

Erroneous Gambling-Related Beliefs as Illusions of Primary and Secondary Control: A Confirmatory Factor Analysis

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Abstract Different classification systems for erroneous beliefs about gambling have been proposed, consistently alluding to ‘illusion of control’ and ‘gambler’s fallacy’ categories. None of these classification systems have, however, considered the how the illusion of control and the gambler’s fallacy might be interrelated. In this paper, we report the findings of a confirmatory factor analysis that examines the proposal that most erroneous gambling-related beliefs can be defined in terms of Rothbaum et al.’s (J Pers Soc Psychol, doi:[10.1037/0022-3514.42.1.5](https://doi.org/10.1037/0022-3514.42.1.5), 1982) distinction between ‘primary’ and ‘secondary’ illusory control, with the former being driven to a large extent by the well-known gambler’s fallacy and the latter being driven by a complex of beliefs about supernatural forces such as God and luck. A survey consisting of 100 items derived from existing instruments was administered to 329 participants. The analysis confirmed the existence of two latent structures (beliefs in primary and secondary control), while also offering support to the idea that gambler’s fallacy-style reasoning may underlie both perceived primary control and beliefs about the cyclical nature of luck, a form of perceived secondary control. The results suggest the need for a greater focus on the role of underlying processes or belief structures as factors that foster susceptibility to specific beliefs in gambling situations. Addressing and recognising the importance of these underlying factors may also have implications for cognitive therapy treatments for problem gambling.

Keywords Gambling-related beliefs · Illusion of control · Gambler’s fallacy · Luck · Factor analysis

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Introduction

Erroneous beliefs about gambling have long been thought to play a role in the development and maintenance of problem gambling (e.g., Ladouceur et al. 2001; Walker 1992b). The beliefs have been documented in therapy case studies, interviews, and transcripts of gambling sessions in which players verbalise their thoughts (Griffiths 1994; Keren and Wagenaar 1985; Ladouceur et al. 2002; Livingstone et al. 2006; Toneatto et al. 1997; Walker 1992a). Surveys of these beliefs have also been developed, typically requiring the respondent to express his or her degree of agreement with a number of erroneous statements about gambling (e.g., “My choices or actions affect the game on which I’m betting”); for a review, see Goodie and Fortune 2013).

Suggestions about categories of erroneous gambling-related beliefs have come in the form of survey factor analyses and theoretical reviews of the original interviews and session transcripts. Both types of suggestions (interpretations of factor analysis results and qualitative reviews) often make reference to the ‘illusion of control’, the ‘gambler’s fallacy’, and the more general heuristics and biases literature of which the gambler’s fallacy literature is a part (e.g., Fortune and Goodie 2012; Griffiths 1994; Raylu and Oei 2004; Toneatto 1999; Wagenaar 1988; Wood and Clapham 2005). This paper proposes and tests a conceptual framework according to which most erroneous gambling-related beliefs can be categorised with reference to two variants of the illusion of control, both of which reflect the gambler’s fallacy.

Conceptual Issues Surrounding Existing Belief Typologies

Factor-analytic investigations of belief-survey data and other typologies of erroneous gambling-related beliefs have consistently made reference to the illusion of control, the gambler’s fallacy or ‘representativeness bias’, and biases other than representativeness. The illusion of control refers to the tendency for people to overestimate the extent to which their actions (e.g., choices) influence outcomes in games of chance. In a seminal study, Langer (1975) observed that people placed greater value on lottery tickets they had chosen than on ones they had been randomly allocated. Langer concluded that the illusion of control occurs as a result of the confusion of games of chance with skilled activities, since games of chance almost invariably possess features of skilled tasks. These features include opportunity for choice and physical involvement (e.g., as when a lottery allows for ticket choice). In a later literature review, Rothbaum et al. (1982) suggested that there are two types of the illusion of control: ‘primary’ and ‘secondary’. Illusory primary control relates to strategies aimed at physically changing the game environment, whereas illusory secondary control involves attempts to influence outcomes through alignment with higher forces such as luck and God.

The gambler’s fallacy is a well-documented belief about the sequencing of chance-based outcomes. Specifically, it is the belief that random sequences tend to self-correct even in the short-term, producing a ‘head’ after a series of ‘tails’ in a coin toss game, a ‘red’ after a series of ‘blacks’ in roulette, and a win after a series of losses on slot machines (Nickerson 2002; Oskarsson et al. 2009). The fallacy is commonly expressed in behaviours such as the seeking out of slot machines that are ‘due’ for a win (e.g., Jefferson and Nicki 2003). The most widely cited explanation for the fallacy is Kahneman and Tversky’s (1972) proposal that, when making judgements about whether a stimulus (e.g., a sequence) is a member of some stimulus category (e.g., random sequences), people consistently apply the ‘heuristic’, or short-cut, of making the decision based on the extent to which the

stimulus possesses the category's defining features (e.g., equiprobability of possible outcomes). Decision-making based on heuristics such as this 'representativeness heuristic' is usually efficient but can lead to systematic errors, known as 'biases'. Under this account, the gambler's fallacy, the erroneous belief that short random sequences must possess the essential characteristics of long random sequences, is one example of the bias resulting from the application of the representativeness heuristic.

Typologies of erroneous gambling-related beliefs have also defined belief categories stemming from the misapplication of other identified heuristics, including, most notably, the 'availability heuristic' (Tversky and Kahneman 1973, 1974). Essentially, existing typologies classify erroneous gambling-related beliefs as instances of 'representativeness, availability or other (including the illusion of control)' (Fortune and Goodie 2012; Griffiths 1994; Toneatto 1999; Toneatto et al. 1997).

A problem with this classification system is that it defines the illusion of control and the gambler's fallacy as separate belief categories even though many of the beliefs relating to systems and strategies in gambling (often considered instances of the illusion of control) are likely to be related to the gambler's fallacy. For example, people who have a strategy for picking slot machines, knowing when to stop playing, or knowing which numbers to pick in roulette or lotteries will often refer to outcomes being more (or less) likely because of the preceding event sequence (e.g., Livingstone et al. 2006).

A related problem is that, given the number of 'gambler's fallacy' beliefs that can be labelled instances of the illusion of control, it might be the case that many 'gamblers fallacy' beliefs can be accounted for without reference to heuristics and biases. Instead, accounts and typologies could be based on existing explanations of the illusion of control, of which Langer's (1975) original explanation is but one (for alternative explanations, see Bar-Hillel and Neter 1996; Cummins and Nistico 2002; Leotti et al. 2010; Rothbaum et al. 1982; Thompson et al. 1998).

Another potential difficulty with gambling-beliefs typologies is that they do not recognise possible overlaps between 'beliefs about luck' and the illusion of control and gambler's fallacy. Typologies and surveys of gambling-related beliefs most frequently define luck as a supernatural force with which players attempt to engage through rituals and objects (e.g., lucky charms; Henslin 1967; Joukhador et al. 2004; Toneatto 1999). Appealing to luck in this way is a form of illusory secondary control under Rothbaum et al.'s (1982) definition. Luck may also be linked to the gambler's fallacy in that those who subscribe to the fallacy may reason that luck comes in cycles. Indeed, people have reported believing that a skilled player is one who is able to know when their luck is 'in season' and who can anticipate when luck is no longer available (Keren and Wagenaar 1985). People have also been found to conceive of luck as a stable personal quality, possessed by individuals to various degrees (Wohl and Enzle 2009).

Given the unresolved conceptual issues surrounding typologies of erroneous gambling-related beliefs, it is necessary to suggest a typology that accounts for possible interrelationships between the gambler's fallacy, the illusion of control and beliefs about luck. To achieve this, it is also necessary to better define the illusion of control, considering competing explanations for it and, in light of these considerations, determining whether there is merit to defining the illusion in terms of 'primary' and 'secondary' variants. Below, we outline one possible explanation for the illusion of control—an explanation that recognises the illusion's relationship to the gambler's fallacy and beliefs about luck, and that distinguishes between the illusion's primary and secondary variants. A typology of erroneous gambling-related beliefs proceeding from this explanation is then outlined, along with an approach to testing whether the conceptual framework underlying the typology is sound.

An Alternative Typology

Our conceptual framework for classifying erroneous gambling-related beliefs proceeds from the assumption that the vast majority of documented erroneous gambling-related beliefs are instances of the illusion of control. That is, we assume that most erroneous gambling-related beliefs are beliefs about effective actions to take while gambling. The conceptual framework is further informed by an emerging literature in cognitive science that has drawn attention to the role played by existing general belief structures in influencing how people might respond to situations, including gambling situations (Murphy and Medin 1985; Wellman and Gelman 1992).

Instances of the illusion of control are defined not merely as the result of situational factors (choice, physical involvement, etc.) as Langer suggested, but as the result of an interaction between situational factors and existing belief structures. As players in games of chance look for ways of obtaining a sizeable win, not only can existing belief structures cause particular situational factors to be noticed, but apparent situational factors can be interpreted in light of belief structures (Murphy and Medin 1985). For example, in relation to the illusion of secondary control, it is likely that there are broader belief structures that make people susceptible to beliefs of this nature. As Atran and Norenzayan (2004) point out, three broad interconnected belief structures about supernatural beings are observed across cultures and mostly likely to be by-products of the evolution of adaptive cognitive faculties. These are beliefs in supernatural agents (e.g., gods, ghosts, luck), beliefs in the power and omniscience of these agents with regard to important events (e.g., death and calamity), and beliefs about rituals directed at the agents (e.g., wearing lucky socks).

Other general belief structures (again, very likely evolved) are likely to underlie people's susceptibility to illusions of primary control. However, whereas the illusion of secondary control may be influenced by a structure of beliefs about supernatural entities, the illusion of primary control must be influenced by belief structures relating to non-supernatural (i.e., natural/physical) phenomena. We propose that, in games of chance, the gambler's fallacy is a particularly relevant general belief structure. It is general in that it has been argued to be unavoidable in games of chance. The unavoidability has been attributed to the representativeness heuristic (Tversky and Kahneman 1974), and to the fact that people only ever encounter short random outcomes, which, it turns out, have particular features, such as a lower probability of strings of three identical outcomes (Hahn and Warren 2009).

A summary of how items in gambling-beliefs surveys could be classified in light of this conceptual framework is presented in Fig. 1 and Table 1. The illusions of primary and secondary control are presented as belief categories expressed through agreement with the survey statements. Sub-categories of survey statements are shown as arising, at least in part, from the gambler's fallacy and/or supernatural beliefs as defined by Atran and Norenzayan (2004). The joint influence of these broader belief structures results in the belief that luck appears and disappears in cycles. Otherwise, the gambler's fallacy gives rise to sub-categories of the illusion of primary control while general supernatural beliefs give rise to sub-categories of the illusion of secondary control. We elaborate on the sub-categories below, with example survey statements being presented in Table 1.

Beliefs Reflecting the Illusion of Primary Control

With respect to perceived primary control, an inspection of interview data and gambling-beliefs survey items points to three principal sub-categories, all potentially reflecting the

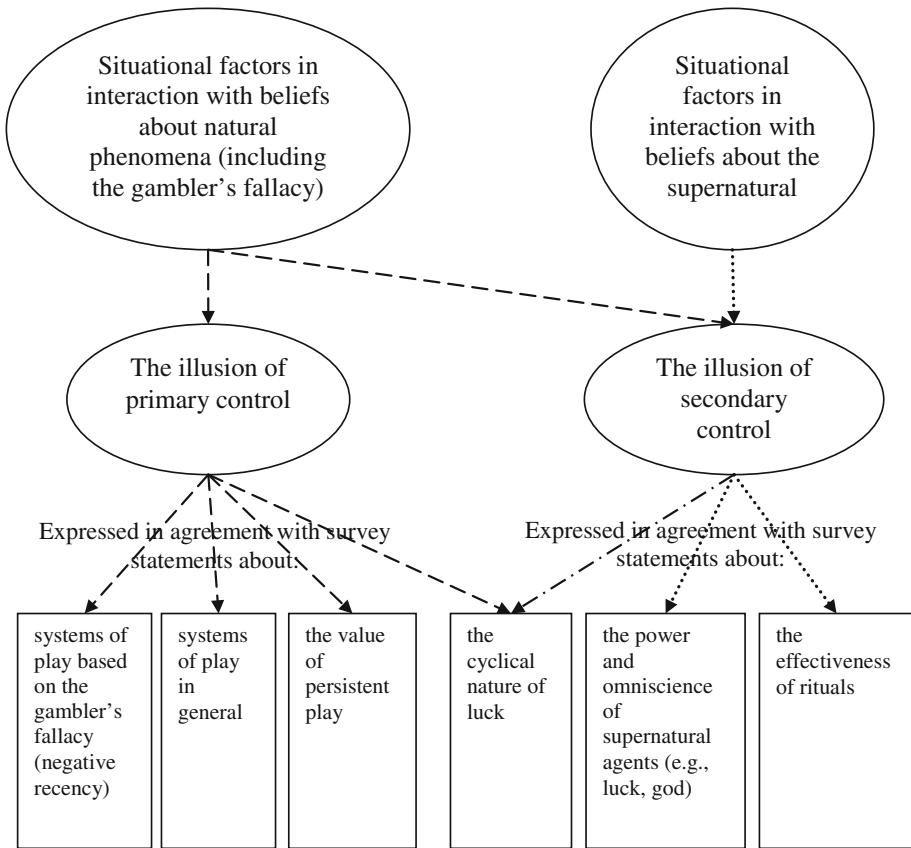


Fig. 1 A proposed basis for distinguishing between the illusions of primary and secondary control: the general belief structures that give rise to them. Notably, in a gambling context, where luck is a particularly relevant supernatural agent, the gambler’s fallacy contributes to shaping the belief that luck is cyclical

gambler’s fallacy in some way. The first consists of strategies arising directly from the fallacy; that is, directly from the ‘*negative recency*’ expectation that, in games of chance, the most recent outcome types will fail to repeat (Oskarsson et al. 2009). Strategies in this category include waiting for a win that is due, betting progressively higher amounts on one colour in roulette in expectation that the colour will be the winning one eventually, and alternating between colours in line with expectations of what outcome the random roulette wheel will produce next. Use of the two latter strategies has been observed in field settings (Walker 1992b) and empirically demonstrated in a laboratory roulette game (Ayton and Fisher 2004).

A second set of statements in gambling-beliefs surveys contain references to *systems of play* (i.e., strategies) more generally. Since the gambler’s fallacy is central to human (or, at least, Western) concepts of chance, it is possible that many strategies in gambling are informed by the fallacy. However, it is possible that playing systems are additionally informed by beliefs less general than the gambler’s fallacy—beliefs about specific situational aspects of the task. Some of these situational factors were identified by Langer. For example, the free spin feature on slot machines, a choice and physical-involvement factor in Langer’s terms, gives rise to numerous strategic beliefs (Livingstone et al. 2006).

Table 1 Examples of survey statements reflecting sub-categories of the illusions of primary and secondary control

 Illusion of primary control

Beliefs in ‘negative recency’ strategies

If I’m experiencing a losing streak, the thought that a win has to be coming soon keeps me gambling.¹

I should keep the same bet even when it hasn’t come up lately because it is bound to win.²

Sometimes I feel that I can keep winning because I have learned to predict the next random, new thing the machine is going to do.³

Beliefs in ‘systems of play’ (i.e., strategies generally)

Show me a gambler with a well-planned system and I’ll show you a winner.⁴

I know I can win if I follow my strategies.⁵

Beliefs in a ‘persistence’ strategy

If I continue to gamble, it will eventually pay off and I will make money.²

Those who don’t gamble much don’t understand that gambling success requires dedication and a willingness to invest some money.²

Illusion of secondary control

Beliefs in the ‘power and omniscience’ of supernatural agents

I believe that fate is against me when I lose.⁴

Some gamblers are just born lucky.⁴

Beliefs in ‘ritual’ appeals to supernatural agents

There are certain things I do when I am betting (for example, tapping a certain number of times, holding a lucky coin in my hand, crossing my fingers, etc.) which increase the chances that I will win.²

I can improve my chances of winning by performing special rituals.⁴

Belief that ‘luck is cyclical’

There are times that I feel lucky and thus gamble those times only.¹

It is good advice to stay with the same pair of dice on a winning streak.⁴

¹ The Informational Biases Scale (Jefferson and Nicki 2003)

² Gamblers’ Beliefs Questionnaire (Steenbergh et al. 2002)

³ Newly-written for this study

⁴ Drake Beliefs About Chance Inventory (Wood & Clapham, 2005)

⁵ Thoughts and Beliefs About Gambling Questionnaire (Joukhador et al. 2003)

Another way of defining these more-situation-specific beliefs is as rules for playing acquired through learning, problem-solving, or conditioning (e.g., Anderson 1993; Skinner 1948).

The third sub-category of the illusion of primary control is a set of beliefs about the effectiveness of a *persistence* strategy in gambling. It follows from the gambler’s fallacy that, after a series of losses, persistence in playing on a particular chosen option or slot machine makes a win imminent in the short-term. However, the belief in an imminent win can also proceed from a general adaptive sense of optimism (Cummins and Nistico 2002), and from a feeling of entrapment in a losing investment (Walker 1992b). Overall, then, the illusion of primary control expresses itself in three belief categories, shaped by the gambler’s fallacy, learning and motivational factors.

Beliefs Reflecting the Illusion of Secondary Control

Beliefs constituting the illusion of secondary control in a gambling context appear to fall into the sub-categories prescribed by the existing characterisation of supernatural beliefs (Atran and Norenzayan 2004). Table 1, once again, provides examples of representative

survey statements. The first sub-category of supernatural control beliefs pertains to the *omniscience and power* of supernatural agents. With regard to one supernatural agent, luck, the fact that people believe it to be influential in important life events (e.g., escape from negative consequences) has even been demonstrated empirically (Wagenaar and Keren 1988). Also indicative of belief in the omniscience and power of luck is the belief that luck is a personal quality (e.g., Wohl and Enzle 2009). This belief is consistent with the general belief that omniscient divine agents are inclined towards rewarding ‘good’ people (Atran and Norenzayan 2004).

The second sub-category refers to *ritual* appeals to supernatural agents. Sociologists Henslin (1967) and King (1990) made note of the abundance of rituals and lucky charms in craps and bingo. For example, Henslin observed that, since dropping the dice in craps is considered a bad omen, “without exception, each shooter, after dropping the dice, rubs both dice on the ground or playing surface” (p. 323).¹

The third sub-category of illusory secondary control consists of variations on the belief that the supernatural agent luck is *cyclical*. As Keren and Wagenaar (1985) reported in summarizing interviews with 150 blackjack players:

Most of our subjects (some of them explicitly) perceived luck as having a wave form. The art of the game is to catch the crest of the wave, that is, the lucky periods. (p. 152; see also Ohtsuka and Ohtsuka (2010) and King (1990))

On the one hand, believing in a cyclical luck implies believing that luck is an agent—an entity capable of varying its intentions, or ‘moods’. In this sense, the belief proceeds from the general supernatural beliefs structure. At the same time, the belief proceeds from the gambler’s fallacy in implying that runs of positive (and negative) outcomes are bound to end in the short-term. Notably, cyclical properties tend to be attributed to luck and not other supernatural agents (e.g., God, Fate). This could be due to the fact that beliefs about luck are particularly relevant to gambling and therefore more likely to be influenced by a belief structure about randomness and gambling—the gambler’s fallacy. Beliefs in the cyclical nature of luck, thus, appear to be shaped by supernatural beliefs and the gambler’s fallacy simultaneously.

The Present Study

This study aimed to determine whether psychometric analyses of a comprehensive gambling-beliefs survey could reveal primary and secondary illusory control constructs with their respective sub-categories. The survey consisted of 100 statements, largely from existing surveys. Statements were adapted to refer specifically to a purely chance-based form of gambling—slot-machine play. In light of a well-documented trend for participants to disagree with most erroneous survey statements about gambling, participants were selected in such a way various levels of slot machine gambling experience were represented. People who gamble regularly were expected to be more likely to agree with statements, thereby providing variability in responses. Each of the belief sub-categories described above was expressed in terms of a unique set of statements. For example, degree of belief in the ‘omniscience and power’ of supernatural agents was calculated by averaging agreement ratings for the sample statements in Table 1 and the statements:

¹ While many rituals in gambling contexts may result from broader supernatural beliefs, rituals can also emerge from simple conditioning processes (Jahoda 1969; Skinner 1948). The advocated conceptual framework is compatible with conditioning-based accounts of beliefs in rituals and systems of play.

“Following lucky signs can help me win”, “Bad vibes from people around me cause me to lose”, “I make the right choice because I’m generally lucky”, “It’s possible for the good or bad luck of other players to rub off on me”, “I have the psychic ability to predict a winner”, and “There is useful information in my daily horoscope”.

Confirmatory factor analysis (CFA) was used to determine whether relationships between the belief sub-categories could be accounted for by higher-order primary and secondary illusory control constructs. In CFA, models are fitted to a matrix of covariances between observed (i.e., measured) variables, termed ‘indicators’. Higher-order ‘latent’, or unobserved, factors predicted by the model can then be derived through multiple regression (see, for example, Kline 2010). In our model, the belief sub-categories served as the indicators, and Fig. 2 outlines model predictions regarding latent constructs. Beliefs in ‘negative recency’, ‘systems of play’, and ‘persistence’ were predicted to be indicators of the illusion of primary control. Meanwhile, the illusion of supernatural control was predicted to express itself in beliefs in the ‘omniscience and power’ of supernatural agents, as well as in beliefs about ‘rituals’. Beliefs about ‘the cyclical nature of luck’ were predicted to be a further expression of the illusion of secondary control, but also an expression of the illusion of primary control.

To complement the CFA, where results were dependent on the manner in which items were arbitrarily parcelled into sub-categories, an exploratory factor analysis (EFA) was performed. EFA does not require item-parcelling, since it involves analysing item

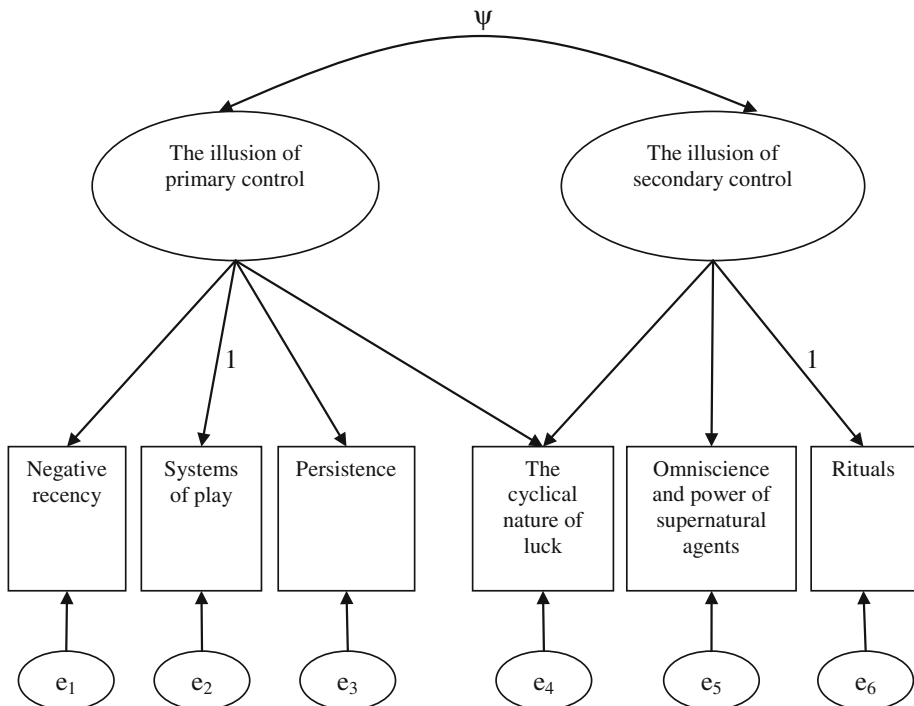


Fig. 2 The CFA model of erroneous gambling-related beliefs, based on the proposed definition of primary and secondary illusory control. The six belief sub-categories are indicator variables, while the two forms of the illusion of control are higher-order latent variables

correlations to determine how many latent groupings best describe the item set (e.g., Costello and Osborne 2005; Floyd and Widaman 1995). The expectation was that the items would be described by two latent groupings, reflecting the illusions of primary and secondary control.

Overall, the study is geared at testing a conceptual framework for classifying erroneous gambling-related beliefs. Should supporting evidence be obtained, the framework can be used as the basis for further survey development and the discussion of erroneous beliefs during treatment for problem-gambling.

Method

Design

The data were drawn from the survey component of a larger study in which a laboratory gambling session was attended 2 weeks after survey completion.

Participants

There were 329 participants² (140 males), with a mean age of 24.8 (SD = 11.88). Among them were first-year Psychology students at the University of Adelaide ($N = 189$), other students at the university ($N = 118$) and members of the general community ($N = 22$). Participation was only open to people who (1) were over the age of 18, (2) had gambled at a licensed venue at least once previously, and (3) were not in treatment for gambling-related problems. Recruitment processes were geared at ensuring that various levels of slot-machine gambling experience were represented. That is, advertisements placed outside the psychology department for other university students and the general community extended the invitation to participate only to people who gambled on slot machines relatively frequently (i.e., once a month or more often). The end result was that, in the 12 months preceding participation, 13.7 % of participants had not played on slot machines at all, 46.5 % played a few times but not regularly, 14 % played approximately once a month, 17.6 % played two to three times a month, and 8.2 % played weekly or more often. In terms of problem-gambling symptoms, responses to the Problem Gambling Severity Index (see *Measures*) suggested that 7 % of participants had gambling-related problems, while 38 % were at no risk of developing such problems, 29 % were at low risk, and 25 % were at moderate risk.

Measures: Slot-Machine Beliefs Survey

Apart from demographic questions, a question regarding degree of involvement in various forms of gambling in the past 12 months, and a Problem Gambling Severity Index (Ferris and Wynne 2001), the survey contained 100 statements describing beliefs about slot-machine gambling. The statements are presented in [Appendix 1](#). For each statement, agreement was rated on a seven-point Likert scale, anchored at (−3) Strongly disagree, (0) Neither agree nor disagree, and (3) Strongly agree.

The survey was designed to incorporate as many existing surveys as possible in their entirety without substantial overlap between items. To this effect, two surveys and a scale

² Of an original 330 participants, one was removed after providing the same answer to all survey items.

were included in full. These were the Drake Beliefs About Chance Inventory (Wood and Clapham 2005; 22 items), the Gamblers' Beliefs Questionnaire (Steenbergh et al. 2002; 21 items³), and the Predictive Control Scale of the Gambling-Related Cognitions survey (Raylu and Oei 2004; 6 items).

In the interests of including references to a wide variety of erroneous strategies, the complete surveys were supplemented by items selected from other existing surveys (17 items). Appendix 1 identifies the source survey for each item. Seventeen new items were also written and Appendix 1 details the experimental and observational findings on which each of these items was based.

A further concern was to make the collection of items suitable for undergraduate students, who made up the majority of our sample. All existing surveys from which items were sourced have been validated within this population (for a review, see Goodie and Fortune 2013). In addition, preliminary removal of items that correlated with few other items (see "Results") ensured that existing and newly-written items expressing beliefs held only by experienced gamblers were not analysed.

A final objective was to include a broader range of negatively-worded (i.e., objectively correct) statements, since there was only one such statement in the complete surveys. Eight negatively-worded items were sourced from existing surveys and nine were newly-written. Notably, all negatively-worded items were reverse-scored.

Procedure

Members of the general community who played slot machines regularly (once a month or more often) were recruited through an advertisement in a local newspaper. First-year Psychology students who met the basic participation requirements (see 'Participants') were recruited through a departmental research participation website. All other participants were students from other departments at the university who responded to poster advertisements around campus. Community and wider-university participants were reimbursed with a department store voucher, while the first-year Psychology students received course credit.

All advertisements directed potential participants to a website where the larger study was explained and the survey could be completed online. Alternatively, participants could contact the researcher (first author) with questions and requests for a posted hardcopy of the survey.

In the online version of the survey, the order of the 100 erroneous statements was randomised for each participant. Participants opting to complete hardcopies received one of three versions, each with a different random ordering of the items.

De-briefing occurred by post or e-mail at the end of data collection. De-briefings contained a copy of the survey, emphasised the erroneous nature of the survey's positively-worded statements, and encouraged participants to contact the researcher if they were unclear about why any particular statement was erroneous.

Results

Fitting the described CFA model of relationships between sub-categories of the illusions of primary and secondary control (Fig. 2) required a number of steps. After the removal of

³ Two items from this survey were excluded because they did not express erroneous beliefs: "Gambling is the best way for me to experience excitement", "When I lose at gambling, my losses are not as bad if I don't tell my loved ones".

Table 2 Belief sub-categories: constituent items, descriptive statistics, distributional information and Cronbach's alpha

	Constituent items (Appendix 1)	M (SD)	Distributional information		Cronbach's alpha	Range
			Skew.	Kurt.		
Negative recency	1–10	−1.1 (1.11)	−.01	−1.00	.87	−3.0–1.5
Systems of play	11–41	−1.1 (1.01)	0	−.86	.95	−3.0–1.4
Persistence	42–46	−1.6 (1.09)	.53	−.52	.77	−3.0–1.4
Cyclical nature of luck	47–54	−1.2 (1.07)	−.02	−.90	.84	−3.0–1.4
Omniscience and power	55–62	−1.3 (1.13)	.13	−1.03	.83	−3.0–1.3
Rituals	63–70	−1.4 (1.20)	.24	−1.18	.87	−3.0–1.4

problematic survey statements, the model's indicators, measures of the belief sub-categories, could be constructed. The model was then fitted, and models without key features of the proposed model were tested as a follow-up.

Removal of Weak Items

As recommended by some authors (Hooper et al. 2008; MacCallum et al. 1999), measurement error was reduced by removing items that did not correlate substantially with most other items. Specifically, items that correlated with 60 or more other items at a magnitude of less than .3 were removed.⁴ There were 27 such items. Among them were 14 of the 17 negatively-worded items, so the remaining three negatively-worded items were also removed, leaving a total of 70 items for further analysis. Removed items are identified in Appendix 1.

Measures of Belief Sub-Categories

The retained statements were grouped according to which belief sub-category ('negative recency', 'rituals' etc.) they reflected. Table 2 lists the items selected to represent each sub-category. Measures of agreement with each sub-category (i.e., the indicators in the CFA model) were calculated by averaging the agreement ratings for constituent items (DiStefano et al. 2009). For two participants who accidentally omitted some items when filling out hardcopies of the survey, sub-category scores were calculated using a reduced set of items.

For each sub-category score, Table 2 presents means, standard deviations, and distributional information (skew, kurtosis and range). The Cronbach's alpha coefficients presented in the table imply internal consistency among the items comprising each measure. As Table 3 shows, however, almost all pairwise score correlations were greater than .80, suggesting that the measures had poor discriminant validity. This issue was addressed through the fitting of an alternative theoretically meaningless CFA model (see below).

⁴ The value of .3 was chosen because correlations of .3 mean that less than 10 % of variance is shared between items. The cut-off point of 60 such correlations was set based on the inspection of the items containing various amounts of low correlations. Items with 60 or more problematic correlations appeared qualitatively unrelated to most survey items. For example, the item "If a coin is tossed and comes up heads ten times in a row, the next toss is more likely to be tails" lowly correlated with 65 items and appeared to be a sensible candidate for removal because it does not refer to slot machine gambling.

Table 3 Pearson correlations between belief sub-category scores

	Neg. rec.	Systems	Persist.	Cyclical luck	Omnisc.
Systems of play	.87				
Persistence	.72	.77			
Cyclical nature of luck	.84	.86	.71		
Omniscience and power	.82	.84	.72	.84	
Rituals	.72	.74	.63	.75	.83

All $p < .001$

Table 4 Standardised and unstandardised coefficients for the fitted CFA model

	β	B	SE
Illusion of primary control → Negative recency	.92	1.00	
Illusion of primary control → Systems of play	.95	.94	.03
Illusion of primary control → Persistence	.80	.86	.04
Illusion of primary control → Cyclical luck	.66	.71	.09
Illusion of secondary control → Cyclical luck	.26	.26	.09
Illusion of secondary control → Omnisc. and power	.97	1.07	.04
Illusion of secondary control → Rituals	.85	1.00	
e_1 → Negative recency	.16	.20	.02
e_2 → Systems of play	.10	.11	.01
e_3 → Persistence	.35	.43	.04
e_4 → Cyclical luck	.17	.20	.02
e_5 → Omnisc. and power	.06	.08	.02
e_6 → Rituals	.27	.39	.04
Ψ (Latent construct correlation)	.93	.96	.09

R^2 for indicators: Negative recency: .84, Systems of play: .90, Persistence: .64, Cyclical nature of luck: .83, Omniscience: .94, Rituals: .73

Model Fit

The CFA model shown in Fig. 2 was fitted using maximum likelihood estimation in the sem package (Fox et al. 2012) in R version 2.15.2. All fit indices indicated good fit ($\chi^2(7) = 5.75, p = .56$; RMSEA = 0, CI₉₀ [0, .06]; SRMR = .006; CFI = 1; BIC = 87).⁵ Standardised and unstandardised parameter estimates are presented in Table 4.

Alternative Models

Aspects of the model were tested further by examining whether their removal or modification reduced model fit. Among the tested components was the prediction that beliefs about the cyclical nature of luck are an indicator of both types of illusory control. The test involved

⁵ Mardia's tests of multivariate skew and kurtosis (Mardia, 1970; Ullman, 2006), conducted using the *psych* package (Revelle, 2012), indicated violation of the multivariate normality assumption ($b_{1,p} = 2.4$, skew = 131.43, $p < .001$; $b_{2,p} = 52.97$, kurtosis = 4.6, $p < .001$). However, the effect of this violation is inflation of the χ^2 statistic (Curran et al. 1996), which was still non-significant in this case.

fitting a simpler model in which beliefs in the cyclical nature of luck were an indicator of the illusion of secondary control only. Obtained fit indices suggested that this model had a poor fit ($\chi^2(8) = 39.64$, $p < .001$; RMSEA = .11, CI₉₀ [.08, .14]; SRMR = .016; CFI = .99; BIC = 115). A model in which beliefs in the cyclical nature of luck were an indicator only of the illusion of primary control also fit slightly worse than the original model ($\chi^2(8) = 12.86$, $p = .12$; RMSEA = .04, CI₉₀ [0, .08]; SRMR = .009; CFI = .99; BIC = 88).

A further assumption of the model is that beliefs in systems of play pertain only to natural systems, and not supernatural ones (e.g., rituals). The assumption was tested by fitting a model with a hypothesized additional relationship between the illusion of secondary control and the ‘systems of play’ score. Incorporating this relationship did not improve model fit ($\chi^2(6) = 4.51$, $p = .60$; RMSEA = 0, CI₉₀ [0, .06]; SRMR = .006; CFI = 1; BIC = 91), implying that ‘systems of play’ are commonly understood to refer to conventional strategies rather than rituals.

The observed high correlation between the model’s latent constructs, the illusions of primary and secondary control ($\beta\psi = .92$; see Table 4), necessitated the testing of a model in which these constructs were amalgamated into a single latent construct. Again, however, the fit of this modified model was poor ($\chi^2(10) = 63.88$, $p < .001$; RMSEA = .13, CI₉₀ [.10, .16]; SRMR = .023; CFI = .97; BIC = 128).

Finally, in light of the poor discriminant validity of the belief sub-category measures (see Table 3), we tested the possibility that any equivalent model could capture the relationships between them. The fitted equivalent model featured two latent constructs, L1 and L2. ‘Negative recency’, ‘Omniscience and power’, ‘Rituals’ and ‘Systems of play’ served as indicators of L1, while L2 was expressed in terms of the other two sub-category scores and the shared indicator, ‘Systems of play’. The parameter-value search for the model failed to converge in 5000 iterations, providing evidence of non-equivalence among the sub-category measures.

Exploratory Factor Analysis

To demonstrate that the CFA model’s good fit was not due to the manner in which items were grouped into scales, an exploratory factor analysis (EFA) was conducted, with the expectation that items would form clusters expressing the illusions of primary and secondary control, once the ‘cyclical luck’ items were excluded. The exclusion of the ‘cyclical luck’ items was necessary because EFA is difficult to apply when items load on multiple factors, as the ‘cyclical luck’ items were found to do in the CFA (MacCallum et al. 1999).

Full results of the EFA are reported in Appendix 2, where it can be seen that the expected two-factor structure was obtained. Factor 1 appeared to reflect the illusion of primary control, in that it included nine of the 10 ‘negative recency’ items, 27 of the 31 ‘systems of play’ items, and three out of five ‘persistence’ items. Meanwhile, Factor 2 corresponded to the illusion of secondary control in that it was defined by all eight items relating to the use of ‘rituals’ and four of the eight items relating to the ‘omniscience and power’ of supernatural agents.

Discussion

The aim of this study was to examine the construct validity of a conceptual model that postulates that gambling-related beliefs converge around two broader belief structures relating to the illusion of control. The first of these structures, the illusion of primary control, is postulated to involve behaviours and beliefs based, to a large extent, on the

gambler's fallacy. A second construct, the illusion of secondary control, is assumed to involve behaviours and beliefs relating to general beliefs about supernatural agents and forces. In light of these assumptions, six sub-categories of beliefs were defined and measured, and a CFA model of latent primary and secondary illusory control constructs relating the sub-categories was specified. On the whole, it was found that model predictions about the relationships between belief sub-categories were supported. Latent primary and secondary illusory constructs also emerged in an EFA.

The main implication of these results for typologies of erroneous gambling-related beliefs is that the prominence of the illusion of control and the gambler's fallacy in existing typologies is not a coincidence (cf. Fortune and Goodie 2012 and Goodie and Fortune 2013). The results, further, suggest a mechanism—decision-making informed by higher-level belief structures—that accounts for the overlap between beliefs expressing the illusion of control, the gambler's fallacy, and various notions about luck, a supernatural agent.

The results also have implications for conceptualisations of the illusion of control. They support the earlier work of Rothbaum et al. (1982), who argued that the illusion of control is not a one-dimensional construct. The results are also consistent with an earlier study by Ejova et al. (2010), who provided evidence of the illusion's bi-dimensionality using a multi-item perceived control question presented after experience with a laboratory gambling task. The question consisted of 13 statements, each rated from 0 to 10 in terms of the degree to which it might have accounted for experienced wins. Apart from "It was all chance", the statements included, (1) "My skill in playing", (2) "I developed a logical strategy", (3) "I deserved to win", and (4) "I took advantage of moments when my luck was good". Factor analysis revealed a statement cluster consisting of statements such as 1 and 2, and a statement cluster consisting of statements such as 3 and 4.

The present findings extend this work by providing evidence for an explanation of *why* the illusion of control has two dimensions. Specifically, the CFA model's good fit serves as evidence for the proposal that one dimension (secondary) is the result of general beliefs about supernatural agents, whereas the other (primary) is the result of non-supernatural beliefs, including the general gambler's fallacy.

Most research on the illusion of control has followed Langer's (1975) example in seeking to identify situational factors that give rise to what is assumed to be a unidimensional effect: an over-estimation of personal skill. We argue that the effect is likely to be more complex than this. Our CFA results suggest that a person allowed to choose her lottery ticket might feel more confident of winning because she was able to choose numbers that haven't appeared for some time, or because she was able to choose her 'lucky' number. The former is an instance of the illusion of primary control, while the latter is an instance of the illusion of secondary control. More generally, our findings imply that the same situational factor can give rise to different kinds of illusory control, depending on what pre-existing beliefs are applied in reasoning about the factor.

In light of the explanation of the illusion of control advanced in this study, we propose that greater conceptual clarity might be achieved by exchanging the terms 'primary' and 'secondary' for 'natural' and 'supernatural', respectively. Rothbaum et al. (1982) meant for the original terms to indicate that, in instances of perceived secondary control, a higher force rather than the individual takes the controlling action. In this study, the illusion of control is defined as a theory-driven belief in an effective personal action, be it a strategy or ritual. In the case of a ritual, the theory (belief structure) driving the action concerns supernatural agents and their powers. In the case of a strategy, the underlying theory

pertains to natural phenomena. It seems more appropriate to distinguish between variants of the illusion of control based on the belief structures that potentially inform them.

Future Surveys of Erroneous Gambling-Related Beliefs

From a psychometric perspective, our findings are generally consistent with the broad two-factor structure observed by Wood and Clapham (2005) in the development of the *Drake Beliefs About Chance Inventory*. One of the observed factors expressed beliefs that winning odds could be improved through supernatural means (illusory secondary control), whereas the other expressed beliefs that winning odds could be improved through natural means, including strategies based on the gambler's fallacy (illusory primary control). A similar distinction emerged in a factor analysis of the *Gambler's Beliefs Questionnaire* (Steenbergh et al. 2002). More specifically, items were found to load on the same illusion of primary control factor and a 'Luck/Perseverance' factor. In combining statements about the value of persistence with statements about luck, the latter factor captured the 'cyclical luck' component of the illusion of secondary control—the belief that one should persevere in waiting for a period of good luck. On the other hand, there are items in the often cited *Gambling Related Cognitions Scale* (Raylu and Oei 2004) that appear ambiguous in that it is unclear how the beliefs they express might have emerged from the gambler's fallacy or supernatural beliefs: "Relating my losses to bad luck and bad circumstances makes me continue gambling", "Relating my losses to probability makes me continue gambling", and "Remembering how much money I won last time makes me continue gambling".

The conducted EFA is a useful mechanism for identifying weak items for potential exclusion in future surveys of erroneous gambling-related beliefs. Candidates for exclusion are items with weak factor loadings (e.g., item 22) and items with similar loadings on both factors (e.g., items 28 and 60–62).

A side issue for consideration in future survey development is the role of objectively correct statements in gambling-beliefs surveys (e.g., "In slot machine gambling, there is no place for any kind of special knowledge"). Seventeen such items were included in our survey, nine newly-written. Associated reverse-scored responses were, however, excluded from analysis due to lack of correlation with responses to other items. Numerous authors have observed that people who gamble hold correct and incorrect beliefs without noticing a contradiction between the two (King 1990; Livingstone et al. 2006; Walker 1992a). Walker (1992a, p. 251) suggested that correct beliefs are expressed to "avoid ridicule". Livingstone et al. (2006) attributed the contradictory beliefs to the fact that the belief 'gambling games are chance-driven' is not logically incompatible with beliefs about the *properties of chance* (beliefs premised on the gambler's fallacy). Both of these suggestions constitute a case for including objectively correct statements in future surveys, even if the statements are consistently excluded from psychometric analyses. Walker's suggestion implies that the inclusion of correct statements would make respondents feel more comfortable; Livingstone's suggests that the inclusion of such statements would enhance the survey's face validity.

Clinical and Policy Implications

Many modern treatment programs and community education initiatives for problem gambling are aimed at correcting erroneous gambling-related beliefs. Our work can be seen as evidence about internal theories of the world (broader belief structures) that are a cause

of such beliefs. Therapists treating gambling-related problems can use the evidence to develop more coherent typologies of beliefs for discussion with clients. At the same time, the evidence suggests that explaining why various types of beliefs are erroneous is only one component of therapy and education. The other must address the internal-theory-based causes of the beliefs: the gambler's fallacy and beliefs in the supernatural. As general theories of the world which may have an evolutionary history, these causes might not be reversible through therapy. Instead, therapists might need to explain to patients that humans have two ingrained broader belief structures that make them prone to developing erroneous beliefs in gambling settings, which are to be avoided for this reason.⁶

As a working example, our findings have implications for an influential belief-correction procedure developed in the last two decades by Ladouceur and colleagues (e.g., Toneatto and Ladouceur 2003; Ladouceur et al. 2002). A clinically trialled version of this procedure (Ladouceur et al. 2001) had four objectives, the first two of which are quoted below:

- a) understanding the concept of randomness: the therapist explained the concept of randomness, that each "throw of the dice" is independent, that no strategies exist to control the outcome, that there is a negative expectation of gain, and that it is impossible to control the game; b) understanding the erroneous beliefs held by gamblers: this component mainly addressed the difficulty of applying the principle of independence of random events: the therapist explained how an illusion of control contributes to the maintenance of gambling habits, and then corrected these erroneous beliefs... (pp. 776–7)

The procedure's emphasis on explaining the 'independence' of random events is consistent with our conceptual framework. Many erroneous beliefs stem from the gambler's fallacy, so explanation of the principle of independence should alert the patient to the error of many of their beliefs.

Where Ladouceur's approach is inconsistent with our results is in its presentation of the illusion of control as *another* underlying cause of erroneous beliefs. In our framework, this underlying causal role is played by the gambler's fallacy, while the illusion of control is a descriptive term for expressed erroneous beliefs. In other words, our results suggest that a more coherent approach would involve explaining that erroneous beliefs are illusions driven by the general gambler's fallacy. Treatment could, further, involve outlining various explanations for why the gambler's fallacy is so widespread. Tversky and Kahneman's (1974) notion of a representativeness bias is one explanation and it was mentioned earlier in this paper. Another explanation, put forward by Estes (1964), describes the gambler's fallacy as a branch of the rational belief that many real-world outcomes follow a law of sampling without replacement. Given the way weather systems work, for instance, it is rational to assume that a sunny period draws nearer with each day of rain (see Hahn and Warren 2009 for a third theory, also described earlier in the paper). The next step would be to explain that gambling environments are dangerous and need to be avoided because they take advantage of the human proneness to the gambler's fallacy and ensuing erroneous beliefs.

According to our results, Ladouceur and colleagues' approach could also benefit from greater emphasis on common gambling-related beliefs about luck, rituals and other supernatural phenomena. Since, according to Atran and Norenzayan (2004), these beliefs

⁶ Fortune and Goodie (2012) echo this point in observing that gambling environments might be "situations where normal human biases have outsized consequences" (p. 307).

share evolutionary and conceptual roots with religious beliefs, explaining why they are erroneous could present difficulties. For example, explaining why a certain ritual is ineffective could involve challenging the existence of God. Once the erroneous nature of some of the patient's specific supernatural gambling beliefs is established, the therapist could explain that these beliefs are the product of a more ingrained belief structure that is, like the gambler's fallacy, likely to be evolved. Atran and Norenzayan (2004) present a comprehensive evolutionary account of how beliefs about supernatural agents, their power and their responsiveness to rituals came to be related.

In sum, our findings help distinguish between gambling-related beliefs and their causes, and between two causes. This should allow therapists to work from a more coherent typology of beliefs and should encourage them to warn patients about the potential immutability of the causes—an immutability that makes gambling environments highly dangerous.

Limitations

A clear limitation of the study is that our main hypotheses regarding the structure of gambling-related beliefs could feasibly only be tested through CFA, which is customarily performed on scale scores. Therefore, our model accounted for variance in averaged rather than raw agreement scores. In addition, the averaged scores (expressing the six belief sub-categories) were calculated based on purely theoretical grounds rather than exploratory statistical ones. However, with a cross-loading 'cyclical nature of luck' sub-category, the belief sub-categories were not detectable through exploratory factor analysis. Moreover, the theory-driven parceling of items into scales is recommended in CFA (Floyd and Widaman 1995).

Conclusion

We attempted to reconcile three frequently cited concepts in factor-analytic research on erroneous gambling-related beliefs. These are the illusion of control, the distinction between illusions of primary and secondary control, and the gambler's fallacy. Groupings for gambling-beliefs survey statements were suggested based on the proposal that the illusion of control, a set of beliefs about effective gambling action patterns, is caused by general belief structures such as the gambler's fallacy, in interaction with situational factors. The gambler's fallacy gives rise to the illusion of primary (natural) control while a general set of beliefs about supernatural agents gives rise to the illusion of secondary (supernatural) control. Seventy survey statements were then categorised in line with the suggested groupings, and CFA was used to demonstrate that category intercorrelations expressed higher-order natural and supernatural illusion-of-control constructs. The findings have implications for research on the illusion of control and for how erroneous gambling-related beliefs are discussed in treatment settings. More broadly, the findings provide preliminary evidence for a perspective that gambling-related beliefs are, at least in part, a function of broader belief systems that people bring to the session and which come to act as information processing filters.

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Appendix 1: Survey

Participant instructions

Below are 100 statements about gambling. Read each statement carefully and indicate the degree to which you agree or disagree with it. Unless a statement explicitly refers to a particular type of gambling (e.g., dice, lotteries) consider it a statement about poker machine gambling. Don't spend too long thinking about any particular statement. Just go with your initial reaction. Spend approximately 20 s on each statement.

Scale

Strongly disagree (−3), Disagree (−2), Moderately disagree (−1), Neither agree nor disagree (0), Moderately agree (1), Agree (2), Strongly agree (3)

Sources

- Drake Beliefs about chance inventory (DBC; Wood and Clapham 2005)
- Gamblers' Beliefs Questionnaire (GBQ; Steenbergh et al. 2002)
- The Predictive Control Scale of the Gambling Related Cognitions Scale (GRCS; Raylu and Oei 2004)
- The Informational Biases Scale (IBS; Jefferson and Nicki 2003)
- Thoughts and Beliefs About Gambling questionnaire devised by (TBAG; Joukhador et al. 2003)
- Questionnaire developed by Moore and Ohtsuka (1998)
- Weinstein Event Characteristics (W; included in Moore and Ohtsuka 1999)
- Primary and Secondary Control Beliefs Scale (PSCB; Williams 2007, Unpublished Honours Thesis)
- Belief in Good Luck Scale (BIGL; Darke and Freedman 1997)

Terminology

In South Australia, where the survey was administered, slot machines are typically referred to as “poker” machines.

Items

1. The longer I've been losing, the more likely I am to win. (DBC)
2. I should keep the same bet even when it hasn't come up lately because it is bound to win. (GBQ)
3. If I am gambling and losing, I should continue because I don't want to miss a win. (GBQ)
4. Even though I may be losing with my gambling strategy or plan, I must maintain that strategy or plan because I know it will eventually come through for me. (GBQ)
5. I have some control over predicting my gambling wins. (GRCS)
6. If I keep changing my responses, I have less chances of winning than if I keep the same response every time. (GRCS)
7. Losses when gambling are bound to be followed by a series of wins. (GRCS)

8. If I'm experiencing a losing streak the thought that a win has to be coming soon keeps me gambling. (IBS)
9. Sometimes I feel that I can keep winning because I have learned to predict the next random, new thing the machine is going to do. (Newly-written et al. 2004)
10. Winning in poker machine gambling is a matter of knowing how random patterns work. Each time, the machine is bound to do something different to what it did in the previous round. (Newly-written et al. 2004)
11. I will be more successful if I have a system for playing poker machines. (DBC)
12. A good poker machine, roulette or dice gambler is like a sports person who knows winning plays and when to use them. (DBC)
13. There are secrets to successful poker machine, roulette and dice gambling that can be learned. (DBC)
14. Show me a [poker machine] gambler with a well-planned system and I'll show you a winner. (DBC)
15. The more familiar I am with poker machine gambling, the more likely I am to win. (DBC)
16. One should pay attention to lottery numbers that often win. (DBC)
17. A game of chance is a contest of wills between the game and the player. (DBC)
18. Playing poker machines is a form of competition between the player and the machine. (DBC)
19. My choices or actions affect the game on which I am betting. (GBQ)
20. My gambling wins are evidence that I have skill and knowledge related to gambling. (GBQ)
21. My knowledge and skill in gambling contribute to the likelihood that I will make money. (GBQ)
22. I have more skills and knowledge related to gambling than most people who gamble. (GBQ)
23. I am pretty accurate at predicting when a win will occur. (GBQ)
24. I should keep track of previous winning bets so that I can figure out how I should bet in the future. (GBQ)
25. When I am gambling, "near misses" or times when I almost win remind me that if I keep playing I will win. (GBQ)
26. I think of poker machine gambling as a challenge. (GBQ)
27. When I have a win once, I will definitely win again. (GRCS)
28. A series of losses will provide me with a learning experience that will help me win later. (GRCS)
29. I believe I can beat the system. (TBAG)
30. If I lose it's because something unforeseen has happened. (TBAG)
31. I know I can win if I follow my strategies. (TBAG)
32. Identifying a pattern helps me predict a winner. (TBAG)
33. The chances of winning improve after a near win. (TBAG)
34. When I've lost it's because I've made a hasty decision or didn't concentrate. (TBAG)
35. The way in which I press the buttons on the poker machine can influence the outcome. (PSCB)
36. Winning on poker machines is all about knowing the right time to get on the machine. (PSCB)
37. There is a definite type of person who has big wins at gambling. (W)

38. To be successful in poker machine gambling it is important to know how to maintain a winning streak when one comes around. (Newly-written based on Ocean and Smith 1993)
39. To be successful in poker machine gambling it is important to know how to change the flow of the game when facing a losing streak. (Newly-written based on Ocean and Smith 1993)
40. The machines pay out more at different times of day. (Newly-written based on Livingstone et al. 2006)
41. You can win more money overall if you know how to make good use of free spins. (Newly-written Livingstone et al. 2006)
42. Where I get money to gamble doesn't matter because I will win and pay it back. (GBQ)
43. In the long run, I will win more money than I will lose gambling. (GBQ)
44. If I continue to gamble, it will eventually pay off and I will make money (GBQ)
45. If I lose money gambling, I should try to win it back. (GBQ)
46. Those who don't gamble much don't understand that gambling success requires dedication and a willingness to invest some money. (GBQ)
47. Wins are more likely to occur on a hot machine (i.e. a machine that has just paid out). (DBC)
48. It is good advice to stay with the same pair of dice on a winning streak. (DBC)
49. There are times that I feel lucky and thus gamble those times only. (GRCS)
50. Luck works in cycles and is, therefore, predictable to some extent. (Newly-written based on Keren and Wagenaar 1985)
51. A series of losses is a sign that good luck is about to set in. (Newly-written based on Ohtsuka and Ohtsuka 2010)
52. You should make at least one bet every day. Otherwise, you might be walking around lucky and not even know. (Newly-written based on Aasved 2002)
53. It is important to bet big when you feel that you've come across a lucky way of playing the machine. (Newly-written based on King 1990)
54. Luck sometimes hides all the wins behind a certain response pattern, so it's always worth sticking with a response pattern that has just produced a win to check whether you've stumbled upon a lucky way of playing. (Newly-written based on King 1990)
55. I believe that fate is against me when I lose. (DBC)
56. There is useful information in my daily horoscope. (DBC)
57. Some gamblers are just born lucky. (DBC)
58. Following lucky signs can help me win. (TBAG)
59. I have the psychic ability to predict a winner [in poker machine gambling]. (TBAG)
60. Bad vibes from people around me cause me to lose. (TBAG)
61. I make the right choice because I'm generally lucky. (TBAG)
62. It's possible for the good or bad luck of other players at the gambling venue to rub off on me. (Newly-written based on Ohtsuka and Ohtsuka 2010)
63. There may be magic in certain numbers [or actions]. (DBC)
64. When I need a little luck I wear lucky clothes or jewellery. (DBC)
65. I can improve my chances of winning by performing special rituals. (DBC)
66. I like to carry a lucky coin, charm or token when I'm doing something important. (DBC)
67. I have a "lucky" technique that I use when I gamble. (GBQ)
68. There are certain things I do when I am betting (for example, tapping a certain number of times, holding a lucky coin in my hand, crossing my fingers, etc.) which increase the chances that I will win. (GBQ)

69. Sometimes I think I might have the power to ‘will’ my desired outcomes to come up [during poker machine play]. (Moore and Ohtsuka 1998)
70. You never know what might happen if you don’t perform certain rituals while gambling. (Newly-written based on Rudski and Edwards 2007)

Removed prior to model fitting:

71. I do not consider myself to be a superstitious person. (DBC)
72. Winning in poker machine gambling is based entirely on chance. (TBAG)
73. The outcome of one poker machine event has no effect on the outcome of the next. (TBAG)
74. It’s a mistake to base any decisions on how lucky you feel. (BIGL)
75. Luck is nothing more than random chance. (BIGL)
76. The likelihood of winning a large amount of money in poker machine gambling is so small, it’s not worth bothering. (Moore and Ohtsuka 1998)
77. I do not expect to win at gambling. (Moore and Ohtsuka 1998)
78. There is no way of predicting when a win will occur in poker machine gambling. (Newly-written)
79. There is nothing the player can do to influence the outcome of poker machine gambling. (Newly-written)
80. In poker machine gambling there is no place for any kind of special knowledge. (Newly-written)
81. No matter what system of play you adopt in poker machine gambling, your chances of winning are no different to anyone else’s. (Newly-written)
82. Near-misses in poker machine gambling are not a sign that a win is close by. (Newly-written)
83. It is true that any run of losses eventually comes to an end, but this does not mean that I can predict when to raise my bet amounts ahead of a win. (Newly-written based on Delfabbro 2004)
84. Luck does not follow a pattern. (Newly-written)
85. A gambler can’t be lucky or unlucky by nature. (Newly-written)
86. Lucky items or charms can’t help a person when playing poker machines. (Newly-written)
87. Once you have lost money on poker machine gambling, there is no point playing on to win it back. (Newly-written)
88. I have a special system for picking lottery numbers. (DBC)
89. If a coin is tossed and comes up heads ten times in a row, the next toss is more likely to be tails. (DBC)
90. When I take a test (or took them in the past) I use a lucky pen or pencil. (DBC)
91. Gambling is more than just luck. (GBQ)
92. If I win on a certain machine, I am more likely to use that machine again at a later date. (IBS)
93. After a long string of wins on a machine, the chances of losing become greater. (IBS)
94. A run of losses must come to an end sooner rather than later. (TBAG)
95. There is a definite type of person who has big losses at gambling. (W)
96. A person’s chances of winning are better if they gamble on a machine that has not paid out in a long time. (PSCB)
97. I try to bet on the maximum number of lines because I don’t want to miss out on a big win on a line I didn’t gamble. (Newly-written based on Livingstone et al. 2006)

98. Since poker machines are a game of chance and chance distributes wins evenly across different possible responses, the only way to win is to keep ‘changing up’ your play pattern. (Newly-written based on Keren and Wagenaar 1985)
99. Luck works in a different way to chance. (Newly-written based on Wagenaar and Keren 1988)
100. It can’t hurt to perform little rituals during gambling—just in case. (Newly-written based on Rudski and Edwards 2007)

Appendix 2: Exploratory factor analysis (EFA)

As a first step, it was ascertained that the 62 survey items of interest (all but the eight items in the ‘cyclical luck’ sub-category) satisfied the assumptions of EFA ($KMO = .96$; Bartlett’s test: $\chi^2(1891) = 10966, p < .001$; all initial communalities $> .4$). When the items were subjected to Principal Axis Factoring, visual inspection of the scree plot suggested a two-factor solution. A two-factor solution was also recommended by a parallel analysis, conducted using the *nFactors* package (Raiche and Magis 2010) in R version 2.15.0. Table 5 shows the items that came to define each factor after a direct oblimin rotation.

Table 5 Factor loadings produced by a PAF analysis with oblimin rotation for the survey items not expressing belief in ‘cyclical luck’ ($N = 327$)

Item*	Categorisation in CFA	Factor loading	
		F1: Illusion of primary control	F2: Illusion of secondary control
1. The longer I’ve been losing, the more likely I am to win.	Primary: Negative recency	.62	
2. I should keep the same bet... because it is bound to win.		.62	
3. ...I don’t want to miss a win.		.44	
4. ...I must maintain that strategy or plan because I know it will eventually come through for me.		.70	
5. I have some control over predicting my gambling wins.		.34	
6. If I keep changing my responses, I have less chances of winning...		.70	
7. Losses... are bound to be followed by a series of wins.		.44	
8. The thought that a win has to be coming soon keeps me gambling...		.73	
9. Sometimes I feel that I can keep winning because I have learned to predict the next random thing the machine is going to do.			-.47
10. Winning in poker machine gambling is a matter of knowing how random patterns work.		.55	

Table 5 continued

Item*	Categorisation in CFA	Factor loading	
		F1: Illusion of primary control	F2: Illusion of secondary control
11. I will be more successful if I have a system for playing poker machines.	Primary: Systems of play	.59	
12. A good poker machine, roulette or dice gambler is like a sports person who knows winning plays and when to use them.		.43	
13. There are secrets to successful gambling that can be learned.		.48	
14. Show me a gambler with a well-planned system and I'll show you a winner.		.34	
15. The more familiar I am with poker machine gambling, the more likely I am to win.		.69	
16. One should pay attention to lottery numbers that often win.		.49	
17. A game of chance is a contest of wills between the game and the player.		.59	
18. Playing poker machines is a form of competition between the player and the machine.		.46	
19. My choices or actions affect the game...		.47	
20. ... gambling wins are evidence that I have skill and knowledge...		.56	
21. My knowledge and skill in gambling contribute to the likelihood that I will make money.		.46	
22. I have more skills and knowledge... than most people who gamble.		.26	-.22
23. I am pretty accurate at predicting when a win will occur.			-.50
24. I should keep track of previous winning bets...		.52	
25. ... "near misses" or times when I almost win remind me that if I keep playing I will win.		.67	
26. I think of poker machine gambling as a challenge.		.55	
27. When I have a win once, I will definitely win again.		.53	
28. A series of losses will provide me with a learning experience...		.40	-.32
29. ... I can beat the system.		.36	
30. If I lose it's because something unforeseen has happened.			-.49
31. ... I can win if I follow my strategies.		.53	
32. Identifying a pattern helps...		.57	

Table 5 continued

Item*	Categorisation in CFA	Factor loading	
		F1: Illusion of primary control	F2: Illusion of secondary control
33. The chances of winning improve after a near win...		.51	
34. When I've lost it's because I've made a hasty decision or didn't concentrate.			-.39
35. The way in which I press the buttons... can influence the outcome.			-.36
36. Winning... is all about knowing the right time to get on the machine.		.67	
37. There is a definite type of person who has big wins at gambling.		.58	
38. ... it is important to know how to maintain a winning streak when one comes around.		.73	
39. ... it is important to know how to change the flow of the game when facing a losing streak.		.52	
40. The machines pay out more at different times of day.		.44	
41. You can win more... if you know how to make good use of free spins.		.74	
42. Where I get money to gamble doesn't matter because I will win and pay it back.	Primary: Persistence		-.54
43. In the long run, I will win more money than I will lose gambling.			-.41
44. If I continue to gamble, it will eventually pay off and I will make money		.50	
45. If I lose money gambling, I should try to win it back.		.50	
46. ... gambling success requires dedication and a willingness to invest some money.		.40	
55. ...fate is against me when I lose.	Secondary: Power and omniscience	.43	
56. There is useful information in my horoscope.			-.47
57. Some gamblers are just born lucky.		.57	
58. Following lucky signs can help me win.			-.58
59. I have the psychic ability to predict a winner.			-.64
60. Bad vibes from people around me cause me to lose.		.42	-.33

Table 5 continued

Item*	Categorisation in main paper	Factor loading	
		F1: Illusion of primary control	F2: Illusion of secondary control
61. I make the right choice because I'm generally lucky.		.32	-.34
62. ... the good or bad luck of other players could rub off on me.		.40	-.35
63. There may be magic in certain numbers.	Secondary: Rituals		-.66
64. ... I wear lucky clothes or jewellery.			-.63
65. I can improve my chances of winning by performing special rituals.			-.75
66. I like to carry a lucky coin, charm or token...			-.73
67. I have a "lucky" technique that I use...		.31	-.43
68. There are certain things I do when I am betting; for example, tapping a certain number of times, holding a lucky coin in my hand...			-.64
69. ... I have the power to 'will' my desired outcomes to come up.			-.40
70. You never know what might happen if you don't perform certain rituals...			-.57
Variance explained after rotation		21 %	18 %
Correlation between factors		-.73	

Note: Factor loadings of magnitude < .3 are suppressed (except for item 22)

*For exact item wording, see [Appendix 1](#)

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