Cognitive distortions in addictive consumption: Evidence from gambling

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Abstract

Across a wide range of commercially available products, some individuals engage in harmful addictive consumption. A challenging task for managers and policymakers is to identify how to modify commercial practices to reduce those harms, while minimizing unintended impacts on consumers without issues. In this study, we propose that one area of intervention should be the reduction of practices that reinforce cognitive distortions (maladaptive and erroneous thoughts) about likely consumption outcomes. Our study makes two direct contributions to the management literature. First, we extend the two-system model of consumer behavior to describe potential impacts cognitive distortions and discuss how they can lead to irrational choices. Our framing of ethical issues distinguishes between practices that are *intrinsic* to the goods sold, without which the product or service could be not be reasonably offered, and practices that are *extrinsic*, purposely added in the value chain to reinforce erroneous thoughts. Second, using the case of gambling disorders, we empirically implicate cognitive distortions in the development of addictive consumption and argue, using our findings and related literature, that management decisions can reinforce cognitive biases that lead to addictive behavior. We demonstrate that cognitive distortions are often purposefully reinforced by commercial gambling practices, and, using an instrumental variable identification strategy with a sample of gamblers (n=185), we demonstrate that cognitive distortions are likely to impact a pathway that leads to loss chasing, overspending, and addiction.

Keywords: addictive consumption; heuristics; illusion of control, misleading advertising; cognitive distortions; gambling disorders

Cognitive distortions in addictive consumption: Evidence from gambling

Researchers estimate that 15% to 61% of the U.S. adult population have features of some level of addiction over the past 12-months (Sussman, Lisha, & Griffiths, 2011). Many of these addictions relate to products that are commercially available. Alcohol, tobacco, caffeine, cannabis, and pharmaceutical drugs are legal goods in many jurisdictions and all appear in the reference manual of mental disorders published by the American Psychiatric Association (DSM-5, 2013). Other goods and services, including compulsive buying more generally, have been considered as additions to the manual (Pinna et al., 2015). But despite those impacts, most consumers do not have issues with compulsive consumption of specific goods (Sussman et al., 2011). In fact, even heavy users of illicit substances, such as daily users of smoked cocaine, can demonstrate evidence of rational purchase decision making (Hart, Haney, Foltin, & Fischman, 2000). A challenging task for firms and policymakers therefore emerges in how to balance commercial practices with regulations that reduce the risk of addictive consumption – i.e. continued consumption despite negative long-run consequences, which may relate to neurobiological, genetic, psychological, and sociological factors (Buchman, Skinner, & Illes, 2010; A. Goodman, 1990).

Although many policy interventions with addictive consumption are subjective, paternalistic, and related to cultural values and norms, we posit that for many consumers, there are unique features of addiction that may warrant stronger controls. In this study, we argue that some individuals engage in addictive consumption as function of domain specific irrational and maladaptive thoughts that compromise their ability to make informed consumption decisions beyond that implied by bounded rationality models (Kahneman, 2003; Tversky & Kahneman, 1974). Using the industrial setting of gambling, we argue that such related consumption is

welfare-reducing due to its impacts on rational decision making, and therefore warrants stronger interventions by firms and policymakers.

Gambling, an activity spanning several industries that includes lottery games, electronic gaming machines (e.g. slot machines or video lottery terminals), and sports/event wagering, is a particularly useful industry to use in examination of these issues as it is the first non-substance addiction to have been added as a mental health disorder in the Diagnostic and Statistical Manual of Mental Disorders (2013). It therefore has a set of validated psychometric scales that can be used to understand consumer behavior. This enables more precise measurement of its domain-specific distortions and risks, in support of potentially wider understanding of behavior by consumers with maladaptive thoughts.

Our study makes two direct contributions to the management literature. First, we extend the dual-process model of consumer behavior (e.g. Strack et al. 2006) to include the potential role of cognitive distortions, and describe how they can lead to irrational choices. Our framing of ethical issues distinguishes between practices that are *intrinsic* to the goods sold, without which the product or service could not be reasonably offered, and practices that are *extrinsic*, purposely added in the value chain to reinforce erroneous thoughts. Second, we empirically implicate cognitive distortions in the development of an addictive disorder and argue, using our findings and related literature, that management decisions can reinforce cognitive schemata that lead to addictive behavior.

In subsequent sections, we summarize evidence on cognitive distortions in gambling and risk-taking from the cognitive sciences. We then articulate several categories of commercial practices where cognitive distortions are purposefully reinforced by firms. To demonstrate the importance of these errors to consumer behavior, we describe how cognitive distortions can

impact rational decision-making within a dual-system model. We then use data from a community sample of Mechanical Turk participants and an instrumental variable identification strategy to address potential confounding bias (Angrist, Imbens, & Rubin, 1996), and estimate the impact of cognitive distortions on gambling disorder risk. We find evidence that cognitive distortions are likely to impact gambling disorders along our proposed pathway. Our discussion concludes with appropriate strategies and interventions in gambling industries, and extensions of the model to management practices more broadly.

Cognitive Distortions in Gambling

Gambling-related cognitive distortions are a set of loosely related errors in human decision-making that are connected by their relationship to the gambling consumption experience and their role in the development and maintenance of gambling disorders (Blaszczynski & Nower, 2002; Fortune & Goodie, 2012; Goodie & Fortune, 2013; Hodgins, Stea, & Grant, 2011; Toneatto, 1999). Much of the early research on gamblers' cognitive distortions derived from 'think-aloud' methods, where gamblers expressed their thoughts while gambling or performing related tasks (Gaboury & Ladouceur, 1989; Griffiths, 1994; Ladouceur, Gaboury, Dumont, & Rochette, 1988; Sharpe, 2002). Analysis of transcripts from these studies revealed several categories of maladaptive thoughts, which conflicted with an objective assessment of reality. For example, irrational verbalizations in Ladouceur et al. (1988) included misattributions about skill while playing a slot machine, "I'm getting good at this game. I think I've mastered it" (p.414). Correcting distorted thoughts became, and continues to be, an important part of treatment protocols for gambling disorders (Hodgins et al., 2011; Sharpe & Tarrier, 1993).

Several validated scales of gambling cognitive distortions were developed in the early-2000s (for a review, see Goodie & Fortune, 2013), leading to many studies that demonstrate a correlation between distorted thinking and gambling problems across multiple populations (Cunningham, Hodgins, & Toneatto, 2014; Joukhador, MacCallum, & Blaszczynski, 2003; MacKay & Hodgins, 2012; Xian et al., 2008). Today, leading etiological models, most notably the “pathway model”, propose a causal impact of cognitive distortions on gambling disorders (Blaszczynski & Nower, 2002; Hodgins et al., 2011; Sharpe, 2002). Cognitive distortions are described in this literature as playing a role in conjunction with classical and operant conditioning, through the intermittent reward and punishment structure of games. This leads to increased frequency of play and exposure, and potential development of more pervasive cognitive schema, which further shape and distort consumers’ experiences with gambling.

Gambling related biases include a class of heuristics and other misattributions that emerge throughout the gambling experience (Fortune & Goodie, 2012), which lead to false beliefs by the player about the likely outcomes of their play (Hodgins et al., 2011). These beliefs often do not correct over time or experience, and are related to persistence in gambling (Billieux, Van der Linden, Khazaaal, Zullino, & Clark, 2012). Across a range of logic or probability tasks, individuals often give irrational responses due to attributed use of heuristics instead of deliberate reasoning processes (Kahneman, Tversky, & Slovic, 1974). Although the use of heuristics can provide fast choices that do not burden limited executive resources, they can systemically fail to provide reasonable decisions (De Neys & Goel, 2011; Stanovich, 2000).

One of the largest categories of distorted thinking by gamblers is related to availability heuristics (Tversky & Kahneman, 1973), which are biases where events that are more easily recalled in memory are perceived as more likely to occur. These include gamblers drawing

illusory correlations between events, such as salient environmental features or the impact of superstitious beliefs, talismans, and behaviors (Fortune & Goodie, 2012). It also includes biases from selective memory, including more prominent recall of own and others' wins rather than losses (Griffiths, 1994; Hodgins et al., 2011).

Availability heuristics occur in individuals without reinforcement (Chapman, 1967). However, they are implicated in commercial practices such as advertisement of recent lottery winners at local stores (Guryan & Kearney, 2008) and making wins more salient than losses through slot machine sounds (Dixon et al., 2014). Guryan & Kearney (2008) estimate that retailers who advertise that they have sold a winning lottery tickets experience a 12 to 35% increase in ticket sales within the following weeks, suggesting that consumers are seeking out locations that they erroneously believe will increase their chances of winning. These types of effects drive use of superstitious elements in product design and marketing.

A second class of errors is related to the representativeness heuristic, where randomly distributed small sequences of numbers are believed to be representative of the distributions from which they are derived (Tversky & Kahneman, 1971). This set of errors includes the hot hand fallacy, which is a false belief that past success in randomly determined events is indicative that future success will occur. This cognitive distortion has most notably been reinforced in slot machines, where multiline games respond with lights and sounds similar to a win, despite a net loss occurring across multiple simultaneous wagers. Those outcomes, known as 'losses disguised as wins', are believed to be associated with overestimation of win rates, and are in machines found to be preferred by problem gamblers (Barton et al., 2017).

The gambler's fallacy is also an error in representativeness, and is found throughout the gambler's consumption experience (Croson & Sundali, 2005). The gambler's fallacy refers to a

mistaken belief that if an outcome has occurred more often in the past, it will occur less often in the future, despite the trials being statistically independent (Croson & Sundali, 2005). The fallacy is reinforced by firms in more subtle ways. For example, casinos typically allow slot machine customers to save seats, often connected to customers mistaken belief that the machine is 'due for a win'. Observational studies confirm that consumers bet consistently with the gambler's fallacy and hot hand (that a win will follow a series of wins) beliefs (Croson & Sundali, 2005; Xu & Harvey, 2014). The impact of the gambler's fallacy is further evident from observations that the amount of money bet on a particular lottery number falls sharply immediately after the number has been drawn and gradually recovers to its former level over the course of several months (Clotfelter & Cook, 1993).

Perhaps the most frequently reinforced cognitive distortion in the gambling industry is the illusion of control. This bias refers to an erroneous belief by players that they can influence games of chance through skillful behavior or decisions, or that they have influence over chance elements in games of mixed skill and chance (Ladouceur, Mayrand, Dussault, Letarte, & Tremblay, 1984; Langer, 1975). Many illusions appear due to core aspects of the games. For example, craps games require a player to roll dice, and players tend to place higher and more risky wagers on their own rolls than rolls by other players (Davis, Sundahl, & Lesbo, 2000). However, illusions of control are also reinforced through unnecessary game elements or other firm practices. For example, lottery advertisements often imply gamblers have control over outcomes by picking numbers (Miyazaki, Brumbaugh, & Sprott, 2001), and electronic gaming machines have features like stop buttons that appear to change reel outcomes, but have no actual influence on outcomes that were determined before the button was pressed (Inoue, 1998).

A related design feature that has received attention in both slot machine and instant ticket research is the artificial near-miss, where losses are purposefully manipulated to appear close to a winning outcome, rather than a randomly distributed loss appearance (Muir, 2009; Stange, Brown, Harrigan, & Dixon, 2017). Near misses are interpreted by gamblers as progress in mastering the game, and are therefore attributed as biases in illusion of control (Clark, 2010; Clark, Lawrence, Astley-Jones, & Gray, 2009; Griffiths, 1991; Stange, Grau, Osazuwa, Graydon, & Dixon, 2017). They may also encourage a gambler's fallacy bias, by implying that the game is close to a win, after a series of losses.

To provide a broad overview of the extent of cognitive distortion reinforcement in gambling industries, we describe several categories of popular commercial practices and related biases implicated in gamblers in Table 1.

Table 1: Popular extrinsic commercial marketing and product design elements that impact gamblers cognitive biases

Commercial practice	Examples	Biases
Depiction of lucky numbers in marketing	Logos, advertisements, designs, and promotions feature numbers attributed to fortune or luck. Typically, '7' in western cultures and '8' in eastern.	Superstitious beliefs may emerge through <i>availability heuristics</i> , as lucky numbers are associated more strongly with winning outcomes. They may also be related to an <i>illusion of control</i> over luck.
Depiction of lucky talismans or symbols in marketing	Logos, advertisements, designs, and promotions feature symbols attributed to fortune or luck. Common symbols include four leaf clovers, pots of gold, Maneki-Neko (lucky cat), and crossed fingers.	Superstitious beliefs may emerge through <i>availability heuristics</i> , as lucky symbols are associated more strongly with winning outcomes. They may also be related to an <i>illusion of control</i> over luck.
Irrelevant information on past outcomes	Includes baccarat score boards, roulette tote boards, and tracking of winning 'point' numbers on craps tables.	Implicated in gambler's fallacies and hot-hand fallacies, which are errors related to <i>availability heuristics</i> .

Commercial practice	Examples	Biases
Irrelevant information on past large wins	Includes lottery and keno winning stores, and slot machine jackpot winners. Often promoted in retail displays, in advertisements, and through earned media channels.	Making own and others' large wins more salient distorts perceived probability of winning through <i>representativeness heuristics</i> .
Artificial game controls	Features are added to games that create a sense of control over outcomes but have no actual impact. Includes stop buttons on slot machines, bonus games on electronic gaming with choice or controls, and betting on randomly determined virtual sports.	Game elements that imply control where there is none reinforce an <i>illusion of control</i> bias.
Losses disguised as wins	Multi-line slot machine games respond with lights and sounds similar to a win, despite a net loss occurring across multiple wagers.	Losses disguised as wins reinforce the hot-hand fallacy with increase "winning" game elements, an error related to <i>availability heuristics</i> .
Artificial near misses	Losing trials in electronic gaming machines and scratch cards are artificially manipulated to appear close to a winning outcome, rather than a randomly distributed loss.	Players view near misses as progress in mastering the game, reinforcing an <i>illusion of control</i> . May also affect gambler's fallacy by increasing belief that the game is due for a win.

Intrinsic and Extrinsic Reinforcement of Cognitive Distortions

We propose that there are two psychologically similar but ethically different categories of marketing and design through which commercial practices reinforce cognitive distortions: *intrinsic* features, which occur endogenously as a result of the provision of the gambling product, and without which the product could not be offered; and *extrinsic* practices, which are changes to the design of the product, environment, or marketing that meaningfully reinforce known cognitive distortions. We note that it is not a necessary condition that operators purposefully design extrinsic practices to target cognitive distortions. It is sufficient that they are redundant characteristics to the product and are reasonably implicated in cognitive distortions.

We distinguish between intrinsically and extrinsically reinforced cognitive distortions due to the ethical and practical implications for consumers overall. By our definition, curbing the occurrence of extrinsic practices has little, if any, impact on the ability for all consumers to continue to engage in what may be a rational and positive consumption event. Conversely, reducing the appearance of intrinsic features necessarily requires the removal of the gambling product altogether, which may be welfare reducing due to the restrictions it places on all consumers.

In some cases, the distinction between intrinsic and extrinsic elements may be clear. For example, near misses solely determined by a slot machine's random number generator and its implied link to the machine reels are an intrinsic feature – on some trials, a near miss will randomly occur. Near misses that are artificially created to inflate the frequency of occurrence are an extrinsic feature – they are a redundant game element that is not necessary to play a slot machine, and they are not consistent with a typical consumer's subjective experience in interpreting the randomness of outcomes.

In other cases, the distinction may be less clear. For example, in multi-line slot machines where gamblers can make multiple simultaneous wagers, it will be often be the case that trials will result in some lines winning but a net overall loss. Game designers must decide whether the machine will alert the gambler to the winning lines with the same lights and sounds as a typical win (loss disguised as a win), or to provide another response. In these less obvious circumstances, managers must contemplate the moral implications of their decisions more closely, weighing the trade-off between what may be an appealing product feature against the impact of reinforcing cognitive distortions.

Behavioral Model

To understand the implications of cognitive distortions in the decision making of gamblers and subsequent business practices, we use a dual process model as a framework of decision making (Strack & Deutsch, 2004). Dual process models are widely used to describe decision making, including acts of buying (Strack et al., 2006), models of health behavior (Hofmann, Friese, & Wiers, 2008), and models of addiction (Deutsch & Strack, 2006; Redish, Jensen, & Johnson, 2008). We view a dual process model as a useful framework for describing related phenomena, due to the clear distinction between impulsive and well-reasoned systems that models potentially conflicting cognitive processes involved in behavioral decisions (Strack & Deutsch, 2015).

In the reflective-impulsive two-system model (Strack & Deutsch, 2004, 2015; Strack et al., 2006), an impulsive system is conceptualized as a distinct organization of elements connected by associative links, which are automatic, inflexible, and capable of operating unconsciously (Krishna & Strack, 2017). The impulsive system interacts with a second, reflective system. The reflective system is slower, requiring effort and motivation, and is limited by working memory. But the reflective system, also referred to as the “rational” system, is capable of more complex and deductive reasoning.

System activation is influenced by environmental input and superordinate attention (Strack & Deutsch, 2004). Each of the two systems may be activated along a spectrum in different situations (Kahneman, 2003). The systems each connect to and activate behaviorally related schemata, and these schemata may be different and in conflict with one another. For example, observing a high Powerball jackpot may activate an impulsive schema that associates aspirational wealth with purchase of a lottery ticket. Conversely, the reflective system is

executing a decision to save money on non-essential purchases, perhaps connected to achievement of a longer-term goal, such as home down payment. Resolution is a function of strength of activation of respective schemata, and a set of moderating variables known as boundary conditions, including ego depletion, alcohol, habits, cognitive load, working memory, and mood (Hofmann & Friese, 2016; Hofmann et al., 2008).

There are compelling physiological reasons to believe that decision making and related heuristic biases operate like a two-system model, which have been demonstrated through neuroimaging studies (e.g. De Neys and Goel 2011; Evans 2012b; Goel 2003; Shulman et al. 2016). There are also domain-specific physiological reasons to use a two-system framework to describe decision making by gamblers. In an article that consolidates several lines of research to describe a model of choice in addiction, Noël et al. (2013) frame decision-making along competing brain systems, describing an impulsive, predominantly dependent on the amygdala-striatum, neural system, and a reflective system, mainly related to prefrontal cortex activity. They also describe a third system, identified physiologically as the insula region of the brain, which may mediate competing impulsive and reflective systems, along with other information transmitted from the body, like feelings of withdrawal (Naqvi, Rudrauf, Damasio, & Bechara, 2007; Noël et al., 2013; Turel & Bechara, 2016). This third system closely aligns with more recent cognitive views of dual-system models, which attempt to identify how conflicts between systems arise and are resolved (e.g. Pennycook et al. 2015).

In a conventional application of the reflective-impulsive model to harmful gambling decisions, the inability to attain subjective long-term wellness in an individual's consumption of gambling can be described as repeated resolutions of conflicting schemata where an impulsive schema outcompetes a reflective schema. This is analogous to a person impulsively eating a

unhealthy food on repeated occasions, despite intending to be on a long-term diet and knowing that eating unhealthy food is harmful to those related goals. We propose a different mechanism explaining the role of cognitive distortions in addictive consumption of gambling: through the formation and reinforcement of cognitive distortions, the gambler forms a distorted understanding of the likely experiences from gambling. Depending on the distortion implicated, the individual may believe that they can control outcomes, can predict outcomes, have a higher than actual chance of winning, or similarly maladaptive thoughts. As a result, the schema activated by the reflective system may encourage gambling behavior as an action likely to lead to winning and wealth, rather than compete against impulsive schemata with an objective perspective grounded in realistic outcomes.

This view aligns with more recent perspectives on dual process models that provide evidence that there are two potential sources of biased responses by individuals: (1) a failure to engage conflicting schemata that would activate the reflective system; and (2) successful engagement of the reflective system, but a failure to override the biased response (De Neys, 2014; Evans, 2012b; Pennycook et al., 2015). It appears plausible that gambling cognitive distortions initially influence decision making through the latter, but ongoing conditioning may lead to more biases relating to the former. That is, individuals may question the causes of gambling-related outcomes, but in using their environment to inform their understanding, including commercial practices that promote distorted ideas, their reflective system may fail to adequately recognize the role of chance. If gamblers believe that they are likely win due to a fundamental misunderstanding of the game elements or their own abilities, even a ‘reasoned’ deductive process leads to the decision to gamble. Over time, this may condition individuals such

that the bias occurs without reflection. The result is continued gambling, whether there is adequate activation of the reflective system to consider the likely outcomes or not.

In addition to explaining non-clinical gambling consumption behavior, this model helps further explain gambling disorder's etiology. A seminal model of gambling addiction, the pathways model of problem gambling, has been substantiated empirically and integrates understanding of biological, psychological and ecological variables across three sub-types of gamblers (Blaszczynski & Nower, 2002; Chan & Ohtsuka, 2014; Hodgins et al., 2011; Ledgerwood & Petry, 2010; Milosevic & Ledgerwood, 2010; Moon, Lister, Milosevic, & Ledgerwood, 2017; Nower & Blaszczynski, 2004, 2017; Valleur et al., 2016). Across three sub-types of gamblers, the authors propose a causal role for distortions in reinforcing schema through habit formation, which then lead to chasing behavior and losing more money than expected.

In Figure 1, we illustrate our description of how cognitive distortions can enter the reflective system in two-system model, and we further illustrate where the "pathways model" would propose specific consumption behaviors connect to development of a gambling disorder. Losing more than expected is related to excessive risk taking, where the consequences include unforeseen financial stress and related thoughts like guilt and regret (Fortune & Goodie, 2012; Golec & Tamarkin, 1995; Goodie, 2005; Lakey, Goodie, & Campbell, 2007). Overspending is also related in some empirical studies to overconfidence, a characteristic closely connected to cognitive distortions (Goodie, 2005; MacKay, Bard, Bowling, & Hodgins, 2014). Loss chasing refers to continuing to gamble to recover losses, which may be related to false beliefs about the likelihood of winning, and further exacerbate the negative financial and emotional impacts of gambling (Breen & Zuckerman, 1999; Campbell-Meiklejohn et al., 2011; Campbell-Meiklejohn,

Woolrich, Passingham, & Rogers, 2008). Both loss chasing and losing more than expected are viewed as direct contributors to gambling disorder development in the “pathways model”.

Figure 1: Model illustrating the role of cognitive distortions in the development of gambling disorders. Adapted from Hofmann, Friese, & Wiers (2008), with the addition of Blaszczynski and Nower’s (2002) pathways model, which suggests a path from chasing losses and overspending to gambling disorders. Cognitive distortions are implicated in the development of reflective processes, and therefore can bias decision making and related behaviors in the formation of consumption decisions.

We note that there is ongoing debate in the literature about the causal role of cognitive distortions in the development of clinical levels of addiction. Despite the appearance of cognitive distortions in individuals with gambling disorders, many gamblers experience some of these phenomena without meeting clinical criteria (Goodie & Fortune, 2013). Given that most literature examining cognitive distortions and gambling problems has been associative, and

distortions occur in gamblers without problems, some scholars have questioned the importance to gambling disorder etiology (Dickerson & Baron, 2000; Potenza, 2014). However, recent neuropsychological research has provided evidence that there may be a physiological link. Individuals with damage to their insula show no evidence of gambling-related cognitive distortions compared to healthy individuals or individuals with damage to other areas of the brain (Clark, Studer, Bruss, Tranel, & Bechara, 2014), which is consistent with broader models of addictive behavior (Noël et al., 2013).

Hypotheses

The two-system model we describe helps explain how many schemata can compete for behavioral control. However, there are empirical challenges in estimating relationships with statistical consistency. This is due to the role of the reflective system in conditioning the impulsive system, the role of gambling experiences in framing reflective cognitions, and the potential feedback of gambling problems in further contributing to cognitive distortions. We therefore identify the following two hypotheses, which recognize these endogenous effects:

H1: Gambling-related cognitive distortions are related to increases in loss chasing after controlling for endogenous effects.

H2: Gambling-related cognitive distortions are related wagering more than an individual can subjectively afford to lose after controlling for endogenous effects.

As a function of the purported pathway from cognitive distortions to harmful gambling consumption, the following third hypothesis emerges directly:

H3: Gambling-related cognitive distortions are positively related to gambling problems severity, after controlling for endogenous effects.

Methods

Cognitive distortions in gambling are formed over time and their prospective impact on harmful consumption is similarly long, making experimental design infeasible. To test our hypotheses, we employ an instrumental variable method in this study, using self-reported survey information from a community sample. Instrumental variable methods can improve the consistency of empirical models when there are endogenous effects (Angrist & Imbens, 1995; Angrist et al., 1996; Baiocchi, Cheng, & Small, 2014; Rassen, Brookhart, Glynn, Mittleman, & Schneeweiss, 2009). As we are examining reflective processes, a survey based approach is suitable to our study. Hofmann et al. (2008) describe explicit measures of verbal self-report as descriptive of reflective systems, as the symbolic processes by which communication with others is facilitated are connected to reflective precursors of behavior. Two classes of models are estimated using Stata 15.1 and its extended regression models package (StataCorp LLC, 2017).

Participants

Due to the low prevalence of persons with gambling problems in the general population, which is estimated at less than 1% of adults (Kessler et al., 2008), we recruit gamblers through the Amazon Mechanical Turk (MTurk) panel. Online panels are noted to have over four times the incidence of persons with gambling disorders than random-digit dialed samples (Lee, Back, Williams, & Ahn, 2015). Individuals join MTurk's platform without recruitment and choose to complete solicited tasks in exchange for compensation from the solicitor. Most workers are jointly motivated by financial compensation and enjoyment of the tasks (Paolacci & Chandler, 2014).

Participants in this study were restricted to those with an MTurk approval rating of at least 95 percent. Past research has shown that respondents with 95 percent approval ratings show

higher consistency, better attention, and lower social desirability bias (J. K. Goodman, Cryder, & Cheema, 2013; Peer, Vosgerau, & Acquisti, 2014). To further reduce social desirability bias, respondents were told their data would be anonymous and the specific nature of the research question was concealed (Paolacci & Chandler, 2014). Subjects were told they would complete a survey with a number of questionnaires asking about thoughts and intention to play various gaming and gambling machines.

Participants were English speaking North Americans of the legal gambling age that had lived in or visited the jurisdictions that contain the games discussed in the study (Nevada, New Jersey, Connecticut, and California) in the past 12 months. A total of 232 respondents were recruited, and 48 responses were removed due to failing at least one of two attention checks or not completing the survey. The sample was more male (67.93%) with a mean age of 34.0 ($SD=9.3$). Study procedures were approved by the [redacted] Human Research Ethics Committee.

Measures

The Gamblers Belief Questionnaire. A validated and self-administered psychometric measure of gambling cognitive distortions, the gambler's belief questionnaire (GBQ, Steenbergh et al. 2002; Winfree et al. 2015), is used to assess relative distortions. The GBQ was originally validated through five studies described in Steenbergh et al. (2002), and further studies have found it to be a valid scale (Marchetti et al., 2016; Philander, Gainsbury, & Grattan, 2019; Winfree, Meyers, & Whelan, 2013; Wong & Tsang, 2012). The scale includes 20-items measured on a 7-point scale (1 = strongly agree, 7 = strongly disagree), which are reverse coded and summed ($m=71.12$, $sd=9.48$). Higher scores indicate higher levels of cognitive distortions. There are two subscales: 1) An 8-item illusion of control construct; and 2) a 12-item luck/perseverance

construct, which is broadly composed of gambler's fallacy related questions.

The Problem Gambling Severity Index. Gambling disorders are measured using the problem gambling severity index (Ferris & Wynne, 2001). The index is a self-reported epidemiological measure of gambling addiction. The authors describe the tool as designed to measure harmful consequences of gambling behavior in the general population. The initial validation study demonstrated a unidimensional factor structure, good internal consistency ($\alpha = .84$), adequate test-retest reliability ($r = .78$), and subjectively good construct validity. The index has been validated across multiple populations (Currie et al., 2013; Holtgraves, 2009; Jackson, Wynne, Dowling, Tomnay, & Thomas, 2010; N. V. Miller, Currie, Hodgins, & Casey, 2013; Orford, Wardle, Griffiths, Sproston, & Erens, 2010; Sharp et al., 2012) and in multiple languages (Loo, Oei, & Raylu, 2011; Lopez-Gonzalez, Estévez, & Griffiths, 2018; Marchetti et al., 2016; So, Matsushita, Kishimoto, & Furukawa, 2019).

Two of the nine total items from the index are used to test H1 and H2, respectively: (1) [thinking about the last 12 months] "When you gambled, did you go back another day to try to win back the money you lost?"; and (2) "Have you bet more than you could really afford to lose?". Item (1) originally appeared in the fourth edition of the American Psychiatric Association's diagnostic manual (2012). Item (2) originally appeared in the South Oaks Gambling Screen (Lesieur & Blume, 1987). Both screens were developed for use with clinical populations. All items responses occur on a four-point Likert scale: 0, "Never"; 1, "Sometimes"; 2, "Most of the time"; or 3, "Almost always". Item scores are summed and total scores range from 0 to 27, with four interpretative categories (Currie et al., 2013): 0, non-gambler/non-problem gambler ($n=83$, 45.11%); 1-4, low-risk gambler ($n=48$, 26.09%); 5-7, moderate-risk gambler ($n=13$, 7.07%); and >7 , problem gambler ($n=40$, 21.74%).

Skill and chance variables. Respondents are asked to order a series of gambling games (e.g. slot machines) and non-gambling games (e.g. chess) along a 100-point scale from all skill (0) to all chance (100), which we exploit to form our instrumental variables. The instrumental variables are the difference in an individual's perceived slot machine skill/chance ($m=89.93$, $sd=14.65$) from its mean score across all participants (perceived slot skill), and the difference in an individual's perceived poker skill/chance ($m=19.77$, $sd=30.67$) from its mean score across all participants (perceived poker skill).

We propose that individual's experiences playing, observing, or otherwise learning about particular games are likely to influence their potentially distorted thoughts on skill and chance elements of that game, and therein impact their overall cognitive distortions in gambling as measured by the GBQ. Slot machines are games of pure chance, and we expect respondents with stronger cognitive distortions to overvalue the role of skill in slot machines relative to other respondents. Poker is a game of mixed skill and chance, and with the slot machine instrument capturing illusion of control effects, we expect the poker variable will capture further cognitive distortions related to an undervaluation of the role of skill in poker, either through attributing negative outcomes to luck (i.e. attribution bias) or viewing it as similar to other card-based table games (i.e. representativeness bias). We test the power of our instruments as part of our empirical analysis, and control for frequency of play of slot machines and poker.

Other variables. Respondents are asked about frequency of play in various games over the past 12-months on a six-point Likert scale ranging from "Not at all in the past year" to "Daily". Respondents are asked several demographic questions, including age, gender identity, race, income level, and education level.

We estimate linear models using questions of loss chasing, over-spending, and overall problem gambling severity index scores as the dependent variable, and we estimate ordered probit models using problem gambling severity index categories as the dependent variable.

Results

To test if the specific behavioral items related to H1 and H2 are implicated in the relationship with GBQ, we produce an ordered probit model with endogenous regressors for both dependent variables in Table 2. As shown, all model estimates produce a positive significant relationship between increased loss chasing and GBQ scores, supporting H1. Similarly, we estimate a positive relationship between reported over-spending and GBQ, supporting H2. After controlling for frequency of game play, gender, age, race, income, and education, and other endogenous effects, higher rated gambling cognitive distortions score are associated with higher likelihood to reply “Sometimes” or more, and a lower likelihood of reporting “Never”, as shown in the estimated marginal effects.

Table 2: Ordered probit with endogenous regressor – Loss chasing and overspending

	(1) DV: Loss Chasing	(2) DV: Loss Chasing	(3) DV: Loss Chasing	(4) DV: Over- spending	(5) DV: Over- spending	(6) DV: Over- spending
GBQ	0.043*** (0.005)	0.047*** (0.006)	0.036*** (0.007)	0.056*** (0.006)	0.056*** (0.006)	0.046*** (0.006)
Slot play freq.			0.445*** (0.107)			0.344** (0.113)
Poker play freq.			0.0717 (0.102)			0.107 (0.101)
Gender	No	Yes	Yes	No	Yes	Yes
Age group	No	Yes	Yes	No	Yes	Yes
Race	No	Yes	Yes	No	Yes	Yes
Income	No	Yes	Yes	No	Yes	Yes
Education	No	Yes	Yes	No	Yes	Yes
<i>First stage instrument estimates (DV: GBQ)</i>						
Perc. slot skill	-0.954*** (0.143)	-0.963*** (0.136)	-0.959*** (0.138)	-0.950*** (0.141)	-0.955*** (0.135)	-0.951*** (0.137)
Perc. poker skill	0.357*** (0.079)	0.349*** (0.079)	0.352*** (0.079)	0.360*** (0.077)	0.356*** (0.076)	0.359*** (0.076)

<i>Average marginal effects of GBQ</i>						
Never	-0.009***	-0.008***	-0.005***	-0.008***	-0.007***	-0.004***
Sometimes	0.003***	0.003***	0.002***	0.003***	0.003***	0.002***
Most of the time	0.004***	0.003***	0.002**	0.003***	0.002*	0.001**
Almost always	0.003**	0.002**	0.001*	0.002*	0.001**	0.001**

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We further test the validity of our instruments in our linear model estimating problem gambling severity index scores. We note that all models in this study have the same first-stage equation variables. The fully specified linear two-stage regression model (Table 3, Model 6) is statistically significant (adjusted $R^2 = .63$, $\chi^2(22, n=184)=619.97$, $p<.001$). The perceived slot skill variable appears to be a good instrument ($\beta=-0.596$, $p<.001$), while the perceived poker skill variable is not significant ($\beta=0.123$, $p=.071$). We retain perceived poker skill as an instrument, as it is significant in the similar ordered regression model appearing in Table 4 ($\beta=0.330$, $p<.001$), which is functional form that may better align with the distribution of the scale (Currie et al., 2013). Jointly, the instruments perform well. The F-test of weak identification = 15.740, exceeding the benchmark value of 10, and suggesting that these variables satisfy a necessary condition of strong instruments (Sovey & Green, 2011; Staiger & Stock, 1997). The Sargan test statistic $\chi^2 = 0.202$, $p = 0.653$, failed to reject the assumption that perceived skill variables do not belong in the structural equation predicting PGSI scores (Sargan, 1958), supporting the other necessary condition. In all the linear models, higher GBQ scores are associated with higher PGSI scores, supporting H3.

Table 3: Linear regression – Problem gambling severity index score

	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
GBQ	0.154*** (0.013)	0.114*** (0.014)	0.045*** (0.015)	0.221*** (0.021)	0.187*** (0.031)	0.161** (0.050)
Slot play freq.			1.755*** (0.415)			0.701 (0.579)
Poker play freq.			0.874*			0.142

			(0.402)			(0.529)
Constant	-6.660***	1.025	-3.012	-11.43***	-6.817	-7.681**
	(0.772)	(2.246)	(1.861)	(1.479)	(3.640)	(2.824)
Gender	No	Yes	Yes	No	Yes	Yes
Age group	No	Yes	Yes	No	Yes	Yes
Race	No	Yes	Yes	No	Yes	Yes
Income	No	Yes	Yes	No	Yes	Yes
Education	No	Yes	Yes	No	Yes	Yes
<i>First stage instrument estimates (DV: GBQ)</i>						
Perc. slot skill				-0.954***	-0.892***	-0.596***
				(0.145)	(0.146)	(0.148)
Perc. poker skill				0.357***	0.227**	0.123
				(0.079)	(0.078)	(0.068)
Observations	184	184	184	184	184	184
Adjusted R ²	0.510	0.601	0.703	0.412	0.515	0.578

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In our ordinal models estimating problem gambling severity index groups, GBQ is statistically significant and the correct sign, again supporting H3. As shown in Table 4, across all marginal effect estimates, higher cognitive distortions are associated with a lower probability of belonging to the non-problem gambler category and a higher probability of belonging to one of the problem gambling risk categories. The endogenous ordered probit model instruments are all statistically significant, $p < 0.001$, again suggesting that the instruments are strong.

Table 4: Ordered regression - Problem gambling severity index group

	(1)	(2)	(3)	(4)	(5)	(6)
	OLogit	OLogit	OLogit	EOProbit	EOProbit	EOProbit
GBQ	0.071***	0.067***	0.044***	0.048***	0.049***	0.039***
	(0.009)	(0.010)	(0.011)	(0.004)	(0.004)	(0.005)
Slot play freq.			0.886***			0.369***
			(0.234)			(0.109)
Poker play freq.			0.399			0.182
			(0.214)			(0.093)
Gender	No	Yes	Yes	No	Yes	Yes
Age group	No	Yes	Yes	No	Yes	Yes
Race	No	Yes	Yes	No	Yes	Yes
Income	No	Yes	Yes	No	Yes	Yes
Education	No	Yes	Yes	No	Yes	Yes

First stage instrument estimates (DV: GBQ)

Perc. slot skill -0.960*** -0.986*** -0.984***

				(0.143)	(0.131)	(0.134)
Perc. poker skill				0.352***	0.328***	0.330***
				(0.079)	(0.076)	(0.076)
<i>Average marginal effects of GBQ</i>						
Non-problem	-0.010***	-0.008***	-0.005***	-0.008***	-0.006***	-0.003**
Low-risk	0.001***	0.002***	0.002***	0.001***	0.002***	0.001***
Moderate risk	0.001***	0.001**	0.001**	0.001***	0.001**	0.001*
Problem	0.008***	0.005***	0.002***	0.006***	0.003***	0.001*
Robust standard errors in parentheses						
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$						

Discussion

The repeated cycle of consumption by consumers with addictions is challenging to explain within the domain of consumer behavior models. There are many opportunities for long-term reflection, but harmful consumption continues. One compelling explanation for the observed behavior is that consumers may be using a compromised reflective decision-making system. Consumers may hold distorted thoughts about their relationship to the subject of consumption, and because of this, may not have the cognitive capacity to make behavioral changes that are beneficial to their long-run welfare. In our two-system model of gamblers' cognitive processes, even if a gambling consumer is using their reflective capacities to initiate a behavioral decision, their beliefs may simply be distorted. This leads to poor outcomes that do not self-correct. In fact, such systems may reinforce into stronger schemata over time.

Our empirical findings support a key component of this model. The impact of gambling-related cognitive distortions on loss-chasing and overspending appears to be robust. Further, a similar relationship appears between cognitive distortions and gambling disorders. While past research has shown a strong correlation between these items, our findings add to the confidence in the direction of the relationship due to the ability of our empirical model to control for endogenous effects. This complements neuropsychological research in gambling disorders, where there is substantial and growing evidence these processes are physiological and extend to

other substances and behaviors (Clark, 2014; Naqvi, Gaznick, Tranel, & Bechara, 2014). Based on our review of the addiction literature, our model of the role of cognitive distortions in reflective processes, and the evidence from our empirical analysis, it appears likely that there is a causal pathway that connects cognitive distortions to failures in rational decision making about spending money on gambling.

Although gambling industries are a useful setting in which to explore commercial practices and irrational decision making by consumers, our results hold management implications more generally. An accurately informed reflective system is a necessary tool to control consumption of any good that naturally creates an approach orientation by the impulsive system. Management practices that deceive consumers may have a relatively innocuous impact on short-term welfare, such as unmet marketing promises that lead to modest purchase regret. Other practices are more directly implicated in the wellbeing of consumers. For example, many food products make truthful but misleading claims that can lead to poor health outcomes over a long period of time, such as high calorie foods that are labeled as ‘low-fat’ to attract weight conscious eaters (Hastak & Mazis, 2011). Non-durable goods with a high satiation threshold like gambling can be particularly damaging, due to the potential of ongoing harms.

Related ethical issues for managers may extend beyond cases of addictive consumption. For example, body image cognitive distortions are heavily involved in the etiology of anorexia nervosa, a feeding and eating disorder (*Diagnostic and statistical manual of mental disorders* 2013). Some scholars propose that industrialization and related media exposure plays an environmental role in related development (Smink, Van Hoeken, & Hoek, 2012; Zipfel, Giel, Bulik, Hay, & Schmidt, 2015). Managers should consider how their practices may

simultaneously add value to some users' consumption experience, while contributing to psychological disorders and harms in other users.

Management and Policy Advice

There are direct implications of these findings to business practices. Many aspects of the consumer experience intrinsically reinforce maladaptive thoughts, which leads to irrational consumption decisions. Firms should engage in practices that minimize these effects. For example, standardized food labels can reduce asymmetric information about unhealthy foods that lead to undesirable consumption decisions (Golan, Kuchler, Mitchell, Greene, & Jessup, 2001). Although some casino firms have introduced responsible gambling programs that discourage cognitive distortions, robust responsible gambling programs are rare (e.g. Cheng, Leung, & Stanley, 2015; Hing, 2001), and operator license quotas in most jurisdictions makes it unlikely for firms to compete on the strength of those programs. Market mechanisms are therefore unlikely to discipline unethical firms. In addition, many firms also engage in extrinsic practices that overtly reinforce those same distortions. This has helped lead to the skepticism held by many observers' about the morality of private gambling companies (Cheng et al., 2015; Markham & Young, 2015; R. Miller & Michelson, 2013).

Specific practices adopted by some firms and policymakers in the gambling industry seem helpful to adopt more widely across industry. Interventions to educate players and the public of common distortions can be used to enable resistance to the development of erroneous cognitive schemata (Shaffer, Ladouceur, Blaszczynski, & Whyte, 2016). If a reflective system can effectively rationalize likely consequences of consumption, an individual can resist competing schema from the impulsive system and consider other tactics more aligned with their long-term goals or wellness, such as leaving debit cards at home during casino visits. This may

be particularly important for youth and young adults who do not have firmly established beliefs. Prior research has provided evidence that even simple warning labels on lottery tickets may be effective in reducing play from distorted thought processes (Miyazaki et al., 2001), and this is also consistent with evidence on the effectiveness of food labeling, which is found to lead to more healthy eating decisions (Cecchini & Warin, 2016).

Managers should closely examine the occurrence of extrinsic reinforcement practices in their operations. Given the evidence of widespread commercial practices, substantial regulatory intervention may be appropriate in some cases. This could include restriction of advertisements or promotions that portray or encourage myths, and restriction of product design features. We note that a thoughtful approach is needed since consumers typically benefit from more liberalistic policies that presume rational decision making, and restrictive policies may needlessly constrain choice for many consumers.

Limitations and Future Research

This study proposed a model to understand the role of cognitive distortions in addictive consumption, but it is dependent on underlying assumptions of the reflective-impulsive two-system model. Although there is much empirical literature establishing a relationship between gambling disorders and cognitive distortions, further empirical analysis to our small sample would be useful strengthen the causal argument, as would consideration to the emergence of similar phenomena in other industries, which would help illustrate the extent to which these findings are generalizable across consumer behavior. Future research should consider the relative importance of specific biases in the development of addiction, as well the influence of specific industry practices. As noted, cognitive disorders have been implicated in other health-related behaviors, and industry practices may unnecessarily reinforce some of those mechanisms.

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