin values were acceptable (overall = .855, item specific = .737 - .914), as were inter-item correlations and multicollinearity (Bartlett’s test p < .001; determinant = .00008).

3.5.3.2 Reliability & Factor Correlations

Internal consistency was acceptable-to-good for the full-scale (α = .892) and four factors (α = .679 - .891). See Table 3.10 for between factor correlations.

3.5.3.3 Scale Skewness

Full scale score (skewness = .357; p ≥ .05), Personal Illusion of Control (skewness = .335; p > .05), and Hot Hand Fallacy (skewness = .362; p > .05) subscales were not significantly skewed. Magical Thinking was positively skewed (skewness = 1.18, p < .05) and Experienced Luck was negatively skewed (skewness = -0.75, p < .05). See Figure 3.6 for factor distributions.
Table 3.9  GSCS Version 3 Exploratory Factor Loadings

<table>
<thead>
<tr>
<th>Items</th>
<th>Magical Thinking</th>
<th>Personal IC</th>
<th>Experienced Luck</th>
<th>Hot Hand Fallacy</th>
<th>Communalities (after extraction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25. The machine felt blessed or cursed</td>
<td>.824</td>
<td>.134</td>
<td>.028</td>
<td>-.118</td>
<td>.715</td>
</tr>
<tr>
<td>19. There were unknown, almost mystical, forces present</td>
<td>.820</td>
<td>.000</td>
<td>-.055</td>
<td>-.114</td>
<td>.767</td>
</tr>
<tr>
<td>7. My success depended upon the machine’s mood</td>
<td>.803</td>
<td>-.002</td>
<td>-.024</td>
<td>.062</td>
<td>.590</td>
</tr>
<tr>
<td>5. The machine was either friendly or mean toward me</td>
<td>.652</td>
<td>.024</td>
<td>.260</td>
<td>.098</td>
<td>.554</td>
</tr>
<tr>
<td>22. The machine was out to get me</td>
<td>.620</td>
<td>-.073</td>
<td>-.012</td>
<td>.029</td>
<td>.404</td>
</tr>
<tr>
<td>14. My outcome was guided by my prayers and wishes</td>
<td>.610</td>
<td>-.146</td>
<td>-.063</td>
<td>-.071</td>
<td>.492</td>
</tr>
<tr>
<td>16. There was a certain magic surrounding the machine</td>
<td>.578</td>
<td>-.133</td>
<td>.062</td>
<td>-.088</td>
<td>.519</td>
</tr>
<tr>
<td>24. I discovered some techniques that increased my odds</td>
<td>-.031</td>
<td>-.864</td>
<td>.038</td>
<td>.007</td>
<td>.726</td>
</tr>
<tr>
<td>9. I learned strategies from winning streaks</td>
<td>-.021</td>
<td>-.794</td>
<td>-.038</td>
<td>-.136</td>
<td>.730</td>
</tr>
<tr>
<td>15. I felt my skill improve throughout the game</td>
<td>.099</td>
<td>-.750</td>
<td>-.020</td>
<td>.089</td>
<td>.566</td>
</tr>
<tr>
<td>23. There seemed to be some winning strategies</td>
<td>.028</td>
<td>-.710</td>
<td>.051</td>
<td>-.085</td>
<td>.604</td>
</tr>
<tr>
<td>10. Luck played an important role in my outcome</td>
<td>-.107</td>
<td>-.050</td>
<td>.812</td>
<td>.014</td>
<td>.604</td>
</tr>
<tr>
<td>12. I felt particularly lucky or unlucky</td>
<td>.083</td>
<td>-.001</td>
<td>.616</td>
<td>-.170</td>
<td>.517</td>
</tr>
<tr>
<td>21. I was my typical lucky or unlucky self</td>
<td>.077</td>
<td>.024</td>
<td>.481</td>
<td>.025</td>
<td>.257</td>
</tr>
<tr>
<td>26. Sometimes, the wins would just keep on coming</td>
<td>-.070</td>
<td>-.106</td>
<td>.061</td>
<td>-.872</td>
<td>.828</td>
</tr>
<tr>
<td>13. Sometimes, it felt as if my wins wouldn’t stop</td>
<td>.112</td>
<td>.087</td>
<td>.010</td>
<td>-.819</td>
<td>.704</td>
</tr>
<tr>
<td>1. When wins occurred, more seemed to follow</td>
<td>.093</td>
<td>-.176</td>
<td>.021</td>
<td>-.454</td>
<td>.381</td>
</tr>
</tbody>
</table>

Eigenvalues (sample derived)                                         6.20           1.85      1.05     0.86
Parallel analysis eigenvalues (95%ile value)                          0.91           0.73      0.60     0.50
% variance                                                           35.7%          11.5%     6.35%   5.54%  58.6% (full-scale)
Cronbach’s alpha (α)                                                 .891           .877      .679     .812   .892 (full-scale)

Note: Study 3; n = 149. Factor loadings ≥ .400 are bolded. Factor analysis applied to the covariance matrix. Communalities, explained variance, and factor loadings are rescaled for standardization (raw value divided by variable’s SD). Parallel analysis eigenvalues (n = 149; 5,000 samples) are provided to indicate the cut-off threshold for factor eigenvalues. IC = illusion of control.
Note: Study 3; n = 149. Magical Thinking and Experienced Luck are positively and negatively skewed, respectively ($p < .05$). 13 items (including all Magical Thinking items) had a modal floor response of ‘1’.
### 3.5.3.4 Validity Testing

Convergent validity was assessed by correlating Version 3 of the state scale (GSCS) against the trait cognition scales (GRCS & BIGLS). Pearson bivariate correlations were used because skew was reduced for Version 3. These results are summarized in Table 3.11. Moderate-to-strong positive correlations were detected between Magical Thinking and every trait cognition measured \((r = .359 - r = .535)\). Likewise, the trait measures (GRCS factors and BIGLS) also significantly associated with the state scale’s Personal Illusion of Control \((r = .262 - r = .529)\) and Hot Hand Fallacy \((r = .207 - r = .422)\) factors. The GSCS’ Experienced Luck factor expectedly and moderately associated with trait luck \((r = .358)\) and the (luck-related) GRCS factor of Predictive Control \((r = .321)\).

To establish concurrent validity, the state scale’s factors were correlated with the state-related “in-game” module of the GEQ, which measures the state experiences of Game Interest, Immersion, Tension, Challenge, Positive Affect, and Negative Affect. Magical Thinking shared small positive associations with all GEQ factors \((r = .222 \text{ to } r = .296)\), except for Negative Affect \((r = -.047)\). Game Interest, Immersion, Challenge, and Positive Affect positively correlated with the skill-oriented state factors of Personal Illusion of Control \((r = .288 \text{ to } .372)\) and Hot Hand

**Table 3.10 GSCS Version 3 Factor Correlations**

<table>
<thead>
<tr>
<th>Factors</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Magical Thinking</td>
<td>—</td>
<td>.433**</td>
<td>.385**</td>
<td>.498**</td>
</tr>
<tr>
<td>2. Personal Illusion of Control</td>
<td>—</td>
<td>—</td>
<td>.146</td>
<td>.507**</td>
</tr>
<tr>
<td>3. Experienced Luck</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>.279**</td>
</tr>
<tr>
<td>4. Hot Hand Fallacy</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*Note: Study 3; \(n = 149\). Pearson bivariate correlations are displayed.*
Fallacy \((r = .118 \text{ to } .409)\), but not with Tension or Negative Affect. Experienced Luck only weakly associated with Tension \((r = .166)\).

### Table 3.11  GSCS Version 3 Pearson Bivariate Correlations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total Score (Full-scale)</th>
<th>Magical (Factor 1)</th>
<th>P. Control (Factor 2)</th>
<th>Exp. Luck (Factor 3)</th>
<th>Hot Hand (Factor 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BIGLS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Full-scale</td>
<td>.483**</td>
<td>.434**</td>
<td>.283**</td>
<td>.358**</td>
<td>.333**</td>
</tr>
<tr>
<td><strong>GRCS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Gambling Expectancies</td>
<td>.524**</td>
<td>.465**</td>
<td>.379**</td>
<td>.231*</td>
<td>.422**</td>
</tr>
<tr>
<td>2. Illusion of Control</td>
<td>.536**</td>
<td>.535**</td>
<td>.433**</td>
<td>.146</td>
<td>.341**</td>
</tr>
<tr>
<td>3. Predictive Control</td>
<td>.595**</td>
<td>.496**</td>
<td>.514**</td>
<td>.321**</td>
<td>.370**</td>
</tr>
<tr>
<td>4. Interpretive Bias</td>
<td>.556**</td>
<td>.416**</td>
<td>.529**</td>
<td>.254**</td>
<td>.413**</td>
</tr>
<tr>
<td>5. Inability to Stop</td>
<td>.368**</td>
<td>.359**</td>
<td>.262**</td>
<td>.043</td>
<td>.207*</td>
</tr>
<tr>
<td><strong>GEQ</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Game Interest</td>
<td>.370**</td>
<td>.284**</td>
<td>.372**</td>
<td>.106</td>
<td>.291**</td>
</tr>
<tr>
<td>2. Immersion</td>
<td>.323**</td>
<td>.284**</td>
<td>.247**</td>
<td>.132</td>
<td>.256**</td>
</tr>
<tr>
<td>3. Tension</td>
<td>.154</td>
<td>.243**</td>
<td>.022</td>
<td>.166*</td>
<td>-.047</td>
</tr>
<tr>
<td>4. Challenge</td>
<td>.341**</td>
<td>.296**</td>
<td>.345**</td>
<td>.111</td>
<td>.188*</td>
</tr>
<tr>
<td>5. Positive Affect</td>
<td>.344**</td>
<td>.222**</td>
<td>.288**</td>
<td>.121</td>
<td>.409**</td>
</tr>
<tr>
<td>6. Negative Affect</td>
<td>-.162*</td>
<td>-.047</td>
<td>-.267**</td>
<td>.000</td>
<td>-.173*</td>
</tr>
</tbody>
</table>

Note: \(n = 149\); \(*p \leq .05, **p \leq .01\) (two-tailed); BIGLS = Belief in Good Luck Scale; GRCS = Gambling Related Cognitions Scale; GEQ = Game Experience Questionnaire; Magical = Magical Thinking; Exp. Luck = Experienced Luck; Hot Hand = Hot Hand Fallacy; P. Control = Personal Illusion of Control. GEQ Competence not assessed due to poor internal consistency.

The experiment outlined in Section 3.5.2.1 was assessed using independent samples \(t\)-tests (two-tailed) to compare mean differences of the GSCS Version 3 scores between the active (slot machine) and passive (video recording) groups. The state factor of Personal Illusion of Control was visually larger for the active group \((M\text{ difference} = 2.39; \text{Cohen’s }d = 0.40)\), but no significant group differences were detected (Table 3.12). To inform whether this experiment was sufficiently powered, between group comparisons of the GEQ factors were also calculated, and, similarly, no group differences were found (Table 3.12).
Concurrent validity was also assessed using Sample 3 participants’ qualitative statements. Overall, 36 participants were coded as having had a negative experience (themes of disinterest, boredom, irritability, or helplessness), and 60 were coded as having had a positive experience (themes of interest, excitement, or engagement) with the slot machine session. 53 were categorized as ‘other’ and excluded from analysis. Using independent samples t-tests, significant group differences were detected for state cognition’s full-scale ($M$ difference = 11.7, $p < .001$),

Table 3.12  Independent Samples t-tests between Active and Passive Gambling Groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Grouping</th>
<th>$M$</th>
<th>SD</th>
<th>$M$ difference</th>
<th>SE</th>
<th>$t$</th>
<th>$p$-value</th>
<th>Levene $F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSCS Full</td>
<td>Active</td>
<td>48.9</td>
<td>18.8</td>
<td>1.94</td>
<td>4.59</td>
<td>.674</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passive</td>
<td>47.0</td>
<td>18.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCS MT</td>
<td>Active</td>
<td>16.0</td>
<td>9.97</td>
<td>-1.58</td>
<td>2.46</td>
<td>.525</td>
<td>0.46</td>
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</tr>
<tr>
<td></td>
<td>Passive</td>
<td>17.5</td>
<td>10.1</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>GSCS PIC</td>
<td>Active</td>
<td>11.9</td>
<td>6.20</td>
<td>2.39</td>
<td>1.45</td>
<td>.105</td>
<td>0.97</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passive</td>
<td>9.55</td>
<td>5.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCS Luck</td>
<td>Active</td>
<td>12.4</td>
<td>4.55</td>
<td>0.45</td>
<td>1.15</td>
<td>.693</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passive</td>
<td>12.0</td>
<td>4.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCS HH</td>
<td>Active</td>
<td>8.58</td>
<td>4.57</td>
<td>0.67</td>
<td>1.08</td>
<td>.540</td>
<td>1.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passive</td>
<td>12.0</td>
<td>4.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEQ GI</td>
<td>Active</td>
<td>4.48</td>
<td>1.80</td>
<td>0.15</td>
<td>0.41</td>
<td>.713</td>
<td>0.52</td>
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<tr>
<td></td>
<td>Passive</td>
<td>4.33</td>
<td>1.51</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEQ IM</td>
<td>Active</td>
<td>4.30</td>
<td>1.99</td>
<td>0.64</td>
<td>0.49</td>
<td>.201</td>
<td>0.37</td>
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</tr>
<tr>
<td></td>
<td>Passive</td>
<td>3.67</td>
<td>2.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEQ TN</td>
<td>Active</td>
<td>3.39</td>
<td>1.73</td>
<td>-0.48</td>
<td>0.49</td>
<td>.324</td>
<td>0.78</td>
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<tr>
<td></td>
<td>Passive</td>
<td>3.88</td>
<td>2.20</td>
<td></td>
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</tr>
<tr>
<td>GEQ CH</td>
<td>Active</td>
<td>3.48</td>
<td>1.77</td>
<td>0.03</td>
<td>0.45</td>
<td>.946</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passive</td>
<td>3.45</td>
<td>1.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEQ PA</td>
<td>Active</td>
<td>4.45</td>
<td>1.91</td>
<td>0.51</td>
<td>0.42</td>
<td>.219</td>
<td>2.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passive</td>
<td>3.94</td>
<td>1.43</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>GEQ NA</td>
<td>Active</td>
<td>4.09</td>
<td>2.07</td>
<td>-1.00</td>
<td>0.51</td>
<td>.055</td>
<td>0.37</td>
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</tr>
<tr>
<td></td>
<td>Passive</td>
<td>5.09</td>
<td>2.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: $n = 33$ per group; $df = 64$, $p \leq .05$ (two-tailed). Unequal variances were not detected. GEQ = Game Experience Questionnaire; MT = Magical Thinking, PIC = Personal Illusion of Control, Luck = Experienced Luck, HH = Hot Hand Fallacy, GI = Game Interest, IM = Immersion, TN = Tension, CH = Challenge, PA = Positive Affect, NA = Negative Affect.
Magical Thinking ($M$ difference $= 3.83, p = .038$), Personal Illusion of Control ($M$ difference $= 4.17, p < .001$), and the Hot Hand Fallacy ($M$ difference $= 2.91, p < .001$), such that higher scores were associated with positive experiences (Table 3.13). To test the coding methodology, GEQ’s Positive Affect and Negative Affect were also assessed for mean differences. As expected, Positive Affect had a higher mean score for positive experiences, as did Negative Affect for negative experience.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Grouping</th>
<th>$M$</th>
<th>SD</th>
<th>$M$ difference</th>
<th>SE</th>
<th>$t$</th>
<th>$p$-value</th>
<th>Levene $F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSCS Full</td>
<td>Negative</td>
<td>42.5</td>
<td>16.1</td>
<td>11.7</td>
<td>3.52</td>
<td>3.34</td>
<td>&lt;.001*</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>54.2</td>
<td>17.1</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>GSCS MT</td>
<td>Negative</td>
<td>13.6</td>
<td>9.03</td>
<td>3.83</td>
<td>1.82</td>
<td>2.11</td>
<td>&lt;.001*</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>17.4</td>
<td>8.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCS PIC</td>
<td>Negative</td>
<td>9.36</td>
<td>4.93</td>
<td>4.17</td>
<td>1.14</td>
<td>3.67</td>
<td>&lt;.001*</td>
<td>4.47*</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>13.5</td>
<td>6.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCS Luck</td>
<td>Negative</td>
<td>12.3</td>
<td>4.23</td>
<td>0.84</td>
<td>0.82</td>
<td>1.02</td>
<td>.311</td>
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</tr>
<tr>
<td>GSCS HH</td>
<td>Negative</td>
<td>7.28</td>
<td>3.44</td>
<td>2.91</td>
<td>0.84</td>
<td>3.45</td>
<td>&lt;.001*</td>
<td>3.06</td>
</tr>
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<td></td>
<td>Positive</td>
<td>10.2</td>
<td>4.30</td>
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<tr>
<td>GEQ PA</td>
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<td>3.36</td>
<td>1.36</td>
<td>2.06</td>
<td>0.31</td>
<td>6.54</td>
<td>&lt;.001*</td>
<td>5.69*</td>
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<tr>
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<td>5.42</td>
<td>1.69</td>
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<td></td>
</tr>
<tr>
<td>GEQ NA</td>
<td>Negative</td>
<td>5.47</td>
<td>1.96</td>
<td>-2.34</td>
<td>0.37</td>
<td>-6.30</td>
<td>&lt;.001*</td>
<td>9.92*</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>3.13</td>
<td>1.36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: $df = 36, 60$; * $p \leq .05$ (two-tailed). Welch’s $t$-test reported for PIC, PA, & NA due to unequal variances. Grouped by participant gambling experience statements coded as negative or positive. MT = magical thinking, PIC = personal illusion of control, Luck = experienced luck, HH = Hot Hand Fallacy, PA = positive affect, NA = negative affect.

Concurrent validity was tested again using the measure of problematic gambling (PGSI) to predict the state scale, via multiple linear regression. The PGSI-included models significantly predicted full-scale and Magical Thinking (Table 3.14) and improved the prediction beyond the demographics only control model ($F$-change $= 12.5, p < .001$; $F$-change $= 21.2, p < .001$,
respectively). PGSI was also a significant predictor of Personal Illusion of Control ($p = .039$), although it did not improve upon the demographics only model.

### Table 3.14  Linear Regressions Predicting GSCS by PGSI

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>$\beta$</th>
<th>SE</th>
<th>95% CI</th>
<th>t</th>
<th>p-value</th>
<th>$R^2$ / Adj. $R^2$</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSCS Full</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.122 / .104</td>
<td>6.55*</td>
</tr>
<tr>
<td>Age</td>
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<td>-0.18</td>
<td>0.47</td>
<td>-2.21, -0.41</td>
<td>-2.25</td>
<td>.015*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>-0.10</td>
<td>0.00</td>
<td>3.11</td>
<td>-6.28, 6.08</td>
<td>0.03</td>
<td>.968</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PGSI</td>
<td>9.86</td>
<td>0.28</td>
<td>2.48</td>
<td>4.92, 13.9</td>
<td>3.54</td>
<td>&lt;.001*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCS MT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.167 / .149</td>
<td>9.40*</td>
</tr>
<tr>
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<td>-0.16</td>
<td>0.19</td>
<td>-0.94, -0.21</td>
<td>-2.09</td>
<td>.010*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
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<td>-0.01</td>
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<td>-2.83, 2.37</td>
<td>-0.15</td>
<td>.880</td>
<td></td>
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</tr>
<tr>
<td>PGSI</td>
<td>6.14</td>
<td>0.37</td>
<td>1.38</td>
<td>3.20, 8.80</td>
<td>4.60</td>
<td>&lt;.001*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCS PIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.064 / .044</td>
<td>3.21*</td>
</tr>
<tr>
<td>Age</td>
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<td>-0.17</td>
<td>0.18</td>
<td>-0.73, -0.08</td>
<td>-2.05</td>
<td>.024*</td>
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<tr>
<td>Gender</td>
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<td>0.10</td>
<td>1.01</td>
<td>-0.94, 3.53</td>
<td>1.20</td>
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<tr>
<td>PGSI</td>
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<td>0.89</td>
<td>0.10, 3.57</td>
<td>1.81</td>
<td>.039*</td>
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<td></td>
<td></td>
<td>.048 / .027</td>
<td>2.35</td>
</tr>
<tr>
<td>Age</td>
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<td>-0.07</td>
<td>0.14</td>
<td>-0.38, 0.16</td>
<td>-0.84</td>
<td>.475</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
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<td>-0.17</td>
<td>0.71</td>
<td>-2.94, -0.16</td>
<td>-2.07</td>
<td>.018*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PGSI</td>
<td>0.86</td>
<td>0.10</td>
<td>0.56</td>
<td>-0.24, 1.96</td>
<td>1.23</td>
<td>.122</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSCS HH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.024 / .003</td>
<td>1.15</td>
</tr>
<tr>
<td>Age</td>
<td>-0.12</td>
<td>-0.09</td>
<td>0.13</td>
<td>-0.39, 0.04</td>
<td>-1.06</td>
<td>.215</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
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<td>0.04</td>
<td>0.85</td>
<td>-1.29, 1.94</td>
<td>0.44</td>
<td>.660</td>
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</tr>
<tr>
<td>PGSI</td>
<td>1.02</td>
<td>0.11</td>
<td>0.74</td>
<td>-0.52, 2.44</td>
<td>1.35</td>
<td>.174</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: $n = 145$, $df = 141$ (3), *$p \leq .05$ (two-tailed). $\beta =$ standardized coefficient. 95% CI, SE, and predictor $p$-values are bootstrapped (BCa, 5000 samples). MT = magical thinking, PIC = personal illusion of control, Luck = experienced luck, HH = Hot Hand Fallacy. PGSI is log transformed to reduce positive skew.

### 3.5.4 Discussion – GSCS Version 3

Version 3 produced a 17-item scale comprising a four-factor structure with acceptable inter-item correlations and sampling adequacy, consistent with the estimated sample size for a wide communality distribution (range = .257 to .828; see Table 3.9). The factors represented Magical Thinking (combining supernatural control and machine anthropomorphism items),
Personal Illusion of Control, Experienced Luck, and the Hot Hand Fallacy. Together, these explained 58.6% of total item variance. Shared variance between factors ranged from 2.13% to 25.5% (see Table 3.10), supporting the use of direct oblimin rotation while also indicating their conceptual distinction. Adjustments made to the scale structure and individual items improved upon the Version 2 floor effects and the positive skew, which now predominantly affected the Magical Thinking subscale. Full-scale, Magical Thinking, Personal Illusion of Control, and Hot Hand demonstrated acceptable-to-good internal consistency (α = .679 to .891), further supporting the items retained within factors. See Figure 3.6 for histogram distributions.

Study 3 incorporated several approaches to establish scale validity. Convergent validity was assessed by correlating the GSCS Version 3 factors with the trait-based measures of gambling cognitions (GRCS subscales and BIGLS). Broadly speaking, distortions captured by the state scale moderately-to-strongly positively correlated with these established trait-related distortions (Table 3.11). This is evidence that the state scale does in fact measure cognitive distortions. There was less evidence for the specificity of the individual factors as relating to specific distortions captured by the two trait-based scales. This is likely a consequence of the moderate-to-strong between factor correlations found within the state scale (Table 3.10) and GRCS (see Raylu & Oei, 2004), and because latter scale’s factors can contain items that span multiple conventionally classified distortions (i.e., Predictive Control contains items relating to Gambler’s fallacy, hot hand fallacy, and luck). Numerically, the associations between state factors and the trait-based GRCS metacognition of Inability to Stop appeared weaker (see Table 3.11), compared to those factors measuring erroneous distortions. Further conceptual distinction of distortions between the developed state scale’s factors can be inferred from their low shared variance and item face validity (see Table 3.6 for specific items & 3.10 for factor correlations).
The resulting GSCS factors were correlated with the state-focused GEQ in-game module, to established concurrent validity with participant experiences. State gambling distortions were expected to positively correlate with this scales’ factors of: Game Interest, Immersion, Challenge, and Positive Affect; and higher scores on the GSCS Magical Thinking, Personal Illusion of Control, and the Hot Hand Fallacy did so (see Table 3.11). Magical Thinking also had a small association with GEQ Tension, compatible with the sense of risk anthropomorphised slot machines can produce (Kim & McGill, 2011) and the aggressive wording of the retained anthropomorphic items (i.e., “the machine was out to get me”). Experienced Luck only weakly associated with Tension, possibly reflecting the decision for these items to encompass both good and bad luck or a view that luck is a more passive experience (André, 2006; Zitek & Jordan, 2021). These positive correlations were based upon the premise that gambling distortions increase the perceived means to engage with, and the dynamics of, gambling games (Leonard et al., 2015), because outcomes are viewed as controllable and less random through these lenses. The perception of skillful use can, in turn, prompt the experience of immersion and challenge (Csikszentmihalyi, 1990), and it is reasonable this would produce a more enjoyable experience. Thus, these results provide additional evidence that the developed state scale (GSCS) does capture gambling-related cognitive distortions,

The first approach to determine whether the GSCS was specifically targeting state-related beliefs involved the experiment outlined in Section 3.5.2.1. Limited support was found for the hypothesis that participants who actively played the slot machine would score higher than those who passively watched a screen captured video of the same slot machine play (see Table 3.12). One explanation could be that the developed scale does not actually capture state beliefs. Second, it could be that the passive gambling experience is similarly engaging. In support of this
possibility, viewing gambling live streams on platforms, such as Twitch.tv, has grown in popularity, indicating that vicarious gambling experiences can still be engaging even without the possibility of personal gain (Abarbanel, Avramidis, Clark, & Johnson, 2021; Koncz, Demetrovics, Griffiths, & Király, 2023). Lastly, the experiment could have been underpowered, given the reduced sample size for the watchers ($n = 33$; target $n = 51$), due to the onset of COVID-19. Scores on the Personal Illusion of Control subscale were higher among gamblers compared to watchers, but did not reach significance (Cohen’s $d = 0.40$; $p = .105$). This factor might be expected to produce the greatest divergence between the active gambler and watcher groups, due to the inability to interact with the machine. Group differences were also compared across the Game Experiences Questionnaire factors, and no differences were detected, providing further evidence for an underpowered design.

Due to the power limitations described above, another approach to assess the state scale’s capacity to capture state-related belief was devised using participant’s qualitative statements about the gambling experience. Rather than an experimentally-induced difference in gambling experience, these statements were coded as positive, negative, or other. Those who reported positive themes about gambling scored higher on Magical Thinking, Personal Illusion of Control, and the Hot Hand Fallacy, suggesting that enjoyment of the gambling session was associated with greater activation of state cognitions (see Table 3.13). This is consistent with literature demonstrating that positive gambling expectancies (e.g., reduced stress, improved mood) relate to endorsement of trait-based gambling cognitions (Raylu & Oei, 2004; Smith, Woodman, Drummond, & Battersby, 2016; Taylor, Parker, Keefer, Kloosterman, & Summerfeldt, 2014), and could reflect biased recall (e.g., more memorable wins) or a perceived ability to influence outcomes. To test the integrity of statement coding, group differences were also calculated for
GEQ Positive Affect and Negative Affect. Expectedly, participants coded as having a positive experience scored higher in Positive Affect, and those with negative experiences endorsed greater Negative Affect (see Table 3.13).

The problematic gambling measure (PGSI) was used to establish additional concurrent validity. More difficulties with gambling during the past year predicted state activation on the GSCS full-scale, Magical Thinking, and Personal Illusion of Control (see Table 3.14). These effects are notable because of the extreme range restriction on the PGSI, among participants who were primarily non-gambling undergraduates, and were required to score ≤ 7 on the PGSI to ensure that individuals at risk for problematic gambling were not exposed to a slot machine, to protect from potential gambling harms. Overall, these results align with the expectation that riskier gamblers will more regularly produce state cognitions (Griffiths, 1994), and further supports the GSCS’ use as a measure for state-related distortions.

It is also helpful to assess whether the developed state scale corresponds to a specific or comprehensive measure or erroneous gambling cognitions, as was done by Leonard, Williams, and Vokey (2015) in their review of GRCD measures. The GSCS structure appears to assess a range of cognitive distortions in state form: Personal Illusion of Control, the Hot Hand Fallacy, Experienced Luck, and Magical Thinking; with the latter reflecting aspects of both Machine Anthropomorphism and Supernatural Illusion of Control. Although items relating to the Gambler’s fallacy were not retained. With five of the six targeted distortions captured in some form (see Table 3.2), the produced scale can be considered a reasonably broad measure of gambling distortions.
3.6 General Discussion

This study focused on the development and validation of a questionnaire to assess state-activated GRCDs during slot machine use. Through a Pilot Study and two studies to assess revisions, a 17-item scale was produced that captures four GRCDs: Magical Thinking, Personal Illusion of Control, the Hot Hand Fallacy, and Experienced Luck (see Table 3.9). These factors were, on average, moderately correlated with each other (Table 3.10). That gambling-related cognitions show some degree of correlation with one another is not surprising because many may share underlying cognitive mechanisms, such as the use of heuristics (see Section 1.3). The state scale’s (GSCS) factors of Personal Illusion of Control and the Hot Hand Fallacy are consistent with the cognitive distortions outlined by Leonard et al. (2015). In gambling, an illusion of control is the belief that the likelihood of winning can be meaningfully influenced by actors (Langer, 1975), and Personal Illusion of Control focuses upon the gambler’s own actions directed toward the slot machine. Its Hot Hand Fallacy targets the perception that wins predict further winning during the game. It should be noted that in the state context, this subtly differs from a trait manifestation because it actually requires the win-like experiences to have occurred during the session. However, given that wins do not predict future wins when events are independent, this perception can still be considered distorted. The GSCS factor of Experienced Luck also differs from more dispositional conceptualizations of luck (Darke & Freedman, 1997; Leonard et al., 2015; Wohl, Stewart, & Young, 2011), firstly by de-emphasizes an inherent luckiness (i.e., that I am a lucky person), and second by incorporating perceived bad luck (see also Maltby et al. 2008). This allows our state luck factor to be relevant to losing conditions that may more readily be associated with perceptions of unluckiness. Magical Thinking resulted from the shared variance between items designed to assess supernatural control and machine
anthropomorphism (see Table 3.6 for original item list). That these facets pooled together is indicative of a broader tendency to think magically. Supernatural control reflects influence from outside forces (Ejova et al., 2015), while machine anthropomorphism is the process of humanizing the slot machine as friend or foe (Riva et al., 2015), leading to a sense of giving or competition. These results suggest that these 4 factors as specifically relevant to slot machine gambling.

The development of this scale benefitted from multiple iterations of design that refined the focus and specificity of the retained items (see Sections 3.3 & 3.4). Parallel analysis, a data driven approach to determine optimal factor retention (Field, 2017; O’Connor, 2000), resulted in the retention of an additional factor, the Hot Hand Fallacy. This strengthened the overall reach of the GSCS, and internal consistency and overall validity demonstrated for this factor suggests retention was sensible. The methodological approach to the exploratory factor analysis in Study 3 was informed by both literature and data from Study 2. Use of several approaches to establish initial validity increases confidence that this measure accurately targets gambling-related cognitions in the state context. This scale also avoids certain limitations that Leonard, William, & Vokey (2015) reported as common among measures for GRCDs. The GSCS is a reasonably broad measure that spans four categories of GRCDs, and it does not misconstrue non-fallacious attitudes, motivations, biases, or behaviours as erroneous cognitions.

3.6.1 Study and Scale Limitations

This study also presents with some notable limitations. One is the absence of a sample for confirmatory factor analysis (CFA). Confirmatory analyses are used to demonstrate that a factor structure remains stable across samples, and do not result from a capitalization of sampling error. Unlike trait-based scales, the development of this state scale required participants to complete an
in-laboratory gambling activity to activate cognitions, and this was no longer possible once the COVID-19 pandemic ended in-person data collection. Similarly, the additional per participant time required to develop a state scale traded off on the maximum feasible $n$, and using a split half procedure to perform the exploratory factor analysis and CFA would have reduced sampling adequacy to unacceptable levels. Concern that the presented factors is overly influenced by sampling error is somewhat mitigated by the similar structures between Versions 2 & 3, despite modifications. The correlations between the state scale and trait-cognitions measure (GRCS; see Table 3.11) to assess convergent validity did not demonstrate clear specificity between the factors. This is partly due to individual GRCS factors incorporating aspects from multiple conventionally defined distortions. Subsequent assessments of convergence could benefit from use of multiple measures of distortions. The use of the problematic gambling measure (PGSI) to assess additional concurrent validity (see Table 3.14) is also limited because of the extremely limited range of participant responses on this measure. This scale was also validated upon predominantly non-gambling psychology undergraduates. Although participation from this population is commonly solicited in gambling studies, further validation using more frequent gamblers would benefit generalization of the GSCS, as would validation across multiple venues (e.g., live casinos, online casinos, simulated slot machines in laboratories) and timeframes. Although not a limitation of the GSCS, but of state scales more broadly, it is likely these measures should be administered soon after completing the gambling task, to presumably increase the likelihood of capturing activated state cognitions.
3.7 Conclusions

This project revisits a central motivation of older research using the think-aloud technique to capture state gambling cognitions (Gaboury & Ladouceur, 1989). Think-aloud is a methodologically complex procedure that has largely fallen from favour, and current methods in gambling studies emphasize the measurement of trait cognitions using self-report scales. The Gambling State Cognitions Scale (GSCS) is complimentary to these existing trait scales, with the goal of furthering our understanding about the interaction between the gambling experience and gambling distortion activation. While trait scales will remain informative about an individual’s baseline tendency to think erroneously about gambling, the state-related nature of cognition during gambling is an important area that requires much more research attention, given that key decisions (e.g., to quit or chase) are made during the context of gambling. The GSCS captures these state distortions in relation to slot machines, a common and harmful form of gambling (Marionneau et al., 2022). Such research could include an exploration of how slot machine structural characteristics influence gambling-related cognition activation, correlating state cognition activation to psychophysiology (e.g., skin conductance), or to assess the duration required for state distorted cognitions to return to an acontextual baseline. Further, cognitive therapies have attempted to reduce gambling-related cognitive distortions, and there is some evidence that doing so reduces problem gambling behaviours (Fortune & Goodie, 2012; Ladouceur et al., 1998; Smith et al., 2018). Intuitively, these therapies should be more effective if their use also reduces the state-activation of these distortions, and the GSCS could facilitate the study of this question. This scale could also provide clinical utility by allowing clinicians to measure their client’s state-related gambling cognition activation periodically throughout a course of treatment, if validated for an easy to administer computer slot machine simulation.
Chapter 4. The Associations between Loot Box Use, Problematic Gaming, Gambling, and Gambling-Related Cognitive Distortions

4.1 Introduction

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

To what extent does this feature represent gambling? Legal definitions of gambling focus on three properties: i) a cost to play; ii) the prospect of winning a prize; iii) chance is involved in

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4 A version of Chapter 4 has been published: Brooks & Clark, (2019). Associations between loot box use, problematic gaming and gambling, and gambling-related cognitions, Addictive Behaviours, 96, 26-34.
the outcome (Danish Gambling Authority, 2018; Reber, 2012). *Prima facie*, purchasable loot boxes appear to meet the first and third criteria, but the second criterion is more complex. It is often noted that all loot boxes yield a prize, only many prizes are for common items that the gamer may already possess or not want, and the valuation of virtual items is often subjective (Watkins & Molesworth, 2012). Yet, some games permit the trade or sale of loot box prizes, which enables ‘cashing out’ through marketplaces (Drummond & Sauer, 2018). These have borne the brunt of recent regulatory reviews of loot boxes in contemporary games (Danish Gambling Authority, 2018; Yin-Poole, 2018).

Research on gaming monetization features, at the time this chapter was published^5^, came primarily from work on ‘social casino games’. These are gambling-themed games on social media platforms that are free to play (initially) and provide no monetary reward, but offer in-game purchases to unlock extra features or continue play (Gainsbury et al., 2014; Wohl et al., 2017). For people with gambling problems, social casino games associated with increased gambling urges (Gainsbury et al., 2014; Hollingshead et al., 2016), and microtransaction use predicted migration to online gambling (Kim et al., 2015). Similarly, many video games allow free access to loot boxes, but expenditure is encouraged to increase the frequency of use, and early work has linked loot box spend to gambling (Zendle & Cairns, 2018). Gaming and gambling share psychological characteristics, including variable ratio reinforcement schedules, which foster cognitive distortions such as overconfidence and illusory control (King et al., 2010). In gambling, high rates of these distortions are linked to problematic behaviour (Fortune &

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^5^ This chapter’s literature review has intentionally not received an update since publication, to preserve research chronology. Chapter 5 provides an updated literature review on this topic.
Goodie, 2012; Yakovenko et al., 2016), but it is unclear if analogous mechanisms operate during loot box use.

4.1.1 The Present Study

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

4.2 Methodology

4.2.1 Sample & Procedure

Sample 1 was collected via Amazon Mechanical Turk (MTurk). A pre-screen questionnaire (compensation $0.15 USD) established eligibility, which included prior video game play and familiarity with loot boxes. The pre-screen completion time was three minutes and remained on MTurk until 1000 responses were collected (approx. 2 weeks). The pre-screen and full survey were described on MTurk as ‘Video Games & Loot Boxes – Research Study’, with a suffix of ‘pre-screen’ for the former. Data from this sample were also used for unrelated analyses in Chapter 2 (Sample 3). The full survey took approximately 40 minutes to complete. Inclusion criteria included residence in North America, were fluent in English, and an age 21 or over. For data quality, inclusion was restricted to MTurk Workers who had completed ≥ 1000
MTurk tasks with >98% approval ratings. Covert attention checks were also included to enhance data quality, as recommended (Goodman et al., 2013). These were the removal of abnormally fast completions (< 10 minutes), endorsed play on a fictional slot machine or video game, and inconsistent responding across repetitions of the same item. Overall, 721 (84.8%) of 850 otherwise eligible respondents had video game experience and familiarity with loot boxes. The full survey, administered via Qualtrics®, was then made accessible to this subset for a month, again on MTurk (compensation $1.50 USD). The survey was presented in the following order: consent, demographics, video game and loot box questions, non-gambling scales, then gambling-related scales/items. This order reduced contamination or demand characteristics via the gambling items. Overall, 153 individuals found and completed this survey, and 144 passed the attention checks. Full survey data was collected from February through March of 2018.

Sample 2 comprised of students from the University of British Columbia, who participated in an online survey via the UBC Psychology Department’s Human Subject Pool for student participation (using the same title description as the MTurk study), for course credit. No pre-screen was conducted; rather, those who indicated no familiarity with loot boxes on the survey were excluded. Eligibility criteria were as for Sample 1, except for a lowered minimum age requirement (19 years, legal gambling age in BC). Of 138 respondents, 113 (81.9%) were eligible and passed attention checks. Data was collected from March - April 2018.

4.2.2 Measures

4.2.2.1 Video Game & Loot Box Questions

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

4.2.2.2 Problematic Internet Gaming

The Internet Gaming Disorder Scale (IGDS; Lemmens, Valkenburg, & Gentile, 2015) is a 9-item scale that aligns with the provisional criteria for Internet Gaming Disorder in the DSM-5 (American Psychiatric Association, 2013). Items pertain to past 12-month behaviour. Internal consistency was good for Samples 1 & 2 (α = 0.80; α = 0.82).

4.2.2.3 Risk Taking

The Financial subscale of the Domain-Specific Risk-Taking (DOSPERT-F) (Weber & Blais, 2002) includes six items scored on a seven-point Likert scale related to hypothetical engagement in risky investment and gambling behaviours (e.g., “betting a day’s income at the horse races”). Internal consistency was acceptable for Samples 1 & 2 (α = 0.74; α = 0.79).

4.2.2.4 Gambling Beliefs

Two questionnaires were used to measure gambling-related cognitive distortions. The Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004) uses a seven-point scale, ranging from ‘strongly disagree’ to ‘strongly agree’ to measure: Illusion of Control, Interpretive Bias, Predictive Control, Gambling Expectancies, and perceived Inability to Stop gambling. The latter two are conceptually closer to metacognitions about gambling. Internal consistency was
excellent for Samples 1 & 2 (total score $\alpha = 0.92; \alpha = 0.95$). The Darke and Freedman Beliefs Around Luck Scale (BALS; Maltby et al., 2008) measures four aspects of luck; Personal Good Luck (BALS-GL), Personal Bad Luck (BALS-BL), General Belief in Luck (BALS-GB), and Rejection of Luck (BALS-RL) using a six-point Likert scale (strongly disagree – strongly agree). The internal consistency of these subscales was good-to-excellent for Samples 1 & 2 ($\alpha = 0.87 - 0.94; \alpha = 0.86 - 0.97$). See Section 1.4 for a further review of gambling-related cognitions.

4.2.2.5 Problem Gambling

The Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001) was used to assess problem gambling in the previous twelve months. Items are scored 0 (‘never’) to 3 (‘almost always’). This scale is considered the gold standard self-report instrument for gambling problems (Dowling et al., 2018). Internal consistency was excellent for Sample 1 ($\alpha = 0.91$), and good for Sample 2 ($\alpha = 0.82$).

4.2.3 Analysis Plan

Initial analyses focused upon loot box user demographics and descriptive information. A composite index of risky loot box usage was derived, which was then correlated with the other constructs. Informed by this correlation matrix, two hierarchical linear regressions assessed the prediction of this index by gambling-related variables. Gambling-related cognitions have been found to moderate the relationship between gambling frequency and expressions of gambling harm (Miller & Currie, 2008). Therefore, the two gambling cognition scales (GRCS and BALS) were entered first, followed by measures of disordered gambling and gambling-related risk-taking (PGSI and DOSPERT-F). Then, a ‘loot box distortion’ (item 6 in Table 4.5) was incorporated because of its increased proximity to loot box risk. Lastly, the measure of internet
Analyses were conducted using IBM SPSS® 25.0. Given skew in gaming and gambling involvement, descriptive statistics report median values. Following Field (2017), outliers were first assessed with boxplots, noting cases above 3.0 times the interquartile range (IQR). The distribution of z-scores for this subset was assessed, and variables with a greater than expected number of extreme cases were thought to contain outliers. Normality was assessed with P-P plots, and not observed for the GRCS, PGSI, or the BALS’ Personal Bad Luck subscale. A log transformation was applied to the PGSI, to mitigate significant positive skew. Bootstrapping (BCa, 2000 samples) was used to mitigate the impact of outliers and normality deviations for regression analyses. Missing data was excluded listwise. Collinearity diagnostics did not indicate the presence of multicollinearity within regression models. Variance inflation factors ranged from 1.23-2.81 (Sample 1) and 1.05-1.70 (Sample 2); and tolerance ranged from .357-.811 (Sample 1) and .590-.948 (Sample 2).

4.2.4 Ethics

The procedures for this study were carried out in accordance with the Declaration of Helsinki. Surveys began with a consent form about study procedures, and participants could either consent to participate or decline participation at the bottom of this page. The survey ended with a debriefing form that discussed the purpose of the study, and provided participants with
information about mental health resources. Study approval was provided by the University of British Columbia’s Behavioural Research Ethics Board (H17-03571).

4.3 Results – Sample 1

4.3.1 Demographic Information

See Table 4.1 for participant demographics. Current video game play was endorsed by 97.2% of the sample, and online play by 95.1%. The average age participants began gaming was 8-years-old \((SD = 10.4)\), and average frequency was “6-10 hours per week”. 87.4% reported past gambling experience, 53.2% were current gamblers, and 78.3% endorsed slot machine play. Median gambling frequency was “about once a year”, and 39.2% reported gambling every few months. Figure 4.1 provides a distribution of risky gambling behaviour by both PGSI score and PGSI risk categories.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Sample 1: MTurk ((n = 144))</th>
<th>Sample 2: University ((n = 113))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Age ((SD))</td>
<td>34.0 (10.0)</td>
<td>21.0 (2.39)</td>
</tr>
<tr>
<td>Gender (% Female)</td>
<td>48.6%</td>
<td>12.1%</td>
</tr>
<tr>
<td>Ethnicity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>8.32%</td>
<td>62.1%</td>
</tr>
<tr>
<td>African-American/Black</td>
<td>8.33</td>
<td>0.90</td>
</tr>
<tr>
<td>Caucasian/White</td>
<td>78.5</td>
<td>24.1</td>
</tr>
<tr>
<td>Latin American</td>
<td>1.40</td>
<td>0.90</td>
</tr>
<tr>
<td>“Other”</td>
<td>3.47</td>
<td>12.0</td>
</tr>
</tbody>
</table>

*Note: Nine participants were removed from the MTurk sample and 22 were removed from the university sample due to failed attention checks.*
Figure 4.1  PGSI Distributions by Score and Risk Categories

Note: Sample 1 $n = 144$; Sample 2 $n = 113$. Risk categories are based upon Currie et al. (2013); Non-Problem = ‘0’; Low Risk = ‘1-4’, Moderate Risk = ‘5-7’; Problem Gambling = ‘8+’. 
4.3.2 Loot Box Engagement and Attitudes

Table 4.2 provides information regarding loot box engagement. There was a high degree of heterogeneity in preferred video game to open loot boxes, with 44 titles reported. For the 45.1% who endorsed spending on loot boxes, the median expenditure was $10.00 (SD = 16.7) per month, and this was highly skewed (6.2% spent more than $40.00; see Figure 4.2). Attitude towards loot boxes was generally positive (‘good feature’ 52.1%; ‘bad feature’ 33.3%; neutral response 14.6%). Regarding perceived similarity to gambling: 75.7% endorsed agreement that “opening Loot Boxes sometimes feels like making a bet”, and 68.1% endorsed agreement for “I believe Loot Boxes are a form of Gambling”.

### Table 4.2 Loot Box Engagement

<table>
<thead>
<tr>
<th>Questions:</th>
<th>Percent ‘Yes’ Sample 1 / Sample 2</th>
<th>Median Endorsed Statement Sample 1 / Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have you played a game with loot boxes?</td>
<td>93.8 / 97.4%</td>
<td></td>
</tr>
<tr>
<td>2. Have you opened a loot box within a video game?</td>
<td>88.9 / 94.8</td>
<td></td>
</tr>
<tr>
<td>3. Have you spent time specifically to earn loot boxes?</td>
<td>63.2 / 55.2</td>
<td></td>
</tr>
<tr>
<td>4. Have you bought a loot box or “key” to unlock one?</td>
<td>49.3 / 60.3</td>
<td></td>
</tr>
<tr>
<td>5. Have you sold a loot box or loot box item?</td>
<td>27.8 / 39.7</td>
<td></td>
</tr>
<tr>
<td>6. Have you profited from loot boxes?</td>
<td>18.1 / 25.9</td>
<td></td>
</tr>
<tr>
<td>7. Approx. age of first Loot Box Use:</td>
<td>“26 – 30 years old” / “14 – 17 years old”</td>
<td></td>
</tr>
<tr>
<td>8. Approx. hours spent specifically to earn Loot Boxes:</td>
<td>“less than an hour per week” / “less than an hour per week”</td>
<td></td>
</tr>
</tbody>
</table>

Note: Sample 1 n = 144; Sample 2 n = 113. 15.3% of the Sample 1 reported spending more than three hours per week specifically to earn loot boxes, and 5.56% spent more than six hours per week. 15.5% of Sample 2 reported spending three or more hours per week specifically to earn loot boxes, and 6.03% spent six or more hours per week.
Figure 4.2  Estimated Monthly Expenditure on Loot Boxes

Note: Distribution reflects monthly expenditure on loot boxes, restricted to those who reported current expenditure, within the MTurk sample (n = 65) and the university sample (n = 58).
4.3.3 Development of the “Risky Loot Box” Index (RLI)

Twelve items assessed problematic aspects of loot box use (see Table 4.3). To consolidate these items for further analysis, an exploratory factor analysis was conducted \((n = 144)\) with Principal axis factoring to account for measurement error among variables (Thompson, 2004). This followed the same procedure outlined in Section 3.2.4.2 of the previous chapter, although a higher minimum threshold was set for item communality due to the ad-hoc approach to this analysis. From the initial items, one was excluded due to high collinearity, and six were excluded due to low communality \((< .450)\). The overall Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was acceptable \((.830)\), as were individual item KMO values \((.795 - .893)\). Inter-item correlations were suitable (Bartlett’s test \(p < .001\)), and item multicollinearity was not considered problematic (determinant = .098). Parallel analysis indicated that a single factor solution (eigenvalue = 3.24) was most appropriate. This factor explained 56.3% of the total variance, and the individual item factor loadings and communalities are found in Table 4.4. Cronbach’s alpha indicated good internal consistency \((\alpha = .864)\). The remaining five items reflected preoccupation with loot boxes, impulsive use of this feature, and the behaviour of ‘chasing’ specific loot box items through repeated purchases. The latter is similar to loss chasing behaviour in gambling, where the gambler makes continued wagers with the hope of winning back losses. I recognize that this variable is not intended to assess ‘disordered’ or ‘addictive’ loot box usage, only risky behaviours associated with their use that may become problematic.
Table 4.3  Initial Set of Loot Box Items for Factor Analysis

<table>
<thead>
<tr>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I frequently play games longer than I intend to, so I can earn Loot Boxes.</td>
</tr>
<tr>
<td>2. I believe obtaining items from Loot Boxes is an effective way to generate money.</td>
</tr>
<tr>
<td>3. I will play for long periods of time to earn Loot Boxes.</td>
</tr>
<tr>
<td>4. Receiving items from Loot Boxes is a primary reason why I play video games.</td>
</tr>
<tr>
<td>5. I buy Loot Boxes with the hope of receiving valuable items to sell.</td>
</tr>
<tr>
<td>6. I have felt guilty about the amount of time or money I have spent on Loot Boxes.</td>
</tr>
<tr>
<td>7. I have put off other activities, work, or chores to be able to earn or buy more Loot Boxes.</td>
</tr>
<tr>
<td>8. Once I open a Loot Box, I often feel compelled to open another.</td>
</tr>
<tr>
<td>9. I have sometimes spent more on Loot Boxes than I could afford.</td>
</tr>
<tr>
<td>10. I have bought more Loot Boxes after failing to receive valuable items.</td>
</tr>
<tr>
<td>11. The thrill of opening Loot Boxes has encouraged me to buy more.</td>
</tr>
<tr>
<td>12. My Loot Box use has caused me problems.</td>
</tr>
</tbody>
</table>

*Note:* Items are answered on a five-point Likert scale (strongly disagree – strongly agree).

Table 4.4  RLI Item Factor Loadings and Communalities

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

*Note: n = 144. Communalities listed are after extraction. Single factor solution was produced.*
Following the Risky Loot Box Index’s (RLI) development, initial validity was demonstrated through positive moderate Pearson bivariate correlations with questions 1 & 9 in Table 4.5, where risky use was assumed to associate with expenditure and self-reported problematic use. Then, correlations were assessed between RLI and additional questions developed for loot box assessment, gambling and gaming behaviour, gambling-related cognitive distortions, and risk-taking behaviour scales (see Tables 4.5 & 4.6). RLI moderately and positively associated with monthly loot box spend and problematic gambling (PGSI), and it also shared a strong positive association with the trait measure of gambling cognitions (GRCS).

These results informed the regression analysis in the following section.

Table 4.5  Sample 1 Correlations between Scales and Individual Questions

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

Note: n = 143, * p ≤ .05, ** p ≤ .01 (two-tailed), df = 141. Q1-7 used a five-point Likert-scale (strongly disagree – strongly agree). Three responses for Q8 (Bad Feature, Neither Good nor Bad, Good Feature), Q9 = USD. Media = rated exposure to loot box news on a sliding scale (values = 1-9, greater = more exposure). To reduce skew, PGSI scores were log transformed.
Table 4.6  Sample 1 Correlations between Loot Box, Gambling, Gaming, and Risk Scales

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

Note: n = 143, * p ≤ .05, ** p ≤ .01 (two-tailed), df = 140; RLI = Risky Loot Box Index; GRCS = Gambling Related Cognitions Scale; BALS-BL = Belief in Bad Luck; BALS-GL = Belief in Good Luck; BALS-RL = Rejection of Luck; BALS-GB = General Belief in Luck; PGSI = Problem Gambling Severity Index; IGDS = Internet Gaming Disorder Scale; DOSPERT-F = Financial subscale; Media = participants asked to rate their exposure to loot box-related news on a sliding scale (values = 1-9, greater = more exposure). To reduce skew, PGSI scores were log transformed.
4.3.4 Regression Analyses

In the hierarchical regression \((n = 142)\) predicting risky loot box use (RLI), gambling cognitions alone explained 34.3% of the adjusted variance, \(F(4, 137) = 19.4, p < .001, R^2 = .362, \text{ Adj. } R^2 = .34\) (see Table 4.7). Combined, the variables related to gambling cognitions and problem gambling (steps 1-2) accounted for 37.1% of the adjusted variance, \(F(7, 134) = 16.3, p < .001, R^2 = .398, \text{ Adj. } R^2 = .371; \Delta F(2,135) = 4.12, p = .018.\) The measure of internet gaming harm (IGDS), gender, and media exposure were also significant predictors of RLI. A second hierarchical regression was conducted to determine the incremental value of the gambling-related variables. Entered first, IGDS, age, gender, and media exposure accounted for 15.4% of the adjusted variance, \(F(4, 137) = 7.40, p < .001, R^2 = .178, \text{ Adj. } R^2 = .154.\) Following these, gambling-related variables accounted for an additional 28.5% of adjusted variance, \(F(10, 131) = 12.1, p < .001, R^2 = .479, \text{ Adj. } R^2 = .439; \Delta F(6,131) = 12.64, p < .001.\)

4.4 Results – Sample 2

4.4.1 Demographic Information

Table 4.1 provides demographic information for Sample 2. Current video game play was endorsed by 92.2% of the sample, and online video game play by 85.3%. The sample self-reported gaming onset at age 4 \((SD = 2.25)\), with a median frequency of “6-10 hours per week”. Overall, 56.9% reported past gambling experience, 15.5% were current gamblers, and 44.0% had used a slot machine. Compared to MTurk, a smaller proportion of participants scored in the problematic ranges of the PGSI (see Figure 4.1).
<table>
<thead>
<tr>
<th>Variable</th>
<th>Step 1 (df = 4, 137)</th>
<th>Step 2 (df = 6, 135)</th>
<th>Step 3 (df = 7, 134)</th>
<th>Step 4 (df = 11, 130)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$ [CI]</td>
<td>SE</td>
<td>$\beta$ [CI]</td>
<td>SE</td>
</tr>
<tr>
<td>BALS-RL</td>
<td>-.305** [-.455, -.156]</td>
<td>.076</td>
<td>-.311** [-.457, -.164]</td>
<td>.074</td>
</tr>
<tr>
<td></td>
<td>[.117, .198]</td>
<td>.080</td>
<td>[.081, .450]</td>
<td>.075</td>
</tr>
<tr>
<td></td>
<td>[.117, .198]</td>
<td>.080</td>
<td>[.081, .450]</td>
<td>.075</td>
</tr>
<tr>
<td>PGSI</td>
<td>.266* [.081, .450]</td>
<td>.093</td>
<td>.209* [.031, .387]</td>
<td>.090</td>
</tr>
<tr>
<td>DOSPERT-F</td>
<td>.031 [-.117, .178]</td>
<td>.075</td>
<td>.042 [-.099, .183]</td>
<td>.071</td>
</tr>
<tr>
<td></td>
<td>[.122, .390]</td>
<td>.075</td>
<td>[.031, .387]</td>
<td>.071</td>
</tr>
<tr>
<td>LB-EM</td>
<td>[.264** [.127, .401]</td>
<td>.069</td>
<td>[.031, .387]</td>
<td>.071</td>
</tr>
<tr>
<td>IGDS</td>
<td>.189** [.056, .323]</td>
<td>.056</td>
<td>.056 [.031, .387]</td>
<td>.056</td>
</tr>
<tr>
<td>Age</td>
<td>-.019 [-.014, .010]</td>
<td>.014</td>
<td>-.019 [.031, .387]</td>
<td>.014</td>
</tr>
<tr>
<td>Gender</td>
<td>.150* [.042, .288]</td>
<td>.042</td>
<td>.150* [.031, .387]</td>
<td>.042</td>
</tr>
</tbody>
</table>

$R^2 / \Delta R^2$ | .362 / .362 | .398 / .037 | .460 / .062 | .531 / .071
Adj. $R^2$ | .343 | .371 | .432 | .491
$\Delta F$ | 19.4** | 4.1* | 15.4** | 4.90**

Note: $n = 142$, * $p \leq .05$, ** $p \leq .01$ (two-tailed), 95% CI, SE, and $p$-values are bootstrapped (BCa, 2000 samples); GRCS = Gambling Related Cognitions Scale; BALS-BL = Belief in Bad Luck; BALS-GL = Belief in Good Luck; BALS-RL = Rejection of Luck; PGSI = Problem Gambling Severity Index; IGDS = Internet Gaming Disorder Scale; DOSPERT-F = Financial subscale; LB-EM = “I believe obtaining items from Loot Boxes is an effective way to generate money”. To reduce skew, PGSI scores were log transformed.
4.4.2  Loot Box Descriptives

In Sample 2, 60.3% endorsed spending money on loot boxes (see Table 4.2). The 58 individuals who reported monthly expense had a median of $17.50 ($SD = 44.2), and 10.3% spent more than $50.00 (see Figure 4.2 for spend distribution). Game preferences were less diverse (23 vs. 44 titles) compared to Sample 1. There were mixed views on loot boxes (good = 30.2%, neutral = 38.8%, bad = 31.0%). Overall, 79.3% agreed that loot boxes can feel like betting, and 86.2% agreed that loot boxes are a form of gambling.

4.4.3  Correlational Analyses

Risky loot box use (RLI) demonstrated good internal consistency in Sample 2 ($\alpha = .834$). Correlations matrices are reported in Table 4.8 (individual items) & Table 4.9 (scales). The RLI replicated the detected associations with the gambling-related variables (GRCS & PGSI), although the strength of correlations were attenuated.

4.4.4  Regression Analyses

The Sample 2 hierarchical regression ($n = 113$) predicting RLI replicated Sample 1, where gambling-related variables explained a significant proportion of variance, $F(3, 109) = 4.99, p = .003, R^2 = .121, \text{Adj. } R^2 = .097$. Gender, age, and media exposure were not significant predictors. The gaming disorder measure (IGDS) increased explained variance, $F(4, 108) = 6.01, p < .001, R^2 = .183, \text{Adj. } R^2 = .153; \Delta F(1,108) = 8.25, p = .005$. Entered first, the IGDS explained a significant proportion of variance, $F(1, 111) = 12.2, p = .001, R^2 = .099, \text{Adj. } R^2 = .091$. Gambling variables, when entered after this measure, accounted for 6.20% of additional adjusted variance, $F(4, 108) = 5.13, p < .001, R^2 = .183, \text{Adj. } R^2 = .153; \Delta F(3,108) = 3.71, p = .013$. 
4.4.5 Preferred Games to Open Loot Boxes

Sample 2 allowed for analysis between participants who preferred games with (n = 35) vs. without (n = 50) marketplaces, where marketplaces could be identified. As a manipulation check, “I buy Loot Boxes with the hope of receiving valuable items to sell” was tested for differences: those with preference for marketplace games (M = 2.34) scored higher than those who did not (M = 1.62); t(83) = 2.64, p = .010, Cohen’s d = 0.60. On the question “Virtual items that can be sold are better than those that cannot be”, those who preferred marketplace games had higher scores (M = 3.57 vs. 3.04); t(83) = 2.07, p = .041, Cohen’s d = 0.46. This preference also associated with any loot box expense (68.6% vs. 42.0%), χ²(1) = 5.84, p = 0.016, φ = .262.
Table 4.9  Sample 2 Correlations between Loot Box, Gambling, Gaming, and Risk Scales

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

Note: n = 113, * p ≤ .05, ** p ≤ .01 (two-tailed), df = 111; RLI = Risky Loot Box Index; GRCS = Gambling Related Cognitions Scale; BALS-BL = Belief in Bad Luck; BALS-GL = Belief in Good Luck; BALS-RL = Rejection of Luck; BALS-GB = General Belief in Luck; PGSI = Problem Gambling Severity Index; IGDS = Internet Gaming Disorder Scale; DOSPERT-F = Financial subscale; Media = participants asked to rate their exposure to loot box-related news on a sliding scale (values = 1-9, greater = more exposure). To reduce skew, PGSI scores were log transformed.
4.5 Discussion

These two samples of young adult and adult gamers showed high levels of engagement with loot box features (see Table 4.2). In Studies 1 and 2, 88.9% and 94.8% had opened a loot box, respectively. Our participants encountered this feature across a wide variety of games that spanned many genres and platforms. The MTurk sample appeared to endorse a positive view of loot boxes more so than the student sample (52.1% vs. 30.2%). Correlational analyses did not indicate that this was explained by the age difference between the samples, but other possible factors are game-related preferences or non-gaming demographic differences. Approximately half (49.3% and 60.3%) of each sample reported expenditure to buy loot boxes, and substantial variation in expenditure was seen. A similar skew was detected in the weekly hours spent earning loot boxes, implying that non-monetary risks could also arise for some individuals.

In a large survey of video gamers \((n = 7,422)\), Zendle & Cairns (2018) reported that loot box expenditure was associated with problem gambling status (measured by the PGSI). The relationship between other microtransactions and problem gambling was not as strong, indicating a specific roll of loot boxes in this association. Macey & Hamari, (2018) also found ‘video game-gambling habits’, which likely included loot boxes, moderately predicted PGSI score in a sample of video gamers. I replicated these findings in the pattern of correlations between loot box expenditure, risky loot box use (RLI), and PGSI (see Tables 4.5 and 4.6). Within Sample 1, moderate-to-strong relationships were observed for the RLI against the PGSI \((r = .491)\), the measure of gambling cognitions \((GRCS; r = .518)\), and three of the luck subscales. Similar associations were observed, although of smaller size, in Sample 2 (Table 4.9). The muted effect in Sample 2 likely reflects the university sample’s lower gambling engagement: only 15.5% were current gamblers (compared to MTurk sample, 53.2%), which in turn reduced variance on the
gambling measures. Distorted cognitions are implicated as an etiological factor in Gambling Disorder, and analogous cognitions have been posited in gaming (King & Delfabbro, 2014; King, Ejova, & Delfabbro, 2012; Wu, Sescousse, Yu, Clark, & Li, 2018) These correlations indicate that gambling cognitions could be risk factor for the excessive loot box use.

Together, gambling-related variables accounted for 37.1% of variance of risky loot box use (see Table 4.7). Notably, these also contributed an additional 28.5% over the variance attributed to problematic gaming (IGDS). Sample 2 replicated these findings, though gambling involvement within the sample was lower and gambling-related variables correspondingly accounted for less total and incremental variance (9.70%; 6.20%). In sum, gambling measures were more strongly related to risky loot box use, and explained a larger share of the variance, than a typical measure of problematic gaming. This could point to some differentiation between problematic loot box use and the common presentation of disordered gaming, which emphasizes excessive time spent gaming, preoccupation, and consequential functional impairment (American Psychiatric Association, 2013; Lemmens et al., 2015). Rather, problematic loot box use may emerge from financial risk-taking and GRCDs associated with problem gambling. This concurs with research advocating the need to investigate other harms (e.g., financial) arising from modern video games (Starcevic & Billieux, 2018).

Subsets of both Sample 1 (27.8%) and Sample 2 (39.7%) reported selling items from loot boxes (see Table 4.2). This figure is striking because ‘cashing out’ requires either integrated marketplaces or trade features, which not all games allow. This feature allows gamers to enact gambling-like behaviour with loot boxes, where the monetary reward from selling could be the desired outcome. Aligning with these concerns, risky loot box use (RLI) correlated moderately with questions related to virtual item sale (see Table 4.5). Sample 2 provided further insight,
through comparison between preferred loot box games with and without marketplaces. This is a coarse contrast, because preference for marketplace-enabled games did not preclude the player from also playing other non-marketplace games. Nevertheless, reporting monthly spending on loot boxes was associated with preference for marketplace games. Those who preferred marketplace games were more inclined to buy loot boxes specifically to sell the content, and believed that virtual items that could be sold were ‘better’. My interpretation is that marketplace features increase in-game spending and shift players’ valuation of items from subjective qualities (e.g., aesthetics) to monetary worth. This is an important consideration, since loot boxes are commonly portrayed as a method of in-game customization, rather than a digital store of value.

4.5.1 Study Limitations

This study was exploratory and contains limitations. The recruitment ad mentioned loot boxes, which could have influenced individual’s decisions to participate. A comparison of pre-screen and full survey respondents in Sample 1 indicates this could have biased the sample toward regular loot box users but not regular gamblers (see Appendix E, Table E.1). Although I used attention checks and MTurk workers with high approval ratings to improve data quality, deliberate mischievous responding cannot be ruled out. Further variables could moderate these relationships and/or the differences between samples (e.g., the dispositions of MTurk workers or video game playing undergraduates), and I encourage further replication in other populations. Our questions assessing loot box beliefs and engagement were newly created. While effort was undertaken to reduce question ambiguity, it is possible their interpretation differed across participants and samples. For example, the statement, “I believe loot boxes are a form of gambling” did not correlate with risky loot box use or gambling-related measures, but predicted more negative attitudes toward loot boxes ($r = -.408$). It is possible this question aligns more
closely with a pejorative perspective toward loot boxes, rather than gambling-related cognitions or behaviours. Sample 2 relied upon an undergraduate sample comprised largely of psychology students. There is evidence this population’s engagement with gambling does not generalize to the larger community (Gainsbury, Russell, & Blaszczynski, 2014), and the differences in gambling engagement between Sample 1 and 2 supports this (see Section 4.3.1). I also relied upon participant’s self-reports about their frequency of gambling and video game use, however, participant’s accuracy is regularly inaccurate (Heirene, Wang, & Gainsbury, 2022). Sample 2 was also predominantly male (87.9%), and it is unclear why this selection bias occurred.

At the time this chapter was published, the RLI was a newly developed measure of risky loot box use and required further validation. Since publication of the manuscript associated with this chapter, other research groups have provided additional validity and confirmatory analyses, which have generally supported the scale’s structure and generalization to other populations (Drummond, Sauer, Ferguson, & Hall, 2020; Forsström, Chahin, Savander, Mentzoni, & Gainsbury, 2022; Hall, Drummond, Sauer, & Ferguson, 2021; Lloyd et al., 2021). Nevertheless, the RLI will continue to benefit from additional validation approaches, such as its ability to predict gambling onset. I also emphasize that the RLI should not be taken as a measure of ‘loot box disorder’, rather an aggregate of behaviours that could be considered risky for those who excessively engage with this feature. Additional work is required to develop questions that assess specific beliefs pertaining to loot boxes, rather than relying upon existing measures validated for gambling behaviour. Further, the size of the effect of the gambling-related items in predicting risky loot box use varied substantially between the two samples in this exploratory study, indicating the likely existence of moderators (i.e., past gambling experience; trait impulsivity; overall time spent gaming).
4.6 Conclusions

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

The presence of item marketplaces or player-to-player trading may be a crucial feature for the enactment of gambling behaviours, and it may shift a player’s perspective toward the system’s monetary aspects. Our measure for marketplace presence, though coarse, was associated with differences in virtual item valuation and monthly expenditure. Jurisdictional reviews have identified marketplace features as a key determinant of regulation of specific video games as gambling (Yin-Poole, 2018). Nevertheless, the ability to sell items constitutes a ‘narrow’ view of gambling with loot boxes, and the risks that may be associated with a player’s ‘bound’ items should not be discounted. King and Delfabbro (2018) make no such discrimination when labelling loot boxes as predatory. Beyond restrictions related to item sale or trade, additional regulations could impose limitations on the rarity of items, or the requirement to publish these probabilities, with the latter policy already enacted in China and on the Apple App Store (Hilgert, 2018; Xiao, 2023). Since virtual items are typically associated with game-wide player accounts, the ability to impose spending limits (Drummond, Sauer, & Hall, 2019) or self-exclude from loot box purchases or microtransactions could also be considered.
Chapter 5. The Gamblers of the Future? Testing Migration between Loot Boxes and Gambling in a Longitudinal Study

5.1 Introduction

Loot boxes, as discussed in Chapter 4, are a form of video game microtransaction, ubiquitous throughout modern gaming, and now regularly described as a gambling-like feature (Drummond & Sauer, 2018; Drummond et al., 2020; Zendle et al., 2020). These virtual items, when ‘opened’, produce a randomly generated in-game reward that may have cosmetic (e.g., avatar stylization) or functional (e.g., player enhancements; Zendle et al., 2020) value in the game. The associated audio-visual displays can heighten the anticipation of item reveal and receipt of prizes (King & Delfabbro, 2019), in ways that often further resemble gambling products like slot machines. Irrespective of between game variation, their underlying mechanism is a chance-based reward system, where the most desired items are the rarest, and many other prizes hold limited value to the gamer (e.g., duplicates of already-obtained items). Their likenesses to gambling have prompted concern that loot boxes could introduce and encourage involvement in conventional gambling among gamers, especially among children and young adults (Macey & Hamari, 2022; Spicer et al., 2022; Zendle & Cairns, 2018). Conversely, individuals who are at risk of problematic gambling could be disproportionately harmed by

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6 A version of Chapter 5 has been published: Brooks & Clark (2023). The gamblers of the future? Migration from loot boxes to gambling in a longitudinal study of young adults, Computers in Human Behaviour, 141, 107605.
excessive loot box use, due to the appeal of loot boxes structural similarities to gambling (Brooks & Clark, 2019; Spicer et al., 2022; Zendle & Cairns, 2018).

5.1.1 Associations between Loot Boxes and Gambling

A key empirical finding that underscores the link between loot boxes and gambling is evidence of a positive correlation in cross-sectional surveys between measures of loot box engagement (e.g., spending) and problem gambling symptoms. First shown by Zendle & Cairns (2018) in a large sample ($n = 7,422$) of gamers recruited through Reddit, this finding has been widely replicated in adult (Brooks & Clark, 2019; Li, Mills, & Nower, 2019) and adolescent samples (Kristiansen & Severin, 2020; Zendle, Meyer, & Over, 2019). The effect size of this detected association was small-to-moderate ($r = .260$) in a meta-analysis by Garea et al. (2021). However, Xiao et al. (2023) reported that this effect could be culturally dependent, after observing a weaker association between loot boxes and past year gambling ($r_s = .06$) via a survey of individuals from the People’s Republic of China. Gambling-related cognitive distortions (GRCDs; e.g., the Gambler’s fallacy), a cognitive variable implicated in the development of gambling problems (see Section 1.3 for a review), are also positively correlated with loot box expenditure and the Risky Loot Box Index (RLI; Brooks & Clark, 2019; Spicer et al., 2022). Rarer, more desirable, loot box rewards have been seen to elicit behavioural markers of reward reactivity (post reinforcement pauses), and increased physiological arousal (skin conductance level) has been detected prior to loot box outcomes (Larche, Chini, Lee, Dixon, & Fernandes, 2021). Thus, these associations have now been found at the behavioural, psychological, and physiological levels.

The cross-sectional relationship between loot box engagement and problem gambling is generally interpreted in terms of two possible pathways, with researchers quick to note that
neither causal interpretation can be inferred from the basic correlation (House of Commons Digital, Culture, Media, and Sport Committee, 2019; Spicer et al., 2022). One possibility is that loot boxes form an exposure to randomized reward mechanics that may increase the prospect of future gambling (Macey & Hamari, 2022). I refer to this pathway, from loot boxes to gambling, as ‘migration’ (see also Kim et al. 2015). Uncertain rewards can recruit the dopamine system and a process of incentive sensitization that is implicated in addictions (Zack et al., 2020). For loot boxes, heightening the incentive value of cues that become associated with the desired randomly generated virtual items (e.g., a ‘near-miss’ outcome). Epidemiological data indicate that earlier age of onset of gambling (typically during adolescence) is a risk factor for adult gambling problems (Kessler et al. 2008). The regulatory implication here is that youth, for whom conventional gambling is an age-restricted activity, may be introduced to gambling via the variable-ratio rewards of loot boxes. An alternative possibility is that when experienced gamblers play video games, their familiarity with randomized rewards, or predisposition to hold GRCDs, increases loot boxes appeal (see Chapter 4; Spicer et al., 2022; Zendle & Cairns, 2018). This ‘reverse pathway’ points to distinct regulatory responses, that would primarily target gamblers as a vulnerable group to reduce financial harms when gaming. These causal directions are not mutually exclusive, and other explanatory factors have been postulated; for example, Sidloski et al. (2022), partly a reanalysis of Chapter 4 data, found modest support for the hypothesis that gamers may actually be referring to consequences of their loot box use when completing problem gambling screening measures. However, the authors noted the strength of these effects were unlikely to fully account for the relationship between loot boxes and problem gambling.
5.1.2 Investigating Causal Pathways

To date, few studies have sought to disentangle these causal pathways. Specifically, there is a need for longitudinal research examining gamers around the typical age range for gambling onset. Using a cross-sectional design that relied on retrospective judgments of each activity, Spicer et al. (2022) recruited 1,102 individuals who endorsed using both loot boxes and gambling products. Participants were asked about their ages of onset for each activity, and to judge whether either one influenced their decision to engage in the other. Overall, 19.6% endorsed a migration-type effect (that Spicer et al. label a ‘gateway effect’) in which loot boxes were thought to have promoted subsequent gambling, while 20.1% endorsed the reverse pathway. These two subgroups were characterized by higher levels of youth loot box purchases, higher scores on the risky loot box use (RLI), and greater endorsement of gambling-related cognitions. Nevertheless, the reliance on retrospective data requires that participants were aware of the possible causal influence of one behaviour upon the other, accurately attribute behaviour to this causal influence, and be able to recall such information accurately. In another design that used a brief longitudinal approach, Zendle (2019) assessed players of the game Heroes of the Storm both before and after loot boxes were removed (but not other microtransactions) from the game. Players who were classified as at high-risk of problem gambling at baseline significantly reduced their in-game expenditure when loot boxes were removed, whereas spending levels were unaffected in those without gambling problems. This observation was interpreted as support for the reverse pathway, that the presence of loot boxes specifically encourages spending in gamers already at risk for problematic gambling behaviour. These studies provide glimpses into possible directionality, but also highlight the need for additional longitudinal research to guide these causal interpretations.
The two pathways, and the ensuing discussion about the appropriate regulatory responses to loot boxes, emphasize the role of randomized reward mechanics, while also noting that financial over-spending is the main route to harm (Langham et al., 2016). It is pertinent here that modern video games also offer other, non-randomized microtransactions, including ‘direct purchase microtransactions’ (DPMs) where the gamer pays directly for a desired in-game item -- conceivably the same item that could be won from a loot box. In Zendle & Cairns (2018), direct purchase microtransaction expenditure was not associated with problem gambling (e.g., $\eta^2 = 0.004$ vs. $\eta^2 = 0.054$ for loot boxes), but subsequent studies have produced mixed results (Close, Spicer, Nicklin, Lloyd, & Lloyd, 2022; Drummond, Sauer, Ferguson, et al., 2020; Zendle & Cairns, 2019). In Close et al. (2022), loot box users had a significantly greater rate of gambling participation than those who made other game-related transactions (46.0% vs. 28.1%), but spending across the two modalities was also somewhat correlated. This comparison between direct purchase and loot box spending remains a powerful way to test the specific appeal, and impact, of reward randomization within this relationship between video game microtransactions and gambling.

5.1.3 The Present Study

I conducted a longitudinal study with the primary goal of testing ‘migration’ from engagement with loot boxes to later (conventional) gambling at six months follow-up. To do this, I recruited a group of young adult video gamers, stratified into two subgroups, with and without gambling experience at baseline; the tests for migration were conducted within the subgroup of non-gamblers. The primary analysis plan was pre-registered (AsPredicted #54443), and the estimated effect size and expected attrition rate was based on Kim et al. (2015), who tested for a migration from social casino games (see Section 1.6.1) to gambling over a similar six month
These authors found that spending within social casino games uniquely predicted subsequent gambling ($OR = 8.16$). I also established some exploratory predictions to assess for the specific role of randomized rewards, and the reverse pathway. First, I hypothesized that non-loot box expenditure would not predict gambling migration and tested this by entering direct purchase microtransaction expenditure into the regression models, alone and simultaneously with loot box expenditure. Second, I re-categorized participants to identify a subgroup who reported no loot box spend during the year prior to baseline assessment (i.e., the “loot box non-users”), then tested whether their gambling involvement and endorsed gambling-related cognitive distortions at baseline predicted the initiation of loot box spending at the 6-month follow-up.

5.2 Methodology

5.2.1 Sample & Procedure

Participants were recruited from the United States, United Kingdom, and Canada, using Prolific, a crowdsourcing platform designed for research participation. Of the eligibility criteria, five were established used Prolific’s participant filters: i) a Prolific approval rating of 95% and $\geq$ 50 previous submissions; ii) regular video gaming, defined as $\geq$ 3 hours per week; iii) country of residence; iv) a minimum age above the legal gambling age for their country of residence (i.e., UK = age 18, Canada = age 19, USA = age 21); and v) age $\leq$ 25 on their Prolific account at the time of pre-screen completion. I focused on young adults because I reasoned that the target variable, initiation of gambling, would begin to plateau beyond this age (see Kessler et al., 2008). I used a further pre-screen survey to establish two additional criteria: vi) familiarity with either loot boxes or direct purchase microtransactions (assessed by endorsement of two binary Yes/No
questions); and vi) proficiency with English. For data robustness, these eligibility criteria were repeated in the baseline survey. To ensure an adequate sample of non-gamblers for the primary tests of migration, the pre-screen stratified participants into the non-gambler and gambler subgroups via a Yes/No response to the question, “Do you currently gamble?”, with a target $n$ of 392 per subgroup. These subgroups were recruited concurrently. Informed consent was obtained via a consent form presented at the beginning the pre-screen, baseline, and follow-up surveys.

The baseline survey was titled as “Video Game Spending – Part 1” and took about 30 minutes to complete. The 6-month follow-up was titled “Video Game Spending – Part 2” and took about 12 minutes to complete. Participants were compensated £5.00 (currency of Prolific) for baseline and £2.50 for follow-up. Four attention check items were used to maintain data quality (recommended by Goodman et al., 2013): i) consistent entry of the participant’s age across two sections; ii) did not endorse playing a fictional slot machine; iii) did not endorse playing a fictional video game; and iv) selection of a specified answer for a question. Participants who failed more than one attention check were excluded (as outlined in AsPredicted #54443). Exclusion also occurred for inconsistent responses across key variables (e.g., endorsed current gambling but denied any history of gambling), if nonsensical statements were provided for open text responses, or for extremely fast or slow survey completion ($3.0 \text{ SDs}$ from median).

A total of 712 participants completed baseline. Of these, additional participants were excluded because: i) Qualtrics flagged one participant as a potential bot; ii) 34 indicated no English proficiency on the repeated exclusionary item in the baseline survey; iii) 15 indicated no current gaming activity (likely due to outdated Prolific account data); iv) 6 were not a resident of one of the three target countries (again likely due to incorrect information associated with their Prolific account); v) 4 entered an age less than the minimums (indicating inattention or an
incorrect age on their Prolific account); vi) 9 took excessively long to complete the survey. Of those remaining, all passed 3+ attention checks, and an additional seven were removed for inconsistent responses across the survey. Following exclusions, data from 636 participants (415 non-gamblers; 221 gamblers) were included in baseline analyses. At follow-up assessment, an additional 8 participants were removed for indicating insufficient English (suggesting inattention because sufficient English was reported at baseline), and none failed the attention checks. Two retained participants reported an age of 26 at baseline, possibly due to a birthdate between pre-screen and baseline completion. Overall, 291 non-gamblers (29.9% attrition) and 155 gamblers at baseline (also 29.9% attrition) completed follow-up. The pre-screen launched and completed in November 2020, the baseline survey launched on 16 December 2020 and completed on 23 December 2020, and follow-up launched on 23 June 2021 and completed 20 July 2021. Additional detail about the timeline of data collection and survey structure is provided in Appendix F. The baseline survey also included a number of subsidiary measures for exploratory research questions that are not reported here.

5.2.2 Measures

5.2.2.1 General Descriptives

This included general demographics, degree of video game engagement (e.g., hours per week), and estimated age of video game onset. I also presented some items to assess the impact of the COVID-19 pandemic upon participants’ video game use.

5.2.2.2 Microtransaction Descriptives

A series of questions assessed: 1) Participant exposure to, and engagement with, loot boxes and direct purchase microtransactions; 2) expenditure on loot boxes and direct purchase
microtransactions; 3) familiarity with loot box item odds; 4) reasons for selling loot box items; and 5) preferred games to use these features in.

5.2.2.3 Beliefs and Behaviours about Microtransactions

A range of loot box and direct purchase microtransaction-related beliefs and behaviours was assessed. This also included the Risky Loot Box Index (RLI), a five-item, five-point Likert scale that assesses self-perceived excessive loot box use (Brooks & Clark, 2019). The RLI demonstrated good internal consistency at baseline (α = .840) and follow-up (α = .843).

5.2.2.4 Gambling Descriptives

Past and current gambling activity, expenditure on gambling, and perceptions about anticipated future gambling behaviour were assessed.

5.2.2.5 Gambling Cognitions

The Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004) was used to assess gambling-related cognitions at baseline. GRCS is a seven-point scale (‘strongly disagree’ to ‘strongly agree’) comprised of five subscales: Illusion of Control, Interpretive Bias, Predictive Control, Gambling Expectancies, and Inability to Stop gambling. The latter two subscales are better conceptualized as capturing metacognitions. Total score reliability was excellent (α = .916). The Beliefs Around Luck Scale (BALS; Maltby et al., 2008) was included to assess belief in luck. This is comprised of four subscales that measure Belief in Personal Good Luck, Belief in Personal Bad Luck, a General Belief in Luck, and a Rejection in Luck. Internal consistencies were good-to-excellent for these (α = .825 - .940). See Section 1.4 for more information about these cognitions.
5.2.2.6 Problem Gambling

The Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001) is considered a gold standard screening instrument for problem gambling (Dowling et al., 2018). Nine items are scored from 0 (‘never’) to 3 (‘almost always’), creating the risk categories of: Non-problem gambler (score = ‘0’); low risk (‘1-4’); moderate risk (‘5-7’); and problem gambler (‘8+’; Currie et al., 2013). Due to concern about participant responses on the PGSI being informed by their loot box use (Sidloski et al., 2022), participants were asked to not consider loot box use in their answers. PGSI reliability was good at baseline ($\alpha = .875$), and excellent at follow-up ($\alpha = .912$).

5.2.3 Power Analysis

A power calculation assumed a medium effect size for the continuous dependent variables (defined as $f^2 = .15$), with a single predictor power of .90, and $\alpha \leq .0125$ given the Bonferroni correction for multiple tests (described in Section 5.2.5). Using G*Power 3.1.9.7. (Faul, Erdfelder, Lang, & Buchner, 2007), the recommended sample size was $n = 89$. Our attrition calculations for an online study using a 6-month follow-up assessment were based on Kim et al. (2015): assuming 75% attrition, and a further 10% oversampling for data cleaning, I sought to collect $n = 392$ at baseline, for both the non-gambler and gambler subgroups. Data collection for the subgroup of gamblers ran more slowly compared to the non-gamblers and was ultimately stopped before reaching this target (see Appendix F).

5.2.4 Data Availability

Study data are available in the Borealis repository: https://doi.org/10.5683/SP3/KXHCUN
5.2.5 Analysis Plan

I first characterize the typical level and range of engagement with different forms of microtransactions across the two subgroups. Group differences among these variables are assessed with chi-squared and Mann-Whitney U tests (effect sizes for these tests are given by phi and derived $r$ coefficients, respectively). I conduct an exploratory chi-squared test to assess whether endorsement of any prior loot box expenditure (answered Yes/No) predicted migration to current gambler status by follow-up. To assess the primary hypothesis (H1), I tested whether use of loot boxes at baseline in the non-gamblers predicted gambling behaviour at follow-up; this constitutes the narrowest test of ‘migration to gambling’. Non-gambler status was determined by a ‘No’ response to the question, “Do you currently gamble?” at baseline. Our pre-registered analyses operationalized loot box engagement using the two separate but related facets of 12-month microtransaction expenditure (overall engagement) and RLI score (risky use). Gambling engagement at follow-up was assessed via answering ‘Yes’ to “Do you currently gamble?” and 6-month gambling spend, to assess both self-identification as a gambler and degree of gambling behaviour. Logistic regressions were used to assess whether: H1a) 12-month microtransaction expenditure or H1b) RLI score predicted conversion to current gambler status. Linear regressions were used to assess whether: H1c) 12-month microtransaction expenditure or H1d) RLI score predicted 6-month gambling spend at follow-up. Given the four comparisons, a Bonferroni correction was applied ($p < .0125$). Direct purchase microtransaction expenditure was entered into the model first, to assess the predictive capacity of loot box expenditure beyond microtransactions more generally. All expenditure data was converted to USD using the exchange rate at the midpoint date of data collection.
An exploratory hypothesis (H2; not pre-registered) sought to test the reverse pathway. I re-categorized the participants to identify a subgroup who reported zero expenditure on loot boxes during the 12-months prior to baseline. Using linear regressions, I tested whether gambling-related variables at baseline predicted loot box expenditure (and therefore onset of use) by follow-up. A Bonferroni correction ($p < .0125$) accounted for the four gambling-related variables being assessed (12-month expenditure, PGSI, GRCS, and General Belief in Luck from the BALS). For comparison, direct purchase microtransactions were also used to predict loot box expenditure.

I tested full sample bivariate correlations between gender, age, ethnicity, education, and self-rated degree of self-isolation during the COVID-19 pandemic against the predictors. None of these demographic variables were considered as control variables because none met the pre-registered threshold for consideration, a bivariate association of $r \geq .30$ (all $r \leq .197$ absolute value, see Appendix G, Table G.1). Following Field (2017), outliers were assessed with boxplots and cases above 1.5 times the interquartile range were noted. These datapoints were manually reviewed, those deemed to be non-sensical (e.g., a negative or improbably large dollar expense) were listwise excluded from analysis. All plausible outliers remained in the analysis and bootstrapping (BCa, 5000 samples, run in IBM SPSS 28.0) was used to mitigate their effect in regressions. Normality was assessed with P-P plots. All expenditure variables (for loot boxes, direct purchase microtransactions, and gambling) were right skewed, as were the measures of problematic gambling (PGSI) and gambling-related cognitions (GRCS). These were log base 2 +1 transformed to improve normality, base 2 was used to facilitate interpretability of odds ratios (interpreted as the % increase per doubling of expenditure).
5.2.6 Ethics

The procedures for this study were carried out in accordance with the Declaration of Helsinki. Surveys began with a consent form about study procedures, and participants could either consent to participate or decline participation at the bottom of this page. The survey ended with a debriefing form that discussed the purpose of the study, and provided participants with information about mental health resources. Study approval was provided by the University of British Columbia’s Behavioural Research Ethics Board (H20-02830).

5.3 Results

5.3.1 Demographics Information

Table 5.1 shows the participant demographics in the two subgroups of non-gamblers and gamblers, and the re-categorized participants based on loot box use and non-use at baseline.

5.3.2 Loot Box and Direct Purchase Microtransaction Descriptives

Engagement with loot box and direct purchase microtransaction features by gambling status at baseline are presented in Table 5.2. Almost every participant in both the gambling and non-gambling groups were familiar with loot boxes and direct purchase microtransactions, and had played a video game with these. Among participants who made a microtransaction in the past year \( (n = 541) \), gamblers reported higher spending on loot boxes \( (z = 4.68, p < .001) \) and on direct purchase microtransactions \( (z = 2.85, p = .004.) \) than the non-gamblers. Gamblers were also more likely to have bought loot boxes \( (\chi^2 = 6.99, p = .008) \), and sold loot box items \( (\chi^2 = \)
6.72, \( p = .010 \), relative to the non-gamblers. For both subgroups, the modal response to “Do you look at the odds of receiving specific items before purchasing loot boxes?” was “Sometimes”.

Table 5.1  Participant Demographics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non-gamblers ((n = 415))</th>
<th>Gamblers ((n = 221))</th>
<th>Loot Box Non-users ((n = 251))</th>
<th>Loot Box Users ((n = 385))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age (SD)</td>
<td>22.3 (1.91)</td>
<td>22.7 (1.89)</td>
<td>22.33 (1.89)</td>
<td>22.5 (1.92)</td>
</tr>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woman</td>
<td>34.2%</td>
<td>20.4%</td>
<td>35.9%</td>
<td>25.2%</td>
</tr>
<tr>
<td>Man</td>
<td>62.4%</td>
<td>76.9%</td>
<td>61.0%</td>
<td>71.7%</td>
</tr>
<tr>
<td>Non-binary</td>
<td>3.37%</td>
<td>2.71%</td>
<td>3.19%</td>
<td>3.12%</td>
</tr>
<tr>
<td>Ethnicity:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian/White</td>
<td>56.1%</td>
<td>68.3%</td>
<td>64.9%</td>
<td>57.4%</td>
</tr>
<tr>
<td>Asian</td>
<td>22.9%</td>
<td>13.6%</td>
<td>18.7%</td>
<td>20.3%</td>
</tr>
<tr>
<td>African/Black</td>
<td>5.78%</td>
<td>5.43%</td>
<td>3.59%</td>
<td>7.01%</td>
</tr>
<tr>
<td>Latin American</td>
<td>5.54%</td>
<td>4.98%</td>
<td>3.59%</td>
<td>6.49%</td>
</tr>
<tr>
<td>Multiracial</td>
<td>4.58%</td>
<td>4.52%</td>
<td>5.58%</td>
<td>3.90%</td>
</tr>
<tr>
<td>Other Ethnicity</td>
<td>5.06%</td>
<td>3.17%</td>
<td>3.59%</td>
<td>4.94%</td>
</tr>
<tr>
<td>Country of Residence:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>47.2%</td>
<td>45.7%</td>
<td>44.6%</td>
<td>48.1%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>41.2%</td>
<td>44.8%</td>
<td>45.8%</td>
<td>40.3%</td>
</tr>
<tr>
<td>Canada</td>
<td>11.6%</td>
<td>9.50%</td>
<td>9.56%</td>
<td>11.7%</td>
</tr>
<tr>
<td>Median Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Year Degree:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College or Technical</td>
<td>63.3%</td>
<td>75.3%</td>
<td></td>
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</tr>
<tr>
<td>2-Year Degree:</td>
<td></td>
<td></td>
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<tr>
<td>Part College or University</td>
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<td></td>
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<tr>
<td>2-Year Degree:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College or Technical Degree</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever Gambled</td>
<td>54.9%</td>
<td>100.0%</td>
<td>63.3%</td>
<td>75.3%</td>
</tr>
<tr>
<td>Mean Age of Gaming Onset (SD)</td>
<td>6.75 (2.80)</td>
<td>6.60 (2.53)</td>
<td>6.64 (2.54)</td>
<td>6.74 (2.81)</td>
</tr>
<tr>
<td>Median Weekly Gaming Hours</td>
<td>16-to-20 per week</td>
<td>16-to-20 per week</td>
<td>11-to-15 per week</td>
<td>16-to-20 per week</td>
</tr>
</tbody>
</table>

Note: The sample was sorted into gambling status, and then again into loot box use status. Baseline gambling status determined by response (Yes/No) to the question, “Do you currently gamble?”. Baseline loot box status was determined by past 12 month expenditure prior to baseline data collection (none/any).
Table 5.2  Loot Box and DPM Descriptives by Gambler Status at Baseline

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Non-Gamblers (n = 415)</th>
<th>Gamblers (n = 221)</th>
<th>Group Difference Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loot Boxes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Familiar with loot boxes:</td>
<td>99.8%</td>
<td>99.5%</td>
<td>$\chi^2 = .206, p = .650, \phi = .018$</td>
</tr>
<tr>
<td>Played a game containing loot boxes:</td>
<td>96.9</td>
<td>98.2</td>
<td>$\chi^2 = .970, p = .325, \phi = .039$</td>
</tr>
<tr>
<td>Opened an awarded loot box without purchase:</td>
<td>94.0</td>
<td>95.5</td>
<td>$\chi^2 = .623, p = .430, \phi = .031$</td>
</tr>
<tr>
<td>Bought ‘keys’ to unlock or loot boxes directly:</td>
<td>61.0</td>
<td>71.5</td>
<td>$\chi^2 = 6.99, p = .008*, \phi = .105$</td>
</tr>
<tr>
<td>Sold an item from a loot box for money:</td>
<td>35.2</td>
<td>45.7</td>
<td>$\chi^2 = 6.72, p = .010*, \phi = .103$</td>
</tr>
<tr>
<td>Past 12 month expenditure on loot boxes (IQR):</td>
<td>$13.4 (0.00 – 50.0)$</td>
<td>$33.5 (6.70 – 120)$</td>
<td>$U = 42,138, z = 4.68, p &lt; .001*, r = .201$</td>
</tr>
<tr>
<td>Direct Purchase Microtransactions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Familiar with DPMs:</td>
<td>98.1%</td>
<td>98.2%</td>
<td>$\chi^2 = .011, p = .917, \phi = .004$</td>
</tr>
<tr>
<td>Played a game that contains DPMs:</td>
<td>97.3</td>
<td>96.8</td>
<td>$\chi^2 = .140, p = .708, \phi = .015$</td>
</tr>
<tr>
<td>Bought a DPM:</td>
<td>84.1</td>
<td>87.8</td>
<td>$\chi^2 = 1.57, p = .210, \phi = .050$</td>
</tr>
<tr>
<td>Sold an item that was bought as a DPM:</td>
<td>22.4</td>
<td>29.0</td>
<td>$\chi^2 = 3.33, p = .068, \phi = .072$</td>
</tr>
<tr>
<td>Past 12 month expenditure on DPMs (IQR):</td>
<td>$35.6 (14.6 – 93.8)$</td>
<td>$50.0 (20.0 – 134)$</td>
<td>$U = 39,016, z = 2.85, p = .004*, r = .122$</td>
</tr>
</tbody>
</table>

Note: Expenditure data reflects the median and is calculated among participants that reported any microtransaction purchases in the past 12-months; Group differences (*p ≤ .05, two-tailed) were assessed with chi-squared tests for the Yes/No questions, phi ($\phi$) = effect size. Mann-Whitney U tests were used for expenditure (n = 541), and a derived $r$ value is reported for effect size. Participants reported in currency of residence (USA, UK, Canada), and this was converted to USD using the conversion rate at the midpoint of data collection. Bolded = significant difference between groups. DPM = direct purchase microtransaction.
5.3.3 Chi-squared Analyses

Among the non-gamblers at baseline, a chi-squared analysis tested the relationship between having bought loot boxes during the past 12 months at baseline (Yes/No) and gambling initiation (Yes/No) at follow-up (Table 5.3). An equivalent model tested the same effect for direct purchase microtransaction purchases during the past 12 months at baseline. Participants who initiated gambling between baseline and follow-up (n = 33) were more likely to have purchased loot boxes in the 12 months prior to baseline ($\chi^2 = 4.61, p = .032$). There was no difference in these same participants engagement with direct purchase microtransactions in the past 12 months ($\chi^2 = .670, p = .413$).
5.3.4 Regression Analyses to Predict Gambling Behaviour

For the pre-registered H1, logistic regressions assessed whether the baseline predictors of (H1a) 12-month microtransaction expenditure or (H1b) risky loot box use (RLI) score predicted migration to current gambler status at follow-up. For the model using loot box expenditure, a hierarchical approach was used, where 12-month direct purchase microtransaction expenditure was entered first. Overall, 291 non-gamblers at baseline completed follow-up, and 33 identified as current gamblers by follow-up. After Bonferroni correction, direct purchase microtransaction expenditure did not significantly predict migration when entered alone (OR = 1.15, p = .049) or when added simultaneously with loot box expenditure (OR = 1.04, p = .628). Loot box spend
predicted migration to current gambling status at follow-up ($OR = 1.25, p = .002$) in this model, see Table 5.4. The change in mean predicted probability to migrate for direct purchase microtransaction spend across groups, when controlling versus not controlling for loot box spend, and the corresponding change for loot box spend, when controlling versus not controlling for direct purchase microtransaction spend, are illustrated in Figure 5.1. The RLI model also significantly predicted migration to self-identified gambler status ($OR = 1.62, p = .008$).

### Table 5.4  Logistic Regressions Predicting Migration to Current Gambler Status

<table>
<thead>
<tr>
<th>12-Month Microtransaction Expenditure</th>
<th>Variables – Step 1:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>Wald</th>
<th>$p$-value</th>
<th>OR</th>
<th>98.75% OR CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td></td>
<td>-2.68</td>
<td>-4.00, -1.90</td>
<td>.422</td>
<td>48.9</td>
<td>&lt;.001*</td>
<td>1.15</td>
<td>.957, 1.46</td>
</tr>
<tr>
<td>DPM Expenditure</td>
<td></td>
<td>.143</td>
<td>-.044, .380</td>
<td>.077</td>
<td>4.14</td>
<td>.049</td>
<td>1.15</td>
<td>.957, 1.46</td>
</tr>
<tr>
<td>Test of Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$\chi^2 = 4.41$</td>
<td></td>
</tr>
<tr>
<td>C&amp;S / Nagelkerke $R^2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.015</td>
<td>.030</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables – Step 2:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>Wald</th>
<th>$p$-value</th>
<th>OR</th>
<th>98.75% OR CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-3.00</td>
<td>-4.25, -2.22</td>
<td>.439</td>
<td>53.9</td>
<td>&lt;.001*</td>
<td>1.04</td>
<td>.851, 1.32</td>
</tr>
<tr>
<td>DPM Expenditure</td>
<td>.037</td>
<td>-.161, .275</td>
<td>.080</td>
<td>.236</td>
<td>.628</td>
<td>1.25</td>
<td>1.02, 1.56</td>
</tr>
<tr>
<td>Loot Box Expenditure</td>
<td>.222</td>
<td>.017, .446</td>
<td>.078</td>
<td>8.79</td>
<td>.002*</td>
<td>1.25</td>
<td>1.02, 1.56</td>
</tr>
<tr>
<td>Test of Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$\chi^2 = 9.21*$</td>
<td></td>
</tr>
<tr>
<td>C&amp;S / Nagelkerke $R^2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.046</td>
<td>.090</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Risky Loot Box Index</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>Wald</th>
<th>$p$-value</th>
<th>OR</th>
<th>98.75% OR CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-2.06</td>
<td>-2.59, -1.68</td>
<td>.195</td>
<td>117</td>
<td>&lt;.001*</td>
<td>1.62</td>
<td>1.00, 2.72</td>
</tr>
<tr>
<td>RLI Score</td>
<td>.480</td>
<td>.001, 1.00</td>
<td>.193</td>
<td>6.56</td>
<td>.008*</td>
<td>1.62</td>
<td>1.00, 2.72</td>
</tr>
<tr>
<td>Test of Model</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>$\chi^2 = 6.70*$</td>
<td></td>
</tr>
<tr>
<td>C&amp;S / Nagelkerke $R^2$</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>.023</td>
<td>.045</td>
</tr>
</tbody>
</table>

Note: $n = 291$, Step 1 $df = 1$, Step 2 $df = 2$, *$p \leq .0125$ (two-tailed). 98.75% CIs, SE, and predictor $p$-values are bootstrapped (BCa, 5000 samples). Significance level of $p \leq .0125$ and 98.75% CI are required for the Bonferroni correction applied. C&S = Cox & Snell $R^2$; DPM = direct purchase microtransaction; RLI = Risky Loot Box Index. Expense variables were log base 2 +1 transformed to reduce positive skew; RLI scores were centred and standardized.
Figure 5.1 Mean Predicted Probability of Migration for DPM and Loot Box Spend

Note: \( n = 291 \). 98.75% CIs. Percentages display the mean predicted probability of gambling migration based upon participants direct purchase microtransaction or loot box expenditure at baseline, as calculated via logistic regressions. Mean values are split between those who did not migrate and those who did at follow-up. DPM = direct purchase microtransaction.
Similar results were found in the linear regression models that predicted gambling spend. Direct purchase microtransaction spend did not significantly predict 6-month gambling spend when entered alone ($B = .093, p = .059$), or when entered alongside with loot box expenditure ($B = .012, p = .804$). Loot box expenditure (H1c) predicted gambling spending at follow-up ($B = .182, p = .001$), when included in the model with direct purchase microtransaction spend. The RLI model (H1d) predicted ($B = .497, p = .001$) gambling spend at follow-up (Table 5.5). Figure 2 provides scatter plots between the independent variables of direct purchase microtransaction expenditure alone, direct purchase microtransaction expenditure when controlling for loot box expenditure, loot box expenditure, and the RLI, and the dependent variable of gambling spend.

### Table 5.5 Linear Regressions Predicting Follow-up Gambling Spend

<table>
<thead>
<tr>
<th>Variables – Step 1:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>.889</td>
<td>.411, 1.42</td>
<td>.210</td>
<td>3.82</td>
<td>&lt;.001*</td>
<td></td>
</tr>
<tr>
<td>DPM Expenditure</td>
<td>.093</td>
<td>-.029, .211</td>
<td>.048</td>
<td>.113</td>
<td>1.94</td>
<td>.059</td>
</tr>
<tr>
<td>$R^2 / Adj. R^2$</td>
<td></td>
<td>.013 / .009</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$F$</td>
<td></td>
<td>3.75</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Variables – Step 2:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>.703</td>
<td>.216, 1.26</td>
<td>.209</td>
<td>3.00</td>
<td>.001*</td>
<td></td>
</tr>
<tr>
<td>DPM Expenditure</td>
<td>.012</td>
<td>-.118, .138</td>
<td>.050</td>
<td>.015</td>
<td>.232</td>
<td>.804</td>
</tr>
<tr>
<td>Loot Box Expenditure</td>
<td>.182</td>
<td>.049, .318</td>
<td>.055</td>
<td>.222</td>
<td>3.46</td>
<td>.001*</td>
</tr>
<tr>
<td>$R^2 / Adj. R^2$</td>
<td></td>
<td>.052 / .046</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$F$</td>
<td></td>
<td>7.94</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.34</td>
<td>.993, 1.71</td>
<td>.144</td>
<td>9.85</td>
<td>&lt;.001*</td>
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</tr>
<tr>
<td>RLI Score</td>
<td>.497</td>
<td>.130, .865</td>
<td>.147</td>
<td>.211</td>
<td>3.66</td>
<td>.001*</td>
</tr>
<tr>
<td>$R^2 / Adj. R^2$</td>
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<td>.044 / .041</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$F$</td>
<td></td>
<td>13.4</td>
<td></td>
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</table>

Note: $n = 291$, Step 1 $df = 289$, Step 2 $df = 288$, *$p \leq .0125$ (two-tailed). $\beta$ = standardized coefficient. 98.75% CI, SE, and predictor $p$-values are bootstrapped (BCa, 5000 samples). Significance level of $p \leq .0125$ and 98.75% CI are required for the Bonferroni correction applied. DPM = direct purchase microtransaction; RLI = Risky Loot Box Index. Expense variables were log base 2 +1 transformed to reduce positive skew; RLI scores were centred and standardized.
Figure 5.2  Scatterplots of Primary Variables Predicting Gambling Spend at Follow-up

Note: $n = 291$. 80 baseline non-gamblers reported gambling spend by follow-up. Expense variables were log base 2 +1 transformed to reduce positive skew. Predictor variables are measured at baseline. DPM = direct purchase microtransaction; RLI = Risky Loot Box Index. RLI scores were centered and standardized (Figure 2a). Figures 2b and 2c show trendlines of loot box spend and DPM spend without controlling for DPM or loot box expenditure, respectively. Figure 2d plots the relationship between the standardized residual of loot box spend after regression upon DPM and follow-up gambling spend, to visualize the trendline for DPMs when controlling for loot box spend.
5.3.4.1 Sensitivity Analyses Based on Current Gambling Status

In exploring the data, I noted that non-gambling status at baseline could also be determined from a second item, answering ‘Never’ to the question “In the past 12 months, have you gambled at all?”. These responses did not show full agreement with the item “Do you currently gamble?”. Re-classifying participants in this way shifted the subgroup sizes (non-gamblers: 291 in the original classification to 218; gamblers: 155 to 228) with a further consequence that fewer non-gamblers migrated to gambling at follow-up (17 compared to 33), with a consequent reduction in power. In the basic chi-squared analysis of migration, the effects were qualitatively unchanged using this alternative measure for gambling status (Table 5.3).

In the re-run regression analyses, direct purchase microtransaction expenditure did not predict migration, while the effect of loot box spending was predictive ($OR = 1.27, p = .004$). RLI score did not predict migration ($OR = 1.12, p = .654$; Appendix H, Table H.1). In the linear regressions, neither loot box expense ($B = .096, p = .077$) nor RLI score ($B = -.001, p = .994$) significantly predicted gambling spending at follow-up (Appendix H, Table H.2). Correlation matrices of the predictor and dependent variables for both methods and for tests of the reverse pathway are found in Appendix I, Tables I.1 – I.2.

5.3.5 Tests of the Reverse Pathway

Exploratory analyses of the reverse pathway were conducted by selecting participants who reported no loot box spend during the 12-months prior to baseline ($n = 179$ at follow-up). Linear regressions were used to test whether baseline gambling-related variables (PGSI, GRCS, BALS General Belief in Luck, Past 12 month gambling spend) predicted loot box expenditure at follow-up. GRCS ($B = .632, p = .002$) and luck ($B = .039, p = .010$) were significant predictors;
notably, PGSI ($B = .360$, $p = .061$) and gambling spend ($B = .088$, $p = .041$) were not after correction for multiple comparisons (Table 5.6). direct purchase microtransaction expenditure ($B = .124$, $p = .005$) expectedly predicted subsequent loot box spend.

### Table 5.6 Gambling Variables Predicting Follow-up Loot Box Expenditure

<table>
<thead>
<tr>
<th>Variable:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>$\beta$</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>.515</td>
<td>.288, .768</td>
<td>.104</td>
<td>4.66</td>
<td>&lt;.001*</td>
<td></td>
</tr>
<tr>
<td>PGSI Score</td>
<td>.360</td>
<td>-.053, .860</td>
<td>.191</td>
<td>2.69</td>
<td>.061</td>
<td></td>
</tr>
<tr>
<td>R² / Adj. R²</td>
<td></td>
<td>.039 / .034</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>7.24</td>
<td></td>
<td></td>
<td></td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>Variable:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>$\beta$</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.272</td>
<td>-5.13, -.303</td>
<td>1.02</td>
<td>2.75</td>
<td>.011*</td>
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</tr>
<tr>
<td>GRCS Score</td>
<td>.632</td>
<td>.152, 1.12</td>
<td>.200</td>
<td>.248</td>
<td>.002*</td>
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</tr>
<tr>
<td>R² / Adj. R²</td>
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<td>.062 / .056</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>F</td>
<td>11.6*</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>$\beta$</th>
<th>t</th>
<th>p-value</th>
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<td>-8.71, .501</td>
<td>.280</td>
<td>-.575</td>
<td>.475</td>
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<tr>
<td>Belief in Luck Score</td>
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<td>.005, .074</td>
<td>.014</td>
<td>.185</td>
<td>.006*</td>
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</tr>
<tr>
<td>R² / Adj. R²</td>
<td></td>
<td>.034 / .029</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>F</td>
<td>6.24*</td>
<td></td>
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<th>B</th>
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<th>SE</th>
<th>$\beta$</th>
<th>t</th>
<th>p-value</th>
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<tr>
<td>Constant</td>
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<td>.041</td>
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<td>R² / Adj. R²</td>
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<td>.035 / .030</td>
<td></td>
<td></td>
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<tr>
<td>F</td>
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<th>SE</th>
<th>$\beta$</th>
<th>t</th>
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<td>DPM expenditure</td>
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<td>.022, .231</td>
<td>.043</td>
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<tr>
<td>R² / Adj. R²</td>
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<td>F</td>
<td>9.76*</td>
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Note: $n = 179$, $df = 177$, * $p \leq .0125$ (two-tailed). $\beta$ = standardized coefficient. 98.75% CI, SE, and $p$-value are bootstrapped (BCa, 5000 samples). Significance level of $p \leq .0125$ and 98.75% CI are required for the Bonferroni correction. PGSI = Problem Gambling Severity Index; GRCS = Gambling Related Cognitions Scale. PGSI, GRCS, and expense were log base 2 +1 transformed to reduce positive skew. DPM expense included for comparison.
5.4 Discussion

This study sought to explore the longitudinal relationship between loot box use and gambling behaviour, among young adult video gamers who were stratified into subgroups of gamblers and non-gamblers at the baseline assessment. In cross-sectional comparisons at baseline, gamblers were more likely than non-gamblers to endorse buying and selling loot box items, and to have greater past year expenditure across both loot boxes and direct purchase microtransactions (see Table 5.2). This broadly corroborates Chapter 4 findings, where replicating Chapter 4 findings. The primary (pre-registered) analyses tested whether loot box engagement among the non-gamblers at baseline predicted migration to gambling at follow-up. Over 4 regression models, I tested gambling initiation as the outcome in two logistic models and gambling spend in two linear regressions, using microtransaction expenditure and a self-report measure of risky loot box use (RLI) as predictors. I found supportive evidence for migration across models, with correction for multiple comparisons (see Tables 5.4 & 5.5). Participants were re-classified using an alternative item to identify non-gambling status at baseline. Despite the loss of power from a reduced sample size, loot box expenditure but not direct purchase microtransaction expenditure continued to predict gambling initiation (see Appendix H). Lastly, I operationalized the ‘reverse pathway’ by re-sorting the dataset to create a subgroup of loot box non-users at baseline, and testing whether gambling variables predicted future loot box spending. Gambling-related cognitive distortions predicted later loot box expenditure (see Table 5.6), although a measure of problematic gambling and gambling spend did not, after correction for multiple comparisons.

Among both subgroups of gamers with and without gambling experience at baseline, nearly all participants reported having played video games that included both loot boxes and
direct purchase microtransactions (Table 5.2), reiterating the ubiquity of these monetary systems in modern gaming (Xiao, Henderson, & Newall, 2022; Zendle, Meyer, Cairns, et al., 2020). More gamblers reported purchasing loot boxes than non-gamblers (71.5% vs. 61.0%), whereas the rate for direct purchase microtransaction was similar (87.8% vs. 84.1%). Gamblers reported spending 2.50 times more on loot boxes over the past year than non-gamblers, and their spending was 1.40 times greater on direct purchase microtransactions. This pattern of data, though cross-sectional, is consistent with the notion that gamblers are attracted to loot box features and other forms of microtransaction when they play video games.

In optimizing this study design to test for migration, I recruited a sample of young adults (the mean age of the non-gambler subgroup at baseline was 22 years old), as a window above the legal age for gambling where I expected gambling initiation to still be high (see Kessler et al., 2008). Sample retention was good between measurements with 291 of 415 (70.1%) completing follow-up. Using the pre-registered gambling classification approach (self-identification as a current gambler), 33 non-gamblers initiated gambling over the follow-up window. Loot box expenditure at baseline increased the odds of migration by 24.9% (per doubling of expenditure), when holding direct purchase microtransaction expenditure constant. Risky loot box use (RLI) also predicted migration, with an odds increase of 61.6% per standard unit (Table 5.4). In the linear regressions (Table 5.5), loot box expenditure significantly predicted gambling spend at follow-up (Adjusted $R^2 = .046$), again controlling for direct purchase microtransaction expenditure, as did RLI (Adjusted $R^2 = .041$).

These data establish a longitudinal link from loot box use to subsequent gambling, on both a binary measure reflecting self-identified gambling initiation and a continuous measure of gambling spend. Our findings extend the cross-sectional study by Spicer et al. (2022), in which
19.6% of gamblers retrospectively judged that loot boxes had shaped their subsequent decisions to gamble. Earlier age of initiation of gambling is known to predict later gambling problems (Kessler, Hwang, LaBrie, et al., 2008), and higher levels of gambling spend and losses are seen as a vector to gambling harm and problem gambling symptom severity (Langham et al., 2016; Markham, Young, & Doran, 2016). Nevertheless, with a short 6-month window, the data do not establish a direct link from loot box use to gambling harm. Testing for such effects would likely require longer follow-up periods or selection of higher-risk samples to capture the escalation in gambling harms or symptoms.

Our analyses also included engagement with non-randomized ‘direct purchase’ in-game payments. Direct purchase microtransaction expenditure at baseline weakly (and non-significantly after correction for multiple comparisons) predicted migration to gambling at a univariate level ($OR = 1.15$), and the association was further reduced ($OR = 1.04$) when these were entered simultaneously with loot box expenditure (see Table 5.4). A similar pattern was found in the linear regression models that predicted gambling spend. As might be expected, spending on loot boxes and direct purchase microtransactions was moderately correlated ($r = .452$; see Appendix I, Table I.1), and this could be driven, at least partly, by disposable income or a willingness to spend money on virtual items (randomized or otherwise) in video games (Watkins & Molesworth, 2012). Our multivariate effects provide evidence that the randomized rewards offered by loot boxes drive the links with gambling. This, coupled with the evidence for migration effects, support regulatory action to reduce the exposure to loot box mechanisms among youth and young adults.

Prospective designs require clear categorization of the outcome variable (gambling) at baseline, and I note some fragility and divergence between the two operationalization methods.
Clearly, individuals who do not endorse current gambling may have gambled at an earlier point in their lives, even among a young adult (aged 18-26) sample. For example, in the UK Young People and Gambling Report, 14% of 11-16 year-olds reported past week gambling while 39% reported past year gambling (Gambling Comission, 2018). However, with the more rigorous definition (based on any gambling over the past 12 months), the absolute numbers converting to gambling were unsurprisingly lower, reducing power to detect predictors of migration. Longitudinal designs that use more stringent criteria may again require larger samples or longer follow-up periods to capture adequate rates of migration.

This study also assessed the ‘reverse pathway’, where gamblers are thought to be attracted to loot box features (Spicer et al., 2022; Zendle & Cairns, 2018). I did so by an exploratory re-sorting of participants into a loot box non-user subgroup (see Table 5.1) and then testing the predictive capacity of gambling spend, problematic gambling (PGSI), gambling-related cognitions (GRCS), and the BALS General Belief in Luck subscale for 6-month loot box expenditure at follow-up (Table 5.6). Some support for this pathway was found: GRCS and a general belief in luck significantly predicted loot box expenditure at six month follow-up (Adjusted $R^2 = .056$ and .029, respectively). Erroneous gambling cognitions are typically correlated with problem gambling severity and implicated in the etiology of gambling problems. Certain gambling beliefs can also be implicated in loot boxes, such as the belief that a desired prize is ‘due’ (the ‘gambler’s fallacy’) or illusory control over randomized outcomes. This is consistent with the reverse pathway endorsed retrospectively by 20.1% in Spicer et al. (2022), and the differential reduction of microtransaction spend among problem gamblers after loot boxes were removed in Heroes of the Storm (Zendle, 2019). It is notable that the predictive value of gambling cognitions did not extend to the PGSI and 12-month gambling spend. These latter
variables might seem more conceptually relevant to excessive loot box spending. These results may reflect the distributional properties of the GRCS as a trait measure, compared to PGSI and gambling spend, which necessarily contain many zero responses among non-gamblers. These exploratory results raise a neglected point that it is challenging to detect both causal pathways within the same study, as different design decisions are required to optimize sensitivity to each effect.

Our longitudinal study design operationalizes causality in temporal terms, sometimes called Granger causality, providing evidence that higher levels of loot box engagement predict later gambling involvement. As naturalistic designs, this approach does not specify how this precedence occurs, and various unexplored third variables may play a role. An indirect explanation could involve low parental supervision as a youth risk factor for excessive loot box use, and then subsequently as a risk factor for gambling onset (Lee, Stuart, Ialongo, & Martins, 2014). An alternative approach to testing causality is via a randomized experiment, which can control for third variable explanations via the randomization. In D’Amico et al. (2022), participants were engaged in 20 minutes of video gaming in the lab, and were randomly assigned to either loot boxes, direct purchase microtransactions, or no rewards. The three groups all then completed the Balloon Analogue Risk Task. In that study, the loot box exposed group did not show any short-term elevation in risk taking, but given the shorter timeframe and compromises to ecological validity in both the independent and dependent variables that are necessary in the laboratory, it is difficult to compare their study with this evidence for migration. Both longitudinal studies and randomized experimental designs are likely to prove fruitful in advancing knowledge in this area.
5.4.1 Study Limitations

Our study suffers from a number of limitations. First, I used a crowdsourced sample collected via Prolific. Crowdsourced samples are not representative of young adults in terms of either gaming or gambling (Pickering & Blaszczynski, 2021; Russell, Browne, Hing, Rockloff, & Newall, 2022), and I make no claims about the population prevalence of these activities. This design employed several selection criteria, through Prolific account settings and a pre-screen survey, and included attention checks to maintain data quality. Second, I relied on a single item to identify non-gamblers, and non-gambler status did not fully converge when compared to a similar item, although the findings were generally supported. The decision to also include gambling spend as a continuous measure was made to mitigate concerns about reliance upon this single item. Due to a slower rate of recruitment, I did not reach the target sample size in the subgroup of current gamblers, creating differential sensitivity in those comparisons. Third, I required participants to recall past twelve or six-month spend, and gamblers’ ability to accurately recall their gambling engagement is questionable (Heirene et al., 2022), given that wins are more salient (i.e., the availability heuristic) and may be used to continue gambling with. A fourth limitation was the short follow-up period (six months): longer follow-ups provide a greater chance to capture the onset of the target behaviour (e.g., gambling initiation), but this trades off against sample attrition, which was a chief concern based on the relatively high six-month attrition in Kim et al. (2015). I have also discussed the limitations of establishing causality through temporal precedence in naturalistic study designs. The test of the reverse pathway was limited because, given the ubiquity of loot box use among youth, the young adult sample was comparably smaller. Accordingly, the non-significant effects for problematic gambling and gambling spend as predictors of loot box use are not interpreted as evidence for the null
hypothesis. This speaks to the difficulty of optimizing a design to test for both directional models.

5.5 Conclusions

The literature linking gambling and loot box use has steadily grown and increasing emphasis has been placed upon understanding the directionality of this relationship. In a recent study, Spicer et al. (2022) observed that about 1 in 5 participants retrospectively believed their loot box use influenced subsequent gambling. Our longitudinal study supports a migration pathway, that loot box engagement increases the likelihood of gambling initiation. Our data further indicate that the randomized rewards presented by loot boxes are integral to this relationship. Coupled with the partial findings for the reverse pathway, this reinforces the notion that loot boxes and gambling are “psychologically akin” (Drummond & Sauer, 2018) to the point where one behaviour could influence the other, whereas this likeness does not expand to the broader range of microtransactions. Combined with other research showing earlier age of onset of gambling is associated with adult gambling problems (Kessler et al., 2008), and loot box purchasing is commonly reported among adolescents (Montiel, Basterra-González, Machimbarrena, Ortega-Barón, & González-Cabrera, 2022), these effects underscore the need for loot box policy and regulation to reduce youth and young adult exposure to these products. Such regulation would remain protective of consumers, even if the relationship between loot boxes and gambling is better explained by underlying common vulnerabilities. Regulation could take a number of forms, including restricting underage access to either the loot box functionality within video games, or access to the games themselves; or mandating the availability of ‘limit setting’ tools or self-exclusion programs within video games, as predicated upon responsible
gambling strategy (Xiao & Henderson, 2021). Such regulations would also protect against harm from the reverse pathway, where gamblers are disproportionately attracted to loot boxes, which this study provides partial support for via gambling cognitions. Lastly, I recognize that the risk of migration is not restricted to underage youth and further consumer protection measures are warranted to reduce the effects of ‘predatory’ monetization tactics on young adults (King et al., 2019). I also note the risks of overspending with loot boxes are separate from any debates about their legal classification as gambling, and regulatory action could mitigate both gaming and gambling-related financial harms. Likewise, the results of this study should not be taken as evidence that direct purchase microtransactions are ‘safe’ and entirely free from harmful consequences; this is a separate question that also warrants exploration.
Chapter 6. General Conclusions

6.1 Dissertation Review

This thesis comprised three distinct research programs through four studies that incorporated data from eight participant samples. Three facets of gambling-related cognitive distortions were examined: 1) their associations with schizotypal personality and delusion-proneness, 2) their measurement during the state of gambling, and 3) their utility for understanding emerging forms of gambling. These cognitions can take the form of dispositional (i.e., trait cognitions) beliefs or become activated during the state of gambling (i.e., state cognitions). Trait cognitions may shape the gambler’s decision-making to initiate gambling behaviour. For example, perceiving one’s odds as generally more favourable than they could motivate travel to the casino, lottery ticket purchase, or opening an online gambling platform. On the other hand, state-activated cognitions could be crucial to understanding why gamblers, when already gambling, can continue gambling despite facing losses (e.g., making the decision to overspend during a gambling session). Both trait and state gambling cognitions are reasonable targets for cognitive treatments, yet the influence of current treatment approaches upon state beliefs is understudied. The process of “gamblification” has become increasingly prominent in video games, and it is reasonable to expect that these gambling-related cognitions could also generalize to the gambling-like features now found within traditionally non-gambling games. Thus, assessing for links between these beliefs and video game mechanisms is one effective method to identify the psychological similarities between these behaviours. This final chapter will: 1) Begin with a summary of the research conducted within each data chapter; 2) broaden to
a larger discussion about this research; 3) outline the wider limitations and strengths of this work; and then 4) end with an overview of potential new research directions.

### 6.2 Summary

The study in Chapter 2 sought to expand our knowledge about individual differences that associate with gambling, specifically by characterizing the relationships between schizotypal personality (schizotypy), GRCDs, and problematic gambling. To assess this, I collected survey data from three participant samples, who differed somewhat in their degree of gambling engagement. First, this research replicated earlier findings by (Abdollahnejad et al., 2014), by demonstrating that the narrow facet of delusion-proneness is associated with greater endorsement of gambling cognitions. Then, this was expanded upon by detecting, and replicating across samples, small-to-moderate positive correlations between other facets of schizotypy, a measure of gambling-related cognitions, and problematic gambling. These associations were most pronounced for the delusion-oriented, ‘cognitive-perceptual’ facet of schizotypy, which is consistent with the expected links between erroneous belief formation and GRCDs, yet this also reliably extended to disorganized thought and more modestly with interpersonal difficulties. Schizotypal personality did not correlate significantly with beliefs in good luck, across two different questionnaire measures of perceived luck. In the final sample, I used an alternative measure (the Beliefs Around Luck Scale; Maltby et al., 2008) that included the assessment of perceived bad luck, more general beliefs in luck, and the rejection of luck. With this change, schizotypy was moderately associated with general beliefs in luck and personal bad luck, suggesting that the null findings in the initial samples were due to the focus on beliefs in good luck, and that people scoring higher on schizotypy-related traits are more likely to believe in
luck, and perceive themselves as being unlucky. Overall, these results demonstrated that individuals who are predisposed to experience delusional or disorganized thought, as captured by schizotypy, may also be prone to experience the conceptually similar, but more specific, erroneous beliefs and misperceptions about gambling outcomes.

Chapter 3 designed a measure, the Gambling State Cognitions Scale, to assess the presence of GRCDs that are activated during the state of gambling. This objective resulted from a recognition that state-activated GRCDs do not necessarily correspond to their trait-based counterparts (Sevigny & Ladouceur, 2003), coupled with the dominance of trait-based gambling cognition scales in the current field of gambling research. To achieve this goal, I designed new items, initially borrowing a format from the Peters et al. Delusions Inventory. The items were constructed to target state cognitions in the context of slot machine gambling, which is typically regarded as one of the most harmful forms of gambling (Marionneau et al., 2022). The scale was administered to participants upon completion of a slot machine task to elicit the state experience. Questions attempted to target six erroneous gambling beliefs thought likely to be evoked during the gambling task: the Gambler’s fallacy, the hot hand fallacy, a personal (i.e., direct) illusion of control, the experience of luck (good or bad), a supernatural illusion of control, and slot machine anthropomorphism. These questions and the overall scale structure were refined through a pilot test and two subsequent samples. Exploratory factor analysis produced a 17-item measure comprising four factors that captured Magical Thinking, Personal Illusion of Control, the Hot Hand Fallacy, and Experienced Luck. Validity of this scale was demonstrated through a variety of approaches that sought to demonstrate that gambling distortions were captured in their state form. The development of this scale increases the accessibility of gambling cognitions evoked during slot machine gambling, and therefore opening new avenues for subsequent research.
Chapter 4 presented one of the first empirical studies to investigate the similarities between gambling and the video game monetization feature of “loot boxes”, in which a virtual in-game item produces a randomized reward when ‘opened’. This study administered a survey to two samples, with the primary objectives of: 1) quantifying the extent to which adults who play video games engage with loot boxes, and 2) to detect the associations between loot box use, GRCDs, and problematic gambling behaviour (measured by the PGSI). GRCDs were used to assess the psychological similarity between loot boxes and gambling. These results indicated most participants had opened a loot box, with about half having spent money to purchase this item, signaling that player engagement with this feature is high. Loot box spending was correlated with problem gambling scores on the PGSI, replicating an effect also seen by Zendle and Cairns (2018). Then, I sought to determine if engagement in risky loot box behaviours, a related but conceptually distinct variable from expenditure, was also related to both GRCDs and problematic gambling behaviour. This decision stemmed from the rationale that the spend amount required to be considered problematic necessarily depends upon the individual’s financial situation, whereas assessment of risky behaviour provides some equalization across respondents. To explore this, I developed a new 5-item measure called the Risky Loot Box Index (RLI). The RLI moderately and positively correlated with gambling cognitions and problematic gambling behaviour, and these combined gambling-related variables predicted a substantial 37.1% of variance in the RLI scores. That gambling cognitions associated with both loot box spend and RLI was interpreted as a clear indication that the similarities between loot boxes and gambling extend beyond behaviour and to the psychological level. Overall, these results underscore arguments made in a wide range of academic research on loot boxes and their consequences of financial and mental wellbeing in video gamers, supporting tighter regulation in
this area. At the same time, the correlational nature of this study – along with most other research on loot boxes – did not allow for a definitive causal interpretation, and this is necessary information to inform effective regulatory actions.

Chapter 5 described a longitudinal study that tested for ‘migration’ from loot box use to gambling initiation over a six month interval, in a sample of young adult gamers. The migration pathway asserts that exposure to loot boxes’ randomized reward mechanics can sensitize players to the randomized reward schedules present in gambling (e.g., slot machines). Participants were stratified into two subgroups at baseline: self-identified non-gamblers and gamblers. Among the non-gamblers, baseline loot box expenditure and RLI scores were tested as predictors for self-identified gambling initiation at the 6 month follow-up. Significant effects were found via logistic regressions, which indicated that the odds of migration to gambling increased by 24.9% per doubling of loot box expenditure and by 61.6% per standard unit increase of RLI score, and again on linear regressions using the same independent variables to predict gambling spend at the 6 month follow-up. These findings support the migration pathway and extend recent work by Spicer et al. (2022), who used a cross-sectional survey to show that around one-in-five of their participants (who both played video games and gambled) retrospectively identified loot boxes as a contributor to their later gambling behaviour. In my longitudinal study, expenditure on non-randomized ‘direct purchase microtransactions’ did not significantly predict gambling initiation or spend, when controlling for loot box expenditure, specifically implicates the randomization feature of loot boxes as a contributing factor to subsequent gambling behaviour.

Chapter 5 also included an exploratory re-sorting of the data to longitudinally explore the ‘reverse’ pathway by creating a group of ‘loot box non-users’. According to this causal pathway, gamblers may be disproportionately attracted to loot boxes due of their similarity to gambling,
and those already at risk of problematic gambling behaviour may be at an increased risk for loot box-related harms. Gambling-related variables at baseline were used to predict the onset of loot box expenditure by six months. Both baseline problematic gambling behaviour (PGSI score) and gambling expenditure did not predict subsequent loot box expenditure, after correction for multiple comparisons. The two variables assessing gambling-related cognitive distortions (Gambling Related Cognitions Scale and the General Belief in Luck factor of the BALS) did predict loot box expenditure at follow-up. The null results of PGSI and gambling expenditure were interpreted as a reflection of an unoptimized study design, rather than clear evidence against this temporal relationship. That gambling-related cognitions did predict subsequent loot box engagement among baseline loot box non-users was interpreted as partial support for the reverse pathway, and again underscores the psychological similarity between loot boxes and gambling. These findings were also consistent with a brief longitudinal study conducted by Zendle (2019), who demonstrated reduced microtransaction spending only among problem gamblers, when loot boxes were removed from the game Heroes of the Storm.

6.3 General Discussion

The three areas of research comprising this thesis, while distinct from each other, share a connection through the lens of GRCDs. Kahneman (2011) differentiates between two systems of thought: one that is intuitively and emotionally directed, and another that reflects logical and deliberate thinking. As outlined in Chapter 3, the gambling state can evoke a shift toward emotionally-driven cognitions, resulting in a disproportionate reliance upon heuristics (e.g., the representativeness and availability heuristics) that can be error-prone in the context of the randomized reward structure of most gambling games. This further suggests that individuals who
are susceptible to emotion-influenced decision-making could be at particular risk of making non-optimal decisions during gambling. One such group comprises individuals who score higher on the cognitive-perceptual traits of schizotypal personality (Cicero & Kerns, 2010), who have also been demonstrated to have a greater tendency to “jump to conclusions”, a preference for evidence-hypothesis matches, and a tendency to ignore disconfirmatory information (Balzan et al., 2012; Balzan et al., 2015). Given the reliable associations between schizotypy and gambling cognitions demonstrated in Chapter 2, it is reasonable to expect those high in schizotypy could be especially prone to state-activated erroneous gambling cognitions. Should the psychological processes described by schizotypy contribute to the development and expression of gambling cognitions, then treatments that both target these broader error-prone thinking styles and provide techniques to better regulate emotion (e.g., frustration after gambling losses) could augment existing cognitive treatments for gambling that target specific gambling distortions. Likewise, video games are designed to be emotionally engaging and these may also shift cognition toward an emotionally-driven state, as discussed below.

The Gambling State Cognitions Scale (GSCS) was designed to increase the accessibility of state-activated cognitions for study, given that a discrepancy between dispositional (i.e., trait) cognitions and state cognitions has been demonstrated (Sevigny & Ladouceur, 2003). Whereas holding trait-based gambling beliefs could motivate the gambler toward the gambling state, state-activated beliefs may perpetuate gambling behaviour when already gambling. Yet, the extent to which already held trait beliefs influence the activation of state cognitions an open question, and the development of the GSCS supports the exploration of this. Cognitive therapy that targets erroneous gambling perceptions assumes that treating trait beliefs (i.e., those accessed during therapy) can subsequently influence their activation during gambling. Findings that cognitive
restructuring alone reduces problematic gambling behaviour (Ladouceur et al., 1998; Petry, Ginley, & Rash, 2017) provides indirect evidence for this. The GSCS, coupled with a gambling task, could allow more direct assessment of whether these – contextually and emotionally driven – state cognitions do in fact decrease over the course of treatment. Furthering our understanding of the relationship between trait and state gambling-related cognitions will benefit the continued development treatments for problematic gambling behaviour.

Chapters 4 & 5 focused upon a specific form of gamblification within video games, known as loot boxes. The results from these studies highlight the psychological similarity between loot boxes and gambling, including their linkage via (trait-based) gambling-related cognitive distortions. These studies produced some of the clearest evidence to date that it is specifically the randomized reward aspect of loot boxes that can sensitize young adults toward gambling behaviour. This suggests regulatory guidance is warranted to enact some degree of protection for gamers, especially for those who are young and therefore at greater risk of initiating gambling (Kessler, Hwang, Labrie, et al., 2008). There are a number of possible regulatory steps that could be considered. The presence of warning labels can help to inform potentially unaware gamers – and the parents of minors – that gambling-related content is present in a video game. Implementing an age verification system for access to loot box features would be a more effective approach than the current age recommendation system for video games more broadly. Requiring players to ‘opt-in’ to access loot box features, or separating this feature from the broader direct purchase microtransaction marketplace, would impose barriers to limit impulsive purchasing or ‘item-chasing’. Regulation such as the availability of self-exclusion programs or spending limits (e.g., daily or weekly) could minimize spending harm, and have been demonstrated as effective in the gambling literature (Gainsbury, 2013; Tanner et
al., 2017). Given that virtual item purchases are typically associated with a specific account, gamers would be disincentivized to create new accounts to continue purchases, increasing the effectiveness of these strategies.

The evidence for the reverse pathway, although limited, underlines how experienced gamblers could be exposed to additional harm in the context of video gaming via randomized in-game purchases. Notably, that this evidence resulted from the ability of gambling-related cognitive distortions (GRCDs) at baseline to predict loot box expenditure at six-month follow-up speaks to a specific utility of GRCDs. Gamblification is by no means limited to video games, but refers to the process of introducing gambling-like elements into any activity. Other prominent examples include daily fantasy sports (Nower, Caler, Pickering, & Blaszczynski, 2018) and trading apps which increasingly include cryptocurrency (Delfabbro, King, Williams, & Georgiou, 2021). As seen with loot boxes (Xiao et al., 2022), consistent failures to implement and enforce regulation of these for gamblified products at an adequate pace prolongs the potential for dangerous exposure. This also creates an opportunity for the industry to lobby for self-regulation. However, self-regulation can be problematic, as highlighted by an example from Xiao (2023): The Apple App Store requires item probabilities to be listed alongside randomized rewards. Yet only 64% of the top 100 iPhone games actually disclosed these probabilities, suggesting these self-governed regulations are not strictly enforced. The use GRCDs may provide a means to assess gamblification of traditionally non-gambling activities. As demonstrated in this thesis with loot boxes, gambling-like behaviours could very well be encouraged by trait-based gambling cognitions. It is reasonable to expect that this finding is not limited to loot boxes, and that GRCDs could generalize to other, less explored or emerging, forms of gamblification. Through establishing links between these cognitions and gamblified
behaviours, a psychological similarity can be demonstrated. As also seen in this work, these links can be explored with relative efficiency.

Although not studied in the present research, the influence of state-activated cognitions during video gaming is also pertinent here. Video games are typically designed to be emotionally evocative through their visuals, stories, in-game social structures, action sequences, and between player competitions. It is feasible that the intensity of these experiences could influence decision-making around both loot box and non-loot box virtual item purchases. For example, this could occur through in-game social pressure among players to obtain rare items as a display of social status, the experience of frustration and subsequent desire to obtain a utility item to aid gameplay, or the anticipation evoked by the audio-visual displays when loot boxes are opened. Gamers are also regularly presented with cues to make these purchases, through in-game advertisements of items, seasonal promotions, or observing other players with desired items. I also note that video game related financial harm is not necessarily limited to loot boxes or gambling-like mechanisms, and could extend toward excessive use of direct purchase microtransactions. Overall, the results presented in Chapters 4 & 5, and the broader literature related to video game microtransactions, also strongly suggest that the criteria for video game-related disorders encompass financial harms.

As video games become more intertwined with gambling, we should expect the cognitions typically associated with each of these behaviours increasingly influence each other. As King & Delfabbro (2014) outlined, cognitions related to the need for self-esteem or social acceptance can be primary reasons for individuals to engage in problematic levels of video game play. These cognitions coupled with erroneous gambling beliefs, such as the Gambler’s Fallacy, could become an especially risky combination that perpetuates loot box engagement, in order to
obtain rare items to signal in-game social status. We could similarly expect an inflated importance about rewards within video games to promote excessive loot box use. Further influencing these cognitions, in response to the criticism loot boxes have received, many games have introduced ‘pity timers’, where the odds of a rare item incrementally increase after each loot box purchase (Xiao et al., 2023). At first glance, this loot box mechanic appears protective, yet the perception that rare items will eventually be obtained through the pity timer could promote further expenditure within determined players. Taken together, it is crucial that the continued exploration of gamblification within video games identify the breadth of reasons that gamers engage with and value virtual items, in order to better mitigate the risks of virtual item marketplaces.

6.4 Strengths and Limitations of Presented Research

The use of multiple samples within Chapters 2 & 4 is a strength of these studies that protects against alpha inflation from the many analyses presented. In Chapter 2, the correlational analyses investigating schizotypy demonstrated a robust pattern of effects across three samples, despite quite varied participant engagement in gambling between these samples. Likewise, Chapter 4 was an exploratory study into the associations between loot boxes and gambling. That the findings replicated across two samples helped to strength the assertion that loot box use is positively associated with gambling. Although Chapter 5 relied upon a single sample, the use of pre-registration for the primary hypothesis and the use of Bonferroni correction for multiple analyses increases confidence in the detected effects linking baseline loot box use to the later migration to gambling. Similarly, Chapter 3 presented the development of the Gambling State Cognitions Scale (GSCS) across three samples. By taking this approach, a clear evolution of the
scale can be seen and at least some problematic design choices could be adjusted for, including the removal of a multidimensional approach to assess every distortion.

In Chapters 4 & 5, the creation and use of the Risky Loot Box Index (RLI) is another strength of this thesis’ investigation of gamblification. The RLI provided a method to assess a composite of behaviours and associated cognitions related to loot box use, and therefore, decreasing the reliance on loot box spend as the primary variable for comparison to gambling behaviours. However, the Risky Loot Box Index received only limited validity testing in Chapter 4 did not undergo confirmatory factor analysis. Since its development, other research groups have also deployed this scale. Drummond et al. (2020) have replicated the moderate correlations between RLI, loot box spend, and Problem Gambling Severity Index. Hall et al. (2021) found that the association between RLI score and contamination concern was significantly higher among individuals who self-isolated or were quarantined during the COVID-19 pandemic than those not. This can be interpreted as additional concurrent validity for the scale, if assuming self-isolation promoted increased gaming and loot box exposure. Lloyd et al. (2021) developed another loot box measure, the RAFFLE, and RLI positively associated with this. More recently, Forsström and colleagues (2022) translated the original 12-items of the RLI (see Table 4.3) into Swedish and conducted both an exploratory and confirmatory factor analysis. Their resulting scale retained four of the five original items, along with an additional three, to produce a 7-item two factor measure split between loot box consumption and time spent to obtain. Combined, these studies have provided additional validity and support for continued use of the RLI as a measure of loot box risk.

The studies in this dissertation also suffer from some shared limitations. Both Chapters 2 & 4 completely rely upon cross-sectional survey data to explore the associated hypotheses. The
positive associations between schizotypy, gambling-related cognitions, and problematic gambling provide evidence for a relationship. One possibility here is that the more distal and broader constellation of personality traits comprising schizotypy could subsequently inform the development and maintenance of GRCDs. Yet, these data cannot clarify this specific nature, and follow-up research is needed to do so. I outline one potential experiment in Section 6.5 to explore the causal relationship between schizotypy and GRCDs. Similarly, Chapter 4 data could not identify the underlying mechanisms of the loot box – gambling link: whether gamblers are prone to loot box use, loot box users are at risk of migration to gambling, or if this is better explained by a third variable (Zendle & Cairns, 2018). This constraint was directly addressed in Chapter 5, although still with some limitations, and only partially for the reverse pathway. The longitudinal study presented in Chapter 5 relies upon temporal precedence to establish a causal connection, also referred to as Granger causality. While the randomized reward features of loot boxes were specifically implicated in subsequent gambling migration, when compared to direct purchase microtransactions, this effect could still be due to underlying third variables (e.g., low parental supervision). Thus, continued longitudinal research supplemented with the control randomized experimentation can provide is strongly recommended to better understand why loot boxes predict future gambling.

Chapter 3 suffers from some specific limitations resulting from the complexity of designing a state measure for gambling distortions. First, and most pronounced, is the lack of a confirmatory factor analysis to further support the 4-factor solution produced. In an exploratory factor analysis, every variable is allowed to relate to every latent construct, and the output is one where an optimal number of factors is determined to represent the data variance (Field, 2017). This means that the result is sample dependent and measurement-error dependent, and competing
factor structures can similarly explain the outcome (Schreiber, 2021). Confirmatory factor analysis allows the researcher to set specific model parameters to test whether data sufficiently fit a predetermined factor structure. Unlike trait measures, which can be administered to multiple participants at once, online, or through mail, the Gambling State Cognitions Scale (GSCS) required every participant to complete a gambling task. This resulted in time constraints, coupled with the onset of the COVID-19 pandemic, that prohibited a confirmatory sample from being recruited. Likewise, this also resulted in the premature termination of the experimental design to assess the GSCS’ ability to assess state cognitions, resulting in an underpowered analysis of the collected data.

Additional limitations include the impact of COVID-19 upon gambling and video gaming behaviours during the pandemic, which corresponds to the data collection for Chapter 5. In a sample from Sweden, self-reported increased gambling behaviour during the pandemic was associated with problematic gambling (Håkansson, 2020), and self-isolation was also associated with a strengthening of the link between problematic gambling and loot box spend (Hall et al., 2021). Thus, it is reasonable to expect that our participants loot box and gambling behaviour could have also been influenced by the pandemic, possibly contributing to or suppressing migration. To mitigate this concern, participants were asked about their degree of self-isolation due to the pandemic, and this did not significantly correlate with our measures. Reliance upon retrospective recall of expenditure in Chapters 4 & 5 is also a limitation, given evidence that gamblers do not accurately recall their betting outcomes or frequency (Heirene et al., 2022), and this can plausibly extend to microtransaction use. The study samples are largely comprised of either undergraduate university students or crowd-sourced samples, and in both cases, these populations may not represent typical gamblers (Gainsbury et al., 2014; Mishra & Carleton,
However, this research attempted to mitigate some potential concerns via data quality checks and pre-screens to select participants that met specific requirements.

6.5 Directions for Future Study

Given the reliance upon cross-sectional, survey-based data in Chapter 2, one direction focuses upon clarifying the temporal ordering of the onset of schizotypal personality and gambling-related cognitions. Most personality development is typically thought to occur during early life (Herzhoff, Kushner, & Tackett, 2017), and first gambling behaviour tends to occur during adolescence of early adulthood (Kessler et al. 2008). Thus, it is reasonable to hypothesize that early personality development both precedes and contributes to gambling engagement and the development of gambling-related cognitions. This question could be explored by incorporating the Schizotypal Personality Questionnaire – Brief (Raine & Benishay, 1995) into a longitudinal survey of gambling behaviour beginning in childhood and adolescence. Alternatively, a quasi-experimental laboratory approach could provide non-gamblers their first gambling experience, and then assess whether differences in behavioural engagement can be predicted by schizotypy. Such a design could also incorporate the Gambling State Cognitions Scale, to assess the relationship between schizotypy and state activation of gambling cognitions, given the propensity for individuals who endorse schizotypal traits to engage in more emotionally driven thinking.

The Gambling State Cognitions Scale will benefit from additional testing, to further demonstrate its ability to specifically assess of state cognitions and to validate its use in different settings and with populations. As discussed in Section 3.5.4, one reason for the similar scores
between the ‘watcher’ group and active gambler group on the Gambling State Cognitions Scale is that viewing gambling is similarly engaging, evidenced by the prevalence of slot machine streams on Twitch.tv (Abarbanel et al., 2021). This could be partially explained by the audiovisual characteristics of slot machines, where the resulting excitement and anticipation of outcomes amplifies state-activated beliefs. Manipulating these audiovisual components, in addition to active gambling engagement, between groups could increase the sensitivity of the experimental design. Beyond additional validation and confirmation of the scale’s factor structure, its utility could be greatly expanded by adapting the Gambling State Cognitions Scale and an associated slot machine task for online deployment. Doing so would allow the combined scale and task to be much more easily deployed by researchers assessing treatments for problematic gambling behaviour, and could even extend to a clinician version to be used as a treatment outcome measure. This could assess for differential changes between trait and state-activated gambling cognitions throughout a course of treatment, and provide insight about their respective contributions to gambling-related harms.

The causal relationship between loot box use and subsequent gambling behaviour requires continued exploration. The detected temporal relationship in Chapter 5 requires further replication, ideally within non-crowd-sourced samples, and the impact of possible third variables needs to be tested (e.g., parental supervision and awareness about gamblified video games). Another area to consider is the impact of individual differences, such as personality, upon loot box engagement. Schimmenti et al. (2017) reported that disorganized and interpersonal traits related to schizotypy decreased when gamers played an online multiplayer game, and suggested that such gameplay provided a “psychic retreat” from the symptoms associated with these traits. Coupled with the associations between schizotypy and gambling reported in Chapter 2, this
spectrum of personality could be a prime candidate to explore for interactions with loot box use. Another consideration for future study comes from the evidence that supports both causal directions. It is feasible that both pathways might be active simultaneously within the same individual. An at-risk gambler could find loot boxes particularly appealing, and the resulting excessive use of loot boxes could subsequently prompt a behavioural shift toward their preferred gambling games. Thus, resulting in a cyclical pattern of engagement with the mutually reinforcing loot box and gambling behaviours.

The program development and evaluation of harm reduction strategies that target video game gamblification has received increased attention, given the growing consensus of the risk associated with such gamblified features. However, any strategy implemented, such as allowing players to set weekly spending limits, requires study to determine their effectiveness. Broadly speaking, research on loot boxes should begin to pilot such approaches to harm reduction. This could have a two-fold effect of: 1) hastening the implementation of regulation by demonstration of effective loot box management; and 2) decreasing the likelihood that ineffective methods to reduce harm are not implemented. The development of treatments for individuals harmed by gamblified video game features is also warranted and needed. Such treatments will benefit from being informed by the undoubtedly varied reasons that gamers value the acquisition of virtual items.
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## Appendices

### Appendix A: Summary Table of the Measures in Chapter 2

<table>
<thead>
<tr>
<th>Measure:</th>
<th>Subscales:</th>
<th>Assessed Constructs or Behaviours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Peters et al. Delusions Inventory (PD1-21)</td>
<td>n/a</td>
<td>Tendency to engage in delusional thinking (e.g., ideas of self-reference, paranoid ideation, magical thinking).</td>
</tr>
<tr>
<td>2) Schizotypal Personality Questionnaire-Brief (SPQ-B)</td>
<td>Cognitive-Perceptual Features</td>
<td>Tendency to engage in delusional thinking (e.g., ideas of self-reference; paranoid ideation), and unusual perceptions.</td>
</tr>
<tr>
<td></td>
<td>Interpersonal Deficits</td>
<td>Tendency for excessive social anxiety, lack of close friends, blunted affect.</td>
</tr>
<tr>
<td></td>
<td>Disorganized Thought</td>
<td>Tendency for odd or eccentric behaviour, and odd speech.</td>
</tr>
<tr>
<td>3) Gambling Related Cognitions Scale (GRCS)</td>
<td>Illusion of Control</td>
<td>Belief of being able to enact control over random-chance games due to personal skill, ability, or knowledge.</td>
</tr>
<tr>
<td></td>
<td>Interpretive Bias</td>
<td>Tendency to reframe gambling outcomes that encourage continued play (e.g., wins due to skill; losses due to bad luck).</td>
</tr>
<tr>
<td></td>
<td>Predictive Control</td>
<td>Belief that one can predict gambling outcomes (e.g., that a “win” is due).</td>
</tr>
<tr>
<td></td>
<td>Gambling-related Expectances</td>
<td>Expectations about the result of gambling behaviour (e.g., feeling excitement).</td>
</tr>
<tr>
<td></td>
<td>Inability to Stop</td>
<td>Belief that gambling behaviour will be difficult or impossible to stop once started.</td>
</tr>
<tr>
<td>4) Belief in Good Luck Scale (BIGLS)</td>
<td>n/a</td>
<td>Belief about being lucky; that luck works in their favour.</td>
</tr>
<tr>
<td>Measure:</td>
<td>Subscales:</td>
<td>Assessed Constructs or Behaviours</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5) Beliefs Around Luck Scale (BALS)</td>
<td>Belief in Good Luck</td>
<td>Belief about being lucky; that luck works in their favour.</td>
</tr>
<tr>
<td></td>
<td>Belief in Bad Luck</td>
<td>Belief about being unlucky; that luck works against them.</td>
</tr>
<tr>
<td></td>
<td>General Belief in Luck</td>
<td>Belief that luck is a force discrete from random chance.</td>
</tr>
<tr>
<td></td>
<td>Rejection of Luck</td>
<td>Belief that luck is not a discrete force better considered as random chance.</td>
</tr>
<tr>
<td>6) Problem Gambling Severity Index (PGSI)</td>
<td>n/a</td>
<td>Risky and problematic gambling behaviour.</td>
</tr>
</tbody>
</table>

*Note:* The PDI-21 has a conviction, distress, and preoccupation subscale for each item that may be scored individually. A “grand total” metric is calculated by summing these and the yes/no response together. These subscales are not reported upon above because the study only used the grand total.
Table B.1  Multiple Regression Analysis for Demographic Variables Predicting Gambling-Related Measures in Sample 1

<table>
<thead>
<tr>
<th>Predicting the Gambling Related Cognitions Scale</th>
<th>Variables:</th>
<th>β</th>
<th>[CI]</th>
<th>SE</th>
<th>t</th>
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</thead>
<tbody>
<tr>
<td>Constant</td>
<td>.000</td>
<td>[-.174, .174]</td>
<td>.088</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian/White</td>
<td>-.319</td>
<td>[-.500, -.138]</td>
<td>.091</td>
<td>-3.50*</td>
<td></td>
</tr>
<tr>
<td>Other Ethnicity</td>
<td>-.088</td>
<td>[-.270, .093]</td>
<td>.091</td>
<td>-.968</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>.250</td>
<td>[.075, .425]</td>
<td>.088</td>
<td>2.84*</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-.080</td>
<td>[-.266, .105]</td>
<td>.093</td>
<td>-8.60</td>
<td></td>
</tr>
<tr>
<td>SPQ-B</td>
<td>.221</td>
<td>[.033, .409]</td>
<td>.095</td>
<td>2.34*</td>
<td></td>
</tr>
<tr>
<td><strong>R²/ Adj. R²</strong></td>
<td>.242 / .204</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>6.27*</td>
<td></td>
<td></td>
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<td></td>
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<table>
<thead>
<tr>
<th>Predicting the Belief in Good Luck Scale</th>
<th>Variables:</th>
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<th>t</th>
</tr>
</thead>
<tbody>
<tr>
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<td>.000</td>
<td>[-.194, .194]</td>
<td>.098</td>
<td>.000</td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>-.184</td>
<td>[-.386, .017]</td>
<td>.102</td>
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<tr>
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<td>.102</td>
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</tr>
<tr>
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<td>[-.086, .304]</td>
<td>.098</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>Age</td>
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<td>[-.157, .256]</td>
<td>.104</td>
<td>.477</td>
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</tr>
<tr>
<td>SPQ-B</td>
<td>.111</td>
<td>[-.099, .320]</td>
<td>.106</td>
<td>1.05</td>
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</tr>
<tr>
<td><strong>R²/ Adj. R²</strong></td>
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<td></td>
<td></td>
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<td></td>
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<td><strong>F</strong></td>
<td>1.22</td>
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<table>
<thead>
<tr>
<th>Predicting the Problem Gambling Severity Index</th>
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<tr>
<td>Constant</td>
<td>.000</td>
<td>[-.183, .183]</td>
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<td>.000</td>
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<td>.096</td>
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</tr>
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<td>Other Ethnicity</td>
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<td>.096</td>
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<tr>
<td>Gender</td>
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<td>[.085, .453]</td>
<td>.093</td>
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<tr>
<td>Age</td>
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<td>[-.120, .270]</td>
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<tr>
<td>SPQ-B</td>
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<td></td>
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</tr>
<tr>
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<td>3.73*</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

*Note: n = 104, df = 5 (98). *p ≤ .05 (two-tailed). β = standardized coefficient. CI = 95% confidence interval of β. Ethnicity and gender were coded as 0 or 1 (1 = endorsed, male). The ethnicity of the sample majority is used as the reference (Asian). Ethnicities with n < 5 collapsed into “Other Ethnicity”. To reduce skew, PGSI and GRCS were log transformed.*
Table B.2   Multiple Regression Analysis for Demographic Variables Predicting
Gambling-Related Measures in Sample 2

<table>
<thead>
<tr>
<th>Variables:</th>
<th>$\beta$</th>
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<th>$t$</th>
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<td>[-.109, .109]</td>
<td>.055</td>
<td>.000</td>
</tr>
<tr>
<td>Ethnicity</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>.057</td>
<td>-1.01</td>
</tr>
<tr>
<td>African/Black</td>
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<td>[-.114, .107]</td>
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<td>-.062</td>
</tr>
<tr>
<td>Latin American</td>
<td>-.010</td>
<td>[-.119, .100]</td>
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<td>-1.72</td>
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<tr>
<td>Other Ethnicity</td>
<td>-.076</td>
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<td>.056</td>
<td>-1.36</td>
</tr>
<tr>
<td>Gender</td>
<td>-.058</td>
<td>[-.168, .052]</td>
<td>.056</td>
<td>-1.04</td>
</tr>
<tr>
<td>Age</td>
<td>-.348</td>
<td>[-.460, -.235]</td>
<td>.057</td>
<td>-6.10*</td>
</tr>
<tr>
<td>SPQ-B</td>
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<td>[.087, .312]</td>
<td>.057</td>
<td>3.49*</td>
</tr>
<tr>
<td>$R^2$ / Adj. $R^2$</td>
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<td></td>
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</tr>
<tr>
<td>$F$</td>
<td></td>
<td></td>
<td></td>
<td>8.24*</td>
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Predicting the Belief in Good Luck Scale

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<td>.000</td>
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<td></td>
<td></td>
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</tr>
<tr>
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<td>[-.246, -.006]</td>
<td>.061</td>
<td>-2.07*</td>
</tr>
<tr>
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<td>.059</td>
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Predicting the Problem Gambling Severity Index

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</tr>
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<td>.055</td>
<td>.190</td>
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<td>.057</td>
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Note: $n = 277$, df = 7 (269), * $p \leq .05$ (two-tailed). $\beta$ = standardized coefficient. CI = 95% confidence interval of $\beta$. Ethnicity and gender were coded as 0 or 1 (1 = endorsed, male). The ethnicity of the sample majority is used as the reference (Caucasian/White). Ethnicities with $n < 5$ collapsed into “Other Ethnicity”. To reduce skew, PGSI was log transformed.
Table B.3  Multiple Regression Analysis for Demographic Variables Predicting Gambling-Related Measures in Sample 3

**Predicting the Gambling Related Cognitions Scale**

<table>
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<td>.295</td>
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<tr>
<td>African/Black</td>
<td>.095</td>
<td>[-.067, .257]</td>
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<tr>
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<td>-1.30</td>
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<td>.216</td>
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**Predicting the Problem Gambling Severity Index**

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<td>.162</td>
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**Predicting the Beliefs Around Luck Scale – Good Luck Subscale**

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<td>.000</td>
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<td></td>
</tr>
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<td>.336</td>
</tr>
<tr>
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<td>1.79</td>
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</tr>
<tr>
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<td>-1.13</td>
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<tr>
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<td>-1.66</td>
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<td>$F$</td>
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*Note: n = 144, df = 6 (137), * $p \leq .05$ (two-tailed). $\beta$ = standardized coefficient. CI = 95% confidence interval of $\beta$. Ethnicity and gender were coded as 0 or 1 (1 = endorsed, male). The ethnicity of the sample majority is used as the reference (Caucasian/White). Ethnicities with $n < 5$ collapsed into “Other Ethnicity”. To reduce skew, PGSI, GRCS, and BALS-BL were log transformed.*
Table B.3 Cont. Multiple Regression Analysis for Demographic Variables Predicting Gambling-Related Measures in Sample 3

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<table>
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<td>Ethnicity</td>
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*Note: n = 144, df = 6 (137), *p ≤ .05 (two-tailed). β = standardized coefficient. CI = 95% confidence interval of β. Ethnicity and gender were coded as 0 or 1 (1 = endorsed, male). The ethnicity of the sample majority is used as the reference (Caucasian/White). Ethnicities with n < 5 collapsed into “Other Ethnicity”. To reduce skew, PGSI, GRCS, and BALS-BL were log transformed.
Appendix C: Recalculated Correlation Analyses using Spearman Rank-Order to Reassess Under Different Assumptions in Chapter 2

Table C.1  Full-scale Spearman Rank-Order Correlations

Sample 1: Student (n = 104)

<table>
<thead>
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<th>3.</th>
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<th>5.</th>
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<td>.276**</td>
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<td>18.6</td>
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<td>.338***</td>
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<tr>
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<td>—</td>
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Sample 2: MTurk (n = 277)

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<th>4.</th>
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<td>.031</td>
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<td>11.0</td>
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<td>—</td>
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<td>5. PGSI</td>
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Sample 3: MTurk (n = 144)

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<td>.416***</td>
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<td>.273***</td>
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<td>27.2</td>
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<td>.359***</td>
<td>.148</td>
<td>.487***</td>
<td>-.376***</td>
<td>.655***</td>
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<tr>
<td>3. B-GL</td>
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<td>.129</td>
<td>-.192*</td>
<td>.183*</td>
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<td>.372***</td>
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Note: * p ≤ .05, ** p ≤ .01, *** p ≤ .001 (two-tailed); partial correlations reported to control for Caucasian/White ethnicity and gender in Sample 1, Asian ethnicity, gender, and age in Sample 2, and gender in Sample 3. PDI-21 = Peters et al. Delusions Inventory; SPQ-B = Schizotypal Personality Questionnaire-Brief; GRCS = Gambling Related Cognitions Scale; BIGLS = Belief in Good Luck Scale; B-GL = belief in good luck; B-BL = belief in bad luck; B-GB = general belief in luck; B-RL = rejection of luck.; PGSI = Problem Gambling Severity Index.
Table C.2  Subscale Spearman Rank-Order Correlations

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<th>Sample 1: Student ($n = 104$) Variables</th>
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<td>.098</td>
<td>.266***</td>
<td>.252***</td>
<td>.174**</td>
<td>.194**</td>
<td>.228***</td>
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Note: * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$ (two-tailed); partial correlations reported to control for Caucasian/White ethnicity and gender in Sample 1, and Asian ethnicity, gender, and age in Sample 2. PDI-21 = Peters et al. Delusions Inventory; Subscales: SPQ-CP = cognitive-perceptual; SPQ-IP = interpersonal; SPQ-DS = disorganized thought; GR-GE = gambling expectancies; GR-IC = illusion of control; GR-PC = predictive control; GR-IS = inability to stop; GR-IB = interpretive bias; PGSI = Problem Gambling Severity Index.
Table C.3 Subscale Spearman Rank-Order Correlations

Sample 3: MTurk (n = 144)

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Note: * p ≤ .05, ** p ≤ .01, *** p ≤ .001 (two-tailed); partial correlations reported to control for gender. Subscales: SPQ-CP = cognitive-perceptual; SPQ-IP = interpersonal; SPQ-DS = disorganized thought; GR-GE = gambling expectancies; GR-IC = illusion of control; GR-PC = predictive control; GR-IS = inability to stop; GR-IB = interpretive bias; B-GL = belief in good luck; B-BL = belief in bad luck; B-GB = general belief in luck; B-RL = rejection of luck; PGSI = Problem Gambling Severity Index.
Appendix D: Research Assistant Consistency Script used in Chapter 3

Figure D.1 Consistency Script – Page 1

Scale Validation Study - Research Assistant Script

After Consent Form and Problem Gambling Severity Index Forms are filled out:

"Hello, welcome to the study! Today we will be looking at your perceptions of gambling on a slot machine both before and after a slot machine activity. Please follow me to the study room.

[Participant is led to the study room and seated in front of the study laptop]

"We'll begin with some computerized questionnaires that ask about your beliefs and experiences about slot machine gambling. Please answer these questions to the best of your ability, there are no right or wrong answers. If you have any questions while filling out these questionnaires, please let me know. I will be over here."

[The experimenter prepares the next stage of the experiment, by retrieving the cash for gambling and preparing the slot machine recording. The participant should notify the experimenter when they reach the prompt to do so in the survey]

Scenario A: Authentic Slot Machine Group

[The participant is seated at the machine]

"In front of you is a real slot machine. It hasn’t been modified in any way. The screen has a number of spinning reels. ‘Wins’ happen when the matching symbols on those reels line up across the screen. These matching symbols can be arranged in many different patterns or ‘lines’ on the screen. They can be straight across, diagonal, or even zig-zag patterns. To win with a matching line, you need to have placed a bet on it. You’ll notice that there are two parallel rows of different buttons on the machine. The top row of buttons determines how many lines you will be betting on and the bottom row of buttons determines the size of the bet you are placing on each line. While the math of these games never changes, the size of wins, and how often they happen, depends on the type of bet you make. For example, you could bet one cent across one row. Meaning that you are betting 1 cent each time you play the game. Wins will happen only when symbols match across the middle of the screen, and the size of the win will be smaller. Alternatively, you could bet 5 cents across 40 different lines, meaning that you are betting 2 dollars on each spin. Wins will happen more often because you are playing on all lines and the size of the wins will be greater because you are spending more money on each bet. Today, I am going to let you play the game however you like for a little while.”

[Participant is shown $60 in 20-dollar bills]

"Today you will be given sixty dollars to play in the slot machine. You will be awarded a proportion of the remaining money after your 10-minute slot machine play session. You can earn a bonus of up to fifteen dollars, depending on the outcome of this gambling session. You should think of this money as your money now."

[Participant is given the sixty dollars and asked to insert it into the machine]

"Great, your play session begins now. We ask that you play the slot machine regularly during this session. You can try to play any number of lines, with small or large bets using these buttons. It is up to you how you would like to play. We do ask that you do play the slot machine for the full 10-minutes. Do not just sit here without playing."

Page 1 of 2 Version 1.0 dated May 18, 2017
Scenario B: Computerized Recording of Slot Machine Group

[The participant is seated at the laptop that has a recorded slot machine session]

"In front of you is a recording of a real slot machine. It hasn’t been modified in any way. The screen has a number of spinning reels. ‘Wins’ happen when the matching symbols on those reels line up across the screen. These matching symbols can be arranged in many different patterns or ‘lines’ on the screen. They can be straight across, diagonal, or even zig-zag patterns. To win with a matching line, you need to have placed a bet on it. While the math of these games never changes, the size of wins, and how often they happen, depends on the type of bet you make. For example, you could bet one cent across one payline, meaning that you are betting 1 cent each time you play the game. Wins will happen only when symbols match across the middle of the screen, and the size of the win will be smaller. Alternatively, you could bet 5 cents across 40 different lines, meaning that you are betting 2 dollars on each spin. Wins will happen more often because you are playing on all lines and the size of the wins will be greater because you are spending more money on each bet.

Today, I am going to let you watch this recording of a 10-minute play session of a real slot machine. Although you are not actually playing the machine that was recorded, we ask that you watch the video as if you were."

[Participant is shown $60 in 20-dollar bills]

"Today you will be given sixty dollars to play with during the slot machine recording. You will be awarded a proportion of the remaining money after your 10-minute session of watching the video recording is over. You can earn a bonus of up to fifteen dollars, depending on the outcome of this recording of the gambling session. You should think of this money as your money now."

[Participant is given the sixty dollars then asked to give it back to the experimenter]

"Great, your play session begins now. Again, we ask that you watch this recording as if you were actually playing the slot machine. The outcome has a real impact on the amount of money you are awarded at the end. We do ask that you do pay attention to the slot machine recording for the full 10-minutes. Do not just sit here without watching."

After the 10-Minute Gambling Session

"Now that the gambling session is done, I would like you to answer some more questions. When answer these questions please do so with the gambling session you just completed in mind."

[The State scale and the GEQ are administered via the study laptop survey]

"And that concludes the study experiment. Based on the outcome of the slot machine, you will be rewarded $XX.XX, rounding up to the nearest quarter. This number was arrived at by dividing the remaining amount in the machine by six, as stated, you were to receive a proportion of the money remaining. In order for you to receive this, I will need you to sign a record of your receipt of this money."

[Record of given money is completed and then the study debriefing is conducted. Afterward, the participant is directed to the online debriefing questionnaire, as required by the department]
Appendix E: Chi-square Tests to Assess Recruitment Bias in Chapter 4

Table E.1  Chi-square between Pre-screen & Full Survey Participants for Gambling and Loot Box Use

<table>
<thead>
<tr>
<th>Questions</th>
<th>Pre-screen (n = 850)</th>
<th>Full Survey (n = 144)</th>
<th>Chi-Square Test</th>
<th>p-value</th>
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<td>Do you currently gamble?</td>
<td></td>
<td></td>
<td>$\chi^2(1) = .316$</td>
<td>.574</td>
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<tr>
<td>Yes:</td>
<td>433</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No:</td>
<td>417</td>
<td>68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have you ever gambled?</td>
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<td></td>
<td>$\chi^2(1) = .176$</td>
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<tr>
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<td>754</td>
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<tr>
<td>No:</td>
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<tr>
<td>Have you opened a loot box?</td>
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<td>&lt;.001***</td>
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<td>16</td>
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<td></td>
</tr>
</tbody>
</table>
Appendix F: Supplementary Methods for Chapter 5

F.1 Timeline of Data Collection

The pre-screen launched and completed in November 2020. In total, 663 individuals who completed the pre-screen met eligibility criteria for the non-gambler subgroup, and 397 were eligible for the gambler subgroup. Using custom Prolific filters, these individuals were provided access to the baseline survey. Data collection for the baseline survey (in both subgroups) launched on 16 December 2020. Data collection was terminated after reaching the target $n$ for non-gamblers on 23 December 2020. In making this decision – i.e. to also terminate recruitment in the gambler subgroup before the target $n$ was reached – I considered a number of factors: i) the eligible pool of gamblers ($n = 397$) on the Prolific platform was fairly small, due to the combination of eligibility criteria that required engagement in gambling and familiarity with video game loot boxes, and it was unlikely I would reach the original target of 392; ii) recruitment was expected to be slow through the seasonal holidays in December, and iii) I wanted to clearly delineate the 6-month follow-up interval across both subgroups, to avoid the possibility that external factors (e.g. pandemic-related events) might differentially affect the two subgroups. Data collection for the follow-up ran from 23 June 2021 to 20 July 2021 for both subgroups. From the exact timing across participants, all participants had at least six months between baseline and follow-up assessment, with this interval increasing towards seven months in a small minority (note that most data collection at both assessments occurred in the first week of survey launch).
F.2 Survey Structure

The baseline survey structure proceeded as follows: i) informed consent; ii) individual demographics, including video game and microtransaction descriptives; iii) questions about virtual item valuation; iv) Risky Loot Box Index (RLI); and v) beliefs and behaviours about microtransactions; vi) an online deployment within Qualtrics of the Balloon Analogue Risk Task that comprised 15 trials; vii) the standard Problem Gambling Severity Index (PGSI); viii) randomly presented trait scales (Schizotypal Personality Questionnaire – Brief, Depression Anxiety Stress Scale – 21 Items, TIPI 10 Question Big Five Measure, Internet Gaming Disorder Scale – Dichotomous Version, Gambling Related Cognitions Scale, Game Playing Preferences Scale, Beliefs Around Luck Scale, and Attitudes Toward Gambling Scale – 8 Item); ix) a modified version of the PGSI that instructed participants to not consider loot boxes in their responses and provided examples of conventional gambling (the inclusion of this scale was inspired by the argument presented in Sidloski et al 2022 and data will be reported elsewhere); and x) the gambling-related descriptives. Upon completion, participants read a debriefing message that included resources for participants who felt their gaming or gambling might be problematic, with different options for participants located in the USA, UK, and Canada.

The follow-up survey structure proceeded as follows: i) informed consent; ii) an abbreviated assessment of demographics and video game descriptives; iii) RLI; iv) questions about virtual item valuation; v) randomly presented select retained scales (Internet Gaming Disorder Scale – Dichotomous Version, Attitudes Toward Gambling Scale – 8 Item, the modified PGSI); vi) and gambling-related descriptives. The same debriefing resources from the baseline assessment were re-presented on completing the follow-up. The measures that are not reported in the current manuscript will be described elsewhere.
Appendix G: Correlations between Predictor Variables and Demographic Variables to Assess for Possible Confounds in Chapter 5

Table G.1 Correlations between Predictors and Demographics

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Loot Box Expense</th>
<th>DPM Expense</th>
<th>Gambling Expense</th>
<th>RLI</th>
<th>PGSI</th>
<th>GRCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.077</td>
<td>.009</td>
<td>.088*</td>
<td>-.002</td>
<td>.052</td>
<td>.011</td>
</tr>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Man</td>
<td>.134*</td>
<td>.120*</td>
<td>.197*</td>
<td>-.030</td>
<td>.172*</td>
<td>.119*</td>
</tr>
<tr>
<td>Woman</td>
<td>-.140*</td>
<td>-.127*</td>
<td>-.187*</td>
<td>.020</td>
<td>-.169*</td>
<td>-.098*</td>
</tr>
<tr>
<td>Non-binary</td>
<td>.006</td>
<td>.010</td>
<td>-.040</td>
<td>.027</td>
<td>-.021</td>
<td>-.064</td>
</tr>
<tr>
<td>Ethnicity:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>.020</td>
<td>-.012</td>
<td>-.069</td>
<td>.049</td>
<td>-.005</td>
<td>.116*</td>
</tr>
<tr>
<td>Multiracial</td>
<td>-.039</td>
<td>-.004</td>
<td>-.023</td>
<td>.047</td>
<td>-.037</td>
<td>.002</td>
</tr>
<tr>
<td>African/Black</td>
<td>.034</td>
<td>.019</td>
<td>-.015</td>
<td>.017</td>
<td>.035</td>
<td>.039</td>
</tr>
<tr>
<td>Latin American</td>
<td>.063</td>
<td>.031</td>
<td>-.009</td>
<td>.016</td>
<td>-.009</td>
<td>.023</td>
</tr>
<tr>
<td>Caucasian/White</td>
<td>-.047</td>
<td>-.002</td>
<td>.094*</td>
<td>-.080*</td>
<td>.008</td>
<td>-.101*</td>
</tr>
<tr>
<td>Other Ethnicity</td>
<td>.006</td>
<td>-.024</td>
<td>-.041</td>
<td>.010</td>
<td>-.002</td>
<td>-.055</td>
</tr>
<tr>
<td>Education</td>
<td>.037</td>
<td>.010</td>
<td>.044</td>
<td>-.012</td>
<td>.012</td>
<td>.042</td>
</tr>
<tr>
<td>C19 Self-isolation</td>
<td>.063</td>
<td>.071</td>
<td>-.074</td>
<td>-.064</td>
<td>.033</td>
<td>-.028</td>
</tr>
</tbody>
</table>

Note: n = 636, *p ≤ .05 (two-tailed). Gender and ethnicity variables were dummy coded (0 = No, 1 = Yes), and values reflect Pearson point-biserial correlations. All correlations conducted on baseline data. Expense variables are estimations of the past 12-month expenditure at baseline. Expense variables, PGSI, and GRCS were log base 2 +1 transformed. C19 Self-isolation = degree of self-isolation during the COVID-19 pandemic as reported by the participant, measured using a sliding scale from 0 – 100 (not at all – all the time).
Appendix H: Regression Analyses Using Alternative Gambler Classification at Baseline in Chapter 5

Table H.1 Logistic Regressions Predicting Migration to Reclassified Non-gamblers

<table>
<thead>
<tr>
<th>12-Month Microtransaction Expenditure</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>Wald</th>
<th>p-value</th>
<th>OR</th>
<th>98.75% OR CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-3.20</td>
<td>-5.56, -2.15</td>
<td>.702</td>
<td>33.0</td>
<td>&lt;.001*</td>
<td>33.0</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>DPM Expenditure</td>
<td>.163</td>
<td>-.121, .609</td>
<td>.122</td>
<td>2.68</td>
<td>.128</td>
<td>1.18</td>
<td>.886, 1.84</td>
</tr>
<tr>
<td>Test of Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C&amp;S / Nagelkerke R²</td>
<td>.013</td>
<td>/ .032</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Variables – Step 2:

<table>
<thead>
<tr>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>Wald</th>
<th>p-value</th>
<th>OR</th>
<th>98.75% OR CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-3.46</td>
<td>-5.79, -2.41</td>
<td>.745</td>
<td>35.2</td>
<td>&lt;.001*</td>
<td>35.2</td>
</tr>
<tr>
<td>DPM Expenditure</td>
<td>.042</td>
<td>-.242, .448</td>
<td>.122</td>
<td>1.45</td>
<td>.690</td>
<td>1.04</td>
</tr>
<tr>
<td>LBox Expenditure</td>
<td>.237</td>
<td>-.002, .544</td>
<td>.093</td>
<td>5.12</td>
<td>.004*</td>
<td>1.27</td>
</tr>
<tr>
<td>Test of Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C&amp;S / Nagelkerke R²</td>
<td>.037</td>
<td>/ .087</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Risky Loot Box Index Variables:

<table>
<thead>
<tr>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>Wald</th>
<th>p-value</th>
<th>OR</th>
<th>98.75% OR CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-2.44</td>
<td>-3.23, -1.98</td>
<td>.288</td>
<td>89.3</td>
<td>&lt;.001*</td>
<td>49.3</td>
</tr>
<tr>
<td>RLI Score</td>
<td>.114</td>
<td>-.702, .812</td>
<td>.284</td>
<td>.190</td>
<td>.654</td>
<td>1.12</td>
</tr>
<tr>
<td>Test of Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C&amp;S / Nagelkerke R²</td>
<td>.001</td>
<td>/ .002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: n = 218, Step 1 df = 1, Step 2 df = 2, * p ≤ .0125 (two-tailed). Baseline non-gamblers defined by answer of ‘Never’ to “In the past 12 months, have you gambled at all?”. 98.75% CIs, SE, and predictor p-values are bootstrapped (BCa, 5000 samples). Significance level of p ≤ .0125 and 98.75% CI are required for the Bonferroni correction applied. C&S = Cox & Snell R²; LBox = loot box. Expense variables were log base 2 +1 transformed to reduce positive skew; RLI scores were centred and standardized.
Table H.2  Linear Regressions Predicting Follow-up Gambling Spend of Reclassified Non-gamblers

<table>
<thead>
<tr>
<th>12-Month Microtransaction Expenditure Variables – Step 1:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>β</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>.684</td>
<td>.224, 1.28</td>
<td>.229</td>
<td>3.24</td>
<td>.003*</td>
<td></td>
</tr>
<tr>
<td>DPM Expenditure</td>
<td>-.001</td>
<td>-.131, .109</td>
<td>.044</td>
<td>-.001</td>
<td>-.019</td>
<td>.985</td>
</tr>
<tr>
<td>R² / Adj. R²</td>
<td>.000</td>
<td></td>
<td></td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables – Step 2:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>β</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>.621</td>
<td>.173, 1.21</td>
<td>.224</td>
<td>2.92</td>
<td>.008*</td>
<td></td>
</tr>
<tr>
<td>DPM Expenditure</td>
<td>-.047</td>
<td>-.187, .077</td>
<td>.050</td>
<td>-.074</td>
<td>-.949</td>
<td>.348</td>
</tr>
<tr>
<td>LBox Expenditure</td>
<td>.096</td>
<td>-.030, .238</td>
<td>.054</td>
<td>.147</td>
<td>1.90</td>
<td>.077</td>
</tr>
<tr>
<td>R² / Adj. R²</td>
<td>.016</td>
<td></td>
<td></td>
<td>.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>1.80</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risky Loot Box Index Variables:</th>
<th>B</th>
<th>98.75% CI</th>
<th>SE</th>
<th>β</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>.681</td>
<td>.396, .995</td>
<td>.124</td>
<td>5.32</td>
<td>&lt;.001*</td>
<td></td>
</tr>
<tr>
<td>RLI Score</td>
<td>-.001</td>
<td>-.326, .318</td>
<td>.126</td>
<td>.000</td>
<td>-.006</td>
<td>.996</td>
</tr>
<tr>
<td>R² / Adj. R²</td>
<td>.000</td>
<td></td>
<td></td>
<td>.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: n = 218, Step 1 df = 216, Step 2 df = 215, * p ≤ .0125 (two-tailed). Baseline non-gamblers defined by answer of ‘Never’ to “In the past 12 months, have you gambled at all?”. β = standardized coefficient. 98.75% CI, SE, and predictor p-values are bootstrapped (BCa, 5000 samples). Significance level of p ≤ .0125 and 98.75% CI are required for the Bonferroni correction applied. LBox = loot box. Expense variables were log base 2 +1 transformed to reduce positive skew; RLI scores were centred and standardized.
Appendix I: Correlations between Predictor and Dependent Variables in Chapter 5

Table I.1  Correlations between Predictor and Dependent Variables in Section 5.3.4

<table>
<thead>
<tr>
<th>Variables:</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. DPM Expense (baseline)</td>
<td>.452**</td>
<td>.248**</td>
<td>.121*</td>
<td>.113</td>
</tr>
<tr>
<td>2. Loot Box Expense (baseline)</td>
<td>—</td>
<td>.537**</td>
<td>.217**</td>
<td>.228**</td>
</tr>
<tr>
<td>3. RLI Score (baseline)</td>
<td>—</td>
<td>—</td>
<td>.153**</td>
<td>.211**</td>
</tr>
<tr>
<td>4. Gambler Status (follow-up)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>.639**</td>
</tr>
<tr>
<td>5. Gambling Expense (follow-up)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables:</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. DPM Expense (baseline)</td>
<td>.487**</td>
<td>.289**</td>
<td>.113</td>
<td>-.001</td>
</tr>
<tr>
<td>2. Loot Box Expense (baseline)</td>
<td>—</td>
<td>.542**</td>
<td>.197**</td>
<td>.111</td>
</tr>
<tr>
<td>3. RLI Score (baseline)</td>
<td>—</td>
<td>—</td>
<td>.030</td>
<td>.000</td>
</tr>
<tr>
<td>4. Gambler Status (follow-up)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>.786**</td>
</tr>
<tr>
<td>5. Gambling Expense (follow-up)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: n = 415 at baseline & 291 at follow-up for baseline non-gamblers; n = 302 at baseline & 218 at follow-up for reclassified non-gamblers. * p ≤ .05, ** p ≤ .01 (two-tailed). Reclassified non-gamblers: Replied ‘Never’ to, “In the past 12 months, have you gambled at all?” Baseline expense variables estimate past 12-months and follow-up gambling expense estimates past 6-months. Gambler status was dummy coded (0 = No, 1 = Yes). Expense variables are log base 2 +1 transformed. Pairwise exclusions.
Table 1.2  Correlations between Predictor and Dependent Variables in Section 5.3.5

<table>
<thead>
<tr>
<th>Variables:</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. DPM Expense (baseline)</td>
<td>.071</td>
<td>.116</td>
<td>.148*</td>
<td>.229**</td>
</tr>
<tr>
<td>2. Gambling Expense (baseline)</td>
<td>—</td>
<td>.602**</td>
<td>.376**</td>
<td>.187*</td>
</tr>
<tr>
<td>3. PGSI Score (baseline)</td>
<td>—</td>
<td>—</td>
<td>.437**</td>
<td>.198**</td>
</tr>
<tr>
<td>4. GRCS Total Score (baseline)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>.248**</td>
</tr>
<tr>
<td>5. Loot Box Expense (follow-up)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: $n = 251$ at baseline & 179 at follow-up; * $p \leq .05$, ** $p \leq .01$ (two-tailed). Loot box non-user status is based upon no expense reported during the 12-months prior to baseline. Baseline expense variables estimate past 12-months and follow-up loot box expense estimates past 6-months. Variables are log base 2 +1 transformed to reduce positive skew. Pairwise exclusions.
Appendix J: Primary Scales used for Research

J.1 Belief in Good Luck Scale (BIGLS)

See original article for scoring:


1. Luck plays an important part in everyone’s life.
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree  
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

2. Some people are consistently lucky, and others are unlucky.
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree  
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

3. I consider myself to be a lucky person.
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree  
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

4. I believe in luck.
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree  
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

5. I often feel like it’s my lucky day.
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree  
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

6. I consistently have good luck.
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree  
   (4) slightly agree  (5) somewhat agree  (6) strongly agree
7. It’s a mistake to base any decisions on how lucky you feel.
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree    (5) somewhat agree     (6) strongly agree

8. Luck works in my favor.
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree    (5) somewhat agree     (6) strongly agree

9. I don’t mind leaving things to chance because I’m a lucky person.
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree    (5) somewhat agree     (6) strongly agree

10. Even the things in life I can’t control tend to go my way because I’m lucky.
    (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
        (4) slightly agree  (5) somewhat agree     (6) strongly agree

11. There is such a thing as luck that favors some people, but not others.
    (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
        (4) slightly agree  (5) somewhat agree     (6) strongly agree

12. Luck is nothing more than random chance.
    (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
        (4) slightly agree  (5) somewhat agree     (6) strongly agree
J.2 Beliefs Around Luck Scale (BALS)

See original article for scoring:


1. I consider myself to be an unlucky person
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

2. I consistently have bad luck
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

3. Even the things in life I can control don’t go my way because I am unlucky
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

4. Luck works against me
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree
5. I often feel like it’s my unlucky day
   (1) strongly disagree   (2) somewhat disagree   (3) slightly disagree
   (4) slightly agree     (5) somewhat agree      (6) strongly agree

6. I mind leaving things to chance because I am an unlucky person
   (1) strongly disagree   (2) somewhat disagree   (3) slightly disagree
   (4) slightly agree      (5) somewhat agree      (6) strongly agree

7. Even the things in life I can’t control tend to go my way because I’m lucky
   (1) strongly disagree   (2) somewhat disagree   (3) slightly disagree
   (4) slightly agree      (5) somewhat agree      (6) strongly agree

8. I consistently have good luck
   (1) strongly disagree   (2) somewhat disagree   (3) slightly disagree
   (4) slightly agree      (5) somewhat agree      (6) strongly agree

9. I often feel like it’s my lucky day
   (1) strongly disagree   (2) somewhat disagree   (3) slightly disagree
   (4) slightly agree      (5) somewhat agree      (6) strongly agree

10. Luck works in my favour
    (1) strongly disagree  (2) somewhat disagree   (3) slightly disagree
     (4) slightly agree    (5) somewhat agree      (6) strongly agree

11. I consider myself to be a lucky person
    (1) strongly disagree  (2) somewhat disagree   (3) slightly disagree
     (4) slightly agree    (5) somewhat agree      (6) strongly agree
12. I don’t mind leaving things to chance because I’m a lucky person
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

13. It’s a mistake to base any decisions on how unlucky you feel
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

14. Being unlucky is nothing more than random
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

15. It’s a mistake to base any decisions on how lucky you feel
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

16. Being lucky is nothing more than random
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

17. Some people are consistently lucky, and others are unlucky
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree

18. Some people are consistently unlucky, and others are lucky
   (1) strongly disagree  (2) somewhat disagree  (3) slightly disagree
   (4) slightly agree  (5) somewhat agree  (6) strongly agree
19. There is such a thing as good luck that favours some people, but not others.

   (1) strongly disagree   (2) somewhat disagree   (3) slightly disagree
   (4) slightly agree      (5) somewhat agree      (6) strongly agree

20. There is such a thing as bad luck that affects some people more than others.

   (1) strongly disagree   (2) somewhat disagree   (3) slightly disagree
   (4) slightly agree      (5) somewhat agree      (6) strongly agree

21. Luck plays an important part in everyone’s life

   (1) strongly disagree   (2) somewhat disagree   (3) slightly disagree
   (4) slightly agree      (5) somewhat agree      (6) strongly agree

22. I believe in Luck

   (1) strongly disagree   (2) somewhat disagree   (3) slightly disagree
   (4) slightly agree      (5) somewhat agree      (6) strongly agree
J.3 Game Experience Questionnaire – In-game Module (GEQ)

See original article for scoring:


Please indicate how you felt while playing the game you just finished for each of the items below.

1. I was interested in the game’s theme.

   | Not at all (0) | Slightly (1) | Moderately (2) | Fairly (3) | Extremely (4) |

2. I felt successful.

   | Not at all (0) | Slightly (1) | Moderately (2) | Fairly (3) | Extremely (4) |

3. I felt bored.

   | Not at all (0) | Slightly (1) | Moderately (2) | Fairly (3) | Extremely (4) |

4. I found the game impressive.

   | Not at all (0) | Slightly (1) | Moderately (2) | Fairly (3) | Extremely (4) |

5. I forgot everything around me.

   | Not at all (0) | Slightly (1) | Moderately (2) | Fairly (3) | Extremely (4) |
6. I felt frustrated.

<table>
<thead>
<tr>
<th>Not at all (0)</th>
<th>Slightly (1)</th>
<th>Moderately (2)</th>
<th>Fairly (3)</th>
<th>Extremely (4)</th>
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</thead>
</table>

7. I found it tiresome.

<table>
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<th>Moderately (2)</th>
<th>Fairly (3)</th>
<th>Extremely (4)</th>
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8. I felt irritable.

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<th>Fairly (3)</th>
<th>Extremely (4)</th>
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9. I felt skillful.

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<th>Fairly (3)</th>
<th>Extremely (4)</th>
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10. I felt completely absorbed.

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<th>Fairly (3)</th>
<th>Extremely (4)</th>
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11. I felt content.

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<th>Moderately (2)</th>
<th>Fairly (3)</th>
<th>Extremely (4)</th>
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12. I felt challenged.

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<th>Moderately (2)</th>
<th>Fairly (3)</th>
<th>Extremely (4)</th>
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</table>

13. I had to put a lot of effort into it.

<table>
<thead>
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<th>Slightly (1)</th>
<th>Moderately (2)</th>
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<td>(2)</td>
<td>(3)</td>
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J.4 Gambling Related Cognitions Scale (GRCS)

See original article for scoring:


Please indicate (by circling) the extent to which you agree with the value expressed in each statement

1 = strongly disagree    2 = moderately disagree    3 = mildly disagree
4 = neither agree nor disagree    5 = mildly agree    6 = moderately agree
7 = strongly agree

1. Gambling makes me happier
   1  2  3  4  5  6  7

2. I can’t function without gambling
   1  2  3  4  5  6  7

3. Praying helps me win
   1  2  3  4  5  6  7

4. Losses when gambling are bound to be followed by a series of wins
   1  2  3  4  5  6  7

5. Relating my winnings to my skill and ability makes me continue gambling
   1  2  3  4  5  6  7
6. Gambling makes things seem better
   1 2 3 4 5 6 7

7. It is difficult to stop gambling as I am so out of control
   1 2 3 4 5 6 7

8. Specific numbers and colours can help increase my chances of winning
   1 2 3 4 5 6 7

9. A series of losses will provide me with a learning experience that will help me win later
   1 2 3 4 5 6 7

10. Relating my losses to bad luck and bad circumstances makes me continue gambling
    1 2 3 4 5 6 7

11. Gambling makes the future brighter
    1 2 3 4 5 6 7

12. My desire to gamble is so overpowering
    1 2 3 4 5 6 7

13. I collect specific objects that help increase my chances of winning
    1 2 3 4 5 6 7

14. When I have a win once, I will definitely win again
    1 2 3 4 5 6 7

15. Relating my losses to probability makes me continue gambling
    1 2 3 4 5 6 7
16. Having a gamble helps reduce tension and stress
   1 2 3 4 5 6 7

17. I’m not strong enough to stop gambling
   1 2 3 4 5 6 7

18. I have specific rituals and behaviours that increase my chances of winning
   1 2 3 4 5 6 7

19. There are times that I feel lucky and thus, gamble those times only
   1 2 3 4 5 6 7

20. Remembering how much money I won last time makes me continue gambling
   1 2 3 4 5 6 7

21. I will never be able to stop gambling
   1 2 3 4 5 6 7

22. I have some control over predicting my gambling wins
   1 2 3 4 5 6 7

23. If I keep changing my numbers, I have less chances of winning than if I keep the same numbers every time.
   1 2 3 4 5 6 7
J.5  Internet Gaming Disorder Scale – 9-Item Dichotomous Version (IGDS)

See original article for scoring:


*During the last year...*

1. Have there been periods when all you could think of was the moment that you could play a game?  
   [Yes] [No]

2. Have you felt unsatisfied because you wanted to play more?  
   [Yes] [No]

3. Have you been feeling miserable when you were unable to play a game?  
   [Yes] [No]

4. Were you unable to reduce your time playing games, after others had repeatedly told you to play less?  
   [Yes] [No]

5. Have you played games so that you would not have to think about annoying things?  
   [Yes] [No]

6. Have you had arguments with others about the consequences of your gaming behavior?  
   [Yes] [No]

7. Have you hidden the time you spend on games from others?  
   [Yes] [No]
(8) Have you lost interest in hobbies or other activities because gaming is all you wanted to do?  
[Yes]   [No]

(9) Have you experienced serious conflicts with family, friends or partner because of gaming?  
[Yes]   [No]
J.6  Problem Gambling Severity Index (PGSI)

See original article for scoring:


In the past 12 months...

(1) Have you bet more than you could really afford to lose?

[Never]  [Sometimes]  [Most of the Time]  [Almost Always]

(2) Still thinking about the last 12 months, have you needed to gamble with larger amounts of money to get the same feeling of excitement?

[Never]  [Sometimes]  [Most of the Time]  [Almost Always]

(3) When you gambled, did you go back another day to try to win back the money you lost?

[Never]  [Sometimes]  [Most of the Time]  [Almost Always]

(4) Have you borrowed money or sold anything to get money to gamble?

[Never]  [Sometimes]  [Most of the Time]  [Almost Always]

(5) Have you felt that you might have a problem with gambling?

[Never]  [Sometimes]  [Most of the Time]  [Almost Always]

(6) Has gambling caused you any health problems, including stress or anxiety?

[Never]  [Sometimes]  [Most of the Time]  [Almost Always]
(7) Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?

[Never]  [Sometimes]  [Most of the Time]  [Almost Always]

(8) Has your gambling caused any financial problems for you or your household?

[Never]  [Sometimes]  [Most of the Time]  [Almost Always]

(9) Have you felt guilty about the way you gamble, or what happens when you gamble?

[Never]  [Sometimes]  [Most of the Time]  [Almost Always]
J.7 Schizotypal Personality Questionnaire – Brief (SPQ-B)

See original article for scoring:


https://doi.org/10.1521/pedi.1995.9.4.346

Please indicate whether you agree or disagree with the following statements by circling YES or NO.

1. People sometimes find me aloof and distant.
   
   YES         NO

2. Have you ever had the sense that some person or force is around you, even though you cannot see anyone?
   
   YES         NO

3. People sometimes comment on my unusual mannerisms and habits.
   
   YES         NO

4. Are you sometimes sure that other people can tell what you are thinking?
   
   YES         NO

5. Have you ever noticed a common event or object that seemed to be a special sign for you?
   
   YES         NO

6. Some people think that I am a very bizarre person.
   
   YES         NO
7. I feel I have to be on my guard even with friends.
   YES         NO

8. Some people find me a bit vague and elusive during a conversation.
   YES         NO

9. Do you often pick up hidden threats or put-downs from what people say or do?
   YES         NO

10. When shopping, do you get the feeling that other people are taking notice of you?
    YES         NO

11. I feel very uncomfortable in social situations involving unfamiliar people.
    YES         NO

12. Have you had experiences with astrology, seeing the future, UFOs, ESP, or a sixth sense?
    YES         NO

13. I sometimes use words in unusual ways.
    YES         NO

14. Have you found that it is best not to let other people know too much about you?
    YES         NO

15. I tend to keep in the background on social occasions.
    YES         NO

16. Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?
    YES         NO
17. Do you often have to keep an eye out to stop people from taking advantage of you?
   YES      NO

18. Do you feel that you are unable to get “close” to people?
   YES      NO

19. I am an odd, unusual person.
   YES      NO

20. I find it hard to communicate clearly what I want to say to people.
   YES      NO

21. I feel very uneasy talking to people I do not know well.
   YES      NO

22. I tend to keep my feelings to myself.
   YES      NO