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RESEARCH ARTICLE

The active foundations of the illusion of control: an experimental test of the Henslin effect

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ABSTRACT

The mistaken belief that personal control can affect the outcomes of random events is seen as a core part of disordered gamblers' irrational beliefs *via* the 'illusion of control'. The present study tests the extent of action-based manifestation of the illusion of control in a dice-rolling game, which provides a novel controlled test of a claim first made by Henslin that craps gamblers tend to shake their dice harder when aiming for higher numbers. We also tested participants' recent involvement in gambling games and rates of disordered gambling symptomology as two theoretically-informed potential moderators of any effect. An incentivized dice-rolling experiment was programmed for participants' mobile devices, where device accelerometer data was used to animate the effects of their shaking and to record the dependent variable of shaking strength. 1,692 US-Based participants (Mean age 37.1; 60.7% male) completed 24 trials each, across which the target number that they would win a $1 bonus if rolled was varied from one to six. Participants rolled the dice 4.1% harder for the highest- (six) compared to lowest-number (one). However, the effect did not vary based on participants' recent engagement with various gambling games, and also did not correlate with gamblers' Problem Gambling Severity Index scores. These results uniquely demonstrate a small Henslin effect, but also challenge theoretical accounts that illusion of control effects should be higher in people with greater familiarity with a given situation (i.e. relevant gambling games), or who have higher levels of disordered gambling symptomatology.

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Introduction

Imagine a simple game of dice where, at the beginning of each round, a target number between one and six is chosen. If you throw a dice and it lands on the target number you win some money, otherwise you receive nothing. The key question is – can a player, through their action, influence the outcome of this game? To the extent that the dice and the game's setup has not been tampered with, the correct answer is no. And yet, existing research suggests that people behave as if they believed that they have 'control over objectively chance-determined events' (Langer and Roth 1975, p. 951). In the context of the dice game described above, this 'illusion of control' could manifest itself in people's irrational beliefs that the strength with which they roll the dice influences the final outcome. Indeed, craps players have been observed in the field to share a common belief that 'a hard throw produces a large number, and a soft or easy throw produces a low number' (Henslin 1967, p. 319). This observation was cited by Langer in her foundational work on the illusion of control theory (Langer 1975), which, over the last 48 years, has found many applications across much of psychological science (Alloy and Abramson 1979; Taylor and Brown 1988; Mirowsky and Ross 1990; Shafir and Tversky 1992; Reuven-Magril et al. 2008; Bracha and Brown 2012; Harris and Osman 2012; Moritz et al. 2014; Risen 2016).

However, psychological researchers have recently begun to question the illusion of control's relevance in decision-making, due to recent mixed results in conceptual replications of this work. For example, across 17 studies with 10,825 participants, Klusowski et al. (2021) tested whether active choice (as opposed to being assigned an option) causes an illusion of control. The authors failed to find evidence that choice influenced people's levels of risk-taking, confidence, and perceived likelihood of winning. These findings bring more attention to previous null findings on illusion of control manipulations (Ladouceur et al. 1984; Kühberger et al. 1995). Given these failures to observe an illusion of control, and considering the wide adoption of the theory across psychology, we therefore looked to further examine the illusion's empirical foundations.

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Langer's four factors of skill-based situations

Langer's (1975) seminal paper identifies four factors that should promote the illusion of control: choice, familiarity, (active) involvement, and competition. Klusowski et al. provide extensive empirical evidence that problematizes choice as a key determinant of the illusion control (Klusowski et al. 2021). Ladouceur et al. (1984) similarly manipulated level of involvement, and again found no behavioral effects consistent with the illusion of control, though their study was limited in sample size ($n = 90$). More recent work has found significant expressions of illusion of control when participants were given involvement in their task (Lim et al. 2014; Lim and Rogers 2020). This is relevant as Klusowski et al. (2021) studies could be critiqued for being largely about single-shot choices in online experiments, which might have insufficient levels of active involvement to promote an illusion of control. In light of these conflicting results, in our own work, we set out to test the role of (active) involvement and familiarity on illusions of control.

Active involvement

Henslin's (1967) original observations of the illusion of control among craps players exemplifies active involvement in particular, as gamblers take turns to throw the dice in craps. Langer's (1975) seminal paper cited Henslin's early observational finding that craps players believe that a hard throw helps produce higher target numbers, and variations on such beliefs persist today. Some frequent craps players believe they can win at casino craps by throwing dice using particular techniques (Wong 2005). Existing experimental evidence provides support for Henslin's related claim that dice are rolled for *longer* to achieve higher target numbers (Lim et al. 2014; Lim and Rogers 2020), however, these studies involved small numbers of gamblers (*N*s 36 - 60), precluding tests of potential moderators such as familiarity (as another factor underlying the illusion of control). These experimental tasks also involved relatively low levels of active involvement, which was also rather removed from the realistic context in which dice are rolled (e.g. by asking participants to hold down a button to 'roll' an electronic dice).

Here we provide a novel test of Henslin's claim that dice are thrown harder to achieve higher numbers. We conducted a large ($N = 1{,}692$) online experiment in which participants 'rolled' digital dice by shaking their mobile device, earning $1 bonuses each time they rolled a trial-varying target number, providing a within-participant test of the Henslin effect.

Familiarity

Familiarity is believed to magnify the illusion of control, such that those who have more knowledge, expertise, and experience with a task, may show more illusionary perceptions about their ability to control outcomes of random events. In order to test the importance of familiarity as a potential moderator of the Henslin effect, we asked participants about their past-year engagement with a list of gambling activities. We therefore tested whether the magnitude of the Henslin effect is the strongest among the past-year craps gamblers; lowest in non-gamblers; and moderate in participants who had participated in other (i.e. non craps) gambling formats.

Disordered gambling

The illusion of control is particularly central in models of disordered gambling (Ejova and Ohtsuka 2020; Clark and Wohl 2022), with disordered gamblers consistently showing higher susceptibility to the illusion (Goodie and Fortune 2013), and therapeutic interventions often focus on addressing such cognitive distortions (Petry 2009; Fortune and Goodie 2012; Petry et al. 2017). Therefore we asked those in our sample who identified as past-year gamblers to complete the Problem Gambling Severity Index (PGSI) (Ferris and Wynne 2001), the gold-standard measure of disordered gambling symptomology (Holtgraves 2009). This allowed us to test another theoretically-informed hypothesis, that higher rates of disordered gambling symptomatology would be associated with a greater Henslin effect.

Study hypotheses

Based on the original demonstrations of the Henslin effect and the subsequent links drawn between illusion of control and disordered gambling, we tested the following three preregistered hypotheses.

> H1. General Henslin Effect – In line with the Henslin effect, we expect that participants will shake the dice harder when their target is for the die to land on a higher number.
>
> H2. Familiarity Effect – We expect that the strength of the Henslin effect (i.e. the positive association found in H1) will be stronger among people with gambling experience, but even stronger among those who have an experience with the game of Craps.
>
> H3. Disordered Gambling Effect – We anticipate that the magnitude of the Henslin effect will be positively associated with gamblers' PGSI scores.

Method

Participants

We collected data from 1,692 participants *via* the online research participation website Prolific.com. Only residents of the USA (as craps is not widely played in Europe; Lim et al. 2014), aged 21 or over were eligible (see Table 1 for full descriptives on the sample). We targeted recruitment of participants with different levels of gambling experience using Prolific's screening questionnaire. We also included our own classification question at the end of our procedure, which asked participants to indicate the gambling games that they have engaged with in the last 12 months. Responses to the latter were the criterion for group allocation in our study.

We had initially aimed to collect a total of 1,800 participants (a maximum according to available funds as we were not aware of any suitable prior work on which to base a

Table 1. Descriptive statistics by groups ($N = 1{,}692$).

Category	n	Mean age	Gender Breakdown (%)	Mean PGSI score (N in the highest risk group)	Median (mean) # gambling games
Craps Gambler	231	37.49	Male: 78.79 Female: 21.21 Non-binary: 0 Other: 0 Did not Disclose: 0	3.91 (7)	6 (6.3)*
Other Gambler	760	37.12	Male: 61.58 Female: 36.71 Non-binary: 0.92 Other: 0.13 Did not disclose: 0.66	2.41 (24)	2 (2.5)*
Non Gambler	701	36.93	Male: 48.50 Female: 47.79 Non-binary: 3.28 Other: 0 Did not disclose: 0.43	N/A	0 (0)

Note: PGSI was not administered to participants indicating they had not gambled in the last 12 months. PGSI is scored from 0 - 27, with a score of 0 indicating a non-problem gambler (NPG), scores of 1-2 low risk (LR) gambler, scores of 3-7 moderate-risk gambler (MR) and scores of 8 or higher indicating high-risk (HR) gamblers.

power analysis given our novel outcome variable), evenly balanced between those who in the past 12 months had a) played 'craps' in the last 12 months, b) gambled on other formats in that period (excluding craps), and c) not gambled at all in the same period. However, during recruitment, it proved harder to recruit craps gamblers than the other two groups. To address this, we conducted a large-scale single-item survey ($N = 5{,}543$), consisting solely of our classification question. Those who stated that they had engaged in craps in the last 12 months were then invited to take part in the main experiment. In total, 117 craps gamblers were recruited using this method. Additionally, we increased the recruitment time from the preregistered four-week period to 44 days. Our final sample contained 231 craps gamblers, 760 other gamblers, and 701 non-gamblers.

Overall, 18 participants were excluded from analysis as preregistered for encountering more than five software errors during the dice rolling task. Participants received a $4.50 show up fee, plus an average of $4 from a $1 bonus for each randomly winning dice throw (range $12-$0). Median completion time for the experiment was 13 min.

Dice rolling task

We designed a mobile device-based dice rolling task to collect individual-level data on the shaking of virtual dice *via* the device's accelerometer, implemented in oTree (Chen et al. 2016). The rules of craps can be fairly complex, so in order to maximize comprehension we programmed a simplified 3D task featuring the essential features of craps (Figure 1c).

The task consisted of six randomly-ordered blocks of four trials each, corresponding to each potential target number. Every block started with a screen drawing participants' attention to the target number (Figure 1a).

Trial started with a loading screen which reminded participants of their target (Figure 1b). After clicking 'Begin', participants had 5 seconds to shake their mobile device, which imparted simulated momentum to the dice within the simulated dice cup (Figure 1c). Device motion data was recorded during the shaking, forming the dependent variable for all analyses. Once the 5 seconds had elapsed, an audio cue notified the participant and the simulation was suspended until participants indicated that they were ready to continue (Figure 1d). The roll result was than randomly determined, and a corresponding roll animation was then shown one of 90 prerecorded animations according to the vigor of the shake recorded during the trial, so that the speed of the die upon release was visibly related to the strength of shaking (Figure 1e). Participants were then told whether they had won a bonus on that trial or not (Figs 1f i-ii). More specifically, if the outcome of the dice roll matched the target number, then participants received an additional $1 (otherwise they received nothing). Over the course of 24 trials, depending on their luck, participants could therefore earn anywhere between $0 and $24 in bonus payments. These bonus payments were intended to keep participants motivated by and engaged with the task.

Past year gambling and PGSI

Following the methodology used in gambling prevalence surveys (Sturgis and Kuha 2022), participants were asked whether they had engaged with any one of 12 popularly-played gambling formats in the past 12 months, and participants who selected one or more formats were asked to complete the PGSI.

The PGSI is the most common self-report measure used in gambling research, and has a strong positive correlation with other gambling behaviors, such as the total amount of time spent gambling (Rockloff 2012), and the total number of gambling formats engaged in Brosowski et al. (2012). The PGSI asks participants about their experiences gambling in the past 12 months, e.g. 'Have you bet more than you could really afford to lose?' and so is not appropriate for people who have not gambled recently. As such, the PGSI was only administered to participants reporting engagement with at least one gambling format in the last 12 months.

Statistical analysis

The outcome variable of shaking vigor was obtained by calculating the absolute magnitudes of the acceleration vector

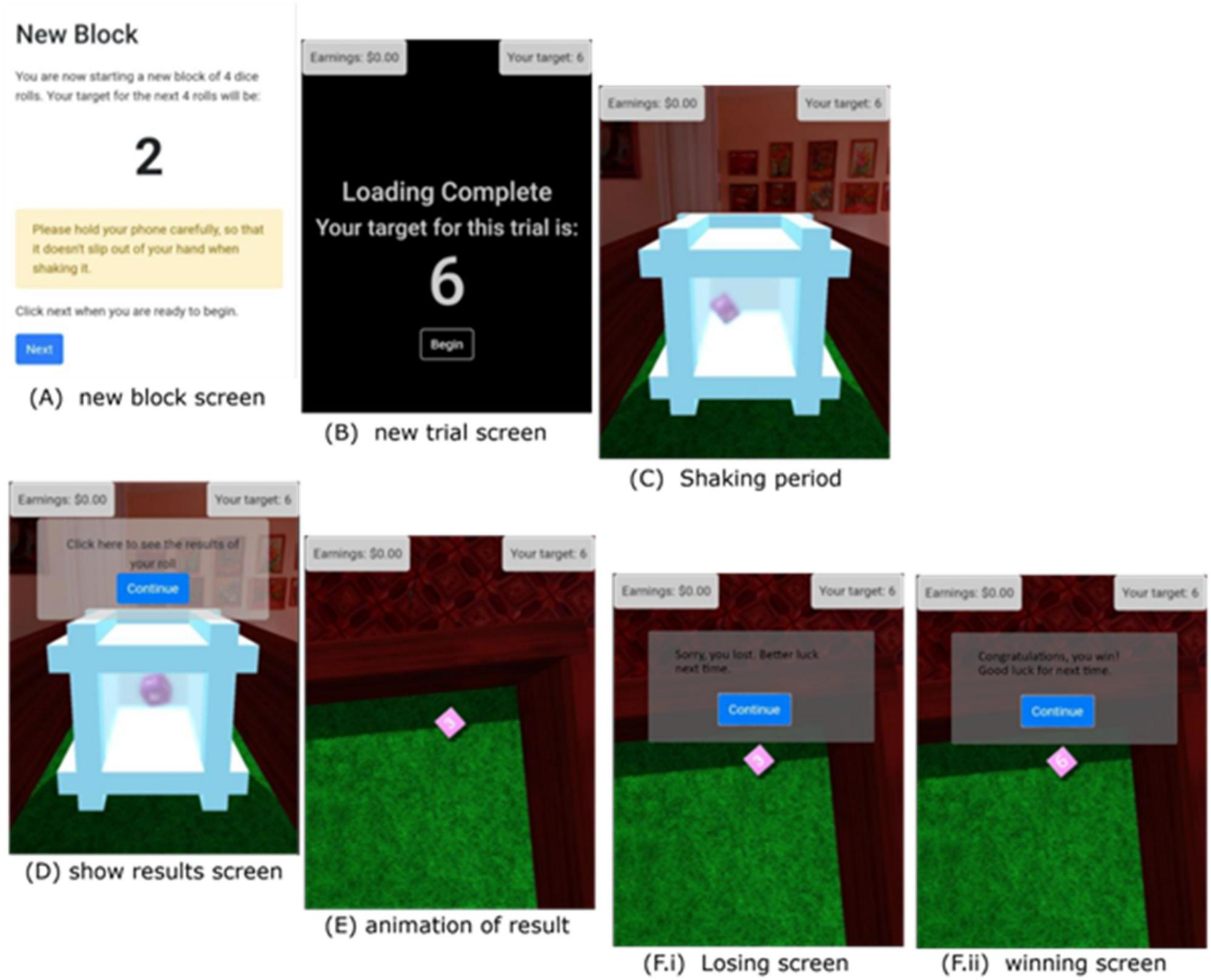

Figure 1. The dice rolling task.

samples taken during the 5-second shaking period for each trial, then calculating the mean of these magnitudes for each trial. The within-subjects design controls for variability in data arising from participants' unique mobile devices. We further normalized people's responses at the level of an individual - the weakest shake for each person was coded as 0 and the strongest as 1. Individual level data (at trial level) were analyzed using mixed effect models implemented in using the R Statistical language (version 4.3.1; R Core Team 2023) using afex (Singmann et al. 2023).

H1 and H2 were tested by regressing normalized shaking on the target number (1-6). The model also included a factor corresponding to the gambling experience of each participant (three levels: non-gambler (reference), other gambler, craps gambler), as well as random intercepts and slopes for each participant. The maximal model failed to converge, but we were successful after removing correlations between random effects. In the absence of any concerning distribution of residuals (see QQ plot in Supplement A), we report the results of the reduced model below. Note that the results of the non-converging model are qualitatively similar to the reduced model, and we report the results of our maximal model in Supplement A.

H3 was tested by a new mixed effect model fitted to data from participants who had gambled in the past 12 months (craps and other gamblers combined). The model included the main effect of target, PGSI score, and their interaction (plus random intercepts and slopes for each participant). Both the maximal and reduced model (removing correlations between random effects) failed to converge, but convergence was achieved with a random intercept only model. We report QQ plots and summaries of the non-converging models in Supplement B, noting that these did not differ notably from the results reported below.

Transparency and openness

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. The preregistration is available here: https://osf.io/32qcm/, and materials, and task- and analysis-code are available here: https://osf.io/q58ab/. This study received IRB approval from the University of Warwick Research Ethics Committee reference HSSREC 106/22-23. Informed consent was obtained from all participants.

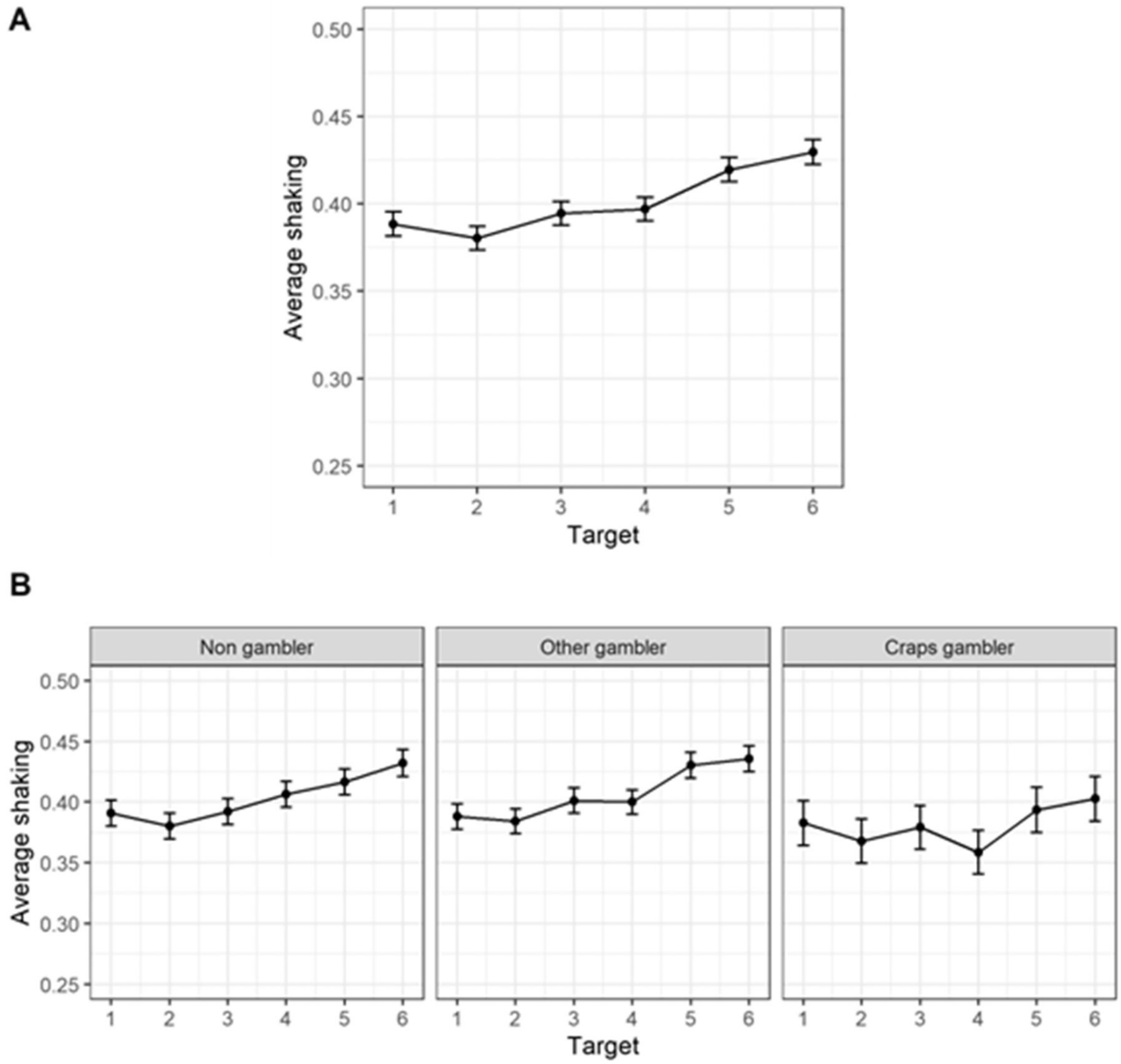

Figure 2. Average normalized shaking of the virtual dice for each trial. Panel A: Pooled data from all participants. Panel B: Data split by three groups of participants with different experiences of gambling. Error bars represent ±2 standard errors around the mean (y-axis truncated for clarity).

Results

Trial averages of shaking vigor are shown in Figure 2A for the entire sample and separately for the three groups of participants in Figure 2B. On visual inspection, a weak positive increase in shaking vigor as the target number increases is visible.

Hypothesis 1 – general Henslin effect

Support was found for H1, *via* a significant effect of target value on shaking vigor ($F(1,3718.75) = 63.11$, $p < .001$), but the effect was small. Estimated marginal means ranged from 0.376 ($SE = .004$) for target being one, to 0.417 ($SE = .005$) for rolling a six. Thus, participants on average shook their device 4.1% ((0.417 − 0.376) * 100) harder if their goal was to roll a six, compared to a one.

Hypothesis 2 – familiarity (gambling group) main effect and interaction

The same mixed model shows that the effect of the gambler group was non-significant. The average shaking vigor did not differ between craps gamblers, non-gamblers, and other gamblers ($F(2,3719.00) = .09$, $p = .916$). More importantly, H2 was not supported, due to a non-significant interaction between the target and gambler group ($F(2,3718.75) = 2.54$, $p = .079$). In pairwise comparisons of the slopes, no significant differences emerge between any of the groups (all $ps > 0.063$, see Supplement A for details). In other words, the effect of target value on shaking vigor did not differ between the groups with different levels of 12-month gambling experience.

However, in addition to this preregistered analysis, some other ways of analyzing the data could be justified and are worth considering on an exploratory basis. For example, the 'other gambler' and 'non gambler' groups could be argued to not sufficiently differ from one another with respect to the measure of familiarity. Additionally, the 'craps gambler' group has higher mean PGSI scores (Table 1), creating a confound between this and the 'other gambler' group. Therefore, we conducted an exploratory analysis, comparing the craps gambler and other gambler groups alone ($n = 991$). The analysis followed the preregistered analysis, with group instead being a binary variable, and added a further control for PGSI. The maximal model converged, and the interaction between target and gambler group was insignificant ($p = .086$). Furthermore, the effect of PGSI was also insignificant ($p = .07$). This exploratory analysis therefore supports the inference that the observed effect was equivalent across different groups of gamblers. Full reporting of this exploratory analysis can be found online at https://osf.io/q58ab/.

Hypothesis 3 – disordered gambling effect

The test of H3 was based on pooled data from gamblers (other gamblers and craps gamblers; $n = 979$). Figure 3 illustrates how the relation between target value and average shaking varies as a function of PGSI score in the (pooled) data from the sample of gamblers. Visibly, all three groups of participants that we illustrate error bars for (low (0), medium (1-4), and high (5+) on the PGSI) show a similar increase of shaking vigor with increases in the target number. The results of our mixed effect model support this interpretation as the interaction between PGSI and target value was not significant ($F(1,22515) = 2.96$, $p = .086$). In addition, the main effect of PGSI was also not significant ($F(1,3246.31) = 0.23$, $p = .629$), but the effect of target was ($F(1,22515) = 74.54$, $p < .001$). Overall, although the target value is positively associated with the shaking vigor among gamblers, this effect did not vary with participants' PGSI scores.

Discussion

Do people shake the dice harder to achieve a higher outcome? Here we provide new empirical evidence for this Henslin effect using a large sample ($N = 1,692$) of individuals with varying levels of involvement with gambling. We tested the effect by measuring people's active involvement directly – by recording the physical motions of virtual dice from the objectively-recorded accelerometer data.

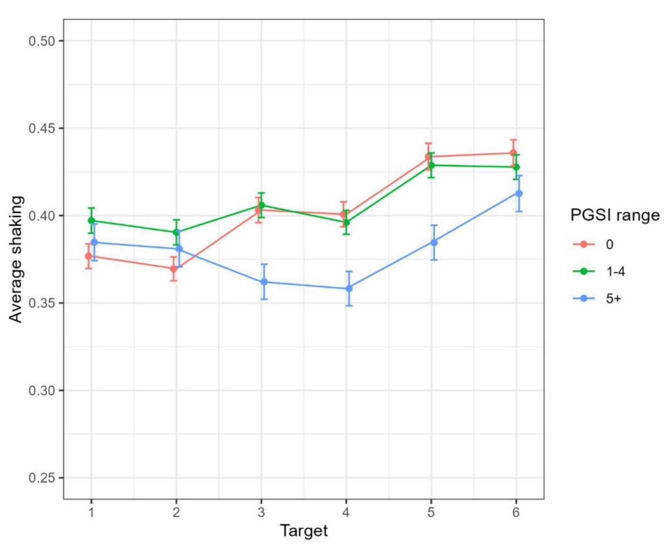

Figure 3. Average normalized shaking of the virtual dice for each trial for the groups of craps gamblers and other gamblers. Data are split based on the PGSI score. Error bars represent +- 2 standard errors around the mean (y-axis truncated for clarity).

We demonstrated a significant and robust Henslin effect. We are the first, to our knowledge, to evidence action-based expressions of the illusion of control (Lim et al. 2014) in a general population sample. Our study conceptually replicates Langer's (1975) finding that active involvement can give rise to the illusion of control, but appears to contrast with null effects reported by others (e.g. Ladouceur et al. (1984)). In the work of Ladouceur and colleagues, university students chose how much to be on the outcomes of a dice roll, which was either thrown by them (active involvement) or by the experimenter (passive involvement). However, despite the null effect, the prima facie difference in means of perceived control between the two groups appears quite large. Our study demonstrates that the Henslin effect is relatively small, and possible to detect it in large part due to our large sample size (1,692 vs. 90 in Ladouceur's work). Thus, it is possible that the non-significant result from Ladouceur et al. is due to insufficient power to detect such a small effect.

Neither Langer's original experiment 4 nor the present study had any wagering element. In contrast, Ladouceur and colleagues' participants were provided options to wager on (un)chosen options, introducing a risk of loss. This provides a good analog for real world situations such as craps gambling or even board-games where a game-specific advantage may be lost on a 'bad' roll. It is possible that this difference in outcome domains (unincentivised in Langer; gains only in the present experiment; loss, zero or gain in Ladouceur et al.) contributes to the difference in observed effects. (Note however, Lim et al. do demonstrate a significant relationship between simulated die-roll times and target numbers in a situation involving risk of loss). As such, future work may wish to further explore how active involvement, betting decisions and outcome domains, interact in larger samples and more naturalistic settings.

However, and to our surprise, the observed Henslin effect did not vary based on participants' recent engagement with various gambling formats (H2), nor gamblers' PGSI levels (H3). This lack of evidence to support H2 and H3 casts doubt on the theoretical links between familiarity (Langer 1975) and disordered gambling symptomatology (Clark and Wohl 2022), with illusory control. It is possible (although requiring further studies) that clinical treatments of gambling disorder may have focused too strongly on the illusion of control and related fallacies, and this may in part explain the lack of evidence for their strong effectiveness beyond rates of natural (unassisted) recovery (Slutske 2006; Petry et al. 2017). Researchers and clinicians could consider other potential cognitive causes of disordered gambling, such as their attraction toward large gains (Kyonka and Schutte 2018; Ring et al. 2018), as other valid areas of therapeutic intervention.

Limitations

Given the small effect size that we found in the general population, our difficulty in recruiting craps players may have resulted in insufficient power to detect any interaction with familiarity. Our typology only recorded whether participants had gambled on craps at any point in the last 12 months, but some of these participants may have engaged much more frequently than others, or played other dice-based games with similar features. Future work could consider more continuous measures of familiarity, including alternative ways of operationalizing this factor. For example, research could adopt self-report measures of time spent gambling (Rockloff 2012) to create a continuous measure of time spent dice-rolling, both in gambling games, and in other scenarios, such as in board games like Monopoly. The present research also involved an incentivized simulated game, which may have limited external validity for actual gambling situations. Although Henslin's (1967) study involved actual gambling situations, it was contrastingly limited by a lack of objectively-recorded data, unlike in the present research. An ideal design for a future study could be one which objectively-records dice throws in an actual gambling environment, such as by using dice with sensors in a game of casino craps.

Similarly, prevalence rates for disordered gambling can be relatively low in the population, and a more targeted approach of recruiting participants may have yielded stronger test of H3. The relationship between illusion of control and disordered gambling may also be more idiosyncratic than previously thought or vary by disordered gambling phenotype (Jiménez-Murcia et al. 2019), which could require other methodologies such as direct participant observation.

It is also possible that the observed Henslin effect may have psychological drivers that are independent of the illusion of control. For example, it has been demonstrated in other areas of psychology that participants tend to expend greater physical effort in the expectancy of greater potential reward (Muhammed et al. 2020 Summerside et al. 2018). It may be that the greater vigor of shaking may have been due to higher numbers either leading to greater intrinsic rewards, or typically being paired in previous environments with greater extrinsic rewards.

Generalizability

Our sample was recruited from a research participant pool, and there is likely some self-selection bias in our sample. Furthermore, the online participant pools' demographic makeups tend to be younger, more liberal and more highly educated than the general public (Chandler et al. 2019). Nevertheless, we would still expect our results to generalize broadly to populations where chance-based dice games are commonly played.

Conclusion

We found evidence in support of a Henslin effect, but its small size and lack of relation with two theoretically-informed moderators, familiarity and problem gambling, question this effect's, and hence the illusion-of-control's, importance to behavior and decision making.

Disclosure statement

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