

## **Langer's Illusion of Control and the Cognitive Model of Disordered Gambling**

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## **Abstract**

E.J. Langer's paper, "The Illusion of Control" (1975), showed that people act in ways that suggest they hold illusory beliefs in their ability to control the outcome of chance-determined games. This highly-cited paper influenced the emerging field of gambling studies, and became a building block for cognitive approaches to problem gambling. Over time, this work has inspired therapeutic approaches based on cognitive restructuring, preventative programs focused on gambling myths, and regulatory scrutiny of skill mechanics in modern gambling products. Yet the psychological mechanisms underlying the 'illusion of control' remain elusive.

## **Introduction**

Imagine you spontaneously decide to buy a lottery ticket. The clerk asks you if you would like the 'lucky dip' (or 'quick pick') option, where the lottery machine assigns you six numbers, or would you like a slip to choose the six numbers yourself? Now imagine you're running late for an important meeting on the other side of campus. You enter the elevator knowing that the 'door close' buttons have been disabled across campus. Do you click the button? If you are like most people, you select your own numbers in the first scenario and you hammer repeatedly on the button in the second scenario. You do so because people are highly motivated to perform irrelevant behaviours that offer no control over their desired outcome (1).

Langer (2) described a series of experiments using games of chance in which participants reported an "expectancy of a personal success probability inappropriately higher than the

objective probability would warrant” (pg 311). In the most well-known of these experiments (Study 2), Langer gave some office workers the opportunity to buy a lottery ticket for \$1, represented by cards with pictures of football players on them. Some participants (n=27) chose their lottery ticket from an array, while others (n=26) were given a ticket by the experimenter. The assigned tickets in the control group were ‘yoked’ to a participant from the choice condition. Just prior to the lottery draw, participants were given the opportunity to sell their ticket back to the experimenter, naming their price. The resale value set by participants who chose their ticket was significantly higher ( $M = \$8.67$ ) than participants who were assigned their ticket ( $M = \$1.96$ ).

Study 6 added two twists to this procedure. Instead of a choice, participants were assigned to a high or low ‘involvement’ condition. Specifically, three lottery numbers were either revealed to the participant over successive days (high involvement), or in one go on the day of purchase (low involvement). Then, on the day of the draw, participants were offered the opportunity to exchange their ticket for a ticket in a different lottery—a lottery with an obviously higher chance of winning. The high involvement group were more confident that their ticket would be selected and were more likely to keep their original ticket (64% vs 32%).

Langer (2) argued that people experience an *illusion of control* in situations where their behaviour can exert no influence over the outcome. Over the six studies, Langer identified four factors that could instil this effect by creating what is often described as ‘skill-chance confusion’ (3): choice, involvement, competition, and familiarity. Subsequent research on the involvement factor has tended to operationalize it as an instrumental action, such as throwing a ball or dice (4,5). One important consequence of the illusion of control is that participants may forgo a more favorable option, as seen in their refusal to switch to the lottery with the higher chance of

winning in Langer's Study 6. In a companion paper, Langer & Roth (6) noted that the sequence of outcomes, such as an early run of successes at a task (ie. beginner's luck), could also affect perceptions of control.

Falling for the illusion of control has a range of clinical and subjective consequences, relevant for mental health and well-being. In patients with panic disorder, breathing air enriched with carbon dioxide can be powerfully anxiogenic, but presenting patients with a dial that they were told could reduce the carbon dioxide level significantly reduced their panic symptoms and subjective anxiety -- even though the dial was ineffective (7). Later work by Langer as well as others found that illusory beliefs of controllability improve well-being among many groups who are deprived of control in their lives, for example due to physical illness, grief, or old age (8–10). But unsurprisingly, illusory beliefs can also have deleterious consequences (11). Particularly when money is wagered on the outcome of games that are objectively uncontrollable and contain a 'house edge', the illusion of control may lead to persistent gambling and financial loss.

### **The Cognitive Model of Gambling**

Langer's paper acknowledged Henslin's (12) earlier work that described superstitious behaviours among craps gamblers, such as blowing on dice, and throwing the dice forcefully to hit high numbers. Langer (2) noted that factors driving illusory control could be introduced or enhanced in gambling products to increase revenue. But notably, Langer stopped short of making any links to harmful gambling, and her studies did not screen for gambling or include any groups of real-world gamblers. Indeed, the immediate clinical connection for her theory was to depression (13), evolving into the influential hypothesis of 'depressive realism' (14, for a contemporary appraisal

see 15). The modern field of gambling studies was in its infancy at the time she published her seminal paper but grew steadily following the clinical recognition of pathological gambling in the ICD 9 (1978) and DSM III (1980).

In looking to establish itself, the field of gambling studies took inspiration from cognitive research of which Langer's work was a key example (see also 16,17), alongside other insights including Skinner's work on variable ratio schedules (18) and nascent findings in the field that later became known as Judgment and Decision-Making (e.g. 19,20). For instance, Robert Ladouceur and his team in Quebec, Canada began their ground-breaking program of research on gambling with a series of experiments that struggled to replicate Langer's effects on confidence ratings and betting, using simple coin-toss and dice-throwing tasks (21–23). His team (23, Study 3) was also the first to study the illusion of control with a group of regular gamblers. Despite the *a priori* prediction that illusory beliefs should be elevated among gamblers, the findings remained inconclusive. But during the debriefs for these experiments, Ladouceur's team noticed a range of misunderstandings among their participants, which were much in line with an illusion of control (24). To capture these cognitions during the act of gambling, Gaboury and Ladouceur (25) pivoted to a 'think aloud' procedure where experienced gamblers were asked to verbalize their uncensored thoughts throughout a period of gambling. This study also marked a shift towards greater ecological validity in gambling research, reporting two experiments using an authentic slot machine housed in the lab (Study 1) and a roulette game (Study 2). The majority of verbalized cognitions during these sessions were classified as 'irrational' or 'erroneous', and many discrete statements indicated that the line between skill and chance was indeed blurry in the gambler's mind (26).

The ‘think aloud’ findings became the foundation for the cognitive formulation of gambling, which argues that gamblers bet excessively because they inaccurately perceive the negative expectancy of gambling. Langer’s illusion of control -- along with the gambler’s fallacy -- are the two best-characterized sources of this misperception (27). A key tenet of the cognitive account is that these erroneous thoughts are elevated in people with gambling problems. Following a decade of research using the think aloud procedure, this hypothesis was confirmed with the development of several questionnaire measures for probing ‘gambling-related cognitive distortions’ (28–30). Illusory control items feature heavily on these scales, and robust associations are reported between illusory control beliefs and disordered gambling (31,32). Other specific consequences of illusory control have been described since, including elevated craving to gamble, and increased motivation in the face of gambling losses (33,34).

At a clinical level, cognitive distortions feature in broader theoretical frameworks that consider biopsychosocial factors in the development and maintenance of disordered gambling (35,36). For example, the influential Pathways Model incorporates cognitive distortions as part of the final common pathway to disordered gambling, as a conduit connecting gambling accessibility to habit formation and loss chasing (35). Because higher levels of cognitive distortions are associated with poorer outcomes (37), cognitive restructuring may be used to identify and modify the specific distortions to which a gambler falls prey, often within the context of Cognitive Behavioural Therapy (CBT). CBT is regarded as the gold standard treatment for disordered gambling (38). Although the ‘think aloud’ technique is used by many CBT practitioners as a means of activating these cognitions (27), clinical trials that test cognitive restructuring as an isolated component remain equivocal (39,40). Nonetheless, the emerging field



of gambling prevention has also paid considerable attention to the goal of raising awareness of cognitive distortions and correcting misperceptions, including the illusion of control.

## **Policy and Prevention**

The concept of informed choice applied to gambling, similar to any consumer protection framework, requires that gamblers understand both the math and the psychology of the products they are using (41). Current programs have two distinct flavours. One focuses on the design of gambling educational programs for youth, such as could be delivered for example in a secondary school curriculum (42). The other is directed at casual gamblers who are at-risk of developing gambling problems in the future (41). Many jurisdictions have invested in ‘myth busting’ messaging, to be available at information booths in casinos, or as part of broader ‘responsible gambling’ programs (43). At the current time, there are few trials evaluating the effectiveness of these tools and indeed limited evidence for efficacy. In a study that is representative of the wider literature, Williams and Connolly (44) found that an undergraduate statistics course that was modified to include content on the mathematics of gambling as well as problem gambling awareness improved performance on an end-of-term test, but this knowledge did not transfer to real-world gambling involvement or problem gambling symptoms. Analogous to the well-known ‘dual-systems’ framework, statistical training (of a ‘cold’ System 1) may do little to stop the gambler switching to hot System 2 when they encounter the exciting, visceral experience of being ‘in the action’ (45,46).

These programs face a number of challenges, including the tendency of gamblers to compartmentalize such knowledge, or the tendency of gamblers to ‘zone out’ during long slot

machine sessions, suggesting an absence of free will and personal responsibility (47). For the illusion of control more specifically, one complication is that different forms of gambling vary in the precise ways that skill may be expressed. In poker most clearly, but also blackjack and sports betting, the application of skill and knowledge does affect the outcome. Gamblers who favour these forms are still seen to over-estimate their level of skill (26,48), as do stock traders (49), but such an effect is not categorically ‘illusory’. Moreover, gamblers often study their preferred games intensively, and develop sophisticated arguments to rationalize their control (50), such as strategies for making their funds last longer, or to reduce the chance that a lottery jackpot would need to be split with other players.

Within chance-based gambling products, technologies are continually being added to provide gamblers with a heightened sense of control. One of the first devices introduced on slot machines was a ‘stopper’ button for braking the reels. The win or loss outcome on such a game is determined when the reel is spun, so any sense of control from using the stopper is illusory (51). Yet many gamblers can attest to a compelling experience of self-agency following a win when applying the stopper. A second example is on contemporary multi-line slot machines, which allow the gambler to choose between a number of line and bet options. By playing more lines, gamblers experience a more frequent rate of small wins yet, counterintuitively, the number of lines played has no impact on the overall rate of return (52). These features peak in a new generation of ‘skill-based’ gambling machines that resemble traditional arcade games (e.g. a basketball game). With these new products, designers face a complex challenge of rewarding continued practice while protecting the operator’s house edge (53). At the current time, it remains unclear whether these skill-based games will be successful from a business perspective, and how they will impact cognitive distortions and gambling harms (54). As the digital

environment advances at pace, it behooves gambling regulators to identify and restrict features of gambling products that are found to foster information asymmetries and increase gambling harm. Helpful in this regard will be a better understanding about why cognitive distortions can lead to excessive gambling.

### **Searching for Mechanisms**

If we return to Langer's classic scenario of exchanging a lottery ticket that you have picked: why do people refuse to exchange that ticket? Langer's description (2), in terms of 'personal success probability', implies an effect on probability judgment: when people choose their lottery ticket, *they feel more likely to win*. In subsequent research it became clear that other mechanisms, of a more emotional nature, may play a role. From an agency perspective, perhaps people assign more reward value to a desired outcome that arose from their own behaviour ("I made that happen!") (55,56). Refusal to exchange one's ticket may be fueled by an effect of ownership (the 'endowment effect') or sunk costs (57), as well as 'regret anticipation' (58,59) by which people forecast how awful they would feel if their chosen ticket ended up winning after exchanging it for another. These mechanisms are not mutually exclusive, and there is a range of support for each.

Humans are creative in the ways that they infer control. One influential account distinguishes primary control and secondary control (60). Primary control is when a person directly modifies their environment, such as choosing a lottery ticket. These are the factors that Langer focused on. But when primary control is unavailable, humans appeal to secondary control: for example, they may interpret a losing streak as a signal that a win is due (predictive

control), or they may interpret a win as a sign that their luck has changed and hence, they should continue to bet. Both of these examples also relate to other cognitive distortions that are widespread among gamblers and captured on questionnaires like the Gambling-Related Cognitions Scale. But many of these effects can also be viewed from an overarching ‘control’ perspective, in which the gambler is looking to master or at least make sense of an unpredictable environment (60).

Although the cognitive account draws heavily on erroneous thoughts, other accounts of illusory control rely on behavioural principles from associative learning. People often face learning environments in which they must gauge whether their behaviours trigger a desired outcome (e.g. an evening at the casino, or the earlier example of the elevator ‘door close’ button). In these settings, high rates of responding and high rates of positive outcomes are seen to fuel ‘illusory correlations’ or exhibit ‘superstitious conditioning’ (14,61), and within this framework, instructions that encouraged analytical thinking were effective at reducing the illusion of control (62), with relevance to the educational programs discussed above. Using this kind of procedure, people with gambling problems were seen to overestimate the effectiveness of a hypothetical new medication in treating an illness, witnessed over a series of observations (63). The effect was striking because the procedure bore no resemblance to gambling, leading the authors to conclude that control biases in people with gambling problems are ‘domain-general’ tendencies.

A recent study by Klusowski et al (64) revisits one of the key tenets in Langer (2): does the simple act of *choosing* the ticket transform the odds of success in the mind of the ticket owner? In a paper that is also notable for its strong open science credentials, 17 pre-registered experiments are reported, with over 10,000 participants in total. Experiments 1-9 randomised

participants to choice and no-choice groups, on tasks involving dice numbers, or trays of identical-looking chocolates that might be different flavours. The results were eerily reminiscent of the original Ladouceur studies (21,23). When participant sampling does not select for gambling involvement, and taking measures of confidence or risk-taking on trivial guessing tasks, the illusion of control was ethereal. In their later experiments, Klusowski et al switched to a task where a prize was hidden in one of several boxes. Here, a minority of participants in the choice condition did rate their chosen box as more likely to win. Critically, by taking these ratings both before and after the choice (Experiments 16 and 17), Klusowski et al generate a major insight: the participant's choice is a behavioural artefact of a pre-existing belief that one of the boxes is more favourable than the rest.

The Klusowski et al study convincingly shows that the sheer act of choosing changes very little; rather, participants choose options that are in line with their beliefs. Some readers may gladly pounce on the conclusion that another classic effect in psychology has bitten the dust, but does Klusowski's formulation of Langer have the outline of a straw man? When people buy lottery tickets, what kinds of numbers do they choose? They might choose their family members' birthdays -- because these are *special numbers* (65). Or they avoid consecutive sequences (1-2-3-4-5-6), because they have a faulty belief that such sequences are less likely (66). In both cases, it is their pre-existing beliefs that guide the choice, not *vice versa* (see also 67). Ultimately, our view is not so far from Langer's, that choice is merely one of many factors that can amplify an almost magical belief that there is more to this game than random chance.

In recent years, the well-established biopsychosocial approach to problem gambling has been superseded by a public health approach to gambling harm, which recognises the systemic and multi-faceted nature of gambling harm, places a greater emphasis on social factors and

inequities, and accordingly, promotes a range of intervention programs that would include not only treatment services and other programs directed at the individual, but also population-wide attention to gambling accessibility (68,69). Despite the shift toward a public health approach, Langer's formulation of the illusion of control has maintained its relevance to the field of gambling studies. It represents a significant advance in understanding the psychology of gambling and was a precursor to both theory and research on the antecedents and consequences of disordered gambling. Yet, relatively little is known about why and when illusory beliefs support excessive gambling. Such an understanding will not only serve to help develop better policies and programs to prevent disordered gambling, but in a clinical context help treatment providers care for those living with gambling problems.

## References

1. Delfabbro P, Georgiou N, Malvaso C, King D. Is self-reported propensity for everyday illusions of control higher in gamblers and is it associated with gambling-specific erroneous beliefs? *SAGE Open*. 2020;10(1).
2. Langer EJ. The illusion of control. *J Pers Soc Psychol*. 1975;32:311–28.
3. Stefan S, David D. Recent developments in the experimental investigation of the illusion of control. A meta-analytic review. *J Appl Soc Psychol*. 2013;43:377–86.
4. Davis D, Sundahl I, Lesbo M. Illusory personal control as a determinant of bet size and type in casino craps games. *J Appl Soc Psychol*. 2000;30:1224–42.
5. Martinez F, Bonnefon JF, Hoskens J. Active involvement, not illusory control, increases risk taking in a gambling game. *Q J Exp Psychol*. 2009;62:1063–71.
6. Langer EJ, Roth J. Heads I win, tails it's chance: The illusion of control as a function of

- the sequence of outcomes in a purely chance task. *J Pers Soc Psychol*. 1975;32(6):951–5.
7. Sanderson WC, Rapee RM, Barlow DH. The influence of an illusion of control on panic attacks induced via inhalation of 5.5% carbon dioxide-enriched air. *Arch Gen Psychiatry*. 1989;46(2):157–62.
  8. Taylor SE, Helgeson V, Reed G, Skokan L. Self-generated feelings of control and adjustment to physical illness. *J Soc Issues*. 1991;47(4):91–109.
  9. Mallers MH, Claver M, Lares LA. Perceived control in the lives of older adults: The influence of Langer and Rodin’s work on gerontological theory, policy, and practice. *Gerontologist*. 2014;54(1):67–74.
  10. Norton MI, Gino F. Rituals alleviate grieving for loved ones, lovers, and lotteries. *J Exp Psychol Gen*. 2014;143(1):266–72.
  11. Yarritu I, Matute H, Luque D. The dark side of cognitive illusions: When an illusory belief interferes with the acquisition of evidence-based knowledge. *Br J Psychol*. 2015;106(4):597–608.
  12. Henslin JM. Craps and magic. *Am J Sociol*. 1967;316–30.
  13. Golin S, Terrell F, Johnson B. Depression and the illusion of control. *J Abnorm Psychol*. 1977;86(4):440–2.
  14. Alloy LB, Abramson LY. Judgment of contingency in depressed and nondepressed students: Sadder but wiser? *J Exp Psychol Gen*. 1979;108(4):441–85.
  15. Msetfi RM, Simpson J, Murphy RA, Kornbrot DE. Depressive realism and outcome density bias in contingency judgments: The effect of the context and intertrial interval. *J Exp Psychol Gen*. 2005;134(1):10–22.
  16. Strickland LH, Lewicki RJ, Katz AM. Temporal orientation and perceived control as

- determinants of risk-taking. *J Exp Soc Psychol.* 1966;2(2):143–51.
17. Walker M. *The Psychology of Gambling.* Sydney: Pergamon Press; 1992.
  18. Knapp TJ. Behaviorism and public policy: B. F. Skinner's views on gambling. *Behav Soc Issues.* 1997;7(2):129–39.
  19. Edwards W. Probability learning in 1000 trials. *J Exp Psychol.* 1961/10/01. 1961;62(4):385–94.
  20. Estes WK. Cognitive processes in reinforcement and choice. In: D'Ydewalle G, Lens W, editors. *Cognition in Human Motivation and Learning.* New York: Psychology Press; 1982.
  21. Ladouceur R, Mayrand M, Dussault R, Letarte A, Tremblay J. Illusion of control: effects of participation and involvement. *J Psychol.* 1984;117:47–52.
  22. Letarte A, Ladouceur R, Mayrand M. Primary and secondary illusory control and risk-taking in gambling (roulette). *Psychol Rep.* 1986;58:299–302.
  23. Ladouceur R, Mayrand M. Evaluation of the “illusion of control”: type of feedback, outcome sequence, and number of trials among regular and occasional gamblers. *J Psychol.* 1984;117:37–46.
  24. Ladouceur R, Walker M. A cognitive perspective on gambling. In: Salkovskis PM, editor. *Trends in Cognitive and Behavioural Therapies.* Chichester, U.K.: Wiley & Sons; 1996. p. 89–120.
  25. Gaboury A, Ladouceur R. Erroneous perceptions and gambling. *J Soc Behav Pers.* 1989;4(4):411–20.
  26. Wohl MJA, Young MM, Hart KE. Untreated young gamblers with game-specific problems: Self-concept involving luck, gambling ecology and delay in seeking



- professional treatment. *Addict Res Theory*. 2005;13(5):445–59.
27. Fortune EE, Goodie AS. Cognitive distortions as a component and treatment focus of pathological gambling: A review. *Psychol Addict Behav*. 2012;26:298–310.
  28. Raylu N, Oei TP. The Gambling Related Cognitions Scale (GRCS): development, confirmatory factor validation and psychometric properties. *Addiction*. 2004;99:757–69.
  29. Steenbergh TA, Meyers AW, May RK, Whelan JP. Development and validation of the Gamblers' Beliefs Questionnaire. *Psychol Addict Behav*. 2002;16(2):143–9.
  30. Jefferson S, Nicki R. A new instrument to measure cognitive distortions in video lottery terminal users: The Informational Biases Scale (IBS). *J Gambl Stud*. 2003;19(4):387–403.
  31. Goodie AS, Fortune EE. Measuring cognitive distortions in pathological gambling: review and meta-analyses. *Psychol Addict Behav*. 2013;27(3):730–43.
  32. Cunningham JA, Hodgins DC, Toneatto T. Relating severity of gambling to cognitive distortions in a representative sample of problem gamblers. *J Gambl Issues*. 2014;(29):2–7.
  33. Young MM, Wohl MJA, Matheson K, Baumann S, Anisman H. The desire to gamble: the influence of outcomes on the priming effects of a gambling episode. *J Gambl Stud*. 2008;24(3):275–93.
  34. Billieux J, Van der Linden M, Khazaal Y, Zullino D, Clark L. Trait gambling cognitions predict near-miss experiences and persistence in laboratory slot machine gambling. *Br J Psychol*. 2012;103(3):412–27.
  35. Blaszczynski A, Nower L. A pathways model of problem and pathological gambling. *Addiction*. 2002;97:487–99.
  36. Sharpe L. A reformulated cognitive-behavioral model of problem gambling: a

- biopsychosocial perspective. *Clin Psychol Rev.* 2002;22(1):1–25.
37. Oei TP, Gordon LM. Psychosocial factors related to gambling abstinence and relapse in members of gamblers anonymous. *J Gambl Stud.* 2008;24(1):91–105.
  38. Petry NM, Ginley MK, Rash CJ. A systematic review of treatments for problem gambling. *Psychol Addict Behav.* 2017;31(8):951–61.
  39. Toneatto T, Gunaratne M. Does the treatment of cognitive distortions improve clinical outcomes for problem gambling ? *J Contemp Psychother.* 2009;39:221–9.
  40. Chrétien M, Giroux I, Goulet A, Jacques C, Bouchard S. Cognitive restructuring of gambling-related thoughts: A systematic review. *Addict Behav.* 2017;75:108–21.
  41. Responsible Gambling Council. Informed Decision Making. Toronto, ON; 2010.  
Available from: <http://www.responsiblegambling.org/rg-news-research/rgc-centre/research-and-analysis/docs/default-source/research-reports/informed-decision-making>
  42. Keen B, Anjoul F, Blaszczynski A. How learning misconceptions can improve outcomes and youth engagement with gambling education programs. *J Behav Addict.* 2019;8(3):372–83.
  43. Wohl MJA, Gainsbury S, Stewart MJ, Sztainert T. Facilitating responsible gambling: the relative effectiveness of education-based animation and monetary limit setting pop-up messages among Electronic Gaming Machine players. *J Gambl Stud.* 2013;29(4):703–17.
  44. Williams RJ, Connolly D. Does learning about the mathematics of gambling change gambling behavior? *Psychol Addict Behav.* 2006;20(1):62–8.
  45. Lambos C, Delfabbro P. Numerical reasoning ability and irrational beliefs in problem gambling. *Int Gambl Stud.* 2007;7(2):157–71.

46. Sevigny S, Ladouceur R. Gamblers' irrational thinking about chance events: the 'double switching' concept. *Int Gambl Stud.* 2003;3(2):149–61.
47. Schull ND. *Addiction by Design: Machine Gambling in Las Vegas.* Princeton, NJ: Princeton University Press; 2012.
48. Myrseth H, Brunborg GS, Eidem M. Differences in cognitive distortions between pathological and non-pathological gamblers with preferences for chance or skill games. *J Gambl Stud.* 2010;26(4):561–9.
49. Fenton-O'Creevy M, Nicholson N, Soane E, Willman P. Trading on illusions: Unrealistic perceptions of control and trading performance. *J Occup Organ Psychol.* 2003;76(1):53–68.
50. Delfabbro P. The stubborn logic of regular gamblers: obstacles and dilemmas in cognitive gambling research. *J Gambl Stud.* 2004;20(1):1–21.
51. Ladouceur R, Sevigny S. Structural characteristics of video lotteries: effects of a stopping device on illusion of control and gambling persistence. *J Gambl Stud.* 2005;21(2):117–31.
52. Harrigan K, MacLaren V, Brown D, Dixon MJ, Livingstone C. Games of chance or masters of illusion: multiline slots design may promote cognitive distortions. *Int Gambl Stud.* 2014;14:301–17.
53. Delfabbro P, King D, Gainsbury SM. Understanding gambling and gaming skill and its implications for the convergence of gaming with electronic gaming machines. *Int Gambl Stud.* 2020;20(1):171–83.
54. Pickering D, Philander KS, Gainsbury SM. Skill-based Electronic Gaming Machines: a review of product structures, risks of harm, and policy issues. *Curr Addict Reports.* 2020;7(2):229–36.

55. Leotti LA, Delgado MR. The value of exercising control over monetary gains and losses. *Psychol Sci.* 2014;25(2):596–604.
56. Tricomi EM, Delgado MR, Fiez JA. Modulation of caudate activity by action contingency. *Neuron.* 2004;41(2):281–92.
57. van de Ven N, Zeelenberg M, van Dijk E. Buying and selling exchange goods: Outcome information, curiosity and the endowment effect. *J Econ Psychol.* 2005;26(3):459–68.
58. Bar-Hillel M, Neter E. Why are people reluctant to exchange lottery tickets? *J Pers Soc Psychol.* 1996;70(1):17–27.
59. Risen JL, Gilovich T. Another look at why people are reluctant to exchange lottery tickets. *J Pers Soc Psychol.* 2007;93(1):12–22.
60. Rothbaum F, Weisz JR, Snyder SS. Changing the world and changing the self: A two-process model of perceived control. *J Pers Soc Psychol.* 1982;42(1):5–37.
61. Tobias-Webb J, Limbrick-Oldfield EH, Gillan CM, Moore JW, Aitken MRF, Clark L. Let me take the wheel: illusory control and sense of agency. *Q J Exp Psychol.* 2017;70:1732–46.
62. Matute H. Illusion of control: detecting response-outcome independence in analytic but not in naturalistic conditions. *Psychol Sci.* 1996 Sep;7(5):289–93.
63. Orgaz C, Estevez A, Matute H. Pathological gamblers are more vulnerable to the illusion of control in a standard associative learning task. *Front Psychol.* 2013;4:306.
64. Klusowski J, Small DA, Simmons JP. Does choice cause an illusion of control? *Psychol Sci.* 2021;32:159–72.
65. Goodman JK, Irwin JR. Special random numbers: beyond the illusion of control. *Organ Behav Hum Decis Process.* 2006;99(2):161–74.

66. Hardoon KK, Baboushkin HR, Derevensky JL, Gupta R. Underlying cognitions in the selection of lottery tickets. *J Clin Psychol.* 2001;57(6):749–63.
67. Ejova A, Ohtsuka K. Erroneous gambling-related beliefs emerge from broader beliefs during problem-solving: a critical review and classification scheme. *Think Reason.* 2020;26:159–87.
68. Langham E, Thorne H, Browne M, Donaldson P, Rose J, Rockloff M. Understanding gambling related harm: A proposed definition, conceptual framework, and taxonomy of harms. *BMC Public Health.* 2016;16(80):1–23.
69. Wardle H, Reith G, Langham E, Rogers RD. Gambling and public health: we need policy action to prevent harm. *Br Med J.* 2019;365:1807.