The illusion of control: structure, measurement and dependence on reinforcement frequency in the context of a laboratory gambling task

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Abstract

We present a new experimental method for studying the illusion of control in a gambling context, along with a new multi-item measure of the degree of perceived control. Responses to the measure were found to reflect a distinction between primary and secondary control – a distinction not recognised by traditional single-item measures. Furthermore, responses to the new measure were, in contrast to ratings on a concurrently administered traditional measure, found to be completely independent of the experienced reinforcement frequency. This finding highlights the purity of the newly-developed measure and calls into question the status of reinforcement frequency as a fundamental determinant of the degree of illusorily perceived control.

Keywords: illusion of control; primary control; secondary control; reinforcement frequency; gambling

Introduction

In a seminal exposition of the cognitive theory of gambling, Walker (1992) argues that most patterns of irrational thinking among gamblers essentially consist of the illusion that "one has more control over the outcome than is in fact the case" (pp. 139-140) or the overestimation of one's chances of winning independently of any actions taken. In the context of poker machine gaming, roulette and dice – gambling forms where outcomes are completely random – any perceived control is necessarily illusory. Nevertheless, regular gamblers report the use of a wide variety of strategies (e.g., changing machines in a systematic fashion; see Joukhador, Blaszczynski & Maccallum, 2004; Livingstone, Wooley & Borrell, 2006) that make sense only on the assumption that the player can exert control over outcomes based on knowledge of the game. While many of these strategies have can be termed products of illusorily perceived "primary" control because they rely on the idea that it is the player who has control, players also report employing "secondary" control strategies, in which they seek to achieve favourable outcomes by aligning themselves with influential higher or external forces (Rothbaum, Weisz & Snyder, 1982), such as luck (Keren & Wagenaar, 1985; King, 1990; Ocean & Smith, 1993; Duong & Ohtsuka, 2000), magic (Felson & Gmelch, 1979; Henslin, 1967), or justice (King, 1990). Although conceptually distinct, primary and secondary strategies tend to blend together: for instance, in Keren and Wagenaar's (1985) study, many of the interviewed regular blackjack players spoke of 'changing-up' play, not as a mathematically appropriate strategy, but, rather, as the necessary response to a period of bad luck. Thus, a very broad range of gambling behaviours can be described as products of an illusion of primary or secondary control over objectively random outcomes.

The basic experimental paradigm for studying the determinants of the illusion of control dates back to Langer (1975), and involves exposing people to uncontrollable events without explicitly indicating that the events in question are uncontrollable. While various elaborations on the design have yielded considerable insight into the illusion of control (e.g., Alloy & Abramson, 1979; Matute 1994, 1995), most work since Langer has employed very minimalist tasks that are often somewhat abstracted from the gambling context (e.g., involving the judgement of the degree of contingency between a button press and the onset of a light). Although a minimalist approach is often helpful from a scientific perspective, there is a noticeable difference in "feel" between a casino and a psychology experiment, which may limit the generalisability of the findings. Additionally, there is the issue of instructional demand effects. The fact that minimalist tasks involve only a few abstract stimuli leads to the use of instructions that either reveal the research aim (e.g., Alloy & Abramson, 1979), or deliberately conceal it by directing participants to focus simply on obtaining the target outcome as often as possible (e.g., Matute, 1994). In the former case, participants proceed to carry out the somewhat unnatural task of monitoring their control levels without expressly seeking reinforcement. In the latter case, participants could come to expect that, since they have been given the task of maximising reinforcement levels, there must be a systematic way of obtaining the target outcome.

It is in part due to such considerations that many studies have featured experimental tasks based on actual gambling activities, such as poker machines (e.g., Ladouceur & Sevigny, 2005), roulette (e.g., Dixon, 2000), and lotteries (e.g., Langer, 1975; Wohl & Enzle, 2002). However, the use of existing gambling game formats can cause participants to base their post-experimental ratings of control not only on what they immediately experienced during the experiment, but also on their existing beliefs about that form of gambling. A partial solution to this problem is to gauge relevant beliefs at the start of the experiment. Recently-developed gambling-related belief questionnaires (Jefferson & Nicki, 2003; Joukhador, Blaszczynski & Maccallum,

2003; Raylu & Oei, 2004; Steenbergh, Meyers, May & Whelan, 2002; Wood & Clapham, 2005) could be employed for this purpose. However, such self-report tasks may not capture many of the elements of decision-making that emerge when people are asked to make judgments in real time. Accordingly, there would appear to be a need to develop tasks that capture the important elements of gambling decision-making, but which are more immune to contamination from variations in previous gambling experience as well as instructional sets.

Apart from the appropriate design of these experiments is the issue of how the strength of the illusion of control might be determined. Some researchers have drawn inferences regarding the illusion of control based solely on participants' average bet amounts (e.g., Burger & Schnerring, 1982; Gilovich & Douglas, 1986), or estimates of the number of reinforcements expected in future rounds of the task (e.g., Budescu & Bruderman, 1995; Langer, 1975). However, these measures necessarily equate the illusion of control to the expectation or perception of success. As noted by Walker (1992) in the quoted passage, confidence and control are not equivalent.

Many other studies have adopted a simpler approach in asking people to rate the degree of perceived control over task outcomes on a visual analogue scale. Due to their brevity, measures of this kind invariably treat control as a unitary construct, making no distinction between primary and secondary facets. This is not a problem if people do not seek secondary control or fail to distinguish between the two types of control processes. However, should either of these conditions not hold, people may find a single question about "control" somewhat confusing. Another concern is that there is some evidence that rating scales of this kind conflate perceived success frequency with control. Jenkins and Ward (1965) found that responses to questions containing the word "control" were strongly positively related to reinforcement frequency, while responses to less transparent questions about contingency were not influenced by reinforcement frequency at all. Jenkins and Ward subsequently argued that people actually interpret "control" to mean 'attainment of the target outcome'. Accordingly, in answer to questions that refer explicitly to the degree of perceived "control", people may not be giving a rating of perceived contingency at all.

Despite this, most studies of the relationship between success frequency and the illusion of control continue to employ explicitly worded measures as the sole measures of perceived control. Thus, although higher reinforcement frequencies are consistently found to produce higher perceived "control" (Alloy & Abramson, 1979; Tennen & Sharp, 1983), it is not clear whether reinforcement frequency is a fundamental determinant of the illusion of control (Thompson et al., 2007), or if the trend is an artifact of the wording of the questions. To address this issue, a more systematic approach is required.

In view of these considerations, the aims of this paper are fourfold. First, we describe an experimental task that was designed to achieve a compromise between the incorporation of novel stimuli and the preservation of a gambling game format. Also described is an experimental procedure geared at minimising instructional demand effects, and, in fact, quantifying some of those effects through the pre-experimental assessment of gambling-related beliefs. Second, we present a perceived control measure that we developed with a view to preserving the primary-secondary distinction and avoiding the potential confusion with reinforcement frequency that arises from explicit references to 'control'. Our third aim was to use the newly-developed measure in determining whether people do in fact distinguish between primary and secondary control processes and, by implication, whether there are grounds for deploying a perceived control measure that conceptualises control as a multi-faceted construct rather than the general unitary construct gauged by traditional measures. Finally, we employ the new task, the new measure and a traditional explicitly worded measure in testing Jenkins and Ward's conjecture regarding the differential effects of reinforcement frequency on ratings of perceived "control" and responses to more subtle questions about perceived contingency. We subsequently seek to make a more general statement regarding the relationship between reinforcement frequency and the illusion of control.

Method

Participants

One hundred students from the University of Adelaide participated in the study, but three participants who responded identically to all the items of the newly-developed measure of perceived control were excluded. A technical error resulted in the loss of another person's pre-experimental-questionnaire data, so some of the reported analyses contain only 96 data points, as will be made clear in the relevant tables and figures.

Materials & Procedure

The overall design of the experiment was as follows. Upon completing a pre-experimental questionnaire concerned with gambling-related beliefs, each participant played 100 compulsory rounds of the gambling task described later. This was done under one of five conditions, in which the average reinforcement frequency ranged from one win in every 16 rounds to one in every two. Participants were not told how many rounds they would be playing, but were informed that they could terminate the game and cash out on remaining credit at any point after completing an impressions-of-the-game questionnaire. This questionnaire appeared automatically after 100 rounds of play.

The pre-experimental questionnaire contained the Drake Beliefs About Chance (DBC) Inventory (Wood & Clapham, 2005), which required participants to rate their degree of agreement with 22 erroneous statements about the nature of gambling (e.g., "Wins are more likely to occur on a hot machine", "I can improve my chances of winning by
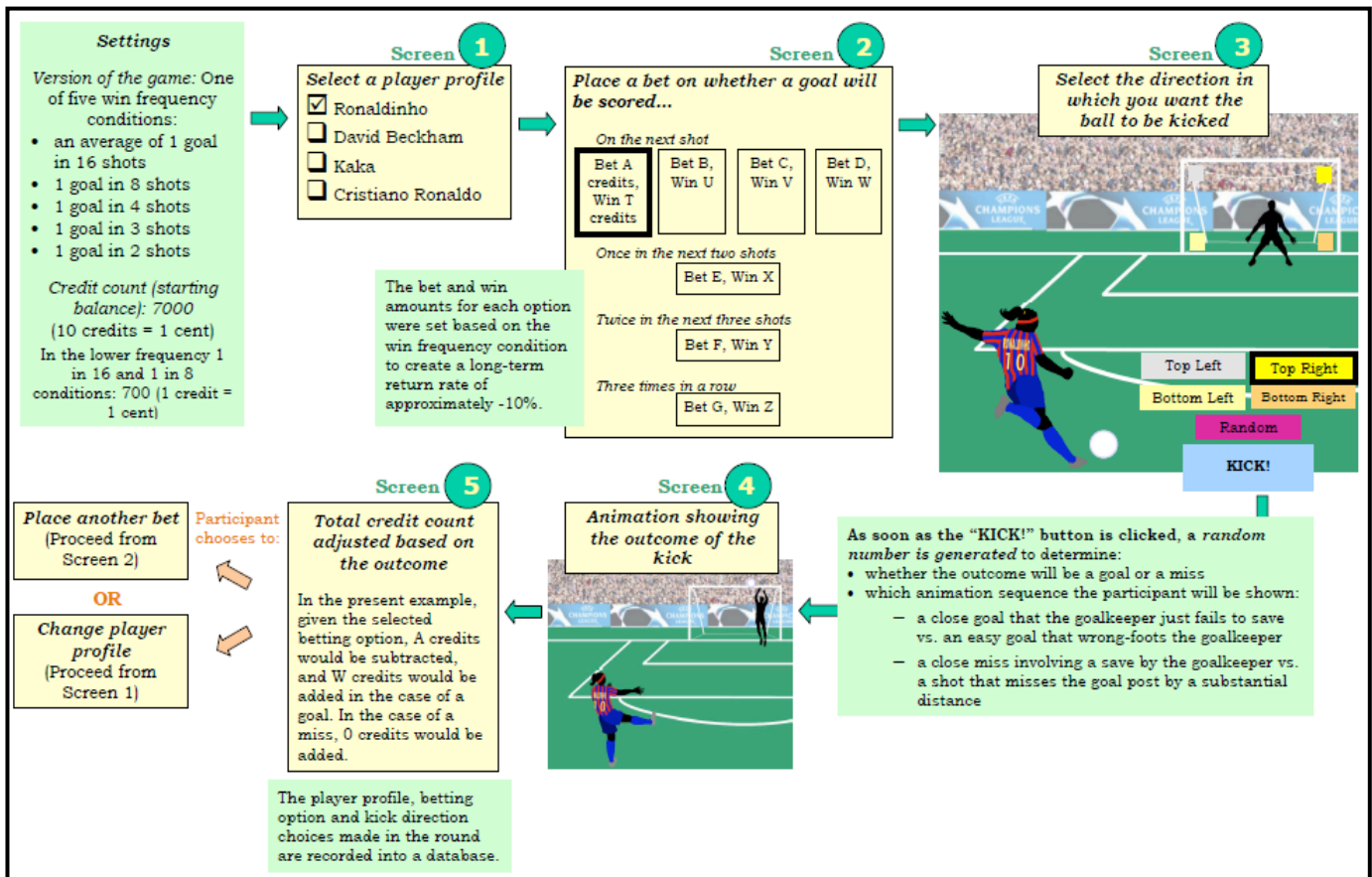
Figure 1. The first round of the experimental task

performing special rituals"). Statements that referred to gambling in general were adapted to refer to the outcomes of poker machines, roulette and dice games. A DBC total score was calculated by summing the provided ratings.

The experimental gambling task had a soccer theme. In each round, participants bet on a player pictured on the screen scoring (as opposed to missing) a goal from a free kick. Hence, each round involved the selection of a bet amount and bet structure from the seven options depicted in the Screen 2 pane of Figure 1. Each round also required the selection of a kick direction (Screen 3). Player profile choices (Screen 1) could be changed at any point but were not compulsory after the first round. Despite the abundance of play-related choices, the outcome of each kick was, as on poker machines, determined by a random number generator and the bet amounts and associated win amounts were calibrated to produce a negative long-term winning expectancy. The experiment was introduced to participants as an investigation of emotional responses to a new, sports-themed gambling game that "operates on the same principles as a poker machine". In referring to the trial of a new game, this instructional set encouraged participants to 'just play' without concerning themselves with the degree of control inherent in the task. The reference to poker machines served to guard against participants automatically assuming that the new sports-themed game possessed a video-game-like skill component.

The third element of the experiment was the "impressions of the game" questionnaire. Placed amid filler items regarding emotional responses to the game, this questionnaire contained two questions about perceptions of
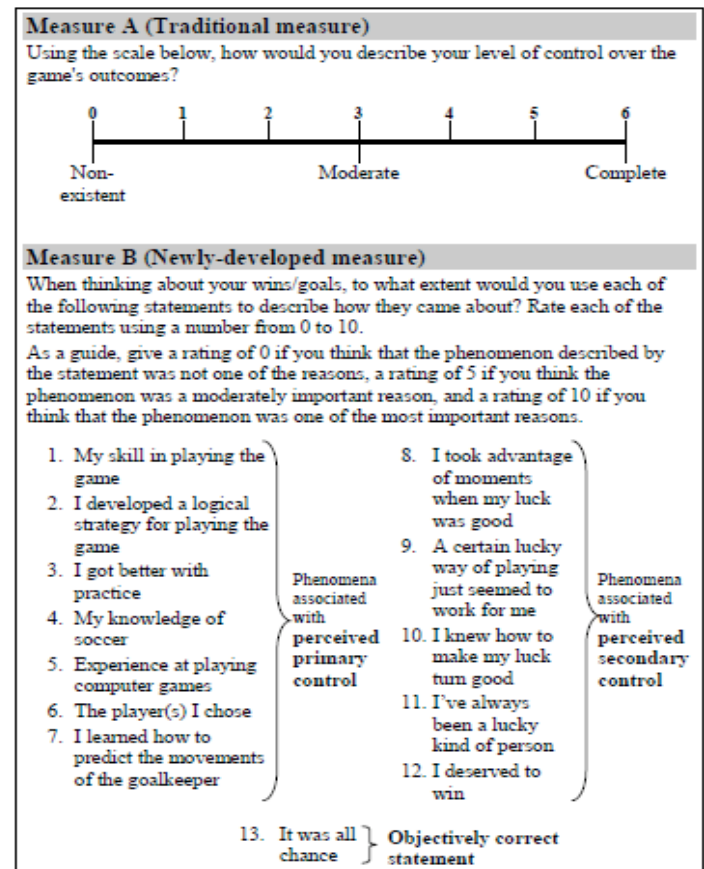

Figure 2: The two featured measures of the degree of illusorily perceived control

control over game outcomes. One of the questions (Measure A in Figure 2) followed the traditionally employed single-item rating-scale-based form. The new measure (Measure B in Figure 2) encompassed 13 randomly-ordered items, presented in the form of to-be-evaluated causal explanations for wins. Each explanation implicated a phenomenon associated either with primary control or secondary control. The objectively accurate account, "It was all chance", was also among the items.

Results

As an initial calibration check, we looked at whether responses to the various measures showed sufficient variability. For the gambling-related beliefs measure, the observed mean of 59.7 was slightly higher than those observed among in-treatment gamblers and members of the general community in the DBC Inventory's original validation study, but the standard deviation of 15.63 was in close agreement (Wood & Clapham, 2005; Gamblers: $M = 48.4$, $SD = 15.84$; Community: $M = 44.9$, $SD = 14.08$). Responses to the traditional rating scale (Measure A in Figure 2) of perceived control also showed a reasonable degree of variability: 30 participants stated that they had no control, but a similar number (29) perceived a level of control that was moderate or higher (i.e., gave ratings of 3 to 6).

The distribution of responses to the newly-developed perceived control measure is summarised in Table 1. Most statements, including the correct "It was all chance"

statement, were awarded non-zero ratings by approximately 60% of participants.

Table 1. Distribution of responses to the newly-developed measure of the degree of perceived control (N = 97)

Statement referring to:	No. of participants providing an agreement rating of:			
	0 out of 10	1 to 4 out of 10	5 out of 10	6 or more out of 10
Skill	37	32	10	18
Strategy	23	29	17	28
Practice	36	28	13	20
Soccer knowledge	46	27	10	13
Computer games	40	33	10	14
Player profiles	30	27	19	21
Goal-keeper	38	36	16	7
Lucky moments	30	20	17	30
Lucky play pattern	30	28	20	19
Knowledge of luck	42	37	11	7
Lucky person	33	37	12	15
Deserving to win	40	23	20	14
	10 out of 10	9 to 6 out of 10	5 out of 10	4 or less out of 10
Chance	42	31	12	12

Only four participants provided ratings of zero on all of the primary- and secondary-control-related statements while awarding maximal ratings to the 'Chance' statement.

Primary and Secondary Control: Factor Analysis

To test the validity of the theoretical distinction between primary and secondary control built into the newly-developed measure a factor analysis of statement rating

Table 2. Spearman correlations between ratings of agreement with the causal explanation statements of the newly-developed measure of the degree of perceived control.
Note that the shaded squares are meaningful only in relation to the columns – not rows – of the table. See main text for details.

Statement relating to:	Skill	Strategy	Practice	Computer games	Player choices	Goal-keeper	Lucky moments	Lucky play pattern	Knowledge of luck	Lucky person	Soccer knowledge	Deserving to win	Chance
Skill													
Strategy	.48**												
Practice	.68**	.51**											
Computer games	.59**	.42**	.58**										
Player choices	.56**	.40**	.46**	.42**									
Goal-keeper	.56**	.31**	.52**	.41**	.51**								
Lucky moments	.55**	.33**	.50**	.42**	.62**	.53**							
Lucky play pattern	.49**	.37**	.31**	.31**	.54**	.55**	.51**						
Knowledge of luck	.61**	.36**	.44**	.49**	.58**	.53**	.47**	.58**					
Lucky person	.50**	.24*	.43**	.38**	.45**	.48**	.51**	.59**	.55**				
Soccer knowledge	.46**	.36**	.44**	.59**	.45**	.61**	.51**	.45**	.55**	.46**			
Deserving to win	.43**	.29**	.43**	.46**	.50**	.50**	.49**	.52**	.47**	.57**	.43**		
Chance	-.37**	-.11	-.37**	-.39**	-.22	-.30**	-.18	-.16	-.36**	-.18	-.29**	-.25*	

** Correlation significant at the .01 level (two-tailed, $N = 97$)
* Correlation significant at the .05 level (two-tailed, $N = 97$)
▨ Correlation significant at the .01 level (two-tailed, N = number of participants who provided a rating other than zero on the statement indicated in the column heading – see Table 1)
◨ Statement excluded from analysis due to high number of associated zero ratings and lack of correlation with other statements
▪▪▪ Pattern of agreement rating correlations potentially underpinned by the degree of perceived **primary** control
▬▬ Pattern of agreement rating correlations potentially underpinned by the degree of perceived **secondary** control

patterns was conducted. However, following the observation of a relatively large number of zero ratings at baseline (see Table 1), we prefaced the factor analysis with a data screening procedure aimed at the identification and removal of statements that correlated with other statements due solely to overlapping (that is, inter-correlating) zero ratings. **Data screening.** Starting with the statement that produced the most "zeros" (soccer knowledge), we excluded all participants who provided a zero rating for that statement. If, following that exclusion, the correlations of other statements with that statement became largely non-significant, we deemed the statement to be unsuitable, and removed it from subsequent analysis on the grounds that the zero vs. non-zero distinction must have been responsible for the entirety of the original correlations.

The application of this procedure led to the removal from further analysis of the statements pertaining to soccer knowledge and deservingness. The lack of correlation between these statements and other statements is illustrated in Table 2, where the shaded squares in each column denote the correlation coefficients that remained significant among participants who provided ratings greater than zero on the statement specified in the column heading. Non-zero responses to the 'Chance' statement were expected to correlate with responses to a range of different statements, but were discovered to be independent of other responses. The statement was, however, retained for use in subsequent analyses to allow for the possibility that, as the scale's single objectively correct statement, it would form a separate factor altogether. Notably, the second-stage (shaded) correlations revealed a 'perceived primary control' cluster consisting of agreement ratings for statements about skill, strategy, practice and computer game experience. Ratings on the remainder of the statements – statements relating largely to luck – inter-correlated substantially in forming a 'perceived secondary control' cluster. Statements about player profile choices and goalkeeper movement represented a point of overlap between the two clusters, but did not share with the 'perceived primary control' statements the feature of being uncorrelated with most of the other statements. Thus emerged the first traces of a multi-faceted perceived control construct involving a distinction between perceived primary control, perceived secondary control and acknowledgement of the role of chance. **Factor analysis.** Upon ascertaining the factorability of ratings on the retained 11 statements (KMO = .88; Bartlett's test: (χ^2 (55) = 428.82, $p < .001$; initial communalities shown in Table 3), we conducted Principal Axis Factoring based on the criterion that a factor should be extracted if it has an eigen value of .7 or above – a value appropriate for small sample sizes (Jolliffe, 1972, 1976). The procedure resulted in the extraction of three factors with initial eigen values of 5.03, 1.26 and 0.99 – all lying above the inflection point of the scree plot. After extraction the factors accounted, respectively, for 42, 7 and 4 percent of total variance in ratings. Table 3 shows the factor loadings of the statements following a direct oblimin rotation. The loadings

were relatively strong, with the lowest loading (for 'Computer games' on Factor 2) having a magnitude of .48.

Most crucially, the pattern of loadings corresponded to the clustering observed at the data screening stage. Factor 1 corresponded to 'Perceived secondary control' in subsuming the four luck-related statements and the more stimulus-specific statements regarding player profile choices and goalkeeper movements. Factor 2 subsumed statements relating to direct – that is, primary – control: 'Skill', 'Strategy', 'Practice' and 'Computer games'. Factor 3 contained the single 'Chance' item.

Table 3. Initial communalities and factor loadings and communalities produced by a PAF analysis with oblimin rotation for 11 retained statements of the newly-developed measure (N = 97)

| Statement referring to: | Initial communality | Factor loadings | | | Communality |
		F1 Secondary control	F2 Primary control	F3 Chance	
Lucky play pattern	.60	.89			.68
Lucky person	.50	.66			.52
Knowledge of luck	.54	.65			.57
Player profiles	.37	.63			.39
Goal-keeper	.51	.57			.63
Lucky moments	.53	.55			.59
Practice	.44		-.82		.46
Skill	.19		-.62		.39
Strategy	.58		-.62		.71
Computer games	.40		-.48		.43
Chance	.38			.60	.45
Cronbach's alpha of factor score		.856	.799		
Correlation of factor with		F2: -.59	F3: .33	F1: -.25	

Note: Factor loadings <.4 are suppressed

Overall, then, the analysis of intercorrelations between components of the newly-developed measure of the illusion of control suggested that the illusion can be conceived of in terms of three facets: perceived primary control, perceived secondary control, and acknowledgement of the role of chance. This, in turn, highlights the advantages of the newly-developed measure over any measure of perceived control that refers to 'control' as though it were a unitary construct.

Reinforcement Frequency and Perceived Control

In further assessing the advantages of the newly-developed measure over the traditional measure, we set out to determine whether, in line with Jenkins and Ward's (1965) findings, the newly-developed measure would, by virtue of not referring explicitly to control, attract responses less reflective of the experienced win frequency. However, since participants were, from the outset, informed that the experimental task was designed to operate on the same principles as a poker machine, we expected that responses to both measures would additionally depend on participants'

Diagram (left): **Score on measure of existing gambling-related beliefs (DBC total score)** and **Win frequency (percentage of compulsory rounds on which goals were scored)** with arrows to: **Perceived primary control factor score**, **Perceived secondary control factor score**, **Acknowledgement of the role of chance factor score**, and **Score on the traditional measure of perceived control**.

— · — · — Significant results of Regression Analysis i

———— Significant results of Regression Analysis ii

— — — Significant results of Regression Analysis iii

········ Significant results of Regression Analysis iv

Regression Analysis i: Perceived primary control

Step	Predictors	B	SE B	β	t	p	Adj R²
1	Constant	-1.73	0.33				.23
	DBC total score	0.03	0.01	.49	5.44	<.001	
2	Constant	-1.88	0.34				.25
	DBC total score	0.03	0.01	.47	5.18	<.001	
	Win frequency	0.01	0.01	.16	1.80	.08	

Regression Analysis ii: Perceived secondary control

Step	Predictors	B	SE B	β	t	p	Adj R²
1	Constant	-1.73	0.32				.24
	DBC total score	-0.03	0.01	-.50	-5.55	<.001	
2	Constant	1.80	0.33				.24
	DBC total score	-0.03	0.01	-.49	-5.35	<.001	
	Win frequency	-0.01	0.01	-.08	-.89	.38	

Regression Analysis iii: Acknowledgement of the role of chance

Step	Predictors	B	SE B	β	t	p	Adj R²
1	Constant	1.27	0.27				.19
	DBC total score	-0.02	0.004	-.45	-4.83	<.001	
2	Constant	1.33	.28				.19
	DBC total score	-0.02	0.004	-.43	-1.18	.24	
	Win frequency	-0.004	0.004	-.09	-1.15	.25	

Regression Analysis iv: Score on traditional measure

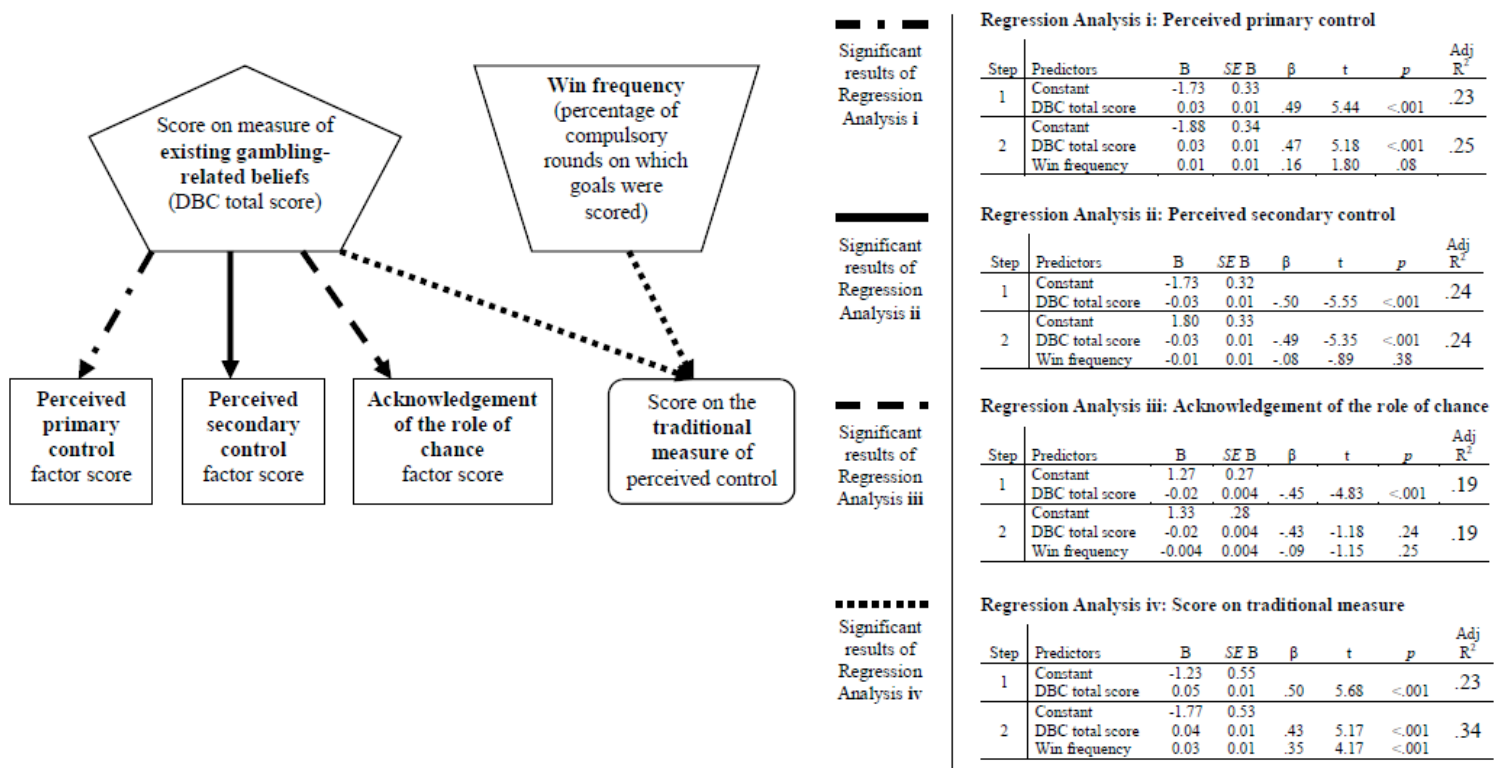| Step	Predictors	B	SE B	β	t	p	Adj R²
1	Constant	-1.23	0.55				.23
	DBC total score	0.05	0.01	.50	5.68	<.001	
2	Constant	-1.77	0.53				.34
	DBC total score	0.04	0.01	.43	5.17	<.001	
	Win frequency	0.03	0.01	.35	4.17	<.001	

Figure 3. Hierarchical regression analyses of the influence of gambling-related beliefs and win frequency on responses to the traditional measure of illusorily perceived control and the (less explicitly worded) newly-developed measure ($N = 96$)

individual beliefs regarding the nature of poker machine gambling. Thus, we conducted hierarchical regression analyses to assess the degree to which indices of the three facets underlying the new measure and, by contrast, responses to the traditional measure, could be attributed to variability in the number of experienced wins over and above the effects of variability in DBC scores. The indices of the three facets of illusorily perceived control were factor scores calculated using the regression method. The Cronbach's-alpha levels associated with the perceived primary control and perceived secondary control factor scores are detailed in Table 3.

For each of the four regression analyses, the DBC score was entered into the regression at Step 1, followed, at Step 2, by the index of win frequency – the percentage of compulsory rounds that resulted in wins. The results are summarised in Figure 3[1].

As the adjusted R^2 values associated with Step 1 of each analysis indicate, existing gambling-related beliefs accounted for a substantial amount of variance in all the indices of perceived control. However, the traditional measure was the only measure of perceived control to also be influenced by the experienced win frequency (adj R^2 at Step 1 = .23; adj R^2 at Step 2 = .34).

Consistently with Jenkins and Ward's observations, then, these results imply that the factor scores derived from the newly-developed measure constitute a purer measure of

perceived control. Moreover, the findings suggest that reinforcement frequency ceases to be a determinant of the degree of illusorily perceived control once the effects of existing task-related beliefs are controlled for and the degree of perceived control is measured as a multi-faceted construct associated with causal explanations for success.

Discussion

Motivated by a concern for the finer methodological points of investigating the determinants of the illusion of control, we used a novel experimental task, instructional set and pre-experimental belief assessment procedure to demonstrate two important advantages of a newly-developed measure of illusorily perceived control. Firstly, ratings of agreement with the various causal explanation statements comprising the measure were found to reflect a distinction between primary and secondary control – a distinction not recognised by the traditionally employed single-item measure. Secondly, responses to the newly-developed measure were, in contrast to responses to the traditional measure, found to be completely independent of the experienced reinforcement frequency.

The present findings were additionally informative with respect to the definition of the illusion of control construct and the body of research on the person-based and situational determinants of the illusion.

Definition of the illusion of control. Our factor analysis produced quantitative evidence for what has up to this point been the largely qualitative observation that illusions of control involve perceptions of secondary as well as primary

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[1] The standardised residuals in each analysis displayed only a slight tendency to increase in line with the values of the dependent variable.

control. The analysis also uncovered a third facet of the illusion: 'acknowledgement of the role of chance'. Subsequent regression analyses produced evidence of a differentiation, in terms of dependence on win frequency, between the perceived degree of "control" and the three facets of causal explanation for experienced successes.

This collection of findings accords with Skinner, Chapman and Baltes' (1988) proposition that, in perceiving control, agents draw upon beliefs about relations between themselves and ends (the available reinforcement), means (potential causes) and ends, and themselves and means, with each of these three types of relational beliefs being held *independently* of the others. Within this framework, ratings of control on the traditional measure could, in light of their positive relationship with win frequency, be considered reflective of agent-ends-type beliefs. Meanwhile, responses to the newly-developed causal explanations measure constituted expressions of means-ends-type beliefs about the game. In fact, the three-faceted structure uncovered by our correlational analysis of responses on this measure corresponded to the structure obtained by Skinner, Chapman and Baltes (1988) in an analysis of children's agreement ratings for means-end-type statements about school performance. In that study, ratings pertaining to personal effort and attributes were found to form one cluster (analogous to our "primary control" facet) while ratings pertaining to powerful others and luck formed a second cluster (analogous to our "secondary control" facet). A third cluster was defined by ratings on statements about unknown causes, of which 'chance' is an instance, at least from an intuitive point of view (Batanero, Henry & Parzysz, 2005), and most prominently among children (Biehl & Halpern-Felsher, 2001; Green, 1984).

While this correspondence between findings importantly demonstrates that illusions of control have the same etiology as perceived control in general, Skinner, Chapman and Baltes' framework does not account for the source of segmentation in control beliefs. The adaptive advantages of possessing three independent belief types as opposed to an integrated representation of agent-means-ends relations remain unspecified. Lewandowsky and Kirsner (2000) proposed that contradictions in expressed beliefs stem from variations in the context of knowledge acquisition and utilisation. Whether the contexts governing the acquisition of information about primary strategies, as opposed to 'higher forces', 'chance' and 'control', differ systematically is an open question.

Determinants of the illusion of control: *Prior beliefs* The results of our regression analyses highlighted the prominence of pre-experimentally assessed gambling-related beliefs in shaping perceptions of control. One could argue that it is hardly surprising that beliefs about poker machine gambling were found to influence perceptions of a task introduced to participants as a "poker-machine-type game". However, in real gambling environments, all people – regardless of prior gambling experience – approach poker machines with precisely the knowledge that they are about to play something called a 'poker machine' and a set of beliefs about the nature of poker machine gambling.

At the same time, a legitimate question to pose is whether self-reported gambling-related beliefs precede and determine illusions of control over game-specific stimuli, or whether these beliefs simply covary with game-specific perceptions of control. The covariation could be underpinned by the optimal organisation of control beliefs suggested by Skinner, Chapman and Baltes (1988) or the variations in acquisition and usage postulated by Lewandowsky and Kirsner (2000). In the present study, the DBC Inventory was selected as a measure of gambling-related beliefs due to its brevity, focus on poker-machine-gambling, and relevance to a population without extensive gambling experience (namely, the university students in our sample). A disadvantage of the measure is that its items related principally to *a priori* beliefs about illusory control and superstition. Thus, future research should concern itself with tracking the determining effects of a broader set of gambling-related beliefs – most notably, those relating to what Walker (1992) considered the second broad dimension of erroneous gambling-related cognitions: optimism or hopefulness about winning independently of control attempts. In general, the structure of gambling-related beliefs among members of the general community and frequent gamblers requires examination.

Reinforcement frequency Crucially, reinforcement frequency, a situational feature that has long been considered a fundamental determinant of the degree of illusorily perceived control, was found to exert no influence on perceptions of control, as gauged by the newly-developed, more subtly worded measure. While this result requires replication, perhaps with a different range of reinforcement frequencies, ensuing studies could also explore the illusion-of-control-elicitation effects of other, more gambling-specific outcome sequence features, such as the frequency of big wins (Aasved, 2002), the general ordering of wins and losses (e.g., whether wins are concentrated at the beginning or end of the sequence; Burger, 1986; Coventry & Norman, 1998; Langer & Roth, 1975), and the degree of 'need for control' in the face of losses exceeding a certain threshold (Walker, 1992).

Whatever set of potential determinants is selected for further investigation, future research could fruitfully make use of the experimental task, procedure and multi-faceted outcome measure described and piloted in the present study.

Acknowledgements

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