To appear in: *Journal of Gambling Studies*

Citation: Walker, A. C., Stange, M., Dixon, M. J., Fugelsang, J. A., & Koehler, D. J. (In Press). Using icon arrays to communicate gambling information reduces the appeal of scratch card games. *Journal of Gambling Studies*, 1-20. https://doi.org/10.1007/s10899-021-10103-5

Using Icon Arrays to Communicate Gambling Information Reduces the Appeal of Scratch Card Games

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Acknowledgments
This research was supported by grants from the Natural Sciences and Engineering Research Council of Canada.

Open Science
All materials and data reported in this manuscript can be accessed via the following link: https://osf.io/gtcxd

Ethical Approval
All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Waterloo Office of Research Ethics and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of Interest
MS has received travel and/or accommodation for speaking engagements from the Responsible Gambling Council (Canada) and the British Columbia Lottery Corporation (Canada). She has received consulting fees from Gambling Research Exchange Ontario (Canada) and was the 2020 recipient of the Responsible Gambling Council's Tibor I. Barsony Student Bursary (Canada). These declarations are unrelated to the research presented in this manuscript. The authors declare that they have no additional conflicts of interest.

Abstract

Past work has demonstrated that presenting statistical information in a foreground-background icon array can improve risk understanding, reduce decision-making biases, and decrease the salience of low-probability risks. In the present study, we assess whether presenting readily available gambling information within a foreground-background icon array influences individuals' gambling-related judgments (e.g., their perceived likelihood of winning a prize). Across two experiments (N = 1,151), we find that using icon arrays to present gambling information reduces the appeal of scratch card games. That is, participants presented with gambling information in a foreground-background icon array, as opposed to a non-graphical numerical format, reported feeling less likely to win a prize, less excitement to play, and less urge to gamble on a scratch card game presented in a hypothetical gambling task. Overall, we conclude that presenting gambling information in an icon array format represents a simple yet promising tool for correcting gamblers' often overly-optimistic perceptions and reducing the appeal of negative expected value scratch card games.

Keywords: icon arrays, gambling, scratch cards, graphical depiction, decision aids

Using Icon Arrays to Communicate Gambling Information Reduces the Appeal of Scratch Card Games

Lottery gambling is one of the most popular forms of legalized gambling (Ariyabuddhiphongs, 2011; Subramaniam et al., 2016; Welte et al., 2002). Within the category of lottery gambling are scratch card games, in which a gambler removes an opaque layer from a card with hopes of uncovering matching symbols corresponding to a prize. While sharing many similarities with other lottery games (e.g., traditional draw-based lotteries), scratch card games offer a set of unique features that may make them especially likely to lead to gambling-related harms (Griffiths, 1995). For example, the overrepresentation of near-miss outcomes (e.g., uncovering two of the three symbols needed to obtain a top prize) can make gamblers falsely feel as if they were close to a big win (Clark et al., 2009; Stange, Brown, Harrigan, & Dixon, 2017), increasing their urge to continue playing (Reid, 1986; Stange, Graydon, & Dixon, 2017). Furthermore, a relatively short event frequency (i.e., a small duration between purchase and outcome) and low price point can support continuous play (Griffiths, 1995). Taken together, it is no surprise that the frequency of scratch card play is positively associated with gambling harm (Williams et al., 2015; Stange et al., 2018) and shares a stronger association with gambling harm compared to other lottery games (Short et al., 2015).

Given their low payback percentages[1] and association with gambling harms, one may wonder why scratch cards hold such widespread appeal. One possibility is that gamblers understand the negative expected value of scratch card games but are willing to pay a premium for the entertainment value derived from playing these games. However, another possibility is

[1] For example, at the time of writing, the mean payback percentage (defined as the proportion of money spent that is paid out in prizing) of scratch cards available in our home jurisdiction of Ontario, Canada was 67.05% (*95% CI* [65.93, 68.16]).

that many gamblers overestimate their likelihood of winning a prize while playing these games, particularly for large prizes with unfavourable odds. A large body of work has highlighted peoples' poorly calibrated estimates of low probability events, with people either ignoring the possibility of low probability events or overestimating their frequency (Barron & Erev, 2003; Bleichrodt & Pinto, 2000; Hertwig et al., 2004; Kahneman & Tversky, 1979; Tversky & Kahneman, 1992; Weber et al., 2004). The overestimation of low-probability events has been linked with the attractiveness of lottery games, with studies demonstrating individuals over-valuing the opportunity to win a large yet low-probability prize (Kachelmeier & Shehata, 1992; Kahneman & Tversky, 1979; Tversky & Kahneman, 1992).

For many lottery operators, gambling information (e.g., payback percentage and odds of winning) is made readily available for each scratch card game (Atlantic Lottery Corporation, 2020; Ontario Lottery and Gaming Corporation, 2020; Western Canada Lottery Corporation, 2020). While it may seem that having access to such information should serve to correct mis-calibrated gambling judgments, recent work suggests that people often fail to use this information in a way that improves their judgments. For example, when presented with both diagnostic (i.e., payback percentage) and non-diagnostic information (i.e., unclaimed prize information) peoples' scratch card preferences commonly contradict the diagnostic information provided (Walker et al., 2019).

One possible reason for peoples' misuse of diagnostic gambling information is that this information may be difficult to understand (Beresford & Blaszczynski, 2020; Newell et al., 2020; Walker et al., 2019). For example, payback percentage information (representing the proportion of money spent that is paid out in prizes) may be unintuitive to gamblers as it communicates a theoretical long-run average in the form of a percentage. Compare this to the intuitive, yet non-

diagnostic, unclaimed prize information, which states a simple integer representing the number of prizes that have yet to be claimed. Supporting the distinction between unintuitive and intuitive gambling information is work demonstrating that presenting diagnostic information in a more intuitive manner improves gambling-related judgments (Oudhoff & Timmermans, 2015; Newall et al., 2020; Walker et al., 2019). For example, when presenting payback percentage information in a simple graphical format (e.g., a visual 1, 3, or 5-star rating), people make better use of this information, resulting in gambling-related judgments that correspond to diagnostic payback percentage information as opposed to non-diagnostic unclaimed prize information (Walker et al., 2019). Thus, finding ways to present gambling information in more intuitive and easy-to-understand formats can help shift biased perceptions closer to reality, improving the decision making of gamblers in the process.

Improving Judgments with Icon Arrays

Research on graphical displays highlights their potential for presenting complex information in a more intuitive and easy-to-understand manner (Ancker et al., 2006; Garcia-Retamero & Galesic, 2010; Garcia-Retamero et al., 2012; Zikmund-Fisher et al., 2008). While many forms of graphical displays exist, perhaps the most promising for improving peoples' understanding of unintuitive statistical information is the icon array. Icon arrays are graphical displays in which the frequency of a particular event is represented using icons. There are two types of icon arrays, *foreground-only* icon arrays in which only the frequency of a particular event is depicted graphically (e.g., a scratch card win) and *foreground-background* icon arrays in which both the frequency of an event and the chances it has to occur are depicted graphically (e.g., both the number of scratch card wins and the total number of scratch card games in circulation). Much research has investigated icon arrays for their effectiveness in communicating

information about risks. This work demonstrates that foreground-only icon arrays increase the salience of low-probability risks and facilitate risk-avoidant behaviours, compared to when information is presented in a non-graphical numerical format (Stone et al., 1997, 2003, 2015). Conversely, foreground-background icon arrays, while often the most effective for improving risk understanding (Garcia-Retamero & Galesic, 2010; Tait et al., 2010; Zikmund-Fisher et al., 2008), tend to decrease the salience of low-probability risk and reduce risk-avoidant behaviours compared to non-graphical numerical formats (Stone et al., 2003; 2018). Such findings may not be surprising given that, when communicating information about a low-probability risk, foreground-only icon arrays graphically highlight the occurrence of a low-probability harm whereas foreground-background displays graphically depict the small ratio of harmed to unharmed individuals.

Along with improving risk understanding, foreground-background icon arrays have been demonstrated to reduce some decision-making biases (Garcia-Retamero & Galesic, 2009; Garcia-Retamero et al., 2010; Galesic et al., 2009; Zikmund-Fisher et al., 2008). For example, presenting statistical information in a foreground-background icon array has been shown to reduce denominator neglect, a bias in which individuals' decisions are overly influenced by how often an event happened (e.g., the number of patients who die) and insufficiently influenced by the total number of opportunities an event had to occur (e.g., the overall number of patients). Denominator neglect has been linked with non-normative gambling preferences (Denes-Raj & Epstein, 1994; Kirkpatrick & Epstein, 1992; Walker et al., 2018). For example, Denes-Raj and Epstein (1994) found that a majority of participants displayed at least some preference for gambles featuring more winning outcomes yet a lower expected value (e.g., preference for a

gamble featuring 7 winning and 93 losing outcomes instead of 1 winning and 9 losing outcomes).

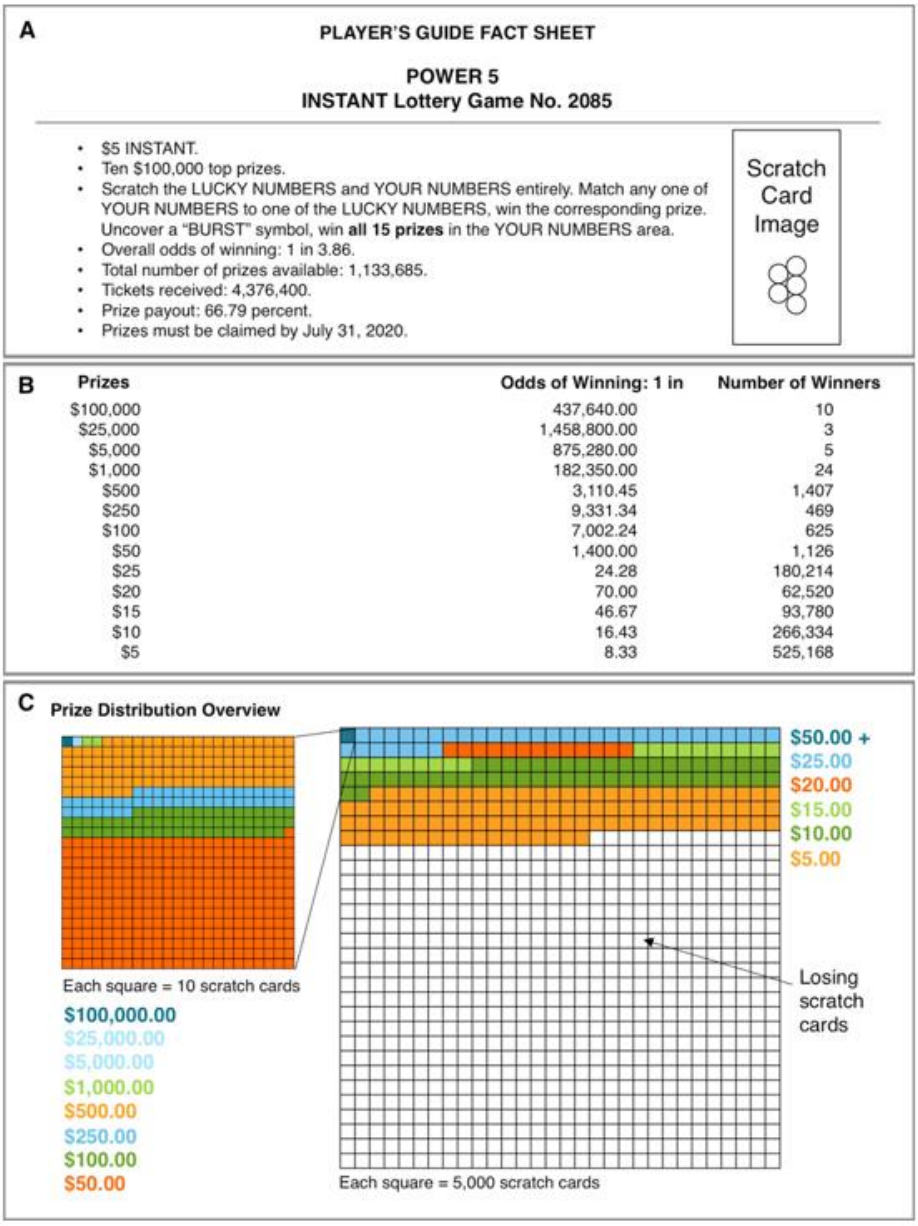
While foreground-background icon arrays may result in people dismissing the possibility of low-probability harms, they may be similarly effective in having people discount the possibility of low-probability lottery wins. Additionally, as foreground-background icon arrays have been shown to improve peoples' understanding of risk information and reduce decision-making biases (e.g., denominator neglect), presenting gambling information in this format may provide gamblers with an improved understanding of the unfavourable odds of negative expected value lottery games. In the domain of scratch cards, gamblers may often pay excess attention to the pool of prizes available while giving insufficient attention to the far greater number of losing cards in circulation. If presenting the outcome distribution of a scratch card game in a foreground-background icon array reduces individuals' focus on winning scratch cards by clearly communicating the unfavourable ratio of winning to losing cards in a graphical display, then such displays may be able to serve as a useful tool for correcting biased misperceptions and improving gambling-related judgments.

The Present Research

The present research investigates how the presentation format of readily available gambling information alters gamblers' perceptions and judgments. Specifically, we assess how presenting scratch card game information in a foreground-background icon array (see Figure 1) alters individuals' gambling-related judgments (e.g., their perceived likelihood of winning a prize). The primary contributions of this work are twofold. First, the present research assesses a method of presenting gambling information that has the potential to correct over-optimistic gambling perceptions and reduce the appeal of negative expected value lottery games. To the

extent that gamblers hold over-optimistic perceptions regarding lottery games—which may be associated with the experience of gambling-related harms—the present work represents an initial investigation of foreground-background icon arrays as a responsible gambling tool. Second, although prior work has demonstrated that depicting low-probability *risks* (e.g., medical risks) within a foreground-background icon array can improve risk understanding (Garcia-Retamero & Galesic, 2010; Tait et al., 2010; Zikmund-Fisher et al., 2008) and reduce decision-making biases (Garcia-Retamero & Galesic, 2009; Garcia-Retamero et al., 2010; Galesic et al., 2009), few studies have assessed the effects of depicting low-probability *positive* outcomes (e.g., lottery wins) in this way. Therefore, the present work adds to the literature on icon arrays by assessing the extent to which depicting low-probability positive—as opposed to negative—outcomes within a foreground-background icon array improves individuals' understanding of statistical information and gambling-related judgments. Given the success of foreground-background icon arrays in improving risk understanding and reducing decision-making biases in non-gambling domains, we predict that presenting gambling information in this format will help correct optimistic perceptions regarding the likelihood of winning a prize, thus reducing the appeal of scratch card games. Therefore, we hypothesize that presenting gambling information in a foreground-background icon array will result in participants feeling less likely to win, being less excited to play, reporting less urge to gamble, and purchasing fewer scratch cards compared to when the same information is provided in a non-graphical numerical format.

Figure 1



Note. Experimental stimuli presented to participants in the basic (A), prizes (B), and icon array (C) information conditions for Experiment 1. Information conditions were cumulative, such that participants in the prizes condition also received information presented to those in the basic condition, and participants in the icon array condition received information presented to those in the basic and prizes conditions. Therefore, participants in the basic condition were presented with information in panel A, participants in the prizes condition with information in panels A and B, and participants in the icon array condition with information in panels A, B, and C.

Experiment 1

Method

Participants

We recruited a sample of 501 participants (46% Female; M_{age} = 39.61, SD_{age} = 12.62) from Amazon Mechanical Turk. Participants received $0.75 upon completion of an 8-minute online questionnaire for which they were required to be residents of Canada or the United States and possess a Mechanical Turk HIT approval rating greater than or equal to 95%. For all experiments, we collected our full sample prior to data analyses and report all data exclusions, all manipulations, and all measures used. Data from all studies can be accessed via the following link: osf.io/gtcxd.

Materials and Measures

Scratch Card Game and Information. Experiment 1 reproduced available information for the scratch card "Power 5s", found on the Ontario Lottery and Gaming Corporation's (OLG) website (Ontario Lottery & Gaming Corporation, 2019). Participants were presented with varying amounts of information depending on the condition they were randomly assigned to (see Figure 1). Information mirroring that which could be found printed on a commercially available scratch card game (e.g., Power 5; see Figure 1A) was presented in all three information conditions (i.e., basic, prizes, and icon array), and was the only information presented within the basic condition. Additional information available on the lottery operator's website concerning the odds of winning each available prize for the presented scratch card game was provided in the prizes and icon array conditions (see Figure 1B). Finally, in the icon array condition, this information was also graphically depicted within a foreground-background icon array (see Figure 1C). The presented icon array featured 900 squares displayed in a 30 x 30 square grid.

Each square represented 5,000 scratch cards containing a specific outcome (e.g., a $10 win). As the Power 5 scratch card featured large prizes of $50.00 or more that were too infrequent to be conveniently depicted within an icon array of this size, we grouped these prizes into a single square which was linked with an adjacent icon array communicating the number of scratch cards containing each of these larger prizes.

Likelihood of Winning. Adopted from Walker and colleagues (2018, 2019), participants' perceived likelihood of winning a prize while playing Power 5 was assessed with the following item: "How likely do you think you are to win a prize while playing Power 5?" Participants responded to this item using a 7-point scale that ranged from 1 (*Extremely unlikely*) to 7 (*Extremely likely*).

Excitement. Participants reported their excitement to play Power 5 by responding to the question "How excited would you be to play Power 5?" Participants responded to this item using a scale that ranged from 1 (*Not at all excited*) to 7 (*Extremely excited*).

Urge to Gamble. Participants' urge to gamble was assessed with the item: "Please indicate your urge to gamble on Power 5." Responses to this item were provided using a scale that ranged from 1 (*No urge to gamble*) to 7 (*Strong urge to gamble*).

Card Purchasing. We assessed participants' hypothetical card purchasing behaviour by presenting them with the following scenario: "Say you had the opportunity to purchase Power 5 scratch cards. Each card costs $5. Hypothetically speaking, how many Power 5 cards would you like to purchase?" Following this scenario, participants indicated how many Power 5 scratch cards they would elect to purchase (up to a maximum of ten).

Problem Gambling Severity Index. The Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001) is a subscale of the Canadian Problem Gambling Index and provides a

reliable and valid measure of problem gambling symptomotology. Participants completed 9 items addressing gambling-related harms on a scale from 0 (*Never*) to 3 (*Almost always*). Responses to individual items were summed to create an overall PGSI score for each participant. Scores of 0 on the PGSI indicate non-problem gambling, scores between 1 and 4 indicate low-risk gambling, scores between 5 and 7 indicate moderate-risk gambling, and scores of 8 and above are considered indicative of problem gambling (Currie et al., 2013).

Cognitive Reflection Test. The Cognitive Reflection Test (CRT; Frederick, 2005) was designed to evaluate individuals' ability to suppress an intuitive incorrect response in favour of a deliberative correct answer. Participants were presented with four CRT items taken from Toplak and colleagues (2014) and Primi and colleagues (2016). We calculated the number of correct responses given by each participant, resulting in a CRT score for each participant that ranged from zero to four.

Numeracy Scale. We administered three numeracy scale items (Schwartz et al., 1997; Weller et al., 2013) to assess participants' ability to understand and properly use numerical information. We calculated a numeracy score for each participant (ranging from zero to three), which reflected the number of correct responses they provided.

Design and Procedure

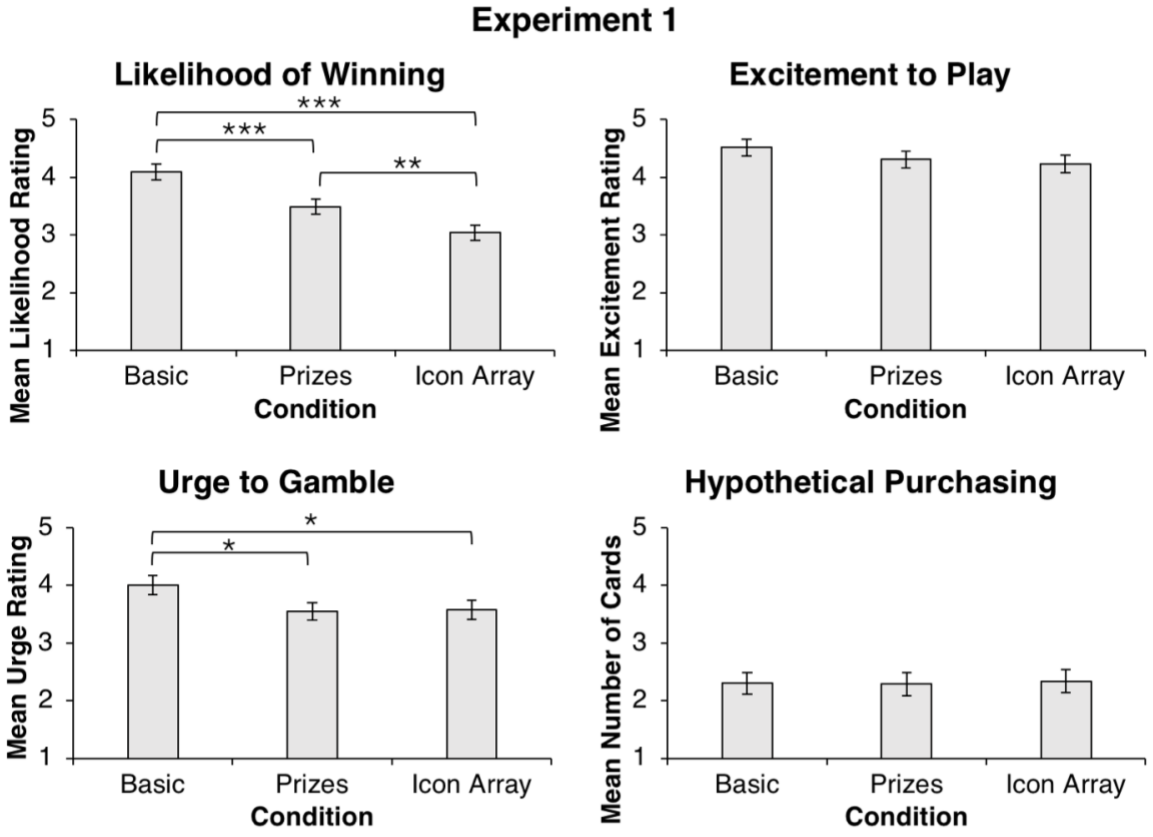
The present experiment used a between-subjects design in which participants were randomly assigned to one of three information conditions (i.e., basic, prizes, or icon array). Notably, each condition differed with regards to the information participants received about the presented scratch card game (see Figure 1). In all conditions, participants were asked to provide a likelihood of winning, excitement, urge to gamble, and card purchasing judgment for the presented scratch card game (Power 5). Following these judgments, participants concluded the

experiment by answering various demographic questions (i.e., age, gender, and scratch card gambling frequency) and completing numeracy, CRT, and PGSI items.

Results and Discussion

Participants' mean likelihood of winning, excitement, urge to gamble, and card purchasing judgments across our three information conditions (basic, prizes, and icon array) are presented in Figure 2. In order to assess the influence of information condition on participants' judgments, we compared participants' likelihood of winning, excitement, urge to gamble, and card purchasing judgments across information conditions using one-way between-subjects analysis of variance (ANOVA). The results of each ANOVA are reported independently for each dependent variable below.

Figure 2



Note. Results for Experiment 1. Error bars represent 95% confidence intervals. *** $p \leq .001$; ** $p < .01$; * $p < .05$.

Likelihood of Winning

We observed a main effect of information condition, $F(2, 498) = 20.27$, $p < .001$, $\eta_p^2 = .075$. Follow-up independent samples *t*-tests revealed that participants in the icon array condition felt less likely to win a prize while playing Power 5 ($M = 3.04$, $SD = 1.52$) compared to those in the basic ($M = 4.10$, $SD = 1.57$), $t(335) = 6.32$, $p < .001$, $d = 0.69$, and prizes conditions ($M = 3.49$, $SD = 1.53$), $t(326) = 2.72$, $p = .007$, $d = 0.30$. Therefore, depicting gambling information in a foreground-background icon array effectively lowered participants' perceived likelihood of winning a prize while playing Power 5. Interestingly, icon arrays were effective at lowering participants' perceived likelihood of winning a prize despite presenting the same information from the prizes condition, albeit in a graphical format. Furthermore, those in the prizes condition provided lower likelihood of winning judgments compared to those in the basic condition, $t(335) = 3.59$, $p < .001$, $d = 0.39$, suggesting that the additional information commonly available on many lottery operator websites also served to reduce participants' perceived odds of winning.

Excitement

We observed no main effect of information condition, $F(2, 498) = 1.34$, $p = .263$, $\eta_p^2 = .005$. That is, participants' excitement judgments did not differ across information conditions.

Urge to Gamble

We observed a main effect of information condition, $F(2, 498) = 3.21$, $p = .041$, $\eta_p^2 = .013$. Follow-up independent samples *t*-tests revealed that participants in the basic condition reported a stronger urge to gamble on Power 5 ($M = 4.01$, $SD = 1.86$) compared to those in the prizes ($M = 3.55$, $SD = 1.80$), $t(335) = 2.26$, $p = .025$, $d = 0.25$, and icon array conditions ($M = 3.58$, $SD = 1.87$), $t(335) = 2.10$, $p = .037$, $d = 0.23$. Participants in the icon array and prizes condition did not differ with regards to their urge to gamble judgments ($p = .904$). Thus, it

appears that providing additional gambling information, either numerically or within a foreground-background icon array, reduced participants' urge to gamble.

Card Purchasing

We observed no main effect of information condition for judgments provided in our hypothetical card purchasing task, $F(2, 495) = 0.02$, $p = .982$, $\eta_p^2 < .001$.

Exploratory Analyses

We conducted correlational analyses to explore associations between four individual difference variables measured in Experiment 1 (see Table 1). Additionally, we conducted exploratory factorial between-subjects ANOVAs examining the interaction between information conditions and various individual difference variables (numeracy, CRT scores, and PGSI scores). For each dependent variable (likelihood of winning, excitement, urge to gamble, and card purchasing), these analyses revealed no significant interactions between information condition and participants' numeracy, CRT, or PGSI scores (all *ps* > .101). The results of each exploratory factorial ANOVA are reported in full in the supplementary materials.

Table 1

Experiment 1 Correlations

	M	*SD*	1	2	3	4
1. CRT	1.64	1.32	-			
2. Numeracy	2.08	0.94	.52**	-		
3. PGSI	2.34	4.22	-.21**	-.33**	-	
4. Scratch Card Frequency	2.19	1.29	-.11*	-.19**	.37**	-

Note. Pearson correlations (Experiment 1; $N = 501$). *CRT* = Cognitive Reflection Test; *Numeracy* = Numeracy Scale; *PGSI* = Problem Gambling Severity Index. Scratch Card Frequency represents participants' self-reported scratch card gambling frequency in the past 12 months. Responses to this item ranged from 1 (*Have not played*) to 6 (*Played 24 or more times*). ** $p < .001$, * $p < .05$.

Experiment 2

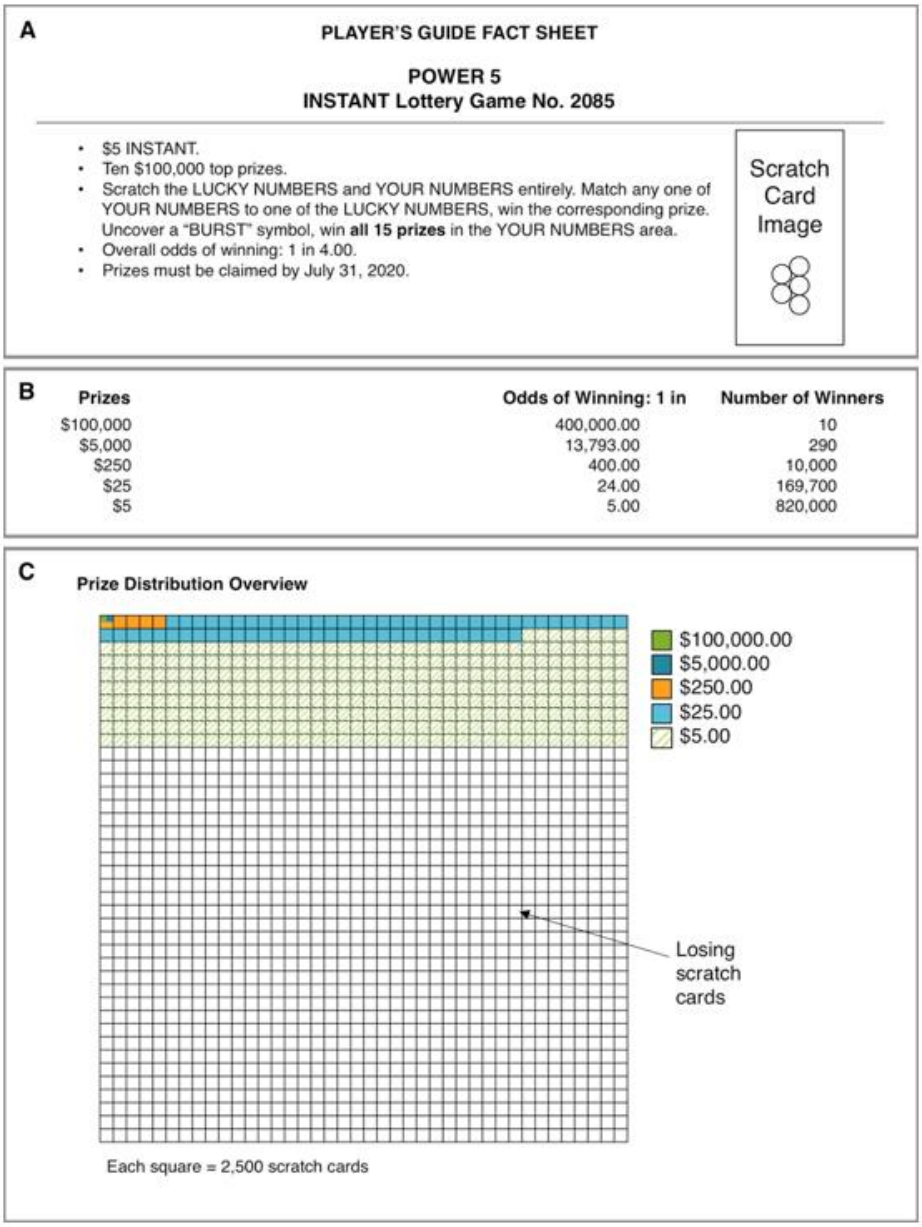
Experiment 1 provided initial evidence that presenting gambling information in a foreground-background icon array can reduce individuals' perceived likelihood of winning a prize while playing a scratch card game. In Experiment 2, we sought to replicate this effect while improving aspects of the presented icon array (see Figure 3). First, unlike Experiment 1, Experiment 2 used simplified fictional gambling information, allowing us to depict the outcomes of all available scratch cards in a less complicated manner. Second, we attempted to visually distinguish five-dollar wins (equal to the cost of play and thus not resulting in any monetary gain) from true wins greater than the five-dollar price point. This change was made to prevent participants from incorrectly interpreting these outcomes as true monetary gains. As in Experiment 1, we hypothesized that presenting gambling information in a foreground-background icon array would result in participants feeling less likely to win, less excited to play, reporting less urge to gamble, and purchasing fewer scratch cards, compared to when this same information was presented in a non-graphical format.

Method

Participants

Using the same recruitment criteria as Experiment 1, we recruited a sample of 650 participants from Amazon Mechanical Turk. Sixty-five participants were excluded from subsequent data analyses on account that they answered "yes" to the question "Is there any reason that we shouldn't use your data (e.g., did you randomly select responses at any point during the survey)?" Consequently, our final sample consisted of 585 participants (45% Female) whose mean age was 38.55 (SD_{age} = 12.06).

Figure 3



Note. Experimental stimuli presented to participants in the basic (A), prizes (B), and icon array (C) information conditions for Experiment 2. Information conditions were cumulative, such that participants in the prizes condition also received information presented to those in the basic condition, and participants in the icon array condition received information presented to those in the basic and prizes conditions. Therefore, participants in the basic condition were presented with information in panel A, participants in the prizes condition with information in panels A and B, and participants in the icon array condition with information in panels A, B, and C.

Materials and Measures

The materials and measures presented in Experiment 2 mirrored that of Experiment 1 with two exceptions. First, we simplified the presented scratch card information (see Figure 3). Second, we added items assessing participants' perceived odds of winning specific prizes while playing Power 5.

Scratch Card Game and Information. Experiment 2 presented Power 5 scratch card information in a similar manner to Experiment 1, however this information was simplified by removing the total number of prizes available, tickets received, and prize payout. Additionally, we simplified the prize structure of the presented scratch card game such that the number of prize categories was reduced, allowing us to create a more streamlined icon array (see Figure 3). This icon array consisted of 1,600 squares presented in a 40 x 40 grid with each square representing 2,500 scratch cards. Importantly, due to the simplified prize structure, we were no longer forced to group a set of larger prizes in an additional icon array. Thus, the prize structure used in Experiment 2 served to simplify our graphical depiction of the presented scratch card information. Notably, in modifying the prize structure, we ensured that the payback percentage and overall odds of winning were similar to that of the original, real-world Power 5 scratch card (and consequently to the scratch card presented in Experiment 1).

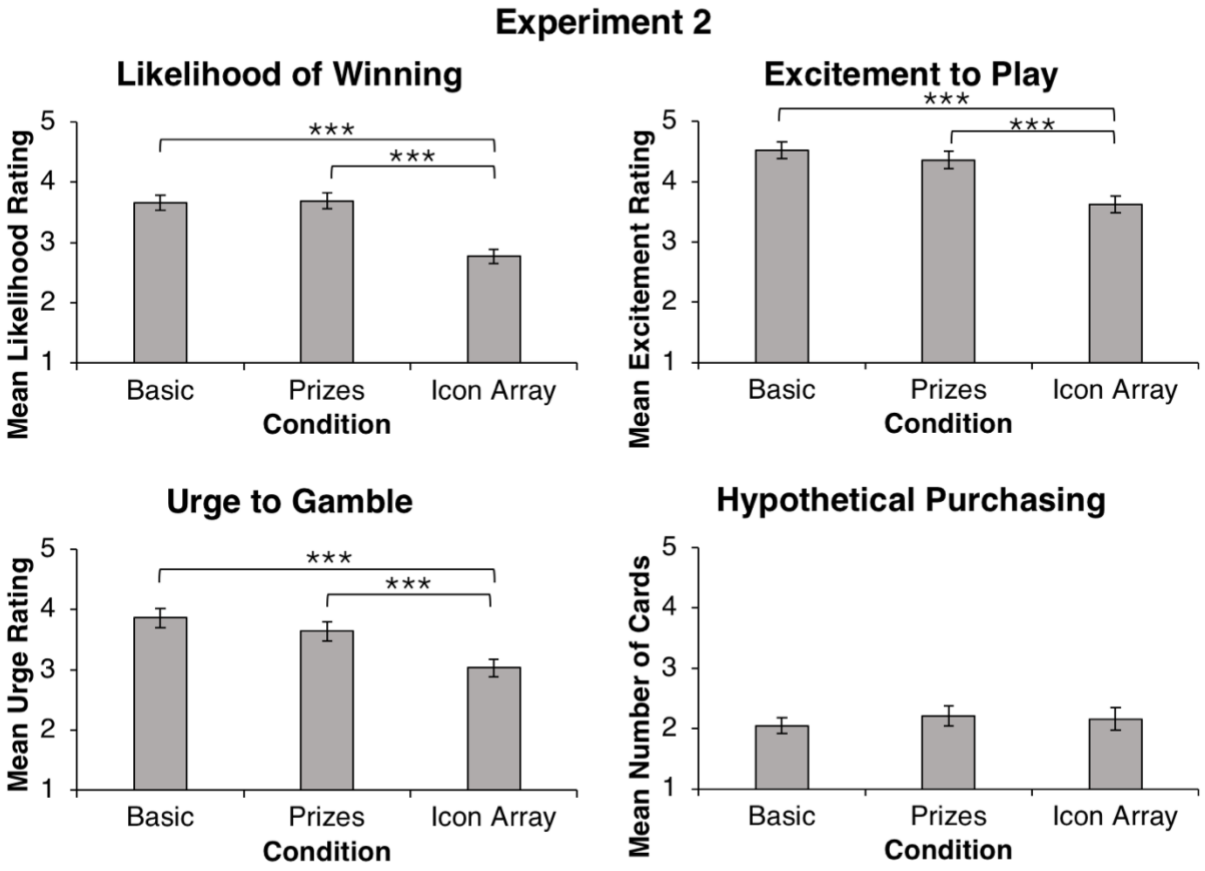
Design and Procedure

Experiment 2 utilized a nearly identical design and procedure to Experiment 1. The procedure of Experiment 2 differed from Experiment 1 only in that participants concluded Experiment 2 by completing three items in which they estimated their odds of winning a small ($25), medium ($250), and large ($100,000) prize while playing Power 5.

Results and Discussion

Participants' mean likelihood of winning, excitement, urge to gamble, and card purchasing judgments across our three information conditions (basic, prizes, and icon array) can be viewed in Figure 4. As in Experiment 1, we assessed the influence of information condition on participants' gambling-related judgments by comparing participants' likelihood of winning, excitement, urge to gamble, and card purchasing judgments across information conditions using one-way between-subjects ANOVAs. The results of each ANOVA are reported independently for each dependent variable below.

Figure 4



Note. Results for Experiment 2. Error bars represent 95% confidence intervals. *** $p \leq .001$; ** $p < .01$; * $p < .05$.

Likelihood of Winning

Consistent with Experiment 1, we observed a main effect of information condition, $F(2, 582) = 22.87$, $p < .001$, $\eta_p^2 = .073$. Follow-up independent samples *t*-tests revealed that participants in the icon array condition felt less likely to win a prize while playing Power 5 ($M = 2.77$, $SD = 1.43$) compared to those in the basic ($M = 3.66$, $SD = 1.59$), $t(388) = 5.88$, $p < .001$, $d = 0.59$, and prizes conditions ($M = 3.69$, $SD = 1.59$), $t(389) = 6.04$, $p < .001$, $d = 0.61$. Participants' likelihood of winning judgments did not differ between basic and prize information conditions ($p = .890$). Overall, the results of Experiment 2 provide further evidence suggesting that presenting gambling information in a foreground-background icon array is an effective way to reduce participants' perceived likelihood of winning a prize while playing a negative expected value scratch card game.

Excitement

We observed a main effect of information condition, $F(2, 582) = 15.68$, $p < .001$, $\eta_p^2 = .051$. Follow-up independent samples *t*-tests revealed that participants in the icon array condition were less excited to play Power 5 ($M = 3.62$, $SD = 1.72$) compared to those in the basic ($M = 4.52$, $SD = 1.62$), $t(388) = 5.30$, $p < .001$, $d = 0.54$, and prizes conditions ($M = 4.36$, $SD = 1.74$), $t(389) = 4.24$, $p < .001$, $d = 0.43$. Therefore, the modified icon array of Experiment 2 was seemingly effective at reducing participants' excitement to play a negative expected value scratch card game. Participants' excitement judgments did not differ between basic and prize information conditions ($p = .359$).

Urge to Gamble

We observed a main effect of information condition, $F(2, 582) = 10.40$, $p < .001$, $\eta_p^2 = .035$. Follow-up independent samples *t*-tests revealed that participants in the icon array condition

reported a weaker urge to gamble on Power 5 (M = 3.03, SD = 1.76) compared to those in the basic (M = 3.86, SD = 1.90), $t(388) = 4.48$, $p < .001$, $d = 0.45$, and prizes conditions (M = 3.64, SD = 1.93), $t(389) = 3.27$, $p = .001$, $d = 0.33$. Thus, presenting gambling information in a foreground-background icon array (specifically the modified icon array featured in Experiment 2) resulted in participants reporting less urge to gamble on a negative expected value scratch card. Participants' urge to gamble judgments did not differ between basic and prize information conditions ($p = .259$).

Card Purchasing

We observed no main effect of information condition on judgments provided in our hypothetical card purchasing task, $F(2, 582) = 0.31$, $p = .732$, $\eta_p^2 = .001$.

Exploratory Analyses

As in Experiment 1, we conducted correlational analyses exploring the relation between four individual difference variables measured in Experiment 2 (see Table 2). Furthermore, we conducted exploratory factorial ANOVAs examining the interaction between information condition and participants' numeracy, CRT, and PGSI scores. Consistent with the results of Experiment 1, we observed no significant interactions between information condition and participants' numeracy, CRT, or PGSI scores for likelihood of winning, excitement, or urge to gamble judgments (all $ps > .211$). However, for participants' card purchasing judgments, information condition was found to interact with participants' numeracy, $F(6, 573) = 3.17$, $p = .005$, $\eta_p^2 = .032$, and PGSI scores, $F(6, 573) = 2.33$, $p = .031$, $\eta_p^2 = .024$. Nevertheless, neither of these interactions survived correction for multiple comparisons ($\alpha/12 = .004$). The results of each exploratory factorial ANOVA are reported in full in the supplementary materials.

Table 2

Experiment 2 Correlations

	M	*SD*	1	2	3	4
1. CRT	1.71	1.34	-			
2. Numeracy	2.11	0.96	.49**	-		
3. PGSI	2.70	4.71	-.21**	-.25**	-	
4. Scratch Card Frequency	2.25	1.38	-.17**	-.19**	.34**	-

Note. Pearson correlations (Experiment 2; $N = 585$). *CRT* = Cognitive Reflection Test; *Numeracy* = Numeracy Scale; *PGSI* = Problem Gambling Severity Index. Scratch Card Frequency represents participants' self-reported scratch card gambling frequency in the past 12 months. Responses to this item ranged from 1 (*Have not played*) to 6 (*Played 24 or more times*). ** $p < .001$, * $p < .05$.

Experiment 2 also allowed us to explore whether participants' estimated odds of winning a small ($25), medium ($250), or large ($100,000) prize differed between information conditions. These estimates were provided in a free-entry text box in the form of a ratio (i.e., "1 in [response text box]"). Unfortunately, this unconstrained format resulted in many mathematically impossible responses (e.g., estimating a 1 in 0.03 chance of winning a $250 prize) and several estimates orders of magnitude higher than the true odds of winning (e.g., estimating a 1 in 2,000,000 chance of winning a prize in which the true odds were 1 in 400). In order to mitigate the impact of outlier responses we conducted exploratory analyses with these items using two different response exclusion criteria (i.e., removing responses three standard deviations above or below the mean or removing responses an order of magnitude larger than the true odds of winning). Furthermore, for both exclusion criterion we removed responses that did not result in a meaningful estimate (e.g., estimates indicating a greater than 100% chance of winning a prize). Nevertheless, regardless of the exclusion criterion used, the results of exploratory one-way between-subjects ANOVAs demonstrated that participants' estimated odds

of winning a small, medium, or large prize did not differ between information conditions (all *ps* > .253).

General Discussion

The present study demonstrates how presenting scratch card information in a graphical (i.e., foreground-background icon array), as opposed to non-graphical format, impacts gambling-related judgments. Across two experiments, we find that using an icon array to communicate scratch card information reduced participants' perceived likelihood of winning a prize while playing a scratch card game. Furthermore, in Experiment 2, participants presented with scratch card information in an icon array reported less excitement to play and less urge to gamble, compared to when provided the same information in a non-graphical format. Overall, the present study provides initial evidence for the effectiveness of foreground-background icon arrays in reducing the appeal of scratch card games. That is, building off past work demonstrating that depicting low-probability risks (e.g., medical risks) using foreground-background icon arrays improves risk assessments and reduces cognitive biases (Garcia-Retamero & Galesic, 2009; Garcia-Retamero et al., 2010; Galesic et al., 2009; Zikmund-Fisher et al., 2008), we find that depicting low-probability *positive* outcomes (i.e., lottery wins) in this format reduces participants' perceived likelihood of winning, excitement to play, and urge to gamble on a negative expected value scratch card game.

In the present study, icon arrays were especially effective at reducing participants' perceived likelihood of winning a prize while playing a scratch card game.[2] As foreground-

[2] While it should be noted that icon arrays did not appear to influence participants' estimated odds of winning particular prizes in Experiment 2, this may have been due to the poor design of these items. That is, we asked participants to provide a ratio estimate of the odds of winning various prizes in a free-entry text box. This unconstrained format resulted in several nonsensical and outlier responses. The frequency of such responses suggests that much of our sample had an imperfect understanding of ratios, or at least a misunderstanding of these items.

background icon arrays are seemingly able to communicate the unfavourable odds of these games by visually displaying the ratio of winning to losing outcomes, one may expect these displays to directly guide participants' likelihood of winning judgments, while having only downstream effects on their excitement to play, urge to gamble, or intent to purchase a scratch card game. That is, there are many other considerations, besides the perceived likelihood of winning a prize that may inform these other judgments. For example, a gambler may be excited at the prospect of winning a large prize, even when believing that this outcome is unlikely. Consistent with these claims, we find that presenting scratch card information in an icon array produced a smaller effect on participants' excitement and urge to gamble judgments (compared to likelihood of winning judgments) and did not impact card purchasing judgments within a hypothetical purchasing task. To the extent that foreground-background icon arrays simply present an intuitive way to illustrate the negative expected value of a scratch card game, the degree to which these displays impact gambling judgments other than assessments of the likelihood of winning a prize may be dependent on the extent to which a particular individuals' gambling perceptions and behaviours are guided by their perceived odds of winning.

Recent work investigating unclaimed prize information bias (Muda et al., 2020; Stange et al., 2021; Walker et al., 2018, 2019) suggests that gamblers may often over-attend to the number of prizes available (e.g., unclaimed prize information), paying less attention to the seemingly less salient number of losing cards or the informative ratio of winning to losing cards. Research on denominator neglect paints a similar picture, with individuals being overly influenced by how often an event has happened, paying insufficient attention to the total number of opportunities it had to occur (Denes-Raj et al., 1995; Reyna, 2004; Reyna & Brainerd, 2008). Within the medical domain, the use of foreground-background icon arrays to communicate statistical information

has been shown to be effective at reducing denominator neglect (Garcia-Retamero et al., 2010; Okan et al., 2012). In the context of our scratch card task, presenting gambling information in a foreground-background icon array may have effectively communicated the unfavourable odds of the presented scratch card game by shifting participants' attention away from the number of prizes available (i.e., the numerator or "foreground") and towards the less salient, but more numerous, number of losing cards (i.e., the often neglected denominator or "background").

Previous work examining gamblers' misuse of gambling information demonstrates how many individuals find such information difficult to understand (Beresford & Blaszczynski, 2020; Newell et al., 2020; Walker et al., 2019). For example, numerical representations of theoretical long-run averages (e.g., payback percentages) are unintuitive to many gamblers, resulting in improper use of this information which communicates the unfavourable odds associated with gambling games. To the extent that depicting gambling information graphically facilitates understanding, this too may explain how presenting scratch card information within an icon array reduced participants' perceived likelihood of winning a prize. That is, while providing individuals with a game's payback percentage should give them an accurate representation of their chances of monetary gain (at least in the long-run), a graphic representing the outcomes of all available games may be more likely to result in individuals forming this accurate representation due to the intuitive visual presentation. Supporting such claims is research demonstrating that presenting gambling information (e.g., payback percentage) in a simple graphical format (e.g., a visual 1, 3, or 5-star rating) results in people making better use of this information and consequently providing more normative gambling judgments (Oudhoff & Timmermans, 2015; Walker et al., 2019).

Along with examining the impact of information format on gambling judgments, we also explored whether individual difference variables (i.e., numeracy, CRT scores, and PGSI scores) interacted with information format to influence gambling judgments. Notably, the impact of information condition on participants' gambling-related judgments did not reliably interact with any of our measured individual difference variables. Thus, it appears that icon arrays were similarly effective at reducing the appeal of a scratch card game across varying levels of numeracy, cognitive reflection and experienced gambling harms. Additionally, we conducted correlational analyses in order to explore associations between individual difference variables of interest. These analyses revealed negative associations between both numeracy and CRT scores and PGSI and scratch card gambling frequency, suggesting that those possessing lower levels of numeracy and cognitive reflection may be especially likely to purchase scratch cards and experience gambling harms. Such findings highlight how individual differences relating to numeracy and cognitive style are associated with individuals' real-world gambling behaviours and experience of gambling-related harm.

Implications

The present study highlights the importance of considering presentation format when providing gambling information, as choices regarding presentation format may reliably impact gambling-related judgments. We demonstrate how providing participants with gambling information in a foreground-background icon array reduces the appeal of a scratch card game, with participants feeling less likely to win a prize compared to when presented the same information in a more standard non-graphical format. Therefore, individuals looking to correct overly optimistic gambling perceptions, specifically those regarding the likelihood of winning a prize while playing negative expected value games, may use foreground-background icon arrays

to accomplish this goal. To the extent that biased perceptions are associated with experienced gambling-related harms, such icon arrays could be used as an effective responsible gambling tool. Even for recreational gamblers, icon arrays may assist gamblers in forming more accurate representations of the games they interact with. In this way, organizations seeking to encourage accurate, informed decision making by gamblers may find icon arrays to be a promising responsible gambling tool. Additionally, this type of information format may have utility in clinical settings, where the correction of misperceptions regarding gambling beliefs (e.g., perceived likelihood of winning) may help modify future gambling behaviour. Future research should examine the potential of this information presentation strategy in these capacities.

Limitations

The present study reports the results of two experiments which recruited participants exclusively from the online crowdsourcing platform Mechanical Turk. Although the data provided by research participants on Mechanical Turk has been found to be of high quality, comparable to that provided by undergraduate research participants (Buhrmester et al., 2016; Hauser & Schwarz, 2016; Paolacci et al., 2010), the exclusive use of online samples in the present study may be considered a limitation.[3] Additionally, due in part to the online nature of the study, we were unable to assess participants' actual gambling behaviour, instead relying on a hypothetical scratch card gambling scenario to investigate the impact of distinct information formats. Therefore, it would be informative for future studies to replicate the present findings within real-world gambling contexts, allowing these findings to be generalized more broadly

[3] Despite the majority of Mechanical Turk participants providing high quality data, there is always the possibility that some participants fail to do so. Thus, along with modifications made to the presented icon arrays, the larger effect of icon arrays on participants' gambling judgments observed in Experiment 2 may have resulted from the addition of a data check item, allowing us to exclude those indicating that they engaged in random responding (or similar behaviour) while completing our hypothetical gambling task.

within the gambling domain. Relatedly, while the present study provides initial evidence that communicating gambling information within a foreground-background icon array reduces the appeal of negative expected value lottery games, future work should examine the extent to which this information presentation strategy may provide real-world benefits to frequent gamblers and/or those experiencing gambling-related harms. That is, while exploratory analyses suggest that foreground-background icon arrays reduce participants' perceived likelihood of winning, excitement to play, and urge to gamble similarly for individuals experiencing varying levels of gambling-related harm (as measured by the PGSI), a limitation of the current study is that our sample featured few individuals (approximately 12% of participants in Experiments 1 and 2) whose responses to PGSI items were indicative of problem gambling (a sample that may be of particular interest[4]).

Conclusion

The present study provides initial evidence that presenting gambling information in a foreground-background icon array reduces the appeal of negative expected value scratch card games. Participants presented with gambling information in a foreground-background icon array felt less likely to win a prize, less excited to play, and reported less urge to gamble on a scratch card game, compared to when the same information was presented in a non-graphical format. Therefore, the use of icon arrays for presenting complex gambling information represents a simple yet promising tool for correcting overly-optimistic gambling-related perceptions and reducing the appeal of negative expected value games.

[4] Note that we observed a main effect of PGSI scores for all four dependent measures within both Experiments 1 and 2 (see supplementary materials). That is, participants who reported experiencing more gambling-related harm also felt more likely to win, more excitement to play, reported a greater urge to gamble, and elected to hypothetically purchase a greater number of negative expected value scratch card games. Thus, from a responsible gambling perspective, the reduction of over-optimistic perceptions may be most critical for those experiencing greater gambling-related harms.

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