Chasing in online gambling and its practical application in gambling intervention

by

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PhD., The University of British Columbia, 2023

Abstract

This study examines between- and within-session chasing behavior in online gambling using data from PlayNow.com in British Columbia, Canada. Chasing refers to a tendency to increase betting in an effort to recoup prior losses (i.e., 'loss chasing') or to satisfy an increased gambling desire following wins (i.e., 'win chasing'). The study found that average gamblers returned more slowly after a losing session and returned more quickly after a winning session. Within-session chasing depends on game type, chasing measurement (bet amount vs. quit probability), and outcome timeframe (immediate vs. cumulative outcomes). After losing more on the last bet, gamblers staked larger amounts over a longer session, but when cumulative losses mounted, gamblers staked smaller amounts over a shorter session. After winning more, gamblers bet more over a shorter session. Furthermore, VSE and Non-VSE gamblers did not differ in between-session chasing but did differ in within-session chasing

The study also evaluated a behavioral intervention to reduce loss chasing using a 'cashing out' procedure. In non-problem gamblers, the cashing out manipulation significantly lowered the amount wagered, aligned with the realization effect. There was no interaction between the cashing-out condition and the gambling group, although the cashing-out procedure was not statistically significant in the at-risk or problem gambling groups.

These findings provide future directions for identifying gambling problems based on behavioral tracking data and present proof of concept data for a new digital harm reduction tool. The study suggests that future research aiming to identify high-risk gambling patterns should also consider within-session behavioral markers.

1 Executive summary

1.1 Aims and objectives

Chasing is the tendency of increased betting after losing or winning. Gamblers will inexorably accumulate financial losses and experience gambling harm with increased betting, thus it is a defining feature of gambling pathology in clinical and psychiatric definitions.

Broadly speaking, chasing can happen across multiple visits (i.e., between-session chasing) or over the course of a visit (i.e., within-session chasing). This dissertation used two complementary approaches of observational (Chapters 2, 3, 4) and experimental (Chapter 5) studies to systematically characterize these two forms of chasing. The aims of this dissertation were to:

1. characterize between- and within-session loss and win chasing behavior across multiple gambling games, including slot machines, video poker, blackjack, roulette, and probability (Chapters 2, 3);
2. differentiate VSE (Voluntary Self-Exclusion) gamblers from Non-VSE gamblers based on their chasing behavior, using enrollment in the VSE program as a proxy for gambling problems (Chapter 4); and
3. design and examine a digital tool to reduce chasing (Chapter 5).

1.2 Research design and approach

Chapter 2, 3, and 4 measured chasing behaviour using real-world online gambling data from the British Columbia Lottery Corporation (BCLC) PlayNow website, the provincial gambling platform in British Columbia, Canada. Chapter 5 administered online experiment via Prolific to examine behavioural intervention of chasing.

Observational Data. The dataset spans from 2014-10-01 to 2015-08-31, comprising 527,015,222 bets placed by 29,964 gamblers on PlayNow eCasino. Game included slot machines, roulette, blackjack, video poker, probability games. Each chapter extracted the samples from this dataset.

Experimental Data. Prolific participants aged 21-50, proficient in English, located in Canada or the US, and who gambled in the past 12 months were recruited. The analytical sample of 689 participants included 227 non-problem gamblers, 239 at-risk gamblers, and 223 gamblers with problems.

1.3 Key findings

- Gamblers returned more slowly to the website after a losing visit, and they returned more quickly after a winning visit.
- During a visit, if gamblers lost more on the last bet, they chased by staking larger over a longer visit, but they stopped chasing when cumulative losses mounted.
- During a visit, if gamblers won more on the last bet or cumulatively, they chased by staking larger over a shorter over a shorter visit.
- VSE gamblers and Non-VSE gamblers did not differ in between-session chasing (i.e. the time to return) following either wins and losses, but they did differ in within-session chasing (i.e. bet amount and quit probability). Future research on identifying high-risk gamblers should expand to within-session chasing tracking.
- Encouraging gamblers to ‘cash out’ and move their funds between betting accounts reduced next bet amounts, but only in non-problem gamblers, not in at-risk gamblers and gamblers with problems.

- Despite the common perception of slot machines as high-risk gambling products, our analyses did not find them to be associated with the greatest chasing intensities in either between- or within-session chasing behavior.

2 Background

2.1 Two major forms of chasing expressions

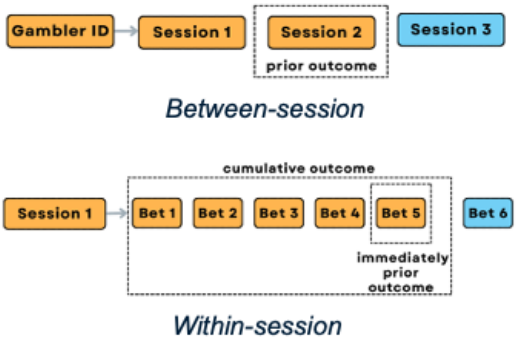

Figure 1. chasing prior outcomes

Between-session chasing (Figure 1) happens when gamblers bet more in response to losses (wins) in the prior session (e.g., return faster to the website).

Within-session chasing happens over the course of a session, gamblers bet more in response to losses (wins) in the immediately prior bet or cumulatively (e.g., stake larger, less likely to quit).

2.2 Gambling problems and chasing

The formal wording of the diagnostic criterion for chasing in Gambling Disorder is if the gambler often returns another day to the gambling platform (DSM-5; American Psychiatric Association, 2013). Returning to casino after a losing visit is the most endorsed item in screening tools for gambling problems (Sleczka & Romild, 2021). Chasing is the only criterion for Gambling Disorder that is directly observable based on DSM-related screenings. Due to the lack of diagnostic information on online gambling websites, chasing tendencies can serve as a behavioural marker of gambling problems.

As most online gambling data do not include a direct assessment of gambling problems, research studies need to use a proxy of gambling problems, and a common practice of using enrollment in VSE programs (Challet-Bouju et al., 2020). Thus, the present dissertation aimed to compare between- and within-session chasing between gamblers have enrolled in the VSE program (VSE gamblers) and those never enrolled (Non-VSE gamblers).

2.3 Adapting the realization effect to intervene in chasing behaviour

Imas (2016) proposed that *realization of outcomes* can alleviate loss chasing. An outcome is *realized* when money is transferred between accounts, allowing people to "make peace" with the loss and start the next bet with a clean mental slate. The accounts can be real (e.g., gambling accounts) or mental accounts. This is termed the *realization effect*. This dissertation aims to translate this realization procedure to online gambling by prompting experienced gamblers to exchange money between gambling accounts, reducing loss chasing.

3 Hypotheses

3.1 Between-session chasing behaviour (Chapter 2)

Chasing was operationalized as the shortened time to return the eCasino, as a function of losing or winning. I hypothesized that:

- H1 & 2: Among online gamblers, the **time interval between sessions** would decrease as a function of the amount lost in the prior session (*H1*), and would decrease as a function of the amount won in the prior session (*H2*).

- H3 & 4: Slot machine sessions would be associated with the shortest between-session intervals, as a function of the amount lost (*H3*) and amount won (*H4)* in the prior session.

3.2 Within-session chasing behaviour (Chapter 3)

Chasing was operationalized as 1) increasing bet amount, or 2) reduced quitting probability, as a function of losing or winning within a session. I hypothesized that:

- H1a & b (loss chasing): Online gamblers increased the **bet amount** as functions of the sizes of the immediately prior loss (*H1a*) and the cumulative loss (*H1b*).
- H1c & d (win chasing): Online gamblers increased the **bet amount** as functions of the sizes of the immediately prior win (*H1c*) and the cumulative win (*H1d*).
- H2a & b (loss chasing): Online gamblers reduced the **quit probability** as functions of the sizes of the immediately prior loss (*H2a*) and the cumulative loss (*H2b*).
- H2c & d (win chasing): Gamblers reduced the **quit probability** as functions of the sizes of the immediately prior win (*H2c*) and the cumulative win (*H2d*).
- H3 & H4: All above chasing tendencies varied by game type.

3.3 Chasing behaviour in VSE and Non-VSE gamblers (Chapter 4)

I investigated differences in between- and within-session chasing behavior between VSE and Non-VSE gamblers playing slot machines. Given that VSE gamblers were expected to have more gambling problems, I hypothesized that they would exhibit higher chasing tendencies than Non-VSE gamblers

3.4 Adapting the realization effect to reduce loss chasing (Chapter 5)

I devised a realization procedure by prompting participants to cash out from one gambling website and re-deposit on a second. I hypothesized that this cash-out procedure would lower the bet amount after losing and have different effects between non-problem, at-risk, and high-risk gamblers.

4 Methodology

4.1 Online gambling data overview

Figure 2. data structure

The data were multi-level structured. Each gambler has a unique ID, and they can visit the website multiple times. In each session, gamblers can play different game types and place multiple bets consecutively. I used multilevel modelling for each analysis.

4.2 Between-session chasing behaviour (Chapter 2)

For the between-session chasing analysis, I selected gamblers who visited the eCasino more than five times during the 11-month data window, resulting an analytical sample of 15,544 gamblers and 1,909,681 sessions.

I examined the impact of prior outcome and game played in the last session on the time to return to the website using session-by-session data. The model specifies as the following:

$$
\begin{aligned}
Log(Time\ to\ Return_{ijt}) \;=\; & \\
& \beta_{0j} + \\
& \beta_{1j} Outcome_{ij(t-1)} + \beta_{2j} Outcome\ Dummy_{ij(t-1)} + \beta_{3j} Game_{1j(t-1)} + \\
& \beta_{4j} Outcome_{ij(t-1)} * Outcome\ Dummy_{ij(t-1)} + \\
& \beta_{5j} Outcome_{ij(t-1)} * Game_{ij(t-1)} + \\
& \beta_{6j} Outcome\ Dummy_{ij(t-1)} * Game_{ij(t-1)} + \\
& \beta_{7j} Outcome_{ij(t-1)} * Outcome\ Dummy_{ij(t-1)} * Game_{ij(t-1)} + \\
& \beta_{8j} BC\ holiday_{ij(t-1)} + \\
& \beta_{9j} Start\ hour_{ij(t-1)} + \\
& \beta_{10j} Weekend_{ij(t-1)} + \\
& \beta_{11j} Log(Session\ Order) + \\
& e_{ij}
\end{aligned}
$$

where i indicates session, j indicates Gambler ID, t indicates time of the session. The key predictors were: 1) *Game* – the game type that gamblers played in the last session. 2) *Outcome Dummy* – win or loss dummy code in the last session. 3) *Outcome* – outcome magnitude in the last session. The time nuisance variables were controlled as covariates.

4.3 Within-session chasing behaviour (Chapter 3)

Due to the computational infeasibility for large data size, I randomly selected a subgroup of 'typical' gamblers with total bet counts in the 35% - 65% percentile, resulting an analytical sample of 2,000 gamblers with 1,913,251 bets.

Within-session chasing analysed bet-by-bet data. I examined the impact of the last and cumulative outcomes on 1) bet amount and 2) quitting probability in the next bet by game types, using these two independent models:

Bet amount model:

$$
\begin{aligned}
Log(bet\ amount_{i(jk),t}) \;=\; & \\
& \beta_{0(jk)} + \\
& \beta_{1jk} Game_{i(jk),t-1} + \\
& \beta_{2jk} Outcome_{i(jk),t-1} + \\
& \beta_{3jk} Outcome\ Dummy_{i(jk),t-1} + \\
& \beta_{4jk} Cumulative\ Outcome_{i(jk),t-1} + \\
& \beta_{3jk} Cumulative\ Dummy_{i(jk),t-1} + \\
& \beta_{5jk} Outcome_{i(jk),t-1} * Outcome\ Dummy_{i(jk),t-1} + \\
& \beta_{6jk} Outcome_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{7jk} Outcome\ Dummy_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{8jk} Cumulative\ Outcome_{i(jk),t-1} * Cumulative\ Dummy_{i(jk),t-1} + \\
& \beta_{9jk} Cumulative\ Outcome_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{10jk} Cumulative\ Dummy_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{11jk} Outcome_{i(jk),t-1} * Outcome\ Dummy_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{12jk} Cumulative\ Outcome_{i(jk),t-1} * Cumulative\ Dummy_{i(jk),t-1} *\ Game_{i(jk),t-1} + \\
& \beta_{13jk} scale(Bet\ Order) + \beta_{14jk} scale(Bet\ Order)^2 + \\
& \beta_{15jk} Session\ Order + \\
& e_{i(jk)}
\end{aligned}
$$

Quit model:

$$
\begin{aligned}
Quit_{i(jk),t}(1 = quit) \quad = \quad & \\
& \beta_{0(jk)} + \\
& \beta_{1jk} Game_{i(jk),t-1} + \\
& \beta_{2jk} Outcome_{i(jk),t-1} + \\
& \beta_{3jk} Outcome\ Dummy_{i(jk),t-1} + \\
& \beta_{4jk} Cumulative\ Outcome_{i(jk),t-1} + \\
& \beta_{3jk} Cumulative\ Dummy_{i(jk),t-1} + \\
& \beta_{5jk} Outcome_{i(jk),t-1} * Outcome\ Dummy_{i(jk),t-1} + \\
& \beta_{6jk} Outcome_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{7jk} Outcome\ Dummy_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{8jk} Cumulative\ Outcome_{i(jk),t-1} * Cumulative\ Dummy_{i(jk),t-1} + \\
& \beta_{9jk} Cumulative\ Outcome_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{10jk} Cumulative\ Dummy_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{11jk} Outcome_{i(jk),t-1} * Outcome\ Dummy_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{12jk} Cumulative\ Outcome_{i(jk),t-1} * Cumulative\ Dummy_{i(jk),t-1} * Game_{i(jk),t-1} + \\
& \beta_{13jk} Session\ Order + \\
& \beta_{14jk} Time\ Duration + \\
& e_{i(jk)}
\end{aligned}
$$

where i indicates session, j indicates Gambler ID, t indicateds time of the session. *Quit* was a binary variable. The key predictors were: 1) *Outcome Dummy* – win or loss dummy code in the last bet. 2) *Outcome* – outcome magnitude in the last bet. 3) *Game* – the game type that gamblers played in the current session. 4) *Cumulative Dummy* – win or loss dummy code for the cumulative outcome. 5) *Cumulative Outcome* – cumulative outcome magnitude from the start of the session up to the current bet. The time nuisance variables were controlled as covariates.

4.4 Chasing in VSE and Non-VSE gamblers (Chapter 4)

I observed between- and within-session chasing behavior differences between VSE and Non-VSE gamblers using the same methods as in Chapters 2 and 3, with VSE status added as a variable. VSE and Non-VSE gamblers were paired on the number of sessions played, excluding the confounding effect of visiting frequencies on the time to return.

I selected two analytical samples for the between- and within-session analyses based on the same criteria in Chapter 2 and 3. The between-session analytical sample included 1,338 VSE gamblers (N = 192,774 sessions) and 1,331 Non-VSE gamblers (N = 253,350 sessions). The within-session analytical sample included 326 VSE gamblers (N = 192,774 bets) and 201 Non-VSE gamblers (N = 253,350 bets).

4.5 Adapting the realization effect to reduce chasing (Chapter 5)

Procedure. This Prolific experiment examined the effectiveness of cashing out on loss chasing in a task framed as online gambling. Participants were endowed with $10 and completed nine rounds of lottery, betting a percentage of their current balance. The experiment was a between-subjects design with participants randomly assigned to either the cash-out or feedback conditions, with the key manipulation at the end of round 6 (Figure 3). Feedback participants received account balance information and continued within the same website, while cash-out participants withdrew their funds and deposited them in a new gambling website.

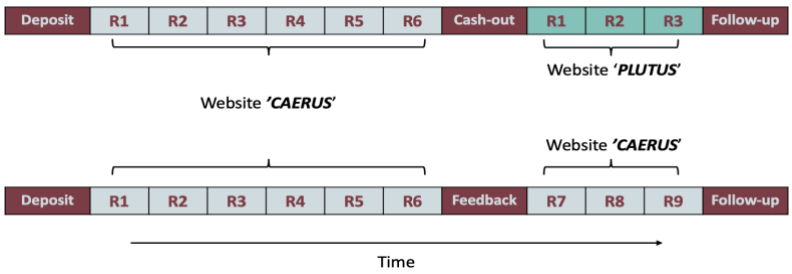

Figure 3. experimental design

Analysis. The chasing tendency was defined by the *bet change* from round 6 to round 7 (i.e. the bet amount before and after the manipulation). I quantified the effect of the cash-out manipulation on chasing by this model:

$$Bet\ changes = Gambling\ group + Condition + Gambling\ group * Condition + Average\ bet\ amount + e.$$

5 Results

Table 1 summa that chasing behavior depends on the form of chasing, the timeframe of prior outcomes, and the game type.

	Between-session	**Within-session**			
		Chase Prior Outcome		*Chase Accumulative Outcome*	
	Time to Return	Bet amount	Quit	Bet amount	Quit
Loss-Chasing					
slots	×	✓	✓	×	×
mixed	×	✓	✓	×	×
roulette	✓	✓	×	×	×
blackjack	×	✓	×	×	×
probability	×	✓	✓	×	×
video poker	×	✓	✓	×	×
Win-Chasing					
slots	✓	✓	×	✓	✓
mixed	✓	✓	×	✓	×
roulette	✓	✓	×	✓	×
blackjack	✓	✓	✓	✓	×
probability	✓	✓	×	✓	✓
video poker	✓	✓	×	✓	×

Table 1. summary of between- and within-session for the different game types

Note: '✓' indicates the presence of chasing under the chasing measurement, and '×' indicates the absence of chasing under the measurement.

5.1 Did gamblers return faster as a function of prior losses (wins)?

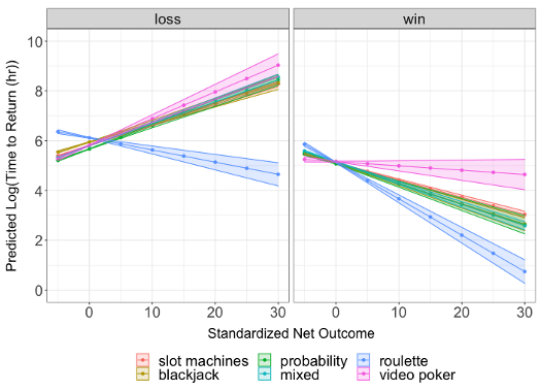

Figure 4. between-session chasing by game type.
Note: The shaded area is standard errors.

Gamblers in most games returned more slowly after losing in the last session, and more quickly after winning (Figure 4). Loss chasing intensities did not differ significantly from slot machine sessions, except for roulette was associated with a shorter interval to return (b = -0.13, p <.001). Similarly, win chasing intensities did not differ significantly from slot machine sessions, except for roulette (b = -0.08, p < .001) and mixed (b = -0.02, p = 0.009) sessions.

5.2 Did gamblers increase the bet amount as a function of losses (wins) within a session?

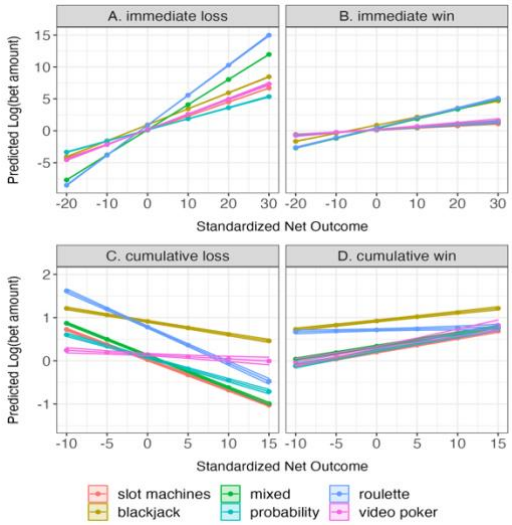

Figure 5. chasing tendencies on the bet amount.

Across all games, gamblers bet more as a function of the immediately prior amount lost (Figure 5 Panel A), but bet less as a function of the cumulative amount lost (Figure 5 Panel C). In terms of win chasing, gamblers bet more as a function of the immediately prior amount won (Figure 5 Panel B), and also as a function of the cumulative amount won (Figure 5 Panel D).

Slot machine sessions were not associated with a significantly steeper chasing slope compared to other games across all panels.

5.3 Did gamblers reduce quit probability as a function of losses (wins)?

Unlike the broadly similar chasing trajectories seen across game types in the *bet amount model*, the game types show much greater heterogeneity for both loss chasing and win chasing on the quit probability (Table 3).

After losing the immediately prior bet, gamblers in most game types reduced their quit probability, while after losing cumulatively, they increased it across all game types. After winning the immediately prior or cumulatively, gamblers in most games increased the quit probability in most game types.

Slot machine sessions were not associated with a significantly steeper chasing slope compared to other games.

5.4 Did VSE and Non-VSE gamblers differ in between-session chasing?

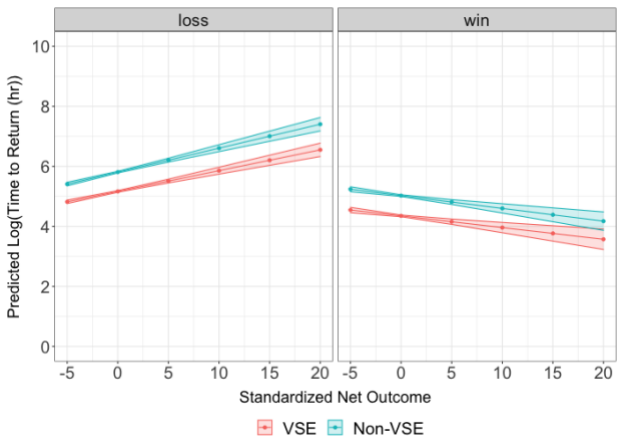

Figure 6. between-session chasing.

No. Both groups did not chase losses. Moreover, the increase in the prior loss did not encourage VSE gamblers to return faster than Non-VSE gamblers (b = 0.01, p = .499). Both groups chased wins, but VSE gamblers did not return significantly faster after winning than Non-VSE gamblers (b = 0.00, p = .877).

5.5 Did VSE and Non-VSE gamblers differ in within-session chasing?

Yes by bet amount. VSE gamblers (vs. Non-VSE gamblers) had steeper chasing slopes after losing the immediately prior bet (b = 0.08, $p < .001$) and losing cumulatively (b = -0.07, $p < .001$; Figure 7 Panel A & C). However, they *did not* differ in win chasing slopes as a function of immediate wins (b = 0.00, $p = .962$) and cumulative wins (b = 0.012, $p = .041$; Figure 7 Panel B & D).

Yes by quit probability. VSE gamblers (vs. Non-VSE gamblers) had a steeper slope after losing the immediately prior bet, such that they were less likely to quit the session after a greater loss in the last bet (OR = 1.21, 99% CI [1.09, 1.34]; Figure 8 Panel A). In contrast, VSE gamblers (vs. Non-VSE gamblers) had a flatter slope after losing cumulatively, such that they were inflexible to change the quitting probability (OR = 0.71, 99% CI [0.61, 0.83]; Figure 8 Panel C).

In terms of win chasing, the two group did not differ in chasing the immediately prior win (OR = 1.06, 99% CI [0.78, 1.43]; Figure 8 Panel B). After winning cumulatively, VSE gamblers were more likely to quit, but their quitting decisions were not sensitive to the cumulative win amount; they always stay in the session regardless of the previous wins (OR = 0.72, 99% CI [0.58, 0.88]; Figure 8 Panel D).

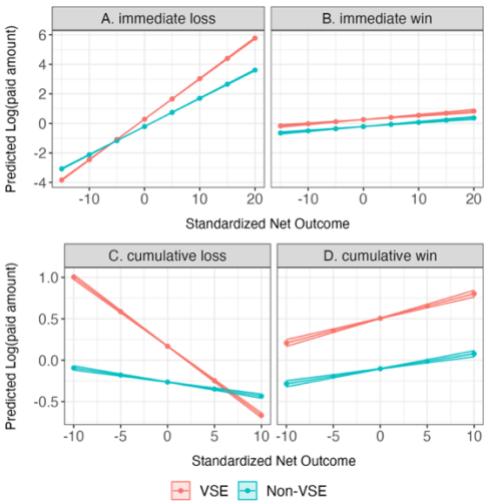

Figure 7. the bet amount model.

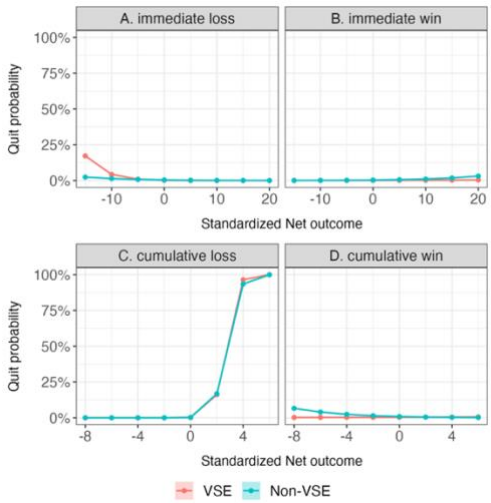

Figure 8. the quit probability model.

5.6 Did the cashing-out procedure change loss chasing?

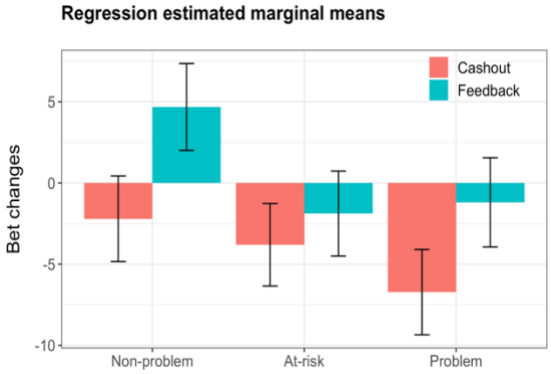

Figure 9. the cashing out effect

Yes. Cash-out significantly lowered the amount bet, compared to the feedback condition in non-problem gamblers (b = -6.88, $p = .022$). But such difference in bet change was weak in the at-risk gamblers (b = -1.92, $p = .593$) and gamblers with problems (b = -5.52, $p = .204$). The realization effect appears to be more fragile in these groups.

6 Discussion

6.1 Unique contribution

This dissertation contributes to the growing body of literature on chasing. A significant strength is its ecological validity; the use of behavioral tracking from a gambling website enabled me to characterize actual chasing trajectories in the real world.

There is a trend among jurisdictions (e.g., Germany) to require operators to monitor problematic gambling behavior and provide personalized gambling protection. This dissertation establishes useful behavioral markers for gambling problems and provides future directions for identifying problems based on within-session chasing behavior.

While some gambling operators claim to have innovated personalized gambling protection based on behavioral data tracking, detecting behavioral markers of problems such as chasing is technically and theoretically challenging. The industry's capability to offer a robust method for identifying problem gamblers is questionable at the current stage. Data analysis demands expensive computational resources and involves arbitrary modeling decisions. Establishing procedures for identifying problem gamblers and delivering personalized interventions requires time and a strong theoretical foundation.

This dissertation presents proof-of-concept data for a new digital harm reduction tool using an ecologically-valid 'cashing out' money transfer process. In the context of gambling, operators allow gamblers to maintain several wallets, enabling this intervention to help customers re-reference with minimal operational costs.

6.2 Limitations and the next steps

This dissertation used 2014 – 2015 eCasino data. At that time, online gambling was not among the most popular gambling platforms, therefore the behaviour of those gamblers may not be representative of online gamblers today. Future studies should replicate the methods in a recent dataset.

Due to large and complex data size and computational feasibility, only a subsample of online gambling data was used, and I did not characterize within-session chasing tendencies among "high-rollers" or among more casual gamblers. The generalizability of the results to these groups remains uncertain, and further research is needed to determine differences in within-session chasing behaviors among gamblers with varying betting frequency and intensity.

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