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A Clean Slate: Adapting the Realization Effect to Online Gambling and Its Effectiveness in People With Gambling Problems

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ABSTRACT

Betting more after losses (i.e., "loss-chasing") is a central clinical feature of disordered gambling. According to prospect theory, increasing risk-seeking following losses could arise from a failure to "re-reference." By contrast, successful re-referencing between successive decisions closes the mental account, and any losses are regarded as final or *realized*; gamblers should not chase realized losses. The present study sought to test this "realization effect" among gamblers using an ecologically valid online gambling task. We were further interested in whether the effectiveness of the loss realization varied as a function of problem gambling severity. Using online recruitment of past-year gamblers stratified on the Problem Gambling Severity Index, we tested a group without gambling problems ($n = 227$), a group with at-risk gambling ($n = 239$), and a group with gambling problems ($n = 223$). Over a sequence of nine bets, after the sixth bet, half of the participants underwent a simulated realization procedure that entailed cashing out from the gambling website and redepositing their remaining funds on another website. The feedback comparison group were shown their account balance after the sixth bet but did not withdraw or transfer their funds. In line with the realization effect, the group with non-problem gambling significantly reduced their bet after cashing out. The realization procedure did not significantly ameliorate loss-chasing in the groups with at-risk gambling or gambling problems. We conclude that the realization effect can be elicited in an online gambling context but that stronger interventions for realizing losses may be required for people experiencing gambling problems.

1 | Introduction

By design, commercial gambling products create a "house edge" or negative expectancy, meaning that gamblers will inexorably lose with continued betting. Faced with accumulating losses, gamblers may escalate their betting in an attempt to recover. This tendency to "chase losses" is widely considered to be a defining feature of the transition from recreational to disordered gambling (Lesieur 1979; Sleczka and Romild 2021) and typically drives financial negative consequences among gamblers given the house edge (American Psychiatric Association, DSM-5 Task Force, and American Psychiatric Association DS 2013; Lesieur 1979; Stinchfield, Govoni, and Ron Frisch 2005). The present research aims to design and

evaluate the effectiveness of a theoretically informed behavioral intervention in mitigating loss-chasing behavior among people who gamble.

There are multiple behavioral expressions of loss-chasing (Chen et al. 2022; Zhang and Clark 2020). The DSM-5 (American Psychiatric Association, DSM-5 Task Force, and American Psychiatric Association DS 2013) criteria for gambling disorder describe loss-chasing as the tendency to "return another day to get even." Items capturing loss-chasing on gambling screening tools are often the most endorsed (Hodgins, Stea, and Grant 2011): 50.7% of "at-risk" gamblers (i.e., those meeting some criteria for gambling problems but who fall under the threshold for diagnosis) and 75.9% of those with diagnosable gambling disorder endorsed chasing their losses (Toce-Gerstein, Gerstein, and Volberg 2003). Field data also showed that those with self-reported gambling problems returned to the venue more rapidly after a loss (mean = 11.3 days) than those without gambling problems (mean = 15.1 days; Wardle et al. 2014).

In addition to the greater propensity to return after a loss, loss-chasing can also take the form of increasing the bet after a loss. Xuan and Shaffer (2009) collected data from 226 gamblers who had voluntarily closed their accounts on an online sports betting website due to self-reported gambling problems, and they retrospectively analyzed behavioral patterns in the 3 weeks leading up to the account closures. Comparing the account closure group with a control group that did not close their accounts during a similar time window, the study found that both groups experienced an overall loss over the gambling window, but gamblers who closed their accounts increased their bet size and lost more, as the closing day approached.

What kind of interventions can alleviate loss-chasing? Imas (2016) proposed that *realization of outcomes* may be beneficial. Realization refers to the process of transferring money between physical and mental accounts. In a gambling context, a loss is realized when a gambler pays their negative balance to the house. Notably, losses are often *not* realized in this manner. In typical circumstances, in both the laboratory and in real-world field settings (e.g., a casino), the participant sees a balance or tally that merely fluctuates with successive outcomes (this is sometimes termed a "paper loss" from the finance literature). In four experiments using student or online samples who experienced a losing sequence of bets, Imas (2016) demonstrated that paper losses induced greater risk-seeking behavior, that is, loss-chasing, whereas realized losses were followed by a decrease in risk-taking—a phenomenon termed the *realization effect*. For example, in the first study in Imas (2016), participants made four sequential investment decisions between a risky and safe asset. After the third decision, participants in the realization condition who lost money were prompted to physically transfer their losses in cash to the experimenter, whereas participants in the paper loss condition—who had lost the same amount—were simply informed of their balance without any transaction. Participants in the realization condition reduced their subsequent investments, whereas participants in the paper loss condition increased their investments. A second study replicated this realization effect in an online setting using an electronic and imaginary realization procedure in which participants were told that their losses would be withdrawn and transferred to a different account.

Recent studies have sought to replicate and extend the realization effect. The model of the realization effect developed in Imas (2016) highlights that loss-chasing—and as a consequence, the realization effect—will only emerge in environments where the agent faces positively skewed risk. Merkle, Müller-Dethard, and Weber (2020) test this prediction by replicating the realization effect when using positively skewed choices—that is, prospects that paired a large potential win against a small loss—as is common for gambling scenarios. But the realization effect was absent in other (non-positively skewed) choices characterized by low probability but large losses. Consistent with the model, participants did not loss chase, which is likely a prerequisite for detecting any realization effect (see Nielsen 2019 for a similar result) (recent work by Heimer et al. (2023) shows that one needs at least 27 rounds of gambling decisions with fair lotteries for loss-chasing to emerge). Stivers et al. (2020) used lottery tickets instead of investment assets and found that participants chased their losses regardless of realization condition. In the field, Meyer and Pagel (2022) replicated the realization effect in retail traders: Investors who had their losses exogenously realized were significantly less likely to reinvest them than those who experienced either paper losses or realized gains.

In a study closest to our own, Flepp, Meier, and Franck (2021) looked at the behavior of casino patrons using data recorded from individual player cards of gamblers visiting a Swiss casino. They found evidence for the realization effect: Visitors tended to increase their risk-taking following losses within a gambling session but decreased their risk-taking on the next casino visit after a losing session, which Flepp, Meier, and Franck (2021) argue to be analogous to a realized outcome. Although these results suggest that realization may be a promising intervention to curb loss-chasing among gamblers, Flepp, Meier, and Franck (2021) did not differentiate between regular customers and people with gambling problems.

The behavioral effects of realization may be explained by the concepts of reference points in prospect theory (Kahneman and Tversky 1979). According to prospect theory, people derive utility from gains and disutility from losses relative to a reference point that corresponds to a *status quo* rather than any overall or absolute level of wealth. Loss-chasing is then prompted when people experience a loss relative to their reference point; they may accept a risky option if this gives them the possibility to return to that reference point. Within this framework, realization may act to reset the reference point ("re-referencing"; Arkes et al. 2008; Thaler 1999), thereby closing the mental account associated with the experienced loss. Without the prospect of recovering the prior losses, realization should ameliorate any subsequent loss-chasing.

In gambling research, "responsible gambling" initiatives approach gambling harm reductions by modifying existing gambling products and platforms to offer the gambler ways of controlling impulsive or excessive behavior. The features that have received most empirical attention involve limit-setting tools, which enable the gambler to pre-commit to specified limits (e.g., a maximum loss of $100 per month). Features that might target the acceptance of prior losses—"wiping the mental slate"—have not yet been investigated. The research highlighted above suggests that realization of prior losses may reduce

loss-chasing, allowing the prospects of subsequent gambles to be evaluated in isolation. Design features that encourage such re-referencing could be effective in reducing loss-chasing tendencies among gamblers.

The current paper sought to adapt the realization paradigm to a more ecologically valid gambling context and explore its utility as an intervention for loss-chasing among regular gamblers. This may inform future initiatives in responsible gambling and the practical application of the realization effect. Specifically, we devised a procedure for realization by prompting the participant to cash out from one gambling website and redeposit their remaining funds on a second website. The procedure is ecologically valid as online gamblers on average hold three accounts (Gambling Commission 2022), and some operators allow gamblers to maintain separate e-wallets for different game types (e.g., casino and sports). We hypothesized that the cash-out procedure will lower the bet amount after losses and that the relative effect will differ between the groups with non-problem gambling, at-risk gambling, and gambling problems.

We collected some further information to better understand the psychological processes underpinning any realization effect on the different gambling groups. We identified four possible factors. First, we considered whether the withdrawal of funds in the realization condition might elicit gambling cravings, given evidence for money priming effects, and that more monetary cues are presented during the cash-out process (Stajkovic, Greenwald, and Stajkovic 2022; Vohs 2015). Such an effect could also vary between groups with and without gambling problems. Second, we considered whether gamblers may vary in their willingness to switch websites as a key element of our realization procedure. People with gambling problems may be more (or perhaps less) reluctant to switch gambling platforms, as a result of gambling-related cognition distortions, such as the tendency to predict winning outcomes from random events (Raylu and Oei 2004). For example, people with gambling problems may be less willing to switch to Website B if they believed a win was imminent on Website A following a run of losses (i.e., the gambler's fallacy; Oskarsson et al. 2009). Third, we considered whether any difference in risk-taking between the realization and feedback conditions might depend on participants' memory of their account balance at the point of the intervention. The memory accuracy could serve as an indicator of re-referencing and could further differ as a function of problem gambling severity. Lastly, we considered whether gamblers may vary in their propensity for mental accounting, such that gamblers may or may not perceive the bets either side of the cash-out intervention as separate betting sessions. Hence, we introduced a manipulation check after the task, asking participants how many sessions they felt they had played.

2 | Materials and Methods

2.1 | Participants

In a preregistered experiment (see https://aspredicted.org/4qy8g.pdf), we recruited participants on Prolific from November 17, to December 17, 2021, using a two-stage method. To take part in the prescreen, participants must (1) have normal or corrected-to-normal vision, (2) be between 21 and 50 years old, (3) be proficient with English, and (4) be located in Canada or the United States. The prescreen involved a four-item English proficiency test, items on gambling engagement over the past year, and the Problem Gambling Severity Index (PGSI). To be invited to the main experiment, participants needed to (1) have gambled in the past 12 months and (2) score 100% accuracy on the English test. PGSI scores were used to stratify participants into three groups for recruitment into the main experiment. Ultimately, we prescreened $N = 4167$ participants and recruited $N = 732$ eligible participants for the main experiment. At the end of the study, all participants were compensated with a flat rate of £0.38 for the prescreen and £1.25 for the main experiment. The study was approved by the Behavioural Research Ethics Board at the University of British Columbia, and all participants provided digital consent to both surveys.

The main experiment repeated the item about past-year gambling, and 17 participants were excluded for giving responses that contradicted their prescreen responses. Two attention check items were used, asking participants to fill in a specific color in a filler question and to select a specific option in a multiple-choice question, which resulted in the exclusion of 15 further participants. As the study hypothesized the effect of manipulations (i.e., cash-out vs. feedback) on *loss-chasing*, we excluded 11 participants who experienced a cumulative win at the point of the manipulation (i.e., the sixth bet; see Section 2.2). Overall, these exclusions resulted in a sample of 689 participants (cash-out = 356, feedback = 333).

2.2 | Procedure

The goal of the current study was to translate the realization paradigm of Imas (2016) to study gamblers in a more ecologically valid setting. We refined our realization procedure based on a series of pilot experiments (see Supporting Information for further details). In these pilots, we initially tested a procedure based on the *imagined* withdrawal of funds and switching between two hypothetical lottery games (cf., Imas (2016); Experiment 2); a later version introduced the *simulated* withdrawal of funds and switching between two online gambling websites, as a more ecologically valid procedure for experienced online gamblers. These pilot experiments also tested a third "no-feedback" control condition and included data collection across two different crowdsourcing platforms (MTurk and Prolific) at the time of the evolving COVID-19 pandemic. The results of these pilot studies informed the final version of the task reported here.

2.2.1 | Gambling Task and Experimental Design

The participant was endowed with $10 and completed nine investment decisions in a positively skewed lottery. The lottery on each bet offered a win of 2.5 times the bet amount with a 1/3 probability, or the loss of the bet with a 2/3 probability. In each bet, the participant could bet a percentage of their current balance, from 10% to 90% (in 10% increments) (this design choice departs from the paradigm used in Imas (2016) and associated replications. In those studies, participants could bet from a set endowment (e.g., $2) that refreshed in each bet; participants could not reinvest their accumulated earnings nor lose them.

We chose to allow participants to bet their accumulated earnings for purposes of ecological validity, given that in gambling sessions, a gambler can bet any percentage of prior earnings. We note that this feature affects the theoretical analysis, which is beyond the scope of the current paper). The bet was offered as a percentage to eliminate any instances in which the participant ran out of funds, which could arise if betting absolute amounts. The use of the absolute bet as the dependent variable would also raise the possibility of compression based on the current balance. The gambling task contained nine bets, which were bracketed into a block of six and a block of three bets (Figure 1). The two blocks were framed as gambling on online gambling website(s), and the participant was informed of the block length when they started to gamble on the respective website. After each bet, the participant was shown the outcome (i.e., "You won" or "You lose"). Participants were counterbalanced to two randomly generated outcome sequences based on the actual lottery prospects

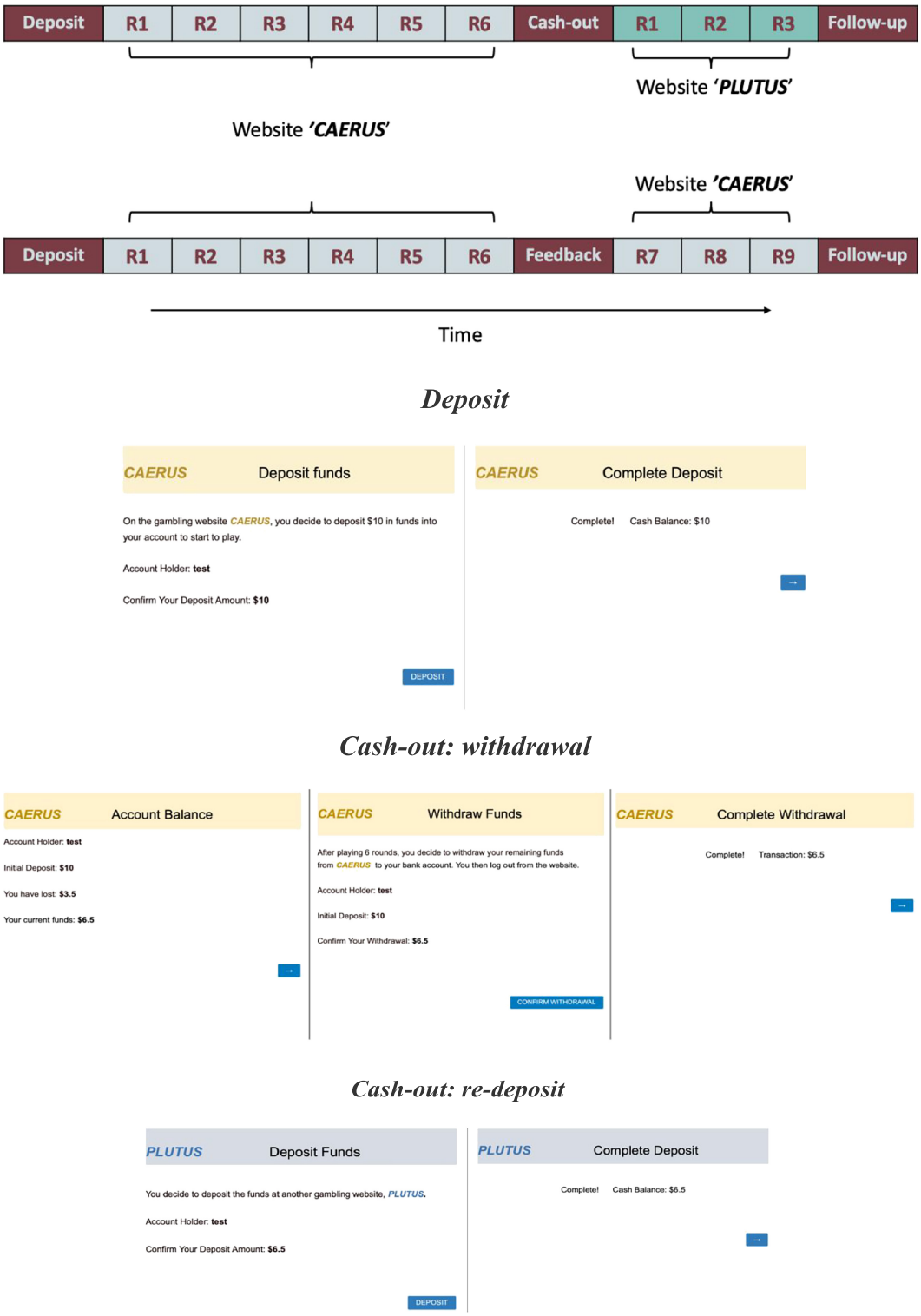

FIGURE 1 | Experimental design in the cash-out and feedback conditions.

(Sequence A: L, L, W, L, L, L, L, W, L; Sequence B: W, L, L, L, L, L, L, W, L).

The experiment was a between-subjects design. Participants were randomly assigned to either the cash-out or feedback conditions, with the key manipulation occurring at the end of the sixth bet. Participants in both conditions started the task by depositing $10 into their account on an online gambling website ("CAERUS"). This entailed clicking a button labeled "Deposit" with confirmation of the new balance. After six bets, the task displayed the balance, alongside the participant's name, and a reminder of their initial deposit and the amount lost. Participants in the feedback condition received this information and then simply continued with three further bets within the same gambling website (i.e., playing "CAERUS"). Participants in the cash-out condition were presented with the same information and were then instructed that they had withdrawn their funds from the first website ("CAERUS") and deposited those funds in a new gambling website ("PLUTUS"). The participant confirmed their withdrawal of funds (clicked "Withdrawal"); a confirmation page then displayed the withdrawal amount; the participant then deposited the money on the new website, with a similar deposit process as in the old website, except for the difference in the background color.

2.2.2 | Follow-Up Questions

Upon completing the nine bets, we asked the participant to recall their account balance after the sixth bet. This question was used to examine if the cash-out manipulation disrupted their memory of the loss and re-referenced it to the account balance at the sixth bet. We classified participants into three groups based on their response to the memory recall question: (1) *fully updated*, in which the participant accurately recalls the sixth bet's loss amount; (2) *partially updated*, in which the participant recalls a smaller loss than the reality; and (3) *over-updated*, in which the participant recalls a greater loss than the reality. We also assessed the participant's craving for gambling using a 5-point Likert scale from *strongly disagree* to *strongly agree*. The craving scale was both ordinal and not normally distributed in our data; hence, we used nonparametric tests to analyze the craving data categorically.

Two further sets of questions were presented to participants in the cash-out condition. One item assessed their preference to have stayed on the first website, using a 5-point Likert scale from "prefer to stay" to "prefer to switch," administered retrospectively at the end of the ninth bet. For participants in the cash-out condition, we asked them to indicate how many gambling sessions they felt they had played. We explained a session as follows: "Some people may view multiple bets as part of one large event or 'gambling session', or other people may view individual bets as part of separate sessions." For participants who indicated more than one session, they dragged and dropped each of the nine bets into boxes representing their specified number of sessions. These items thus tested whether the cash-out procedure affected mental accounting. We hypothesized that a participant for whom the cash-out procedure had successfully "realized" the loss would report two gambling sessions, grouping bets 1–6 and bets 7–9 as their two sessions.

2.3 | Data Analyses

Data cleaning was conducted in Python 3.8.8, and data analyses were conducted in R 4.1.1 (R Core Team 2021). The data, analysis codes, and outputs are available at 10.5683/SP3/AUMOS3. Loss-chasing was operationalized as the *bet change* from the sixth to the seventh bet (i.e., the bet amount before and after the feedback or cash-out intervention). We did not compare absolute bet amounts after manipulations because bet amounts naturally fluctuated over the task (see Figure 2), and thus, we cannot distinguish the effect of time and manipulation. In line with our preregistered analysis plan, we quantify the effect of the cash-out manipulation on loss-chasing, and its interaction with gambling groups, using ordinary least squares (OLS) with Huber–White robust standard errors. We examined *bet changes* as a function of *condition*, *gambling group*, and their *interaction*, and the model takes on the following form:

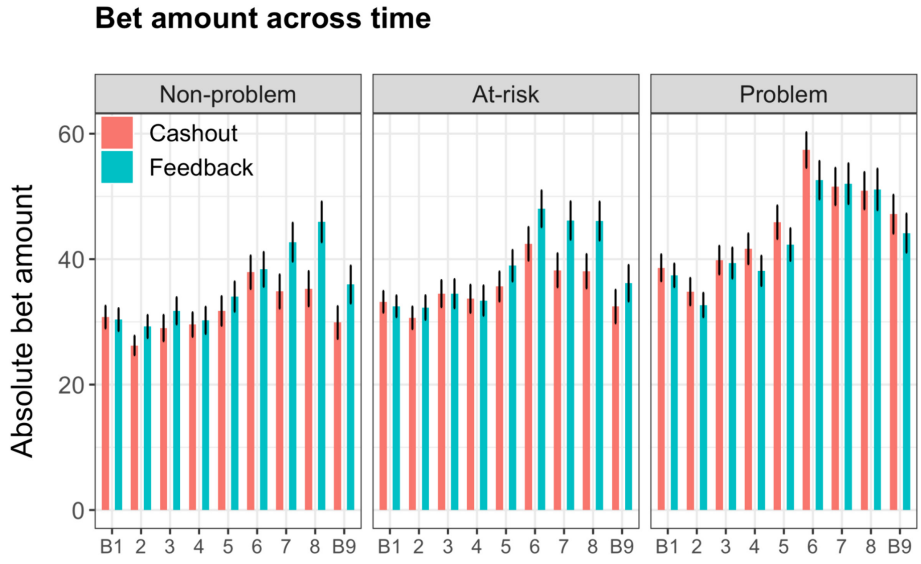

FIGURE 2 | Bet amount across time with standard error bars.

$$\begin{aligned}\textit{Bet changes} = \textit{gambling group} \ + \textit{condition} \ + \textit{gambling group} \\ \times \textit{condition} \ + \textit{average bet} \ + \textit{sequence} \ + e.\end{aligned}$$

With the feedback condition set as the reference category, we parametrized the model three times, each time with a new gambling group as the reference category in order to examine the effect of cash-out within each *gambling group*.

In addition to the preregistered model, we explored the effects of *outcome sequence* on loss-chasing because variations in the outcome sequence may shape risk-taking tendencies via the illusion of control (Eben et al. 2023; Langer and Roth 1975). The interaction of *outcome sequence* condition* and *outcome sequence* gambling group* did not affect loss-chasing significantly. Because of the unbalanced gender in the group with gambling problems relative to the other two groups, we also considered the effect of *gender* gambling group* interaction on loss-chasing, but this interaction term was not significant.

3 | Results

3.1 | Characterization of the Three Gambling Groups

A typical demographic profile of our sample of past-year gamblers was an individual aged in their 30s, single, employed, with an income of $50,000–$74,999 (see Table S1). In our groups of non-problem gambling and at-risk gambling, the ratio of females and males was fairly balanced, but the group with gambling problems consisted of significantly more males than females in both the cash-out ($X^2(2) = 22.74$, $p < 0.001$) and feedback ($X^2(2) = 22.53$, $p < 0.001$) conditions. A Scheirer–Ray–Hare test (i.e., a nonparametric analysis of variance [ANOVA]) showed that although the PGSI scores differed between *gambling groups* ($H(2) = 635.32$, $p < 0.001$), as would be expected based on the stratified recruitment procedure, the PGSI scores did not differ significantly between *condition* ($H(1) = 0.23$, $p = 0.628$).

To further probe the validity of the three gambling groups, we tested for group differences on the gambling craving rating and on the average amount bet on the gambling task. On the craving rating, a Kruskal–Wallis test showed a significant difference between gambling groups, $X^2(2) = 150.28$, $p < 0.001$. The group with gambling problems (median = 4) had a greater craving score than the groups with non-problem gambling (median = 2) and at-risk gambling (median = 2). Post hoc Dunn tests showed that craving differences between all three group pairs were significant (all $ps < 0.001$). The ANOVA test on the average bet amount also showed a significant effect of *gambling group* ($F(2, 686) = 16.59$, $p < 0.001$). Post hoc comparison (Tukey's HSD) showed that the group with gambling problems (M = 44.37%, SD = 20.19) bet significantly more overall than the groups with non-problem gambling (M = 33.51%, SD = 20.56) and at-risk gambling (M = 37.00%, SD = 20.47) at $ps < 0.001$, with no difference between the latter two groups, $p = 0.155$.

3.2 | The Effect of Cash-Out on Chasing Behavior

Figure 2 showed that the absolute bet amounts varied over the task in all groups. The group with non-problem gambling bet the lowest overall. To pinpoint the effect of cash-out on chasing, we examined the bet changes from the sixth to the seventh bet. Figure 3 showed that the group with non-problem gambling had less variability under both conditions compared to the two higher risk groups. In the regression model, the two *Condition*Group* interaction terms were nonsignificant. In the model with the non-problem gambling group as the reference, there was a significant effect of *Condition* (Table 1). On average, the group with non-problem gambling increased their bet amount in the feedback condition and reduced their bet amount in the cash-out condition (Figure 4). When switching the *Group* reference to the groups with at-risk gambling and gambling problems, there were no significant effects of cash-out condition. On average, both groups reduced their bet amount in both conditions. There was a significant effect of outcome sequence on bet change: Participants assigned to Sequence A bet significantly less than participants assigned to Sequence B. These

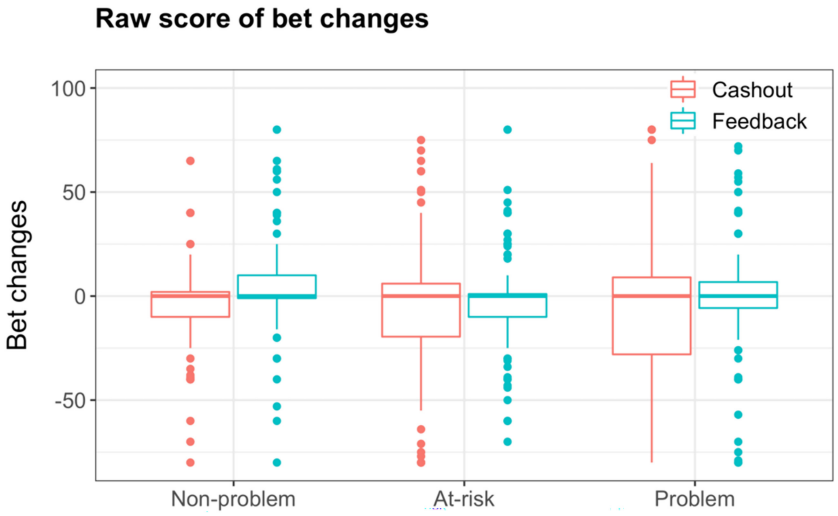

FIGURE 3 | Raw score of loss-chasing.

TABLE 1 | Regression tables. Each used a gambling group as the reference group.

Non-problem group					
Predictor	**Estimate**	**SE**	***t***	**95% CI**	***p***
Average bet	0.13	0.04	3.36	[0.05, 0.20]	< 0.001
Cash-out (vs. feedback)	−6.88	3.00	−2.30	[−12.77, −1.00]	0.022
At-risk group	−6.57	3.16	−2.07	[−12.78, −0.35]	0038
Gambling problem group	−5.88	3.60	−1.63	[−12.95, 1.19]	0.103
Sequence B (vs. Sequence A)	4.56	2.13	2.14	[0.37, 8.74]	0.033
Cash-out*At-risk group	4.96	4.66	1.07	[−4.18, 14.10]	0.287
Cash-out*Gambling problem group	1.36	5.28	0.27	[−9.01, 11.72]	0.798
Intercept	−2.43	2.68	−0.90	[−7.70, 2.84]	0.366
At-risk group					
Predictor	**Estimate**	**SE**	***t***	**CI**	***p***
Average bet	0.13	0.04	3.36	[0.05, 0.20]	< 0.001
Cash-out (vs. feedback)	−1.92	3.59	−0.54	[−8.98, 5.13]	0.593
Non-problem group	6.57	3.16	2.07	[0.35, 12.78]	0.038
Gambling problem group	0.69	3.55	0.19	[−6.28, 7.65]	0.846
Sequence B (vs. Sequence A)	4.56	2.13	2.14	[0.37, 8.74]	0.033
Cash-out*Non-problem group	−4.96	4.66	−1.07	[−14.10, 4.18]	0.287
Cash-out*Gambling problem group	−3.60	5.65	−0.64	[−14.70, 7.49]	0.524
Intercept	−8.99	2.86	−3.15	[−14.60, −3.39]	0.002
Gambling problem group					
Predictor	**Estimate**	**SE**	***t***	**CI**	***p***
Average bet	0.13	0.04	3.36	[0.05, 0.20]	0.013
Cash-out (vs. feedback)	−5.53	4.35	−1.27	[−14.07, 3.01]	0.204
At-risk group	−0.69	3.55	−0.19	[−7.65, 6.28]	0.846
Non-problem group	5.88	3.60	1.64	[−1.19, 12.95]	0.103
Sequence B (vs. Sequence A)	4.56	2.13	2.14	[0.37, 8.74]	0.033
Cash-out*At-risk group	3.60	5.65	0.64	[−7.49, 14.70]	0.524
Cash-out*Non-problem group	−1.36	5.28	−0.26	[−11.7, 9.01]	0.798
Intercept	−8.31	3.34	−2.49	[−14.86, −1.75]	0.013

results suggest that although we replicate the impact of cashing out in the non-problem gambling group, the intervention was not effective in the other two groups.

3.3 | Did Craving, Memory Accuracy, Willingness to Switch, and Mental Accounting Influence Loss-Chasing?

We proposed a number of psychological factors that might contribute to the strength of the realization effect: gambling cravings and memory accuracy for the balance information. Differences in these factors, both across conditions and between gambling groups, might contribute to the bet change variable. The willingness to switch between gambling platforms and a mental accounting manipulation check question were tested only in the cash-out condition.

We have already established that craving levels differed between the three gambling groups. A Scheirer–Ray–Hare test further showed no significant interaction effect between condition and gambling group on craving levels ($H(2) = 0.904$, $p = 0.636$), and the cash-out (median = 2.50) and feedback conditions (median = 3.00) did not elicit differential craving ($H(1) = 0.778$, $p = 0.378$). We also did not find any significant difference in *bet changes* between different craving levels

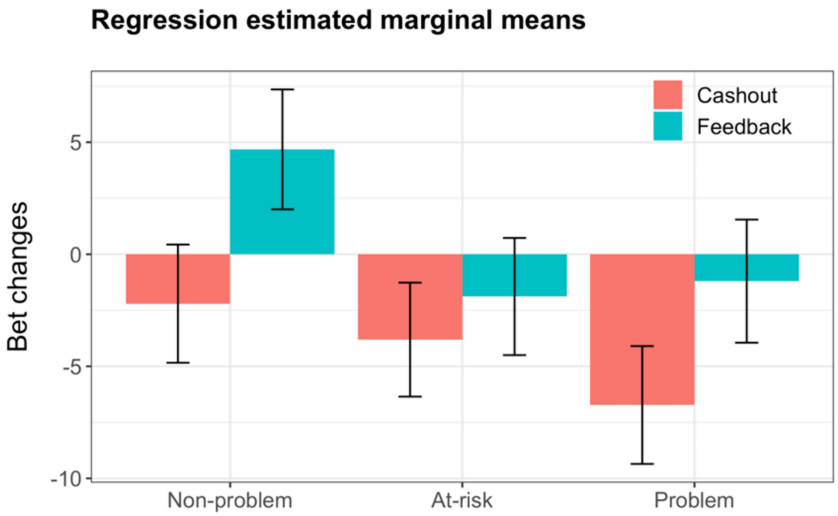

FIGURE 4 | Regression estimated marginal means with standard error bars.

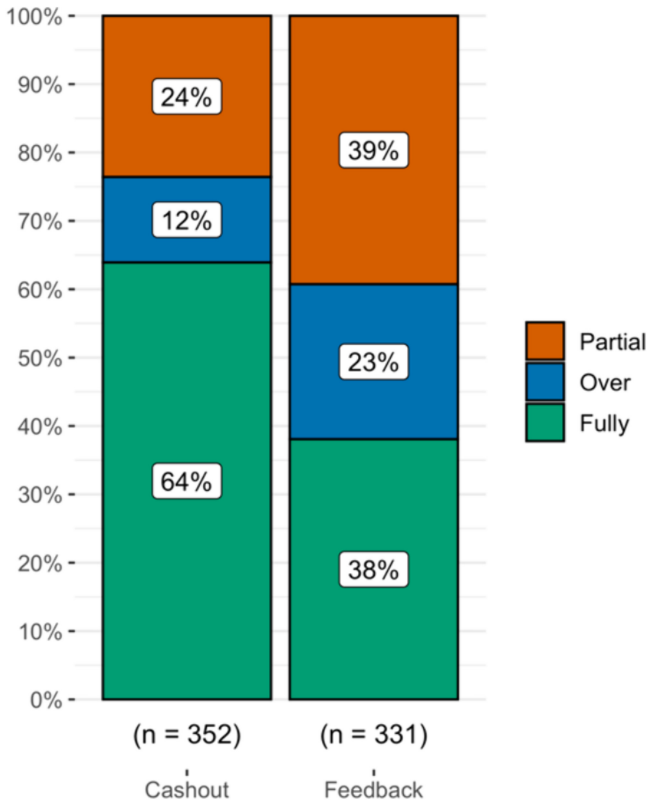

FIGURE 5 | The proportion of participants engaged in different level of re-referencing, marked by their memory scores.

(Kruskal–Wallis test: $X^2(4) = 3.86$, $p = 0.425$). Thus, differential craving elicited by condition and gambling group did not impact bet changes.

In terms of memory accuracy, we categorized the memory recall for the balance information into three types, with respect to three degrees of reference point updating: fully updated, partially updated, and over-updated. More participants were categorized as fully updated (i.e., accurately recalling their account balance) in the cash-out condition versus the feedback condition (chi-squared test: $X^2(2) = 45.77$, $p < 0.001$; Figure 5), which supports the idea that cashing out encourages re-referencing in mental accounts. These three updating categories were distributed equally across the three gambling groups (Table 2). We further examined if these updating categories influenced the bet change variable, but this effect was nonsignificant (Kruskal–Wallis test: $X^2(2) = 5.19$, $p = 0.07$) (see Supporting Information for further details).

Two further measures were taken in the cash-out condition. The three gambling groups endorsed significantly different response distributions on the willingness to switch rating (chi-squared test: $X^2(8) = 17.24$, $p = 0.028$; Figure 6). In the group with non-problem gambling, the modal response to switching between gambling platforms was "neutral," whereas among the groups with at-risk gambling and gambling problems, their ratings were more polarized, but with greater preferences for both switching from, or staying with, the first website. This is in line with the presence of cognitive distortions in the group with gambling problems. There was no significant effect of the different levels of the willingness rating on the *bet change* variable (Kruskal–Wallis test: $X^2(4) = 6.67$, $p = 0.154$) (see Supporting Information for detailed bet changes).

On the mental accounting tests in the cash-out condition, the judgments of the number of gambling "sessions" were heterogeneous: Among 356 participants, the modal response ($n = 160$) was indeed two sessions. Twenty-nine participants reported one session; 78 participants reported nine sessions (i.e., the actual number of bets); 89 participants reported other session counts. The reported number of sessions was not significantly associated with *gambling group* (chi-squared test: $X^2(18) = 18.48$, $p = 0.424$).

Among those participants who reported two sessions, most participants ($n = 112$, 70%; non-problem = 39, at-risk = 43, gambling problems = 30) grouped their bets corresponding to the cash-out manipulation (i.e., bracketing bets 1–6 and bets 7–9), but 48 participants (non-problem = 14, at-risk = 15, gambling problems = 19) did not. We infer that these 112 participants showed a pattern of responding that is most in line with the

TABLE 2 | The proportions of reference point update, categories across gambling group and condition.

	Non-problem group	At-risk group	Gambling problem group
Cash-out	$n = 115$	$n = 121$	$n = 116$
Partial	19%	25%	27%
Over	15%	13%	9%
Fully	66%	62%	64%
Feedback	$n = 110$	$n = 116$	$n = 105$
Partial	36%	39%	43%
Over	26%	21%	21%
Fully	37%	41%	36%

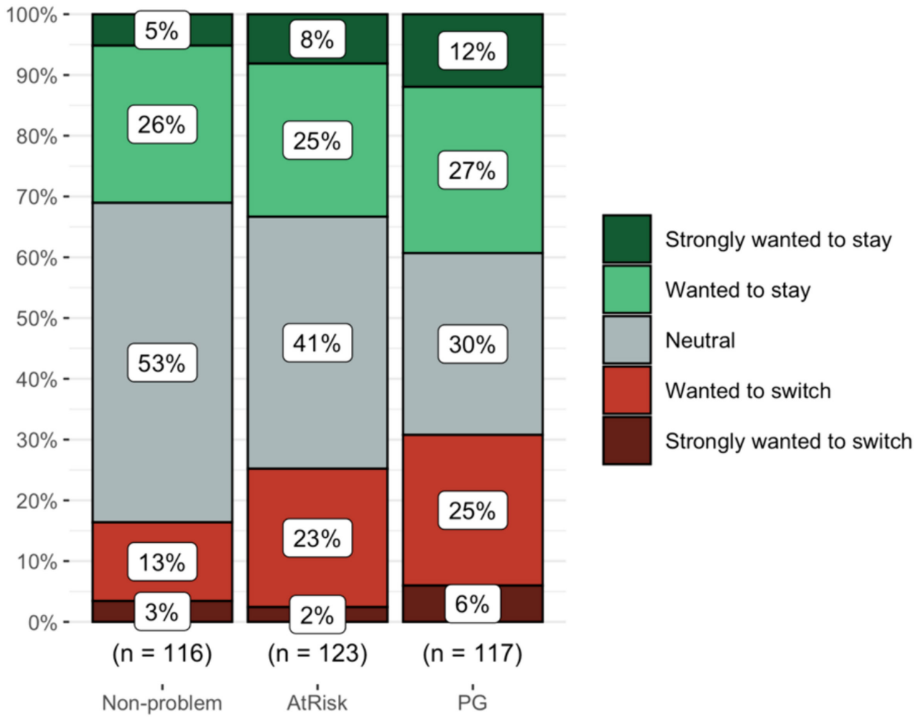

FIGURE 6 | The proportion of participants in each willingness to switch category by gambling group.

principles of mental accounting and should therefore display the strongest evidence for a realization effect. We compared the bet change variable in this subgroup of "two-session" against the participants who reported "one-session" and the participants in the rest of the reported session counts, but these subgroups were not associated with differences in the *bet change* variable (Kruskal–Wallis test: $X^2(2) = 0.01$, $p = 0.99$.)

4 | Discussion

Prior research on healthy participants has found that the transfer of money between physical and/or mental accounts can allow investors to "realize" their sustained losses and reduces their loss-chasing tendencies (Imas 2016; Merkle, Müller-Dethard, and Weber 2020). The present study aimed to adapt this realization procedure to the context of online gambling and test its effects on loss-chasing among experienced gamblers. We recruited experienced gamblers online, stratified into three groups using the PGSI: those without gambling problems, a group with at-risk gambling, and a group with gambling problems. Corroborating this group classification, the group with gambling problems showed higher levels of gambling craving and bet more overall on the task compared to the other groups. In line with the original realization effect, in the group with non-problem gambling, we found that our cash-out manipulation significantly lowered the amount bet compared to the feedback comparison condition. This difference was driven by both an increase in betting after losses in the feedback condition (i.e., loss-chasing) and a decrease in betting in the cash-out intervention. This supports the robustness of realization in a crowdsourced online sample, as well as the first evidence for its generalization to regular gamblers. The effects of the realization procedure were not significant when the reference categories were switched to the two higher risk groups (at-risk gambling and gambling problems)—these groups reduced their bet amount in both conditions,

although the realization effect did not significantly interact with gambling group status. Thus together, we have no evidence that the realization effect differs by groups, but the overall bet difference between the cash-out and feedback conditions (Figure 4) was primarily driven by the group with non-problem gambling. We infer that the realization effect may be more fragile in the groups with at-risk gambling and gambling problems.

We investigated four psychological mechanisms that could contribute to the effectiveness of our cash-out manipulation on loss-chasing: gambling craving, memory accuracy for the account balance, willingness versus reluctance to switch gambling websites, and mental accounting of gambling sessions. None of the four factors impacted the changes in loss-chasing behavior, although we observed some differences underlying these psychological processes across conditions and gambling groups. The group with gambling problems reported more craving, but participants did not differ in craving ratings by condition. More participants were fully updated (i.e., remembered the balance more accurately) in the cash-out than in the feedback condition, reflecting re-referencing, but the fully updated participants did not significantly differ in their loss-chasing behavior. This discrepancy between cognitive and behavioral updating indicated that although cash-out might lead to better memory, it did not affect the participants' actual betting behavior. We specifically examined how the participants in the cash-out condition reacted to the money transaction procedure. Across gambling groups, the participants did not feel they played a significantly different number of gambling sessions, but gamblers with higher risk were more polarized in their willingness to switch websites. Nevertheless, this difference did not change loss-chasing behavior.

Although the group by condition interaction terms were not significant, it is nonetheless notable that the simple effect of the cash-out manipulation was only reliable in the group with non-problem gambling. There are several reasons why the realization of losses might be weaker in the groups with at-risk gambling and gambling problems. In the group with non-problem gambling, the significant realization effect was driven by increased loss-chasing in the feedback condition, along with decreased loss-chasing in the cash-out condition. Looking at the feedback condition in Figure 4, loss-chasing was less pronounced in the groups with at-risk gambling and gambling problems. This might seem, at face value, to contradict the phenomenology of gambling disorder, although the two higher risk groups displayed greater variability in the bet change variable in the cash-out condition, leading to larger standard errors and reducing our ability to reject the null hypothesis. This greater variability could relate to the higher risk groups' willingness to switch websites, although the non-problem gambling group may be more indifferent to website changes. Nonetheless, our findings also showed that the willingness to switch websites did not directly affect bet changes, potentially challenging this explanation.

A further possibility is that the groups with at-risk gambling and gambling problems face cognitive challenges in updating their reference points and "wiping the slate" of their loss history. The realization effect occurs in sequential choices when people accept a prior loss, that is, they update their reference point, and any subsequent decisions are evaluated with no memory for the earlier outcomes. One possibility is that people with problematic levels of gambling may be more immersed in gambling. Slot machine gamblers often describe entering a trance-like state during a session of gambling, which may serve as a way of escaping from everyday stresses or low mood (Murch et al. 2020). Even outside of such a state, people with gambling problems may have decision-making difficulties that limit their ability to re-reference (Limbrick-Oldfield et al. 2020) and may therefore require more powerful interventions for creating a realization effect. Given our reliance upon a digital and hypothetical cashing out procedure, one clear candidate would be a physical cash transfer, because cash amplifies the impact of losses via the "pain of paying" (Palmer, Cringle, and Clark 2021; Prelec and Loewenstein 1998).

A limitation of the study is that because our task involved a negative expectancy, the wins or losses on the task were hypothetical. This could have diminished the sensitivity of the manipulation. At the same time, we do find a significant effect of the manipulation in the non-problem gambler population; other research also indicates that choice biases are largely robust to changes in incentive structure (e.g., Enke et al. 2023; Limbrick-Oldfield et al. 2022). Future research could look to strengthen the realization effect in gamblers by testing more tangible transaction procedures, either online or in-person. Given our cashing out procedure was digital and hypothetical without tangible money, it still reduced the bet amount in the group with non-problem gambling, indicating that cashing out may be effective in alleviating loss-chasing in real gambling settings. Options to withdraw funds can be easily introduced, or made more salient, on online gambling platforms. Under current regulations, gambling websites may highlight the "Deposit" button and/or obscure the "Withdrawal" button (e.g., by placing it in a submenu) or prohibit withdrawals when the account balance is under a minimum amount; these designs all increase the friction of successfully withdrawing funds (Newall and Rockloff 2022; The Behavioural Insights Team 2018). A first step in improving online withdrawal and deposit features would be to give the same salience to "withdrawal" and "deposit" options and allow for easy and immediate withdrawals under all circumstances. As our study suggests a stronger realization effect in the group with non-problem gambling, implementing these changes to the withdrawal process may help prevent migration from low to higher risk status.

5 | Conclusion

Our study examined a digital solution for gambling harm prevention by adjusting gambling product design, which could be used as a compliment to the mainstream one-to-one gambler interventions. With the expansion of gambling products and accessibility, future work should continue to directly incorporate interventions with product design to reach across populations of gamblers.

Conflicts of Interest

K.Z. held the Graduate Fellowship in Gambling Research (2021–2022), a fellowship supported by the BCLC and adjudicated by the UBC Faculty of Arts. L.C. is the Director of the Centre for Gambling Research at UBC, which is supported by funding from the Province of British Columbia

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Data Availability Statement

The data that support the findings of this study are openly available in "Realization Effect and Gambling" at 10.5683/SP3/AUMOS3.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.