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FULL-LENGTH REPORT

Illusions of control: A quasi-experiment comparing skill-based and traditional slot machines

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ABSTRACT

Background and Aims: Electronic gaming machines (EGMs) are a significant source of gambling spend due to their widespread use. Skill-based gambling machines (SGMs) represent an innovative adaptation, merging EGMs' chance-based rewards with video game-like skills. This study aimed to explore the appeal and behavioural consequences of playing SGMs in comparison to traditional reel-based EGMs, particularly focusing on illusions of control, betting behaviour, and the subjective experience of gamblers. *Methods:* Participants ($N = 1{,}260$) were recruited online and engaged in an online task simulating either an SGM or a reel-based EGM, with outcomes represented to influence their survey compensation. The study examined the effect of SGMs relative to EGMs on bet size, persistence, enjoyment, illusions of control, game immersion, and the influence of demographic and gambling problem severity. *Results:* SGMs particularly appealed to younger adults, regular EGM players, and people with more gambling problems. Despite identical payout structures, people assigned to play SGM showed greater illusions of control, believing in the influence of skill on game outcomes and that practice could improve results. However, there was no significant difference in overall betting intensity between SGM and EGM players, although specific demographic groups showed faster betting speeds in SGMs. *Discussion and Conclusions:* SGMs, despite not inherently encouraging higher betting intensity, attract vulnerable groups and create illusions of control, posing new regulatory challenges. The visual and interactive features of SGMs, while appealing, might contribute to these perceptions, indicating a need for careful regulation and further research on their long-term impacts on gambling behaviour and harm.

KEYWORDS

skill-based gambling machines (SGMs), electronic gaming machines (EGMs), illusions of control, betting behavior, gambling harm, video gaming and gambling

INTRODUCTION

EGMs are a major driver of gambling spend and harm because of their inherently risky structural features and their widespread use (Browne et al., 2023). Gamblers have little influence on EGM outcomes since results are random. The only control EGM gamblers have is over the bet size and numbers of lines bet. These choices only affect the size and frequency of wins and losses (Palomäki et al., 2023), but do not influence the overall percentage return-to-player (Turner et al., 2018). The return, instead, is set by a payout table that is fixed and available for view, although often seldom accessed by gamblers (Livingstone, 2017). There are

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some minor deviations from these general guidelines on how specific machines operate. For example, progressive jackpots change in value as people play longer and the pot of the jackpot grows, thus creating variability in the expected value of the return-to-player for each bet placed (Rockloff & Hing, 2013). These variations are nevertheless minor, and gambler behaviour generally cannot affect the likelihood of winning.

People who gamble on EGMs often believe that their playing style can affect their likelihood of winning (Ferland et al., 2002; Keen et al., 2019). This is a consequence of the subjective experience of gambling where, for instance, betting on one line (rather than many or all) produces few wins (Harrigan et al., 2011). While betting on one line, and often losing, gamblers often fail to recognise that in those rare instances of winning, the payouts are proportionately larger. These larger wins compensate for the lack of frequent wins, thus leaving the return-to-player unchanged over time. The misconceptions around the utility of playing style is related to the 'illusion of control' phenomenon studied in economics and psychology literature (Berger & Tymula, 2022). In short, despite superficial experience and common expectations, the choices gamblers make generally cannot affect the likelihood of winning on EGMs (Livingstone, 2017).

Skill-based gambling machines (SGMs)

Skill-based gambling machines (SGMs) are an innovation in EGM technology that combines the skill or apparent skill often employed in video games with the randomised monetary rewards of traditional EGMs (Pickering et al., 2020). They integrate video-gaming attributes, such as reaction-time skilful play, but outcomes are largely chance-determined (Newall et al., 2023). SGM games often resemble classic video games, but with the potential for winning money. Unlike most video games, SGMs can merely suggest the application of skill to the game, even if the outcomes are solely or mostly determined by chance. For instance, some shoot-em-up style games have each successful "hit" on a target (e.g., shooting an enemy) equating to placing a bet, the result of which can be either a monetary win or loss. Hence, the reward for those skilled enough to hit the target is simply the placement of a bet that has a random outcome. In other words, to prevent high-skilled players from generating real influence over the game and subsequent positive returns, skill elements must be either absent or minimised, although the appearance of the utility of skill to the gambler can be influenced by structural aspects of the game.

Given that the application of skill to SGMs necessarily is either minor or absent, it is important to understand how apparent skill can affect people's betting behaviour, their perceptions of winning, and the attractiveness of the games (Delfabbro et al., 2020). In short, true skill only changes the distribution of wins and losses in the direction of better outcomes for the skilled-player and poorer outcomes for the unskilled. As reviewed by Gainsbury and Philander (2022), SGM players may believe skill affects outcomes more than EGM players, although effects on betting behaviour and consequent harm are unclear. Nevertheless, a gambler's perception that they are exercising skill in a game, true or not, may plausibly affect their betting decisions. In an experiment, Gainsbury and Philander (2022) found that people who were assigned to play (without funds) an SGM as opposed to an EGM were more likely to believe skill affected their outcomes. Without a strong theory for guidance, however, it is difficult to know if apparent skill would increase or decrease betting intensity, or how SGMs might be differentially more or less attractive relative to EGMs for different groups of potential users (e.g., EGM players, video gamers). Limited research makes it difficult to predict overall SGM impacts on gamblers (Pickering et al., 2020).

Experiment

The investigation into the behavioural and attractiveness distinctions between SGMs and EGMs was carried out through an experimental study. Simulated SGMs and EGMs were matched on theoretical return-to-player (i.e., equalised likelihoods of wins and losses) and used real-money rewards rather than points (cf., Gainsbury & Philander, 2022). SGMs primarily depend on the perception of skill application, rather than the actual impact of skill on results. Therefore, when an SGM is paired with an EGM game, they only need to share a single, fixed paytable. It was not necessary to have actual skill affect payouts. In fact, any variation in payout likelihood might arguably have its own influence on behaviour and perceived attractiveness of the games, which could be an undesirable confound in this experiment.

The operation and appearance of traditional EGMs are well honed by manufacturer experience, although their basic configuration is remarkably similar to the first one-armed bandits developed over 100 years ago (Livingstone, 2017). Modern EGMs include spinning reels, animated symbols and the ability to spread bets over multiple "lines" that constitute different potential winning symbol combinations. In contrast, skill-based games have highly varied formats, often mimicking classic video games (M. Rockloff et al., 2023). While it is impractical to replicate this diversity within an experimental paradigm, Armstrong et al. (2016, 2016) documented a general framework, termed VICES, for analysing important features of innovated EGMs, which are classic table games automated with EGM technologies. Described in detail later, this VICES framework outlines design characteristics that might influence player behaviour as applied to SGMs, including visual and auditory enhancements, illusions of control, cognitive complexity, expedited play, and social customisation. In addition, qualitative research indicates SGMs may differentially appeal to certain groups, like regular gamblers or video gamers (Gainsbury, Philander, & Grattan, 2020), and plausibly, certain groups may be drawn to different types of SGMs. Therefore, the research program was devised to also explore the differential appeal of SGMs to these groups.

Research questions

This research was designed to contrast SGMs to EGMs via an experimental design. Although the lack of guiding theory

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precluded strong a priori predictions, the experiment sought evidence for differences in attractiveness of the games, as well as potential betting differences between games – recalling that each was designed with an equivalent likelihood of winning. The experiment sought answers to the following research questions:

1. How does playing SGMs versus EGMs affect bet size, persistence, and enjoyment?
2. How does playing SGMs versus EGMs affect illusions of control and game immersion?
3. For SGMs only, how do game characteristics, including visual and auditory enhancements, illusions of control, cognitive complexity, expedited play, and social customisation, affect bet size, persistence, and enjoyment?

For each of these questions, the research also looked at evidence for how individual differences, including gender, age and problem-gambling status, influenced these outcomes.

METHODS

Participants

Online recruitment companies, Qualtrics and PureProfile, provided participants for the SGM and the reel-based EGM comparison, respectively. Although Qualtrics had the larger available sample, they declined to provide a sample for the EGM simulation because it resembled commercial gambling. This limitation is addressed later in the discussion.

Pre-screening by each panel provider helped to recruit participants who were: last-12-month EGM gamblers, video gamers, players of both games (EGMs and video games), and players of neither. The researchers determined the sample sizes based on the number of available participants, not by using a statistical power calculation, which typically estimates the necessary sample size to detect an effect. This approach was chosen to fully utilise the available participant pool, ensuring the study maximised its potential within the given resources. For the Qualtrics sample, there were 337 last-12-month EGM gamblers, 333 video gamers, 212 who played both, and 277 who played neither. For the PureProfile sample, there were 33 last-12-month EGM gamblers, 34 video gamers, 14 who played both, and 20 who played neither. Consequently, there were 1,159 people in the Qualtrics sample who were assigned to play an SGM game, and 101 people in the PureProfile sample who played a similarly styled EGM with the same payout schedule. Post-hoc power calculations are provided in the results section. Participants accessed the surveys and games using either personal computers or Chromebooks. Custom programming in the survey did not allow completion on mobile devices.

The demographics of participants sourced from Qualtrics and PureProfile were largely comparable. The average age was 51.5 years (with a standard deviation of 16.7) for the Qualtrics sample, and 46.7 years (with a standard deviation of 15.6) for the PureProfile sample. In both groups, slightly more than half of the participants were male, and the majority were from Australia's most populous states: New South Wales, Victoria, and Queensland. Approximately 5–9% of respondents spoke a primary language other than English at home, and 1.0–2.6% identified as Aboriginal, Torres Strait Islander, or both. About two-thirds of the participants were married or in a de facto relationship, while a quarter were single/never married. The samples showed a wide range of educational backgrounds and employment statuses.

Procedures

Operation of the reel-based game. The reel-based EGM featured a five-reel, three-position format (refer to Fig. 1). Wins required a continuous sequence of three or more matching symbols from left to right. This design emulated Aristocrat's Reel-Power EGM, which is common in Australia. Players could wager 1, 2, or 5 credits per spin and alter the bet each time, with wins counting on any payline. The 30-spin session included a randomised mix of 10 wins and 20 losses, ensuring no outcome repeated more than five times consecutively. All wins paid equally, independent of the specific winning symbols. The EGM's design was based on a program previously used by Byrne and Russell (2020).

Operation of the SGM. The SGM involved players firing torpedoes from a ship positioned at the bottom of the screen towards moving ships above. Hitting a ship resulted in a win (a hit; the torpedo damaged the ship) or loss (a dud; the torpedo hit the ship but did not explode). Missing a ship or hitting asteroids counted as "no bet" (a miss). Players bet 1, 2, or 5 credits per torpedo, with the option to adjust the bet before firing each torpedo. The game ended after 30 hits or duds, excluding misses. The win/dud(loss)/miss structure in SGMs, compared to the win/loss structure in EGMs, was intended to mirror the experience of 'near misses' in skill-based video games. This structure may contribute to perceptions of skill by providing feedback on the player's performance, even when the outcome is financially equivalent to a loss. The SGM had 10 wins and 20 losses, randomly placed with no more than five consecutive identical outcomes. All wins resulted in a return of double the amount bet, regardless of ship type. Therefore, players who bet the same amount for every torpedo would break even. This setup mirrored the reel-based EGM, making the SGM's "skill" aspect apparent rather than actual (i.e., the paytable was identical). Figure 2 shows the SGM, where players target ships through asteroids. The firm *Two Bulls* custom-designed the SGM for this study.

Figure 2 illustrates the interface during a win, similar to traditional reel-based EGMs. Winning triggers a vibrant display of graphics and music, featuring an explosion where the won credit amount is prominently displayed at the explosion's centre.

In Fig. 3, the SGM is presented in a nostalgic sea themed version, which was devised to contrast with a change in the visual component of the VICES framework, as described in

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Fig. 1. Illustration of the reel-based EGM
Note: asteroids did not count as winning symbols

Fig. 2. A "hit" in the SGM. A player has fired a one credit torpedo and won two credits

more detail below. The game is described here as "nostalgic" because it is highly similar to a popular arcade game in the 1970s and 1980s called Sea Wolf (Kent, 2010). This game, despite appearances, was wholly unchanged regarding betting and outcomes.

Perceptual differences between the SGM and EGM. The key distinction between the SGM and the traditional reel-based EGM lies in how bets and outcomes are treated, especially concerning "misses" in SGMs, a feature not present in EGMs. In EGM gameplay, every bet immediately deducts credits from the player's total. If the player loses, their credit total remains the same as after the bet was placed. Conversely, a win results in their total credits increasing, specifically tripling the amount wagered. For example, wagering 5 credits from an initial 100 reduces the player's total to 95. If they lose, their total stays at 95, but a win would boost it to 110.

In contrast, the SGM introduces a unique "miss" category, alongside wins and losses. When a player fires a torpedo, their total credits don't change until the torpedo's outcome is determined. A "miss" results in no change to the

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Fig. 3. The nostalgic (sea themed) SGM

credit total, essentially acting as if no bet was placed. A loss (or "dud") decreases the player's credits by the bet amount, similar to the EGM but only after the outcome. A win doubles the wager, increasing the player's total credits. For instance, firing a torpedo with a 5-credit bet from an initial 100 credits does not change the credit total until the outcome is determined. A miss keeps the credits at 100, a loss decreases it to 95, and a win increases it to 110. Thus, although the financial outcomes for wins (110 credits) and losses (95 credits) are the same in both SGMs and EGMs, the experience and perception of betting differ. In EGMs, wins are perceived as tripling the bet, whereas in SGMs, wins double the bet, and losses are deducted either before or after the outcome is known, adding a layer of strategy or perceived skill to the SGM experience. This difference in the timing and perception of outcomes creates a distinct gameplay experience between the two types of machines, highlighting perceptual rather than actual financial differences.

Persistence: double-or-nothing. Persistence, typically seen as continued play, was gauged through a final double-or-nothing bet, which was a compromise due to experiment length and attrition concerns. Players could either keep their credits or bet them all for a chance to either double them or lose everything, with a 50/50 win-loss programmed outcome. This bet was called a Mega-torpedo in both the EGM and SGM games. In the skill-based game, a missed Mega-torpedo did not count, allowing subsequent attempts. As detailed in the discussion, choosing the final bet was meant to measure higher persistence, regardless of the result. However, this was a proxy measure, and potentially influenced by risk preferences as much as the desire to continue gambling.

Manipulating game design elements: The VICES framework. The VICES framework (Armstrong, Rockloff, Greer, et al., 2016) utilised in this study involves manipulating five key orthogonal elements: Visual and auditory enhancements, Illusions of control, Cognitive complexity, Expedited play, and Social customisation. These elements were varied independently to create different gaming experiences:

> Visual and auditory enhancements: Games featured either a nostalgic sea-themed or a relatively more novel space-themed design.
>
> Illusions of control: Players experienced conditions where their skill-level affected gameplay, although not financial outcomes. In skilled conditions, misses were possible, while in unskilled conditions, torpedoes always hit a target. This was accomplished through ships being programmed to appear (e.g., a submarine surfacing) in front of torpedoes that would otherwise have been a miss. The game continued until 30 bets were completed regardless of condition, so the distinction between skilled and unskilled was functionally irrelevant in terms of game outcomes.
>
> Cognitive complexity: The game complexity was varied with either a message displayed prior to the game start that encouraged players to use a "strategy" (complex conditions), versus a prompt that simply said, "click next to continue" (basic conditions).
>
> Expedited play: Game pace was manipulated; faster enemy movement in one version made the game more challenging.
>
> Social customisation: The presence of in-game messages suggesting others are winning simulated a social gambling environment. The absence of messages suggested no social element in the gambling environment.

To examine their individual and combined effects on player experience and behaviour, these variables were combined in 32 different ways (2x2x2x2x2) and assigned to players via block randomisation. These game variations were not intended to be a comprehensive representation of how the VICES factors might affect play. Instead, these variations

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encapsulated some of the perceptual differences that could affect gambling behaviour based on findings from a literature review and environmental scan on SGMs (Rockloff et al., 2023). In addition, Rockloff et al. (2023) provide a more detailed account of these considerations, whereas less detail is provided here since these game-variations had minor influences on player behaviour and perceptions, as evidenced in the results that follow.

Comparative design: reel-based EGM versus SGM with VICES framework. As noted, the study compared a traditional reel-based EGM with an SGM using the VICES framework. The reel-based EGM was standardised for all participants, lacking the VICES modifications seen in the SGM. It borrowed the space-themed visuals from the SGM to align both games visually. The EGM's reel pace was set at 3 s per spin, but actual betting happened roughly every 4 s due to delays introduced by players placing bets.

Measures

The data collection included two main types: responses from standardised survey questions administered after gameplay, and in-game performance metrics. These measures applied equally to participants playing both the reel-based EGM and the SGM. Rockloff et al. (2023) provide more details on the survey contents.

Participant information and consent. Before starting, participants viewed a screen explaining the study's nature, emphasising voluntary participation and the option to withdraw at any time. Participants were directed to an online survey featuring a simulated SGM or a reel-based EGM. They started with 100 credits and were promised a standard survey fee, and an additional compensation up to $6.50 based on game winnings. However, this "bonus" pay was instead a certainty revealed to participants at the end of the study. This mild deception was approved by the Central Queensland University Human Research Ethics Committee (CQUHREC) (approval number 23507).

Gameplay completion and final double-or-nothing bet option. The variable, *Skill or Reel*, was recorded as a binary variable to indicate whether players were assigned to play the SGM or EGM, respectively. Participants continued playing until they completed 30 spins in the reel-based game or achieved 30 hits or duds in the skill-based game, excluding any torpedo misses from the count. After reaching this threshold, they were presented with their total credits and given the option to make a final "double or nothing" bet using either a spin (EGM) or a torpedo (SGM). If they chose to take this final bet, a concluding screen displayed the outcome. Figure 4 illustrates the skill-based game's interface for this decision, with a comparable setup in the reel-based game.

In-game performance metrics. The measures calculated from each spin or torpedo included the *bet speed*, defined as the number of valid bets (comprising hits/wins and duds/losses, excluding misses) per minute, calculated by dividing the total number of valid bets by the total time taken in seconds and then multiplying by 60. The average *bet size* was determined by dividing the total expenditure on valid bets by the number of valid bets, specifically 30, as misses were not included. Lastly, a binary variable recorded whether the participant chose to make the *double or nothing* bet, the so-called Mega torpedo, after the 30 spins of regular play.

Fig. 4. Double or nothing question and the final mega-torpedo screen (skill-based)

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Assessment of gambling behaviour and Problem Gambling Severity. Participants who reported any gambling activity in the last 12 months completed the Problem Gambling Severity Index (PGSI), a tool developed by Ferris and Wynne (2001) to measure gambling problems. The PGSI includes nine questions, with responses ranging from "never" (0 points) to "almost always" (3 points). The total score, which can range from 0 to 27, is used to categorise participants into four levels of gambling problems: non-problem (PGSI score of 0), low-risk (scores 1–2), moderate-risk (scores 3–7), and problem gambling (scores 8–27). In this study, the reliability of the PGSI was extremely high, with a Cronbach's alpha of 0.96, indicating consistent and reliable responses across participants. For the analyses that follow, and to reduce model complexity, PGSI categories were collapsed into: 1) non-gamblers, no-risk, and low-risk, versus 2) moderate-risk and problem gambling.

Illusions of control and immersion in play. After the gameplay, participants responded to a series of questions regarding their experience. Participants evaluated the significance of their skill level in influencing their winnings (variable: Skill), using a 5-point Likert scale that ranged from "not important" to "very important." They assessed their level of control over winning outcomes (variable: Win) on a similar 5-point scale, from "none" to "a lot." Additionally, participants were queried on whether they believed that practising the game could potentially increase their winnings (variable: Practice), answering with a simple "yes" or "no".

To measure the degree of subjective immersion in the play experience (variable: Immersion), participants were asked: Did you feel immersed or absorbed, forgetting about everything else? This question was answered on a Likert scale 1–5, with answer stems of "not at all" to "very much".

Game enjoyment

Participants were asked to rate their enjoyment of several features of the game they played on a Likert scale ranging from "not at all" to "very much". The features rated were: graphics, artwork and sound; use of skill; use of strategy; fast-paced action; and competition with others. These ratings were combined into a simple average to create the variable, game enjoyment, for use in subsequent analyses. Game enjoyment, as constructed from the average ratings of various game features, demonstrated high reliability, $\alpha = 0.88$.

Game experience in the last 12 months. To better understand how using EGMs and/or video games might influence play metrics and enjoyment with our SGM, participants were asked if they played on an EGM within the last 12 months (no, yes) and if they played video games at least weekly in the last 12 months (no, yes). Video game play was divided into weekly versus less, since many people play games casually without deep engagement (e.g., playing a video game once on Christmas with a child).

Statistical analysis

Throughout the analysis, a significance level of 0.05 was selected as evidence needed to further interpret multivariate effects. The interpretation of between-subjects effects was restricted to alpha = 0.001 to avoid inflation of Type I errors arising from multiple comparisons. The game data was scrutinised for outliers, and none of significant concern were identified.

Ethics

Ethics: The Central Queensland University Human Research Ethics Committee (CQUHREC), under approval number 23507, has granted its approval for this study. The operating procedures of the Human Research Ethics Committee adhere to the guidelines set forth in the National Statement on Ethical Conduct in Human Research by the NHMRC.

RESULTS

Q1: How does playing SGMs versus EGMs affect play metrics and enjoyment?

A General Linear Model (GLM) was used to investigate the effects of playing either the SGM or reel-based EGM on outcomes of play metrics, including average bet size, bet speed, choice of a final double-or-nothing bet (no, yes), and rated enjoyment of the game experience. In addition to game assignment (i.e., Skill or Reel), other independent variables included Gender, Age, and PGSI category (NR/LR, MR/PG).

Results of multivariate tests indicated significant main effects for all outcomes. Marginal mean comparisons are shown in Table 1. Results focus on the largest and most significant differences, i.e., $p < 0.001$. While bet speed was faster on the EGM, enjoyment was rated higher on the SGM. However, since the potential for fast (or slow) bet speeds are highly influenced by the design of the game, and not just player behaviour, bet speed differences found here between EGMs and SGMs should be interpreted with caution (i.e., $M = 11.403$ SGM vs. $M = 15.921$ EGM). This cautionary note is explained in more detail in the discussion.

Overall, younger participants (18–49 years), bet more, bet faster, and enjoyed the experience more than older participants (aged 50+). We ran our model again using the age cut-off comparing persons 18–29 and older persons. The results were largely similar with respect to age, despite the reduced power of the comparison. Younger persons, 18–29, made larger bets ($M = 3.23$) than older persons ($M = 2.81$), $F = 14.48$, $p < 0.001$, and bet marginally (though not significantly) faster ($M = 14.64$ vs. 13.70), $F = 3.63$, $p = 0.057$, ns. Game enjoyment differences, however, were no longer significant, $p = 0.164$, ns, in absence of more numerically balanced comparisons groups.

Lastly, people with moderate risk or more severe gambling problems enjoyed the betting experience overall more than people with fewer or no problems.

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Table 1. Effects of SGMs versus EGMs on play metrics and game enjoyment

Variable		Avg bet		Bet speed		Double or nothing		Game enjoyment	
Skill or Reel (SGM, EGM)	Mean	2.717	**2.974***	11.403	**15.921*****	0.545	0.574	**3.610**	2.778***
	Std. Err.	0.041	0.124	0.182	0.553	0.017	0.051	0.029	0.087
	n =	1,089	101	1,089	101	1,089	101	1,089	101
Gender (F, M)	Mean	2.788	2.903	13.211	**14.113****	0.515	**0.605****	3.185	3.203
	Std. Err.	0.078	0.074	0.346	0.330	0.032	0.030	0.055	0.052
	n =	551	639	551	639	551	639	551	639
Age (18–49, 50+)	Mean	**3.030**	2.661***	**14.696**	12.628***	0.561	0.558	**3.293**	3.095***
	Std. Err.	0.073	0.079	0.326	0.355	0.030	0.032	0.052	0.056
	n =	551	639	551	639	551	639	551	639
PGSI(NR/LR, MR/PG)	Mean	2.903	2.787	13.334	13.990	0.538	0.581	2.977	**3.411*****
	Std. Err.	0.066	0.089	0.295	0.397	0.027	0.036	0.047	0.063
	n =	860	330	860	330	860	330	860	330

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Bold text indicates a significantly higher mean for each pair.

To better understand what findings might have been missed in comparing SGMs to EGMs, a sensitivity analysis using G*Power (with a two-sided independent *t*-test as the planned test and an alpha level of 0.001) revealed that our sample sizes (N = 1,159 in the SGM group, N = 101 in the EGM group) provide 80% power to detect effect sizes as small as Cohen's d of 0.43 for these comparisons (see Table 1 row 1). While this allowed us to detect medium sized differences, the unbalanced sample sizes limited our ability to draw conclusions on smaller, yet potentially meaningful effects, which included the difference in average bet size noted in Table 1 as significant at $p < 0.05$ but not at our required stringent level of $p < 0.001$.

Q2: How does playing SGMs versus EGMs affect illusions of control and game immersion?

A GLM was calculated using the same between-subject factors listed above, substituting the outcome variables of Skill, Win, Practice, and Immersion, as detailed in the methods above. Multivariate tests on all factors proved significant. Results, including marginal mean comparisons, are shown in Table 2. Focusing on the largest and most significant differences, i.e., $p < 0.001$, the SGM game showed higher ratings than EGMs on all outcomes, including ratings of the utility of skill for outcomes, the ability to exercise control to win, the belief that practice would allow more wins, and the feeling of being immersed in the experience of playing. As detailed in the methods above, these results should be interpreted in the context of the identical pay tables, and thus wins, between the two versions of the game (SGM vs. EGM). Thus, these results represent perceptual differences and not real differences in wins.

Males and younger participants, aged 18–49, each rated more highly their ability to exercise control at winning. People with moderate risk or higher PGSI scores were more likely to believe that skill affected their outcomes and rated the experience of playing as more immersive.

Q3: For SGMs only, how do game characteristics affect play metrics and enjoyment?

This analysis included only the people who played the SGM game. A GLM was computed with average bet size, bet speed, selection of the double or nothing bet, and game enjoyment as outcomes. The independent variables included the manipulations of the VICES features, as described in the methods, including Visual/audio enhancements, Illusions of

Table 2. Effects of SGMs versus EGMs on illusions of control and game immersion

Variable		Skills on outcome		Control at winning		Practice wins more		Feel immersed	
Skill or Reel (SGM, EGM)	Mean	**3.838**	2.292***	**3.555**	2.117***	**1.853**	1.328***	**3.906**	2.981***
	Std. Err.	0.034	0.106	0.030	0.092	0.012	0.036	0.035	0.109
	n =	1,158	101	1,158	101	1,158	101	1,158	101
Gender (F, M)	Mean	3.048	3.082	2.720	**2.952*****	1.590	1.590	3.463	3.424
	Std. Err.	0.066	0.063	0.057	0.055	0.022	0.021	0.068	0.064
	n =	584	675	584	675	584	675	584	675
Age (18–49, 50+)	Mean	3.040	3.089	**2.987**	2.684***	1.560	**1.621****	**3.519**	3.369**
	Std. Err.	0.062	0.067	0.054	0.059	0.021	0.023	0.064	0.069
	n =	576	683	576	683	576	683	576	683
PGSI(NR/LR, MR/PG)	Mean	2.897	**3.233*****	2.745	**2.927****	1.611	1.570	3.215	**3.672*****
	Std. Err.	0.056	0.075	0.049	0.066	0.019	0.025	0.058	0.078
	n =	915	344	915	344	915	344	915	344

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Bold text indicates a significantly higher mean for each pair.

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Table 3. Effect of game characteristics on play metrics and game enjoyment [SGM ONLY]

Variable		Avg bet		Bet speed		Double or nothing		Game enjoyment	
Visual (nostalgic, novel)[a]	Mean	2.746	2.711	10.835	**11.712*****	0.540	0.540	3.614	3.552
	Std. Err.	0.056	0.057	0.218	0.221	0.023	0.023	0.038	0.038
	n =	559	530	559	530	559	530	559	530
Illusions of control (unskilled, skilled)[a]	Mean	2.700	2.756	**14.010**	8.537***	0.551	0.529	3.543	3.623
	Std. Err.	0.056	0.057	0.216	0.221	0.022	0.023	0.038	0.038
	n =	556	533	556	533	556	533	556	533
Complexity (no strategy, strategy)[a]	Mean	2.715	2.742	11.552	10.995	0.550	0.530	3.617	3.549
	Std. Err.	0.056	0.057	0.217	0.221	0.022	0.023	0.038	0.038
	n =	555	534	555	534	555	534	555	534
Expedited play (slow, fast)[a]	Mean	2.681	2.776	11.534	11.013	0.548	0.533	3.584	3.582
	Std. Err.	0.057	0.057	0.219	0.219	0.023	0.023	0.038	0.038
	n =	551	538	551	538	551	538	551	538
Social (no msg,msg)[a]	Mean	2.770	2.687	11.439	11.108	0.542	0.538	3.593	3.573
	Std. Err.	0.056	0.057	0.218	0.220	0.023	0.023	0.038	0.038
	n =	546	543	546	543	546	543	546	543
Gender (F, M)	Mean	2.664	2.792	10.838	**11.708*****	0.494	**0.587*****	3.564	3.602
	Std. Err.	0.059	0.055	0.229	0.211	0.024	0.022	0.040	0.037
	n =	504	585	504	585	504	585	504	585
Age (18–49, 50+)	Mean	**2.903**	2.554***	**12.087**	10.460***	0.527	0.553	**3.706**	3.461***
	Std. Err.	0.061	0.063	0.235	0.244	0.024	0.025	0.041	0.042
	n =	494	595	494	595	494	595	494	595
PGSI(NR/LR, MR/PG)	Mean	2.750	2.707	11.143	11.403	0.531	0.549	3.450	**3.717*****
	Std. Err.	0.047	0.076	0.183	0.294	0.019	0.030	0.032	0.051
	n =	779	310	779	310	779	310	779	310
EGMs last 12 mo. (no, yes)	Mean	**2.821**	2.636*	11.115	11.432	0.512	0.569	3.409	**3.757*****
	Std. Err.	0.064	0.055	0.246	0.214	0.025	0.022	0.043	0.037
	n =	567	522	567	522	567	522	567	522
Games wkly last 12 mo. (no, yes)	Mean	2.716	2.740	10.653	**11.893*****	0.505	**0.576***	3.562	3.604
	Std. Err.	0.063	0.061	0.243	0.234	0.025	0.024	0.042	0.041
	n =	565	524	565	524	565	524	565	524

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Bold text indicates a significantly higher mean for each pair.
[a] See *Manipulating game design elements: The VICES framework* for a description of the levels for each variable.

control, Complexity, Expedited play, and Social customisation. In addition, individual difference predictors included Gender, Age, PGSI status, Play on EGMs in the last 12 months (no, yes), and Play on video games weekly in the last 12 months (no, yes).

Significant multivariate effects were found for VICES features of Visual/Audio enhancements and Illusions of control. Other significant multivariate effects were found for Gender, Age, PGSI category and Play on EGMs within the last 12 months (no, yes).

Table 3 shows estimated marginal means for the contrasts in the model. People playing the novel game (Space Fox), i.e., the Visual/audio enhancement, bet marginally faster than those playing the nostalgic game (Sea Fox). Those assigned to play in the unskilled condition, where it was impossible to miss the targets, bet faster. Male participants bet faster overall than female participants, and were more likely to risk their bank on the final double-or-nothing bet. Younger participants, aged 18–49, bet more on average, bet faster and rated their enjoyment as higher than those aged 50+. Lastly, people with moderate or more severe gambling problems rated their enjoyment higher than those with less severe problems.

DISCUSSION AND CONCLUSION

SGMs are an emerging gambling format combining elements of video games and traditional EGMs. As evidenced in the research questions guiding the current study, meaningful gaps exist in understanding how these games subjectively engage players and influence behavioural outcomes. Our quasi-experimental results revealed key distinctions between an example SGM and EGM across enjoyment, skill perceptions, sense of control, perceived value for practice, and feelings of immersion.

The appeal of SGMs

SGMs may attract vulnerable groups to gambling. Younger players, people with gambling problems, and people with past-12-month experience playing EGMs all rated the SGM as relatively more enjoyable when compared to others. Appealing to younger gamblers and gamblers with problems may exacerbate harm caused by this gambling product. In addition, appealing more strongly to people who already gamble on EGMs suggests that these games are more likely to appeal to people already exposed to gambling-related risks.

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While our findings suggest that SGMs may be particularly appealing to certain vulnerable groups, we did not observe significant increases in betting intensity compared to EGMs. This indicates that the potential risks associated with SGMs may be more nuanced than initially hypothesised. Specifically, SGMs do not appear to produce poorer behavioural outcomes based on gambling intensity, such as bet size, speed, and choice of the double-or-nothing bet. In fact, betting was slower on our SGM compared to the EGM, although this was likely only due to the structural characteristics of the game that slowed betting. Players had the option of moving their own ship left and right across the screen and could then wait for target ships to be in position, which took more time relative to simply pressing an EGM button. Our post-hoc power analysis suggested that we could have detected medium to large effect size differences between the EGM and SGM configurations on average bet size and the selection of the double-or-nothing bet (a proxy for persistence). Nevertheless, we found no medium to large behavioural differences.

It is noteworthy that other conceptualisations of skill-based games in commercial environments could, at least theoretically, structurally increase gambling speed and thus magnify losses. Fish table games, for instance, are capable of high betting rates (*Fish Game Kings – Fish Arcade Game Manufacturing – Fish Game Kings – Fish Arcade Games*, n.d.).

The visual appeal across iterations of the SGM, including the "sea fox" and "space fox" variant, had at least some influence on the betting speed, whereby people playing "space fox" bet faster. This suggests that purely visual appeal can have important behavioural influences that can ultimately impact on player losses, even when these variations do not change game dynamics.

Betting behaviour and game characteristics

Although the SGM did not prompt more intensive betting overall compared to the EGM, specific groups who played the SGM had behaviours that would, in a commercial environment, lead to greater losses. In particular, younger participants (aged 18–49), males, and people who play video games weekly all risked greater losses on SGMs by betting faster. Additionally, younger participants also placed larger bets when playing the SGM.

Illusions of control

The core of the illusion of control lies in individuals' beliefs that their skills can impact their results, even when such beliefs are baseless. Participants were explicitly asked if their "skill" contributed to their results – when we knew it could not. In addition, this study examined the "control" people believed they had over outcomes, whether they defined it as skill or not. It also looked at whether people believed they could use practice to improve their outcomes, which is arguably the definition of how skill is developed. All three perceptions were higher in relation to those playing the SGM game as opposed to the EGM.

Misconceptions about control over gambling outcomes can cause people to involve themselves more intensively, in terms of both time and money, in gambling activities. In our experimental example, there were no differences in terms of the paytable and basic betting within the games, SGM versus EGM. This construction mirrors, at least in part, the real differences between SGMs and EGMs in commercial environments. Skill may have some tiny influence on outcomes, or even none, but nevertheless SGMs explicitly promote the perception of the ability to exercise skill. It is important to note that people playing commercial EGMs also experience illusions of control (Browne et al., 2019; Hing & Russell, 2020). The present results suggest, however, that such illusions are likely more pronounced for SGM styled games.

Limitations

It is important to acknowledge that our study operated as a quasi-experiment rather than a fully controlled experiment regarding the assignment of participants to the conditions involving playing either an SGM or an EGM. Our intended method for participant recruitment encountered a significant obstacle: Qualtrics declined to distribute the EGM among its panellists due to its resemblance to commercial gambling activities. This necessitated finding an alternative panel provider for the EGM component, leading us to utilise PureProfile. Although the demographic profiles of participants recruited from both panels were broadly comparable, the ideal approach would have involved randomly assigning participants to each game condition (SGM vs. EGM) to enhance the internal validity of the comparisons.

Moreover, the online sample and artificial experimental setting may somewhat limit generalisability of the findings beyond the current study context. Self-report measures can introduce biases that more objective metrics could help mitigate. The brief gameplay exposure provides only a narrow window into effects that could compound over time. Using the final double-or-nothing bet to measure persistence confounds persistence and risk-taking tendencies. Testing only one iteration of an SGM restricts conclusions about the broader range of games, and the commercial profit motives driving the industry could exacerbate harms through SGM design in ways not captured here. Supplementing the current quasi-experimental approach with techniques like randomised assignment, longer play exposure, more diverse SGM examples, and additional objective metrics could produce more robust and generalisable insights.

Lastly, while we attempted to match the SGM and EGM as closely as possible, we recognise that the inherent differences between a video game-style SGM and a traditional slot-style EGM may influence perceptions of skill and control. Future research could explore SGM designs that more closely mimic traditional EGMs while incorporating skill elements, such as stop or hold features that likewise more explicitly suggest skill when none is present.

Regulatory implications

Regulators face difficult trade-offs between allowing recreational access to novel games like SGMs and restricting products with harm potential. Our findings reveal risks for

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vulnerable groups who find SGMs uniquely appealing, yet hold overconfident beliefs about skill and control of outcomes that are particularly prompted by these games. While our findings provide initial insights into the potential risks associated with SGMs, we acknowledge that more research is needed before making definitive policy recommendations. Nevertheless, possible regulatory responses under a precautionary principle include mandatory pop-up messaging that emphasises the dominance of chance, enforcing transparent display of paytables, introducing bet limits or reductions after continuous losses, and prohibiting game elements that exploit cognitive biases.

Future research directions

Key evidence gaps remain regarding how prolonged engagement with SGMs influences gambling behaviours over time. Longitudinal studies tracking impacts on betting, persistence, and gambling harm from these products would be helpful in better understanding the risk posed by these novel games. Testing attraction and effects across more diverse SGMs would improve generalisability and help tailor protections by game type.

Conclusion

This study reveals meaningful distinctions between SGMs and traditional EGMs regarding subjective appeal and the heightened illusions of control when playing these new games. Despite no strong evidence of inherently riskier betting behaviours, the attractive gaming features and skill perceptions surrounding SGMs appear to pose new risks. As these games penetrate the marketplace, thoughtful consideration of precautionary regulation and ongoing research are imperative to support consumer welfare and reduce harm.

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Authors' contribution: MR, AR, NH and MB designed the study and research materials. MR, AR, NH, MB, HT, PN and TV contributed to the analyses and interpretation. MR completed the first draft of the manuscript. All authors refined and approved the submitted version of the manuscript.

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