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Childhood use of coin pusher and crane grab machines, and adult gambling: A conceptual replication of Newall et al. (2021)

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FULL-LENGTH REPORT



ABSTRACT

Background and aims: Youth gambling research mainly focuses on the illegal use of age-restricted machines, but coin pusher and crane grab machines are gambling machines that can be used by people of any age in the UK, and are also in use internationally. Previous cross-sectional evidence has associated recollected childhood usage of these machines with adult gambling participation and levels of problem gambling amongst adult gamblers. We attempted to conceptually replicate the findings of one of these studies (Newall et al., 2021), while addressing some limitations of that study. *Methods:* A cross-sectional survey of 2,000 UK-based and -born participants aged 19–24 years. The measures were participants' recollected usage of coin pusher and crane grab machines as a child, whether they had gambled in the past 12-months or not, and the PGSI for past 12-month gamblers. *Results:* Overall, 5 of 7 tested associations were significant and in the hypothesized direction. Logistic regression models showed that adult gamblers were more likely to recollect using, and used at higher levels of frequency, coin pusher and crane grab machines, than non-gamblers. Then, negative binomial regression analysis showed that adults who recollected using crane grab machines at higher levels of frequency showed more gambling-related problems. *Discussion and Conclusions:* These results suggest that childhood usage of coin pusher and crane grab machines may act as an underappreciated risk factor for the development of gambling-related harm across the lifespan. This information may be considered for further youth gambling research and policy.

KEYWORDS

underage gambling, youth gambling, child gambling, disordered gambling, penny falls machine

INTRODUCTION

Youth gambling has become a growing public health concern in recent years (Giralt et al., 2018), with harmful psychosocial and health consequences (Blinn-Pike, Worthy, & Jonkman, 2010; Livazović & Bojčić, 2019). While most research has focused on illegal engagement with age-restricted gambling products (Botella-Guijarro, Lloret-Irles, Segura-Heras, Cabrera-Perona, & Moriano, 2020; Estévez et al., 2021; Farhat et al., 2021; King, Russell, & Hing, 2020; León-Jariego, Parrado-González, & Ojea-Rodríguez, 2020; Montiel, Ortega-Barón, Basterra-González, González-Cabrera, & Machimbarrena, 2021; Noble et al., 2022, 2022; Parrado-González & León-Jariego, 2020, 2022; Raisamo, Kinnunen, Pere, Lindfors, & Rimpelä, 2020; Tani, Ponti, & Ghinassi, 2021), the usage of legal youth gambling products is comparatively under-researched. In some jurisdictions such as the UK, there are products that are legal to be used by people under 18, such as coin pusher and crane grab machines, which are often

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found at seaside arcades (Fisher, 1991; Forrest & McHale, 2012). These non-age-restricted machines allow users to insert money, in the hope of winning either more valuable toys (crane grabs), or larger amounts of money (coin pushers). Playing these machines involves risking money in the chance of winning something more valuable, which is a key feature in the definition of gambling (Neal, Delfabbro, & O'Neil, 2005). Retrospective studies suggest that the over 90% of UK adults remember engaging with these machines as children (Newall, Russell, Sharman, & Walasek, 2020, 2021), making their childhood usage more common than age-restricted gambling machines, which in general only a minority of children engage with (Gambling Commission, 2020). Coin pusher and crane grab machines are used internationally too, within one previous sample showing that around 90% of Australian adults recollected using crane grab machines as a child, and around 55% correspondingly using coin pusher machines (Newall et al., 2021). Moreover, recollected engagement with these machines tended to also positively predict adult gambling participation and levels of problem gambling amongst adult gamblers (Newall et al., 2021). This suggests that legal childhood use of these machines could be an underappreciated risk factor for the development of gambling-related harm across the lifespan.

However, any conclusions should be tempered by various limitations in the previous evidence. These data are retrospective, suggesting that the accuracy of recollected rates of childhood usage of these machines is limited by memory biases, which will tend to increase with age. Newall et al.'s (2021) UK sample had a mean age of 28.2 (range 18–40), suggesting that it would be useful to replicate this finding in a younger cohort of emerging adults. Furthermore, while these machines have traditionally been used at seaside UK locations for decades, their usage may be declining as children shift to more modern forms of entertainment. This finding therefore may be in part a cohort effect, providing a further rationale to attempt replication in a younger sample. Moreover, there was an uneven split between males and females in that sample (67.4% female, 0.25% prefer not to say). To address these limitations, the present study, therefore collects a younger sample of emerging adults aged 19–24 ($M = 21.4$) with a balanced split of females and males.

A second limitation was related to the measurement scale used. In the previous study (Newall et al., 2021), participants indicated their recollected usage of youth gambling machines using a five-point verbal frequency scale of: *never*, *rarely*, *occasionally*, *frequently* and *very frequently*. However, it could be argued that this scale may not always be interpreted as strictly increasing, as some people may believe that “rarely” is not strictly less frequent than “occasionally”. It would therefore be useful to replicate these findings using a different set of verbal frequency scale points. Another gambling study used a five-point verbal frequency scale with three of the same scale points as that previous study (*never*, *occasionally*, *frequently*), but importantly used “*seldom*” instead of “*rarely*” (Hodgins, 2001). In order to attempt to replicate the original finding,

while maximizing comparability with the previous study, the present study uses the following scale: *never*, *seldom*, *occasionally*, *frequently*, *very frequently*.

The previous study also used the logged version of the Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001) for two of its hypothesis tests (Newall et al., 2021). However, post-hoc analysis suggests that the log transformation was not sufficient to remove the skewness in the distribution of PGSI scores. Therefore, the present study instead uses negative binomial models for these two hypotheses tests, as a better way of dealing with anticipated skew. Previous gambling researchers have recommended this statistical model as a way of overcoming this issue with PGSI as an outcome variable (Welte, Barnes, Wieczorek, Tidwell, & Parker, 2004).

To summarize, we attempted to replicate previous research associating the recollected childhood usage of coin pusher and crane grab machines and adult gambling (Newall et al., 2021), while addressing the above limitations. As in that previous work, these predicted associations were split into four independent aspects for both coin pusher and crane grab machines (more details in data analysis section below):

- H1: That any level of recollected engagement with a given machine, versus not recollecting using that machine, is associated with being an adult gambler.
- H2: For participants who recollect using a given machine, that increased frequencies of recollected usage are associated with being an adult gambler.
- H3: That any level of recollected engagement with a given machine, versus not recollecting using that machine, is associated with higher PGSI scores amongst adult gamblers.
- H4: For adult gamblers who recollect using a given machine, that increased frequencies of recollected usage are associated with higher PGSI scores.

METHOD

The preregistration documents, materials, data, and analysis scripts are available on the Open Science Framework (<https://osf.io/95dc7/>), a research management platform that is commonly used in psychology research (Foster & Dear-dorff, 2017).

Participants

Participants were recruited via the crowdsourcing platform Prolific in July 2022. We intended to recruit a sample of 2,000 UK residents (who were also born in the UK), with an even split between female and male participants, aged between 19 and 23 years. This sample size was chosen heuristically in order to match the sample size of the study which is being conceptually replicated (Newall et al., 2021). This age range was selected as, given the number of potential participants on the platform, it was the youngest age range that we anticipated being able to collect the desired sample



size for. Unlike the previous study, a minimum age of 19 was selected (instead of 18), as the PGSI has a time-window of 12 months, meaning that a minimum age of 19 was needed to ensure a temporal sequence between the questions about childhood machine usage and adult gambling. We collected 1,001 females (50.1% of the sample) aged 19–23 years ($M_{\text{age}} = 21.27$; $SD = 1.30$) in three days, and 997 males aged 19–24 ($M_{\text{age}} = 21.55$; $SD = 1.51$) in 14 days, with two participants (0.2%) preferring not to provide disclose this information. In a deviation from the preregistration, the maximum age for males was increased by a year to 24 after 12 days of data collection, as few additional participants were signing-up with the original age range (105 males in the final sample were aged 24). The mean age of males and females in the sample were significantly different ($P < 0.001$). Overall, 60.0% of the sample reported gambling in the past 12 months. According to the PGSI, 40% of these adult gamblers were classified as non-problem gamblers, 31.6% as low-risk gamblers, 20.9% as moderate-risk gamblers, and 7.5% as current problem gamblers (4.5% of overall sample). It took an average of 2.1 min for participants to complete the task, and each participant received monetary compensation (£0.50).

Design and materials

The study used a cross-sectional design. Participants completed two blocks of questions presented in random order. In the first block, participants indicated their level of recollected usage of coin pusher and crane grab machines while being under the age of 18 on a 5-point scale (Never, Seldom, Occasionally, Frequently, Very Frequently). Participants were provided a relevant image of each machine and some descriptive text about it (all materials provided via the Open Science Framework link above), and responses were given on a separate page for each machine.

In the second block, participants were asked if they had gambled in the past 12 months. As is typically done with gambling prevalence surveys (Sturgis & Kuha, 2022), participants who responded “no” were skipped to the end of the block, and participants responding “yes”, were then asked to complete the Problem Gambling Severity Index (PGSI). The PGSI is a nine-item measure of indicators of problem gambling experienced in the past 12 months, with response choices ranging from “never” (0) to “almost always” (3). Scores of 0 indicate recreational gambling, 1–2 low risk gambling, 3–7 moderate risk gambling, and 8 or above as problem gambling. Demographic data were automatically collected by the crowdsourcing platform.

Data analysis

The response “never” on the response scale of the independent variable (frequency of recollected engagement with each machine) is qualitatively different to the other response options. For this reason, the overarching hypothesis associating childhood recollected usage and adult gambling behavior were split into independent aspects, separately looking at any level of recollected engagement versus no recollected engagement (H1 and H3), and levels of

engagement (e.g., seldom vs. frequently) amongst those who recollected using a given machine in their youth on at least one occasion (H2 and H4). The hypotheses are also split via outcome, with past 12-month adult gambling status used for H1 and H2, and PGSI levels amongst adult gamblers used for H3 and H4.

To be able to test these hypotheses, the study required a mix of adult gamblers and non-gamblers, with varying levels of recollected usage of coin pusher and crane grab machines. Therefore, some inclusion criteria were preregistered. First, none of the hypothesized relationships would be tested if less than 4% of the sample were adult gamblers. Hypotheses H1 and H2 would also not be able to be tested if more than 96% of the sample were current adult gamblers. Additionally, to test H1, no more than 96%, or less than 4% of the sample should have recollected using each machine while being under the age of 18, and H2 would also not be tested if a given youth gambling machine was used by less than 4% of the sample. H3 would also not be tested if more than 96% or less than 4% of adult gamblers had used a given machine, and H4 would not be tested if a given youth gambling machine was used by less than 4% of adult gamblers. Of the four hypotheses for each machine, only H3 for coin pusher machines failed these inclusion criteria, as 97.3% of adult gamblers in the sample recollected using this machine as a child.

Different sub-samples, and separate models were therefore used for each hypothesis and each machine. H1 used the full sample; H2 used the full sample that ever recollected using each machine; H3 used the sub-sample that had gambled in the past 12 months; and H4 used the sub-sample of gamblers that recollected ever using each machine. For H1 and H2, the dependent variable was whether the participant has gambled in the past 12 months (0 = no, 1 = yes) and, therefore, logistic regression analyses were run for each machine. To test H3 and H4, the dependent variable was the PGSI. The PGSI is a count of symptoms that could possibly range from 0 to 27. As was expected, this variable was positively skewed (statistic = 2.6) and overdispersed (mean = 2.6; variance = 11.9). Therefore, we used a negative binomial model, which has been recommended by previous gambling researchers to address this non-normal distribution of PGSI responses (Welte et al., 2004). A Bonferroni-adjusted significance level of 0.025 was used as each hypothesis was tested twice.

Since the present research’s aim was to conceptually replicate those of Newall et al. (2021), we decided to at this stage not explore novel research questions, such as any potential interactions between these effects and gender. The underlying data have been made open, however, so that other researchers can explore any of their own potential research questions.

Ethics

The study was approved by the School of Psychological Science Research Ethics Board at the University of Bristol (reference: 11682). All participants were informed about the



study’s contents, and all provided informed consent to participate.

RESULTS

The recollected usage of each machine is shown in Table 1. Both machines had been used at least once by most of the sample as children: coin pusher (94.9%), crane grab (93.0%). As can be seen, gamblers were more likely to both recollect ever using these machines, and more likely to recollect higher levels of usage of the two youth gambling machines assessed than non-gamblers. For example, 97.3% of adult gamblers recollected ever using coin pusher machines as a child, compared to 91.3% of adult non-gamblers. And 95.3% of adult gamblers recollected ever using crane grab machines as a child, compared to 89.6% of adult non-gamblers. Furthermore, 38.0% of adult gamblers recollected using coin

pusher machines “frequently” or “very frequently” as a child, compared to 21.2% of adult non-gamblers. And 20.0% of adult gamblers recollected using grab machines “frequently” or “very frequently” as a child, compared to 10.3% of adult non-gamblers.

Table 2 shows the results of the models carried out for each hypothesis. As can be seen from the coefficients in bold, 5 of 7 tested association were significant and in the hypothesized direction. All four of the tested associations with whether the participants had gambled as an adult in the past 12 months were significant and in the hypothesized direction. The likelihood of being an adult gambler, compared to not being a gambler, was as is indicated by the odds ratio in Table 2, 3.49 times higher amongst participants who recollected ever using coin pusher machines (H1), and increased by 1.79 times for every one-unit increase in the frequency of recollected usage (H2). For crane grab machines, these relationships were also significant, but the coefficients suggested weaker associations. Participants who recollected using crane grab machines were 2.36 times more likely to be an adult gambler (H1), and this odds ratio increased by 1.57 times for every one-unit increase in the frequency of recollected usage (H2).

Of the associations with PGSI amongst adult gamblers, only three of the four associations were tested, as 97.3% of adult gamblers recollected using coin pusher machines while being under 18 years (96% or less was required to test this hypothesis). Of the three tested associations, only one was significant (and in the hypothesized direction): the recollected frequency of usage of crane grab machines was significantly associated with PGSI amongst adult gamblers

Table 1. Recollected usage of coin pusher and crane grab machines. The first number in each cell represents the overall average, the first number in parentheses is for adult non-gamblers, and the second is for adult gamblers

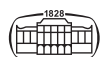
Frequency	Coin pusher	Crane grab
Never	5.1% (8.7%, 2.7%)	7% (10.4%, 4.7%)
Seldom	15.8% (23.8%, 10.3%)	32.7% (39.2%, 28.3%)
Occasionally	47.9% (46.2%, 49.0%)	44.3% (40.2%, 47.0%)
Frequently	23.5% (17.0%, 27.8%)	12.6% (8.4%, 15.3%)
Very frequently	7.8% (4.2%, 10.2%)	3.6% (1.9%, 4.7%)

Table 2. Regression models predicting gambling status (no/yes) and PGSI scores by engagement (no/yes) and frequency of engagement for coin pusher and crane grab machines. For each machine, the coefficients in the first row relate to H1 and H2 from left to right. The second row shows coefficients for H3 and H4

Form	Variable	Statistic	Gambling status (no vs yes) ^a	PGSI ^b
Coin pusher	Engagement (ref – no)	Coeff	3.49	Not tested due to inclusion criteria
		95% CI	[2.27, 5.36]	
		z	5.72	
		P	<0.001	
	Frequency	Coeff	1.79	1.11
		95% CI	[1.58, 2.02]	[1.00, 1.23]
		z	9.29	
Crane grab	Engagement (ref – no)	Coeff	2.36	1.06
		95% CI	[1.66, 3.35]	[0.70, 1.59]
		z	4.79	0.30
		P	<0.001	0.767
	Frequency	Coeff	1.57	1.15
		95% CI	[1.38, 1.78]	[1.04, 1.28]
		z	6.97	2.70
		P	<0.001	0.007
		N	1,861	1,143

^a Bivariate logistic regression (coefficients are odds ratios)

^b Negative binomial regression



(H4). PGSI increased by a factor of 1.15 for every one-unit increase in the frequency of recollected usage of crane grab machines. The association between the level of recollected frequency of usage of coin pusher machines and PGSI, was non-significant ($P = 0.047$; H4). Lastly, the relationship between recollected usage of crane grab machines (versus not recollecting using them) and PGSI was also non-significant ($P = 0.712$; H3).

Finally, we performed two exploratory analyses to investigate the robustness of these results to potential concerns around data quality. We reran all models after dropping both the fastest ~5% (91 participants responding in 31 s or under) and ~10% (190 participants responding in 37 s or under). The significance of findings was unaffected in these two subsamples, with five out of seven tested associations remaining statistically significant in each instance.

DISCUSSION

The present study attempted to replicate a previous study that associated the recollected childhood usage of coin pusher and crane grab machines with adult gambling behavior, while addressing some of that study's limitations. Our findings showed that 5 of the 7 tested associations were statistically significant and in the hypothesized direction. These results closely matched the previous study, where 6 out of 7 corresponding tests were significant and in the hypothesized direction (Newall et al., 2021). The only different outcome between the studies occurred for H3 for coin pusher machines, where the current P -value was 0.047 ($P < 0.001$ in the original study). One way to compare outcomes across a replication and an original study is to look at the percentage change in average effect sizes, with replications usually having effect sizes around 50%–75% the size of original studies (Heirene, 2021). We made that comparison here by rerunning the data from the original study (Newall et al., 2021) with the presently-used analysis plan. This found that the current results had an estimated average effect size that was 102.8% of those found in the original study. This is another way of saying that the present and original studies found very similar patterns of effects.

Overall, the associations with adult PGSI were less clear cut (one out of three tested associations significant) than the associations with adult gambling participation (all four tested associations significant). These four significant associations with adult gambling participation have all been tested in one previous study, where the same four significant associations were also found (Newall et al., 2021). For adult PGSI, an additional earlier study exists which recruited only UK adult gamblers, allowing for more corresponding previous data to compare the current PGSI results with (Newall et al., 2020). All three studies tested the same three associations, due to consistent high rates of engagement with coin pusher machines amongst adult gamblers. Furthermore, all three studies found that merely recollecting some level of engagement with crane grab machines was not associated with adult PGSI. In all three studies, higher rates of

recollected usage of crane grab machines were associated with higher adult PGSI scores (Newall et al., 2020, 2021). Lastly, in the two previous studies, higher rates of recollected usage of coin pusher machines were associated with higher adult PGSI scores (Newall et al., 2020, 2021), with this association being non-significant in the present study ($P = 0.047$). This overall pattern suggests that while all types of recollected usage of these machines are associated with adult gambling participation, adult gambling problems are more likely to be associated with *higher* rates of recollected usage.

These findings highlight the comparatively underexplored importance of children's exposure to gambling via machines that are legal for them to use such as these. It may well be less harmful to a child to play on a coin pusher machine than to play on an age-restricted electronic gambling machine. However, there are two reasons why we believe that further policy attention should be directed towards the two machines studied here. Firstly, most UK adults in these studies report using these machines as children, while only a minority of UK children currently gamble on age-restricted gambling machines. Secondly, the legality of these machines may itself facilitate repeated childhood usage, with this frequency of exposure over time perhaps contributing toward a lifetime habit of similar behaviors. Additionally, a smaller sample of Australian adults (Newall et al., 2021; $N = 640$) revealed rates of childhood engagement of 55.9% (coin pusher) and 90.8% (crane grab), suggesting that these machines should be researched more in jurisdictions other than the UK.

The present findings are subject to various limitations. The maximum age for males had to be increased by a year to 24 during data collection, in order to obtain the planned sample size. The present study used data from a crowdsourcing platform, which have been criticized in gambling research given that they yield non-representative samples (Pickering & Blaszczynski, 2021). While these findings should be subject to further replications in, for example, representative samples of young adults, crowdsourcing samples do have certain advantages, as the overrepresentation of problem gamblers compared to population base-rates yielded an increase in statistical power for H3 and H4 (Russell, Browne, Hing, Rockloff, & Newall, 2022). Another limitation is that the cross-sectional design only allows us to explore associations, and prevented any attribution of causality, with rates of both childhood machine use and adult gambling both potentially being caused by other variables, such as impulsivity (Ioannidis, Hook, Wickham, Grant, & Chamberlain, 2019).

Perhaps the biggest limitation is the retrospective nature of the childhood engagement with the machines. While this sample was younger than used in previous studies, memory biases will still be present. Importantly, since memory is related to constructs such as intelligence, memory, and attention control (Unsworth, 2019), individual differences in memory ability may contribute to the observed effects. One plausible individual difference is related to social identity (Neimeyer & Rareshide, 1991), with adult gamblers potentially being more likely to remember playing coin pusher



and crane grab machines as children, since these activities are linked to their identity as a gambler. One way to control for these individual differences within a retrospective design would be to collect measures of for example, identification as “a gambler”, impulsivity, and recall ability, to see if observed associations remain significant once these constructs are controlled for. Another approach would be to explore these associations via a longitudinal prospective study, where rates of machine usage are collected during childhood, and rates of adult gambling followed-up on after participants have become young adults.

Youth gambling research has tended to focus on illegal gambling, but only a relatively small proportion of children tend to engage with age-restricted gambling products. Rates of engagement with legal youth gambling machines can be much higher, and this aspect of children’s early exposure to gambling has not received as much attention in previous research on the development of gambling-related harm across the lifespan. This observation is also relevant to the current policy debate around video game loot boxes (Xiao, Henderson, Nielsen, & Newall, 2022), which many UK children have legally paid money to open (Gambling Commission, 2019). Our findings mostly confirm of those from Newall et al. (2021), by reinforcing the empirical association between recollected engagement with these legal youth gambling machines and adult gambling behavior.

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Authors’ contributions: The authors contributed equally to this work.

Conflict of interest: Alberto Parrado-González declares no conflicts. Philip Newall is a member of the Advisory Board for Safer Gambling – an advisory group of the Gambling Commission in Great Britain, and in 2020 was a special advisor to the House of Lords Select Committee Enquiry on the Social and Economic Impact of the Gambling Industry. In the last five years Philip Newall has contributed to research projects funded by the Academic Forum for the Study of Gambling, Clean Up Gambling, GambleAware, Gambling Research Australia, NSW Responsible Gambling Fund, and the Victorian Responsible Gambling Foundation. Philip Newall has received travel and accommodation funding from the Spanish Federation of Rehabilitated Gamblers, and received open access fee grant income from Gambling Research Exchange Ontario.

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