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House-edge information and a volatility warning lead to reduced gambling expenditure: potential improvements to return-to-player percentages

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Abstract

Cost-of-play information is one public health intervention recommended to help reduce gambling-related harm. In the UK, this information is given on electronic gambling machines in a format known as the "return-to-player", e.g., "This game has an average percentage payout of 90%." However, previous evidence suggests that this information could be improved by equivalently restating it in terms of the "house-edge", e.g., "This game keeps 10% of all money bet on average." A "volatility warning," stating that this information applies only in the statistical long-run, has also been recommended to help gamblers understand cost-of-play information. However, there is no evidence comparing these information provisions' effect on gamblers' behavior. An experiment tested US gamblers'(*N*=2,433) incentivized behavior in an online slot machine, where this information was manipulated between-participants along with a counter showing the total amount bet. Preregistered analyses showed that participants gambled significantly less when house-edge information or a volatility warning were shown compared to standard return-to-player information, with no effect of the total amount bet counter, and no significant interaction effects. However, these significant findings had small effect sizes, suggesting that a public health approach to gambling should not rely on informational provisions only. Subject to supportive evidence from more ecologically-valid designs such as field studies, these results suggest that improved cost-of-play information could lead to reduced rates of gambling expenditure and therefore benefit a public health approach to gambling.

Keywords: Public health, electronic gambling machines, nudge, gambling messaging

1. Introduction

A public health approach to reduce the population's risk of experiencing gambling-related harm is increasingly being advocated for by policymakers (Gambling Commission, 2019; House of Lords, 2020; Noyes & Shepherd, 2020) and academics (Abbott, 2020; Browne et al., 2016; Livingstone & Rintoul, 2020; Orford, 2019; Price, Hilbrecht, & Billi, 2021; van Schalkwyk, Cassidy, McKee, & Petticrew, 2019; Wardle, Reith, Langham, & Rogers, 2019). Harm-reducing interventions vary in terms of how much they restrict freedoms, with expenditure limits being one example of a restrictive intervention (Noyes & Shepherd, 2020). One less restrictive recommendation is to provide comparable information about the average cost-of-play across gambling products (Eggert, 2004; Livingstone et al., 2019; Newall et al., 2020). The provision of information to gamblers might be likened to calorie labelling in food, which can help consumers to reduce their consumption of calories (Bleich et al., 2017) and lead to the food industry reformulating their products (Grummon et al., 2021). Informational provisions generally have small effects on behavior, as is indeed the case with food labelling (Dubois et al., 2020), but can still be beneficial as public health interventions due to their ability to improve the health of the whole population (Rose, 1992). The present work investigates whether similar information provisions can affect the behavior of gamblers by prompting them to gamble less.

In jurisdictions such as the UK and the Australian state of Victoria (Beresford & Blaszczynski, 2019; Collins, Green, d'Ardenne, Wardle, & Williams, 2014), cost-of-play information on electronic gambling machines is given in a format known as the "return-to-player", e.g., "This game has an average percentage payout of 90%." Although the specific wording of this information is not mandated in the UK, and in practice many alternative wordings have been observed in use by UK gambling operators (Newall, Walasek, Ludvig, & Rockloff, 2021), this was the phrasing used in the first UK study of the return-to-player

(Collins et al., 2014), and which has been subject to the most experimental research. This example return-to-player of 90% means that for every $100 bet, about $90 will be paid out in prizes, but qualitative interviews suggest that many gamblers fail to correctly understand this information (Collins et al., 2014; Harrigan, Brown, & Barton, 2017). However, established psychological research suggests that “reframing” this information might lead to different judgments, as consumers for example judge beef as being healthier when described as “75%-lean” than when described as “25%-fat” (Levin & Gaeth, 1988). Equivalently reframed “house-edge” information, e.g. “This game keeps 10% of all money bet on average” resulted in lower perceived chances of winning in both community (Newall, Walasek, & Ludvig, 2020a) and treatment-seeking samples (Newall, Walasek, Ludvig, & Rockloff, 2020), and was more accurately understood by community gamblers than return-to-player information (Newall et al., 2020a).

Regulators in Victoria have taken a different approach to improving return-to-player information. The judge in a court case brought against a large casino in Melbourne ruled that return-to-player information is confusing for gamblers (Federal Court of Australia, 2018). The judge’s ruling was based on the observation that gambling is statistical, and that a long-run return-to-player percentage may rarely apply in any specific gambling session. The judge’s recommendation was to add what is called here a “volatility warning”, informing gamblers about the high variability inherent in gambling, e.g., “It takes millions of plays for a gambling game to tend towards its average return. A gambling game will not return a minimum value of prizes in any given period of gambling.” One previous study found that this volatility warning reduced gamblers’ perceived chances of winning when added to both return-to-player and house-edge information (Newall, Walasek, & Ludvig, 2020b). In that study, a volatility warning did not consistently improve gamblers’ rates of accurate understanding, whereas house-edge information was (again) better understood than return-to-player information. Importantly, this is a *qualitative* volatility warning, informing gamblers about the general inapplicability of cost-of-play information to small samples, rather than a quantitative measure of any game's volatility. This is relevant, as some electronic gambling machine games have higher volatility than others (Harrigan & Dixon, 2009).

Other information may also help gamblers. One issue with electronic gambling machines is that they enable the repeat wagering of a given amount of money, inclusive of amounts won, possibly leading to gamblers underestimating their total amount bet in a session (Byrne & Russell, 2020; Harrigan et al., 2017). Providing gamblers with a running counter of their total amount bet may therefore be a useful addition to the information discussed thus-far (Loba, Stewart, Klein, & Blackburn, 2001).

However, the literature comparing return-to-player versus house-edge information (Newall et al., 2020a) and the effect of volatility warnings (Newall et al., 2020b), is so-far based on gamblers' self-reports on how this information might affect their gambling. This is an important limitation, as gamblers might intend to make changes that they cannot enact (Sheeran, 2002). Data with behavioral outcomes would help support an evidence base to back up UK policy-makers' recommended switch to house-edge information (Advisory Board for Safer Gambling, 2019; House of Lords, 2020).

The present experiment involved a behavioral dependent variable of the number of spins made in a real-money incentivized online slot machine, using a large sample of gamblers from the US. This jurisdiction was chosen due to the relevance of this issue to US gambling policy (Eggert, 2004), and because prior investigations have largely used samples from other countries (Beresford & Blaszczynski, 2019; Collins et al., 2014; Harrigan et al., 2017; Newall et al., 2020a; Newall et al., 2020b). It was hypothesized that gamblers would voluntarily play fewer spins on the slot machine when: 1) house-edge information was given instead of return-to-player information, 2) when a volatility warning was present, and 3) when a total amount bet counter was provided. It was also hypothesized (4) that these information treatments might interact, either positively or negatively, to influence the number of spins made.

2. Method

Data, materials, and the preregistration document are available from https://osf.io/a9xpm/. We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

2.1 Ethics

All participants received a payment of $2.50 for taking part in the experiment. Participants were informed that if they performed satisfactorily on an initial captcha retying task (described below), then they would receive an additional bonus ($3.00), which could be optionally used to play with on a simulated slot machine. Participants who successfully retyped the captchas could also refuse to play on the slot machine and receive their $3.00 bonus in full. Help-line information was provided on the information sheet and on the task debrief. The study received ethical approval from CQUniversity (#22737).

2.2 Participants

US-based participants, aged 18 and above, with prior experience in gambling (including baccarat, blackjack, craps, roulette, slots and video poker) were recruited via Prolific Academic (N=3,320). Overall, 82 responses were dropped from participants who reattempted the initial captcha task after initially failing it, and 106 incomplete responses were dropped. Of the remaining participants, 699 (22.3%) typed six or fewer captchas correctly and were not invited to the slot machine task. This left a final effective sample size of 2,433 who were given the $3 bonus, which fulfilled the sample size target of at least 2,000 usable responses.

Given that we could meet those 2,000 usable responses, our sample size target was to get as many responses as possible given the size of our financial budget. Of these 2,433 participants, 394 took the bonus without playing the slot machine. These 2,433 participants took an average of 6.5 minutes to complete the experiment, and ended with an average slot machine balance of $2.21 ($43.48 average total compensation per-hour pro-rata). These participants had a mean age of 33.7 years (SD = 11.0) and were 43% female (1,047; 11 participants did not disclose their gender).

In terms of the Problem Gambling Severity Index (PGSI) 43.4% participants were classified as recreational gamblers, 27.1% as low-risk gamblers, 22.2% as moderate-risk gamblers, and 7.3% had a score of 8 or higher, and were therefore in the highest level of risk, in a category referred to by the original scale developers as “problem gamblers” (Ferris and Wynne, 2001).

2.3 Task

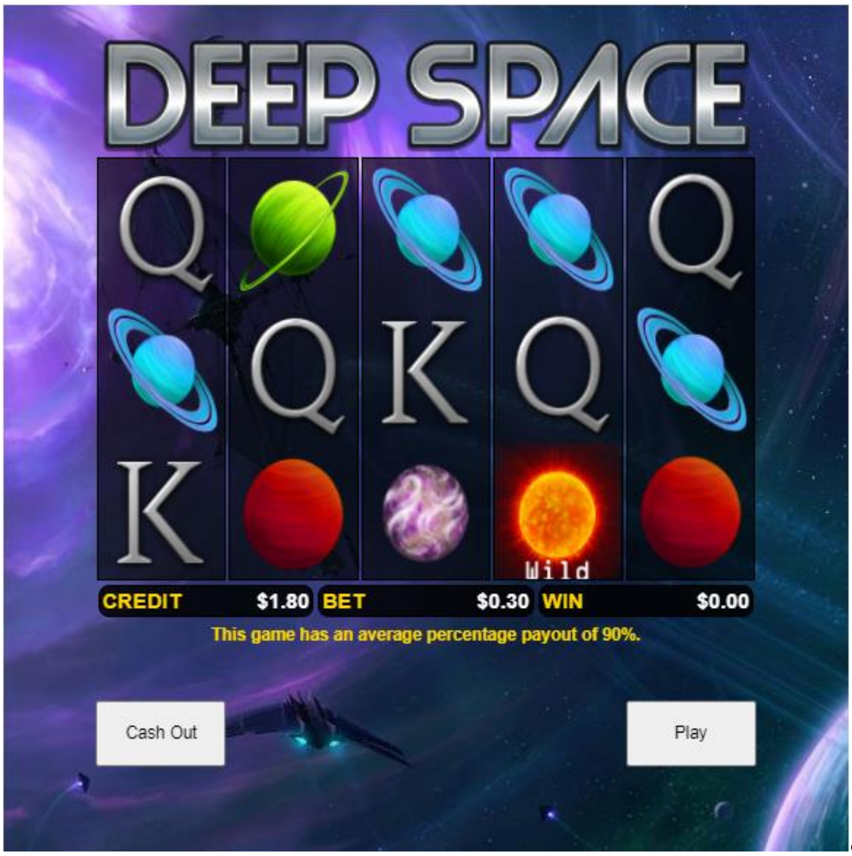
The task involved endowing participants with a $3 bonus that they could choose whether or not to gamble with. In order to better approximate gambling with one’s own money, this bonus was given conditional on receiving satisfactory responses on the initial captcha retyping task. Participants were presented with 10 randomly-chosen captcha codes (each eight characters long, made up of lower-case letters), and had to successfully retype seven or more in order to receive the $3 bonus. Images of the codes used can be accessed from https://osf.io/a9xpm/. This approach is known as a “real-effort” task in experimental economics, and is thought to lead to more naturalistic risky choices when participants are given experimentally-endowed funds (Erkal, Gangadharan, & Nikiforakis, 2011), and has also been used in previous gambling research (Newall et al., 2022). As an additional feature, this initial task screened-out inattentive participants --- which gambling samples from crowdsourcing platforms such as Prolific have been criticized for containing (Pickering & Blaszczynski, 2021).

Participants who proceeded beyond the captchas were then given information about the slot machine. Information treatments were then shown on an instructions page immediately before the slot machine, which participants had to stay on for at least 10 seconds before they could proceed to the slot machine, and were also shown on the slot machine throughout (see Figure 1 for examples). Information was therefore provided more prominently than it is currently done on gambling products (Collins et al., 2014), and this choice was made to maximize the chances of observing significant differences within the experiment. In effect, the experiment assumes the usage of “unavoidable information screens,” which have been proposed by researchers as another harm minimization intervention (Livingstone et al., 2019). Future work is needed to explore the moderating impact of information prominence in realistic gambling environments.

Information treatments were manipulated factorially in a 2 (information type: return-to-player/house-edge) x 2 (volatility warning: absent, present) x 2 (total amount bet counter: absent, present) experiment.

The slot machine application was reused from a previous investigation with new spin data (Byrne & Russell, 2020). All participants received the same sequence of slot machine returns (available at https://osf.io/a9xpm/) in order to reduce extraneous noise in the experiment. The return sequence was designed to be representative of the disclosed return-to-player of 90%: $0.30 bet size, $3 stake exhausted after 100 spins ($30 in total bets). The maximum potential bonus from playing the slot machine was $2.75, available when quitting after spin six; participants received the largest possible amount of $3.00 if they did not play any spins. The 90% return-to-player was chosen to be broadly representative of slot machines worldwide

(Harrigan & Dixon, 2009; Schwartz, 2013; Woolley, Livingstone, Harrigan, & Rintoul, 2013). The outcomes were 52% regular losses, 21% regular wins, and 27% losses disguised as wins, which roughly correspond to results achieved on multi-line slot machine games (Harrigan, Dixon, MacLaren, Collins, & Fugelsang, 2011).


DEEP SPACE
Wild
CREDIT $1.80 BET $0.30 WIN $0.00
This game has an average percentage payout of 90%.
Cash Out
Play
a)

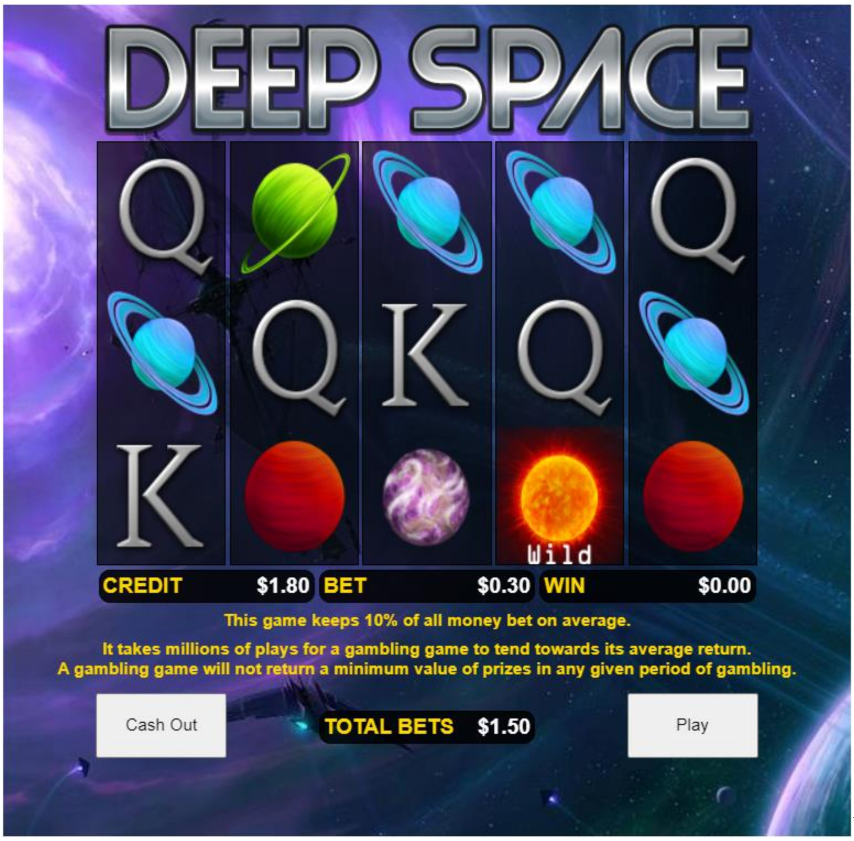

DEEP SPACE
Wild
CREDIT $1.80 BET $0.30 WIN $0.00
This game keeps 10% of all money bet on average.
It takes millions of plays for a gambling game to tend towards its average return.
A gambling game will not return a minimum value of prizes in any given period of gambling.
Cash Out
TOTAL BETS $1.50
Play
b)

Figure 1: Example screenshots, showing state of slot machine after five spins. Panel A condition: return-to-player, volatility warning absent, total amount bet counter absent. Panel B condition: house-edge, volatility warning present, total amount bet counter present.

After cashing-out from the slot machine, participants completed the Problem Gambling Severity Index before finishing the experiment.

2.4 Analyses

An ordered logistic regression model was preregistered, due to the ordinal nature of the outcome variable, and because the spins distribution was expected to be non-normal. A total of seven bins for the number of spins distribution were planned (see Table 1), with a plan to combine adjacent bins if any interior bins had less than 7% of total responses. One regression model was preregistered to test Hypotheses 1-3, and another model with interaction effects to test Hypothesis 4.

3. Results

3.1 Descriptive summary

A summary of the number of spins played, both overall and by each manipulation, is shown in Table 1. The overall distribution was bimodal, with a mean number of spins of 17.5 (*SD* = 29.8) and a median of four --- driven by the 8.8% of participants who played for the full 100 spins. The mean number of spins played per each treatment were as follows: 15.7 when house-edge information was shown (SD=28.2), and 19.3 with return-to-player information (SD=31.3); 15.5 when a volatility warning was shown (SD=28.4), and 19.5 when not (SD=31.1); and 17.7 when a total amount bet was shown (SD=30.0), and 17.3 when not (SD=29.6).

Table 1. Distributions of total of number of spins played.

Number of spins	Overall (*N*=2,433)	Information type		Volatility warning		Total amount bet	
		House-edge (*N*=1,241)	Return-to-player	Yes (*N*=1,247)	No	Yes (*N*=1,180)	No
0	16.2%	19.0%	13.3%	19.5%	12.7%	15.6%	16.8%
1 - 20	64.3%	63.5%	65.2%	64.2%	64.4%	64.8%	63.8%
21 - 40	6.0%	5.9%	6.2%	4.6%	7.6%	5.9%	6.1%
41 – 60	2.4%	1.9%	3.0%	2.0%	2.9%	2.3%	2.6%
61 - 80	0.9%	1.1%	0.7%	0.6%	1.2%	1.0%	0.8%
81 - 99	1.4%	1.2%	1.5%	1.6%	1.1%	1.4%	1.3%
100	8.8%	7.4%	10.2%	7.5%	10.1%	8.9%	8.6%
21 - 99	10.7%	10.1%	11.4%	8.8%	12.7%	10.7%	10.8%

Note: The last row of 21 – 99 shows the total percentage of responses as used in the third bin of the ordered logistic regression model.

Overall, 16.2% of participants refused to play on the slot machine, and therefore received the maximum potential bonus of $3.00. In comparison, 19.0% of participants given house-edge information refused to play: 5.7% more than the 13.3% given equivalent return-to-player information. Similarly, 19.5% of participants given a volatility warning refused to play: 6.8% higher than the 12.7% not given a volatility warning. These two information treatments also led to similar but smaller reductions of 2.6 – 2.8% in the percentage of participants playing the full 100 spins. The total amount bet showed less of an effect, with 15.6% taking their endowment without playing when it was shown as compared to 16.8% when not shown.

3.2 Preregistered analysis

As preregistered, cells corresponding to 21 – 99 spins were combined due to the low number of overall responses in these cells. The ordered logistic regression model therefore had four groups, which were reverse coded so that positive coefficients on the three information treatments would be associated with less spins played. As hypothesized, there was a statistically significant reduction in spins played from house-edge information (OR = 1.40, $p < .001$; full statistical output provided in Table 2). Also as hypothesized, there was also a statistically significant reduction in spins played from the volatility warning (OR = 1.57, $p < .001$). These two effect sizes can be interpreted as being rather small, given that an odds ratio of 1.68 corresponds to a Cohen's *d* of 0.2 (Chen, Cohen, & Chen, 2010). In contrast, there was no significant effect on spins played from showing the total amount bet ($p = .476$). Lastly, an interaction model was run, including all two-way interactions and the three-way interaction. None of these interaction terms were statistically significant (*p*'s ≥ .501). Regression output is shown in Table 2.

Table 2. Regression model outputs.

Variable	Model 1	Model 2
House-edge	1.40 [1.19, 1.65] (<.001)	1.45 [1.06, 1.99] (.020)
Volatility warning	1.57 [1.34, 1.85] (<.001)	1.66 [1.21, 2.28] (.002)
Total amount bet	0.94 [0.80, 1.11] (.476)	1.02 [0.58, 1.79] (.952)
House-edge * Volatility warning		0.98 [0.63, 1.55] (.947)
House-edge * Total amount bet		0.98 [0.62, 1.54] (.915)
Volatility warning * Total amount bet		0.99 [0.62, 1.56] (.954)
House-edge * Volatility warning * Total amount bet		0.80 [0.42, 1.53] (.501)

Note: Each cell shows the odds ratio, its 95% CI in square brackets, and the *p*-value for the odds ratio below in parentheses.

3.3 Exploratory analysis

Exploratory logistic regressions showed that the reduction in gambling from showing house-edge information was significant on both the decision of whether to engage in the first spin (OR = 1.54, $z = 3.87$, $p < .001$, 95% CI [1.24, 1.93]), and the last spin (OR = 1.41, $z = 2.39$, $p = .017$, 95% CI [1.06, 1.88]). Exploratory logistic regressions also showed that the reduction in gambling from showing the volatility warning was significant on both the decision of whether to engage in the first spin (OR = 1.67, z = 4.54, p < .001, 95% CI [1.34, 2.08]), and the last spin (OR = 1.40, z = 2.33, p = .020, 95% CI [1.05, 1.86]).

Some authors have argued that interaction terms cannot always be interpreted in nonlinear regression models such as the ordered logistic model used here (McCabe, Halvorson, King, Cao, & Kim, 2020). We therefore ran an exploratory alternative analysis to test for the presence of interaction effects, using the Akaike information criterion (AIC). The AIC for the main-effect-only model (4983.3) was lower than the AIC for the model with interactions (4989.9), which supported the interpretation that no significant interaction effects were present in the data.

We also ran exploratory analyses to see if the effectiveness of the two significant information treatments depended on PGSI score. An ordered logistic regression was run with main effects of cost-of-play information type, presence of a volatility warning, and PGSI score, and corresponding interaction terms. The nonsignificant treatment of showing the total amount bet was not included in order to reduce the complexity of the model. The model showed a significant main effect of PGSI score, (OR = 0.93, p < .001), whereby participants with higher levels of problem gambling severity tended to play more spins. However, neither of the two-way interaction terms were statistically significant (p's > .105), nor was the three-way interaction term (p = 1). Similarly, the AIC for the main-effect-only model (4931.6) was lower than the AIC for the model with interactions (4950.1). These exploratory analyses did not find evidence that the success of the two significant information treatments differed across gamblers of varying PGSI scores.

4. Discussion

The incentivized behavioral outcome showed reductions in number of spins played when participants were shown house-edge instead of return-to-player information, and similarly when they were shown a volatility warning. These results support previous self-report results of both information treatments on gamblers' perceived chances of winning (Newall et al., 2020b), and furthermore help support the case for inclusion of improved cost-of-play information on gambling products (Eggert, 2004; Livingstone et al., 2019; Newall et al., 2020). Showing the total amount bet did not affect the number of spins played by participants, in contrast to the results of a previous study (Loba et al., 2001). Finally, no interaction effects were observed, suggesting that these effects occurred independently, and did not have effects dependent on participants' PGSI scores. The two significant effects were of a small effect size, suggesting that a public health approach to gambling should not focus exclusively on information improvements.

This study was subject to various limitations. Only one gambling product, one average cost-of-play, and one phrasing of each information treatment were tested. Importantly, the level of slot machine-related compensation was low ($3), and thus may not generalize to people betting larger amounts. The lack of effect from the total amount bet information treatment may have been due to the bimodal distribution of spins played observed, with many participants only spinning a few times, and the remainder mostly playing for the full 100 spins. Showing the total amount bet might work better in a gambling task that a higher proportion of participants interact with in an intermediate range. Information treatments were also shown more prominently than might be found in current gambling products (Newall et al., 2021). This study did not investigate the moderating effect of information prominence, and the usage of unavoidable information screens is another harm minimization intervention that should be tested (Livingstone et al., 2019). Information treatments were shown in a fixed position on the screen and their positions were not randomized (see Figure 1), and this may have affected their relative effectiveness. Although an incentivized behavioral outcome was used, participants were not gambling with their own money, and the maximum bonus payment was $3. Furthermore, only gamblers from the US were recruited. These information treatments should be tested in actual gambling environments via a field trial before any guarantees can be made about their effectiveness, for example by the UK's Behavioural Insights Team (Behavioural Insights Team, 2021), or with the assistance of a State-run Nordic gambling operator (Jonsson, Hodgins, Munck, & Carlbring, 2019), or Australian wagering providers (Heirene & Gainsbury, 2021), all of whom have run gambling field trials in the recent past. Studies should also continue to investigate potentially even better ways of educating gamblers about the risk of gambling products, for example through graphical aides (Garcia-Retamero & Cokely, 2017; Walker, Stange, Dixon, Koehler, & Fugelsang, 2019), or by showing gamblers simulated distributions of outcomes (Broussard & Wulfert, 2019).

Future work may in particular want to test and iterate various wordings of the two successful information treatments. The wording used for the volatility statement was based closely off of an Australian judge's recommendation (Federal Court of Australia, 2018). The wording used for the house-edge was taken from previous research, which has repeatedly found that significantly more gamblers select the correct interpretation of the house-edge than the return-to-player in a four-item multiple-choice question (Newall et al., 2020a; Newall et al., 2020b). However, alternative wordings of house-edge information have also been proposed (Livingstone et al., 2019), and should also be tested. One unexplored issue is that some gamblers incorrectly think that return-to-player information applies to an entire session of play on an electronic gambling machine, whereas it only applies on a per-bet basis (Harrigan et al., 2017). Various rewordings of the information treatments should also be tested to try and correct for this additional misperception.

4.1 Conclusion

This study adds to an evidence base supporting policymakers' proposals for the provision of improved information to gamblers (Advisory Board for Safer Gambling, 2019; House of Lords, 2020). An electronic gambling machine in for example the UK might currently say, "This game has an average percentage payout of 90%." But it would be better to say:

"This game keeps 10% of all money bet on average. It takes millions of plays for a gambling game to tend towards its average return. A gambling game will not return a minimum value of prizes in any given period of gambling."

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