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Article

# Changing Gambling Behavior through Experiential Learning

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## Abstract

This paper tests experiential learning as a debiasing tool to reduce gambling in South Africa, through a randomized field experiment. The study implements a simple, interactive game that simulates the odds of winning the national lottery through dice rolling. Participants first roll one die until they obtain a six, followed by two dice until they roll 2 sixes. They are then informed that the probability of winning the lottery jackpot is equivalent to rolling all sixes with nine dice. The results show that individuals who need many attempts to roll 2 sixes play the lottery significantly less than the control group, while those who need fewer attempts adopt the opposite behavior. These findings provide practical guidance for designing interventions to give individuals brief experiences that correct biases in their beliefs.

**JEL classification:** D03, D12, D81, G02

**Keywords:** debiasing, experiential learning, behavioral economics, financial education



## 1. Introduction

Research in psychology has long emphasized the value of learning through experience (Myers and Sadler 1960; Edwards 1961). Self-iteration provides a powerful mechanism for conveying complex concepts as it prioritizes process over cognition. Early work in the field explains experiential learning as a progression that integrates natural human functions of thinking, feeling, perceiving, and behaving (Kolb 1984). These insights are subsequently captured in a four-stage learning model, which posits that learning is most effective when it involves four aspects: an (i) immediate experience that forms the basis for (ii) observations and reflections, which are then (iii) distilled into actionable concepts, and can be (iv) actively tested and verified (Zull 2002).

Experiential learning can be an effective tool for educational programs, especially among illiterate populations, since it does not rely heavily on cognitive ability (Bell, Raiffa, and Tversky 1988). One

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recent and popular focus among policymakers in developing countries has been on financial education, yet traditional interventions involving classroom or lecture-based instruction for adults have been shown to be largely ineffective in changing financial behaviors (Xu and Zia 2013; Fernandes, Lynch, and Netemeyer 2014; Miller et al. 2014).

This paper studies whether experiential learning can be successful in changing an important and pervasive financial behavior: gambling and specifically lottery purchases. Gambling is prevalent in many world cultures and serves as an important pastime (Custer and Milt 1985; McMillen 1996). Gambling tends to be regressive, with poorer households allocating a much higher proportion of their income to purchasing lottery tickets (Smith and Walker 1993; Kearney 2005). It is also believed to generate negative externalities such as increased crime, including domestic violence (Grote and Matheson 2011). Due to the adaption of online technology, lotteries and other forms of gambling are rapidly growing throughout the developing world. Africa is among the fastest-growing markets with projected annual growth rates of 8 percent (BRC 2019). While critics have called for more comprehensive regulation on the gambling industry, governments have an incentive to permit continued growth, since it presents an important tax revenue stream.[1]

The popularity of lotteries poses a challenge to the classical theory of decision making under risk and uncertainty, which posits that risk-averse individuals should avoid gambles with negative expected value (Tversky and Wakker 1995). One explanation that is consistent with rational utility maximization is that individuals understand winning probabilities in lotteries, but receive a form of entertainment or aspirational utility from playing, which offsets the negative expected payout (Kearney 2005).[2] An alternative set of explanations is that individuals have cognitive biases that lead to systematic misjudgments of risk, in particular overestimation of small probability events (Tversky and Kahneman 1992; Jones, Jones, and Frisch 1995; Barberis 2013). For example, the availability heuristic refers to the tendency to "*assess the likelihood of an event . . . by assessing the ease with which the relevant mental operation of retrieval, construction, or association can be carried out*" (Kahneman and Tversky 1979).

While availability is generally a useful cue for assessing probabilities as more frequent events are usually recalled better and faster, it can easily lead to the overestimation of the likelihood of emotionally arousing (Nisbett and Ross 1980) or unusual and salient events (Plous 1993; Bordalo, Gennaioli, and Shleifer 2012; Miller et al. 2014). This phenomenon is readily apparent in the lottery industry – advertisements of lotteries often emphasize large jackpots, winners are depicted as ordinary folks who won big, and betting houses strategically place slot machines in large clusters so gamblers can hear the sound of others winning (Clotfelter and Cook 1989).[3]

Given these rational and behavioral determinants of lottery behavior, convincing individuals to buy fewer lottery tickets can be particularly challenging. Any educational program conveying the concept of probability would face the additional challenge of relatively low levels of mathematical education of many populations, especially in developing countries.[4]

1 For example, the South African government received almost R1.4 billion from national lottery sales. This revenue is used for various causes, including child welfare and national heritage projects (PWC 2017).

2 Other explanations for gambling consistent with rational utility maximization include nonconcavities in people's indirect utility curves (Friedman and Savage 1948). Recent evidence supports this hypothesis: Herskowitz (2016) finds that people are more likely to gamble if they have unmet liquidity needs for lumpy expenditures, and Mishra, Barclay, and Lalumière (2014) show that people are more risk-taking if they are unlikely to achieve goals through low-risk means.

3 Three advertisement schemes are particularly common in the lottery industry in the United States (Clotfelter and Cook 2013): (i) advertising the size of the jackpot, (ii) emphasizing the fun and excitement of playing, and (iii) highlighting lifestyles of past winners. Example radio advertisement in Arizona: "Every single second, the lottery makes someone very happy. Every single second, someone is cashing a winning ticket."

4 In reviewing strategies to communicate quantitative health risks, Ancker et al. (2006) conclude that education levels and numeracy may affect the success of how information is conveyed and identify this as a direction for future research. A

This paper applies insights from the four-stage learning model to design and study a field experiment to test if experiential learning affects the purchasing of lottery tickets. The sample consists of 841 individuals in the Eastern Cape and KwaZulu-Natal province of South Africa. The experiential learning tool is a simple hands-on dice game that starts by asking participants to roll a six-sided die until they obtain a six. They are then handed two dice and asked to roll until they obtain 2 sixes. This iteration offers a concrete experience in assessing probabilities. Depending on how fast participants can roll 2 sixes, they can then reflect and update their beliefs about winning odds. After the two rounds, participants are informed that the likelihood of winning the South African national lottery jackpot is equivalent to rolling nine dice with all *nine* showing up sixes.

The research design features two levels of random variation. First, half the study participants are randomly assigned to receive the debias treatment at the end of a baseline survey on financial access, while the other half receive a more traditional financial education module on avoiding expensive credit. Both the debiasing and credit modules take on average 10 minutes to complete and cover mutually exclusive topics. Second, the number of rolls it takes for participants to roll 2 sixes provides additional random variation within the treatment group: the hypothesis is that the longer it takes to roll 2 sixes, the clearer it becomes to participants that their chances of winning are low.

The results show substantial variation in lottery purchasing behavior based on how long it took participants to obtain sixes. Individuals who need more than the median number of rolls to obtain 2 sixes (referred to as the "late" group) gamble 19 percent less in a lottery offered after the debiasing intervention and are 34 percent less likely to have played the lottery after one year compared to the control group. By contrast, participants with below median number of rolls (referred to as the "early" group) gamble 29 percent more in a lottery offered immediately after the intervention and are 45 percent more likely than the control group to have played the lottery after one year. The difference between the early and late groups are statistically significant at the 5 percent level. Differences between these two treatment groups and the control group are only statistically significant if outcomes are aggregated to an index (following Kling, Liebman, and Katz 2007).

These differences in effects between the early and late groups shed light on the underlying reason for gambling and the mechanism through which the intervention changes behavior. In particular, it helps to distinguish between rational and behavioral explanations for lottery purchases. If lottery purchases are driven by entertainment utility alone and individuals fully understand winning odds, then the number of rolls should not affect lottery behavior. The importance of how long it took to obtain sixes suggests that participants update their beliefs about winning odds based on their experience in the dice game.

The study further tests whether the experiential game changes individuals' sensitivity to winning odds. Six months after the initial intervention and orthogonal to original treatment status, half the sample was offered a lottery with very low winning odds, and the other half was offered a lottery with higher winning odds. Employing a difference-in-difference strategy, the analysis finds that the late (early) treatment group indeed shows greater (lower) sensitivity to winning odds than the control group. While these coefficients are large in magnitude, they are estimated imprecisely and are not statistically significant at conventional levels. Nevertheless, these results provide suggestive evidence that the channel of belief updating is through greater understanding of odds rather than simply a change in entertainment utility or perception of luck.

growing literature on financial education evaluations consistently shows that such programs are quite unsuccessful at improving numeracy skills of participants (see, e.g., Cole, Sampson, and Zia 2011; Cole et al. 2014; Doi, McKenzie, and Zia 2014).

As a third mechanism test, this paper investigates changes in gambling behavior other than lottery purchases. If the lottery effect is driven by a change in overall entertainment utility from gambling or by participants inferring from the dice rolling that they are a lucky or unlucky "type," one would expect changes in playing the lottery and other forms of gambling to be positively correlated. In fact, the results show that participants substitute between different forms of gambling and that the overall prevalence of (any) gambling does not differ between the early and late group, corroborating the conclusion that the debiasing changes beliefs of lottery-winning odds.

This study adds to a rich literature in decision theory that compares decision making in two contexts: (i) choice alternatives fully described to subjects as a probability distribution over potential outcomes, and (ii) learning about an unknown probability distribution through sampling (repeated draws with replacement) before making decisions (Barron and Erev 2003; Hertwig et al. 2004). Existing studies typically employ lab experiments in which college students conduct abstract tasks. The lab-based literature finds a robust "description-experience gap": most people who learn from experience by sampling from outcome distributions act as if they underweight probabilities of rare events. By contrast, people who learn about distributions from written descriptions act as if they overweight objective probabilities of rare events (for excellent reviews, see Hertwig and Erev 2009; Wulff, Mergenthaler-Canseco, and Hertwig 2018). A second consistent finding from this literature is that the effect of learning from experience depends on the actual draw from the distribution. Observing a rare event by chance leads people to overestimate these events (Hertwig et al. 2004; Rakow, Demes, and Newell 2008), even if they were previously informed about the true distribution of outcomes (Lejarraga and Gonzalez 2011).

It is unclear a priori whether findings from these lab settings generalize to the field setting with real-world outcomes. For many uncertain events, people can only infrequently observe outcomes from the underlying probability distribution (e.g., weekly lottery drawings), and many events are much rarer than what is modeled in lab studies (e.g., winning the lottery jackpot). It is therefore noteworthy that the results of this study are consistent with key findings from the lab. The analysis validates the impact of experiential learning in a field study and measures effects on real-world financial behavior. It shows that the outcome of the random draw has a large effect on behavior – even though the true probability distribution is (at least in theory) known.

Because this study measures behavior over the course of one year, it demonstrates that the effects of experiential learning are persistent. The paper also contributes to the literature on gambling prevention. Most studies in this area assess information-based programs in schools and universities and find that they can reduce misconceptions about gambling (Williams and Connolly 2006), but that they fail to reduce gambling behavior (for a review see Ladouceur, Goulet, and Vitaro 2013). This study is among the first to use experiential learning to correct misperceptions about gambling and to follow participants' behavior over a longer time horizon. One limitation of the present setting is that the prevalence of pathological gamblers is low, so it is not possible test the effect on individuals suffering from gambling disorder. There is reason to believe that treatment effects may differ for this population, as addictive gambling behavior has been linked to neurobiological and genetic factors (Clark and Limbrick-Oldfield 2013, for a review see Hodgins, Stea, and Grant 2011).

Finally, this paper relates to a recent set of papers showing that lotteries can serve as an effective incentive to increase saving (Cole, Iverson, and Tufano 2018), HIV testing (Bjorkman et al. 2018), and labor supply Brune (2017). These papers exploit individuals' preferences for lotteries to draw them into making better financial, health, or employment decisions.

Overall, this research is one of the first field studies that shows that experiential learning interventions have the potential to be promising alternatives to traditional methods of conveying information. To the extent that developing economies have less division of labor, individuals can potentially observe the relationship between actions and outcomes, and hence benefit from a learning process that involves concrete experience and active experimentation.

## 2. Experimental Setting and Research Design

### Context and Study Sample

Since the legalization of gambling in 1996, the South African gambling industry has grown substantially with gross revenues more than doubling between 2001 and 2009 to 18 billion rand (1.57 billion USD) (Nzimande et al. 2010). The prevalence of gambling is also quite skewed – a 2003 survey found that while 43 percent of the population participated in some form of gambling, poorer households spent a significantly higher percentage of total income on it (Smith and Walker 1993). Further research has shown that gambling is most prevalent among blacks in South Africa, with 56.7 percent of urban residents reporting that they gambled at least occasionally (Kincaid et al. 2013). When asked why they gamble, 85 percent of respondents mentioned the chance of winning a large prize. This study also highlighted that gambling is socially acceptable for a majority in South Africa with 69 percent of respondents reporting that either some or all forms of gambling "are OK."

This study focuses on one form of gambling, the national lotto. Players choose 6 out of 49 numbers in a weekly draw and can win cash prizes starting from 3 correct numbers. However, to win the jackpot, players have to get all six numbers correct. People need to be older than 18 to participate in the weekly draw. A 2009 regional study in the Eastern Cape showed that playing the lottery was by far the most common form of gambling in the area – 49 percent of respondents had tried it at least once, and active gamblers played an average of 3.5 times per month (TNS 2009). This study was part of a broader program that delivered classroom-based financial education to members of burial societies[5] and women borrower groups in rural and peri-urban areas.[6]

The study involved in-person baseline and follow-up surveys. The debiasing intervention studies in this paper was carried out as part of the baseline survey. The intervention was conducted separately for all individuals and was supervised by the study's trained survey enumerators. The enumerators first administered a baseline survey, which on average took 30 minutes to complete using electronic tablets. Following each survey, the tablet interface randomly assigned each participant to either the debiasing treatment or a control treatment on credit (described below). The enumerator then carried out the assigned treatment, which on average took an additional 10 minutes. (For more information on the sampling and field work protocol see S1 in the supplementary online appendix available at *The World Bank Economic Review* website.)

The present study sample consists of 841 individuals from 27 women borrower groups and 45 burial societies. Baseline characteristics of the sample were measured between July and November 2011 and are reported in table 1. As the majority of burial society members are female, the sample consists of almost 90 percent women. Education levels are low with 6.3 years of formal education, and less than 8 percent of sample participants are employed. Fifty-five percent report having a bank account, and 50 percent report savings. Given that the project was part of a larger study, the study was constrained on the location of the study sample. An important characteristic of the sample is that the baseline prevalence of lottery purchases is fairly low, at less than 15 percent. This is an important caveat to the generalizability of the results.

5 Burial Societies are a common form of association to save for the typically large costs of funerals in South Africa.

6 As part of a different study, half of the group in the sample received a half-day financial education training between March and June 2012. As the gambling debias was randomly assigned at the individual level, these two treatments are orthogonal. In addition, the financial education curriculum did not include any information on gambling. All estimations in this study control for whether participants received the financial education program. Cole et al. (2014) show that the financial literacy intervention led to small increased self-reported savings, and reduced loan applications, but did not improve other types of financial knowledge or practices.

**Table 1.** Balance Test

| | Assignment to gambling debiasing | | | Number of dice rolls | | |
|---|---|---|---|---|---|---|
| | Control | Treatment | *p*-value (C = T) | Above median | Below median | *p*-value (C = T1 = T2) |
| Age | 52.99 | 52.96 | 0.978 | 51.67 | 54.06 | 0.288 |
| Married | 0.464 | 0.465 | 0.974 | 0.461 | 0.468 | 0.991 |
| Female | 0.84 | 0.88 | 0.099 | 0.918 | 0.849 | 0.036 |
| Education (yrs) | 6.27 | 6.47 | 0.465 | 6.42 | 6.52 | 0.746 |
| Played lottery | 0.12 | 0.127 | 0.755 | 0.11 | 0.141 | 0.612 |
| Understand English | 0.422 | 0.422 | 0.999 | 0.415 | 0.428 | 0.968 |
| Owns TV | 0.672 | 0.643 | 0.397 | 0.646 | 0.641 | 0.695 |
| Owns radio | 0.6 | 0.601 | 0.998 | 0.612 | 0.591 | 0.91 |
| 1st income quartile | 0.22 | 0.208 | 0.67 | 0.19 | 0.222 | 0.672 |
| 2nd income quartile | 0.368 | 0.352 | 0.63 | 0.353 | 0.351 | 0.89 |
| 3rd income quartile | 0.171 | 0.196 | 0.363 | 0.207 | 0.187 | 0.579 |
| Has bank account | 0.569 | 0.551 | 0.609 | 0.538 | 0.563 | 0.776 |
| Employed | 0.074 | 0.071 | 0.86 | 0.082 | 0.063 | 0.751 |
| Has savings | 0.503 | 0.5 | 0.92 | 0.511 | 0.491 | 0.919 |
| Has a loan | 0.352 | 0.377 | 0.458 | 0.418 | 0.342 | 0.213 |
| *N* | 432 | 409 | | 214 | 195 | |

*Source*: The data for this study were collected by a survey field team directly supervised by the authors. The data were collected for 841 individuals over 3 rounds of surveys (baseline, midline, and endline) from June 2011 to November 2012.

*Note*: The right panel of the table compares baseline characteristics between the early (T1: <median), late (T2: >median), and control (C) group. Participants at the median are grouped throughout the paper in the above median group. Results are not sensitive to this choice; *p*-values are reported for a test of equal means.

## Game Design

The game design is inspired by some key features in the debiasing literature. Previous interventions have tried three types of methods to address cognitive biases (see Fischhoff 1982; for a review see Soll, Milkman, and Payne 2014): (i) repeat interaction with immediate unambiguous feedback, (ii) consider the opposite, and (iii) counter-biasing (Jolls and Sunstein 2006; Willis 2008).[7] The first method of immediately providing feedback on an action has been used successfully in the lab to address overconfidence (Lichtenstein and Frischhoff 1980). The "consider the opposite" method has been implemented by asking participants to list alternative choices, think of other potential outcomes, or provide counter-arguments against a default option before making a decision Mussweiler, Strack, and Pfeiffer (2000; Larrick 2004). Theory predicts that participants place increasing weight on these alternatives as they become more mentally available. The third method of "counter-biasing" builds on the premise that cognitive biases may be used to induce desired behavior (Thaler and Benartzi 2004; Jolls and Sunstein 2006). For example, retirement saving plans with automatic increases in contributions over time offset the tendency of people to procrastinate in making important financial decisions.

Based on participants' feedback from extensive piloting, this study decided to employ a strategy that combines elements of the first and third methods – repeat interventions and counter-balancing.[8] Specifically, the study designs a simple dice game to provide an experience-based learning forum to

7 One additional method previously proposed by supporters of the "ecological rationality" theory is to specifically address poor understanding of probabilities by using frequencies rather than probabilities to communicate odds (Hoffrage and Gigerenzer 1998). Hoffrage and Gigerenzer (1998) called this "*the strongest and most consistent debiasing method known today*." However, other research has shown that under most real-life circumstances, intuitive judgments are equally biased regardless of whether odds are presented in frequencies or probabilities (Griffin and Buehler 1999).

8 Other strategies that the study piloted included visual props to communicate small probabilities, comparisons to other rare events like being hit by lightning, and using rules of thumb.

convey low winning probabilities of gambling. Gambling prevalence is often explained by the fact that individuals do not understand how low probabilities translate into the frequency of winning, as probabilities such as 14 million to 1 are unlikely to lie within the range of everyday experiences (Smith and Walker 1993). Hence, this study's game was meant to provide an intuitive mapping of probabilities through active experimentation.

The game was administered by surveyors employed by a professional survey firm and extensively trained by the research team. Study participants convened at a central meeting place in the village. Surveyors took participants to a separate room and first administered the aforementioned baseline surveys using tablets. The survey software then randomly assigned participants to either the treatment or the control group. The experiential learning exercise uses regular six-sided die as props and was administered by surveyors in one-on-one meetings immediately after completing the baseline survey (see S1 in the supplementary online appendix for the exact fieldwork and treatment protocol used).[9] The researchers first let participants roll one die until they obtained a six. Then the researchers added another die and let them roll until they simultaneously obtained 2 sixes, which took them on average much longer.[10] Participants were then told how different numbers of simultaneous sixes translate into odds of winning prizes in the lottery. The chance of having four right numbers in the lottery, for example, was equivalent to rolling all sixes with five dice, and the odds of winning the jackpot was smaller than getting all sixes with nine dice.

In contrast to lecture-based learning, this intervention exploits insights from neuroscience showing that different stages of experiential learning activate different parts of the brain (Zull 2002).[11] The starting point of the intervention is the active experience of rolling dice, and the game incorporates elements from each of the learning models discussed above. Through dice rolling, participants draw a sample from the probability distribution of winning in a lottery (presented by getting a certain number of sixes). This exercise may serve as an easily retrievable experience, given the salient and interactive nature of the exercise. Participants are able to reflect on the difficulty or ease of obtaining simultaneous sixes, and the facilitator explains the link between dice rolling and the abstract concept of lottery-winning probabilities. Likewise, playing a game with dice allows the complex notion of probability to be conveyed in a low-key setting without taxing the cognitively heavy systems of attention or memory.

The control group received a treatment on credit to allay concerns of Hawthorne effects. The researchers administered an intervention aimed to communicate the cost of buying goods through making installment payments over time (known as hire purchase) relative to plausible alternatives. Specifically, the researchers visually demonstrated that finding alternative cheaper loan products allows for the purchase of the desired item, plus an additional good, for the same payment stream. The two interventions were unrelated in content – the gambling intervention did not mention hire purchase credit, or even interest rates; and the credit intervention did not discuss lotteries, odds, or gambling.[12]

9 While the treatment was delivered at the individual level, the study cannot rule out the possibility that participants afterwards talked about their experience to other study members. This would bias the study against finding effects.

10 The expected median number of rolls for this distribution is 24 or 25. In fact, a referee pointed out that this exact problem played a role in the formalization of probability theory, as Cheavlier de Mere and Blaise Pascal debated in the 17th century whether offering even money against a double-six in 24 or 25 rolls was a good or bad deal.

11 Zull (2002) identifies four stages in the learning cycle that relate to the brain structure: concrete experiences (sensory cortex), abstract concepts (frontal cortex), reflective observation (integrative cortex), and active testing (motor brain).

12 While it is theoretically possible that a better understanding of compound interest rates would also affect comprehension of low probabilities, this would only bias the treatment effects downwards. Another potential concern might be if the hire purchase debiasing intervention had a large effect on participants' monthly expenditure: increases or decreases in gambling might be observed due to wealth or liquidity effects. However, changes in financial behavior or in discretionary income were not observed as a result of the hire purchase intervention.

### Identification

In the spirit of Crepon et al. (2013), this study employs two stages of exogenous variation. In the first stage, participants are randomly assigned to receive either the gambling debias or credit information treatment. In the second stage, the number of rolls it takes treated participants to roll 2 sixes provides additional random variation in the treatment. For instance, participants who, by chance, rolled 2 sixes on the third try have a very different experience from participants who required 30 rolls. The study takes advantage of this exogenous variation within the treatment group to test various theories of behavior change discussed in subsequent sections of this paper.

Table 1 tests for balance across the treatment groups and finds that the random assignment at the two stages resulted in groups that were balanced across a range of observable baseline characteristics. The left panel in table 1 reports the sample means and *p*-value of a test of equal means between the gambling debiasing group (T) and credit information participants who served as the control group (C). Of the 15 baseline characteristics tested, only one difference in means is (marginally) significant.

Figure S3.1 in the supplementary online appendix shows the distribution of number of rolls it takes people in the sample to get 2 sixes. While the distribution is roughly normal, there are spikes at 15, 20, and 25 rolls.[13] This resulted from field workers using different stoppage rules. Specifically, given the fatigue that participants displayed during pilots, the study asked surveyors to stop the dice rolling after 25 unsuccessful attempts. However, the distribution suggests that some stopped the demonstration after 15 or 20 rolls. For the main analysis, the study therefore divides the sample into two treatment groups depending on whether they need more than the median (N = 12) number of rolls. The assignment to the early versus late treatment group is therefore likely to be less affected by the stoppage rule used by field workers. (However, the study tests how robust results are to different choices of grouping participants within the treatment group.) The key question for the identification strategy is whether the variation in the number of dice rolls within the treatment group is orthogonal to the baseline characteristics.

The right panel of table 1 reports a balance test of the randomization resulting from dice rolls. The first two columns report average baseline characteristics of the early (below-median rolls) and late (above-median) treatment groups. The last column reports *p*-values of a test of equal means between the control and two treatment groups. Similar to the previous test, only the difference in the share of women between the different groups is statistically significant.[14] When the study simultaneously controls for all covariates in a regression with the number of rolls to get 2 sixes or an indicator variable for being in the late group as the dependent variable, none of the baseline characteristics is statistically significant. While it is reassuring that participant characteristics are not correlated with the number of dice rolls, section 3 provides a series of robustness tests to show that the main results are not driven by differential stoppage rules.

### Outcome Measures

During the course of the study gambling outcomes were measured at three stages: immediately after the treatment during baseline, after six months, and after one year. (To guarantee the validity of data collected by the survey firm, the researchers called a random subset of participants and confirmed responses.) The follow-up surveys were not announced at the beginning of the study. Four measures of outcomes are used:

1. Immediate outcome: Following the baseline survey, participants received 10 Rand ($1.00) and were offered the opportunity to spend part of this compensation in the following game. First, they were

13 Simulation exercises (not reported) show that the observed median value is lower than the simulated median value and a few surveyors appear to have systematically stopped even before reaching 15 rolls. While this would likely bias the results towards zero, the study confirms that results are robust to excluding observations from these surveyors.

14 Likewise, the gender difference in the number of rolls is marginally significant (*p*-value = 0.09). When the study controls for other covariates, the gender dummy turns insignificant (*p*-value = 0.173). Still, the study reports estimates controlling for gender and other covariates for all results.

shown a bag with 50 balls, in which 5 balls were red, and offered the opportunity to pay 1 Rand from their show-up fee to draw a ball (which was replaced after each round). If they drew a red ball, they would receive 5 Rand. They were allowed to draw a ball up to 10 times. On average, participants played 0.8 rounds. 57 percent of people decided not to play this gamble.

2. Midterm outcome: Six months after the debiasing treatment, the survey firm contacted participants via cell phone to collect an intermediate gambling outcome. Participants were offered the choice of a lottery in which they could win R250 or receive R15 for certain (all prizes were delivered as cell phone airtime). To mimic the experience of playing the lottery, participants were asked to guess which 6 numbers between 1 and 49 were drawn at the national lottery at an undisclosed particular date over the past 6 months. The winning odds were randomly assigned within the control and treatment groups: half of the participants were told they would win if they picked all 6 numbers correctly (odds 1:13,983,816), while the other half were told they would win if they picked at least 4 correct numbers (odds 1:1,032).[15] These exact winning odds were not disclosed to participants. Overall, 26.6 percent of the participating sample chose to play the lottery, which nobody won.
3. Endline outcome: Between June and November 2012, approximately one year after the debiasing treatments were administered, an in-person endline survey was conducted that collected data on gambling behavior of participants in the last six months. Information was also collected on a range of financial behaviors and attitudes. Note that although endline outcome measures are self-reported, the study's empirical strategy exploits variation in how long it took participants to obtain 2 sixes, rather than the binary effects of treatment. Since all respondents in this sample received the same treatment (but had different experiences due to differences in the number of rolls), concerns about reporting biases are less relevant. Nevertheless, the study acknowledges that the lottery purchase behavior is a self-reported outcome.
4. Index: In order to take advantage of the fact that the study has gambling outcomes for individuals across time, it also creates an index following Kling et al. (2007) and McKenzie (2012). The index is created by adding values for the binary midterm outcome (choosing lottery), binary endline outcome (played lottery in last six months) and a standardized measure of the number of rounds played to try to draw a red ball (immediate outcome).[16] Attrition was not an issue for the immediate outcome measure since it was captured immediately after the baseline survey. For the midterm outcome data collection, the researchers successfully reached 74 percent of the sample via phone, of which 78.4 percent agreed to participate. Results from a linear probability regression (table S2.1 in the supplementary online appendix, columns 1–4) show that both the probability of reaching individuals and their decision to respond to the survey were not systematically correlated with treatment assignment, nor with the number of die rolls they required to obtain 2 sixes. As an additional test, the study finds that the decision to participate in the midterm survey was not significantly correlated with the gambling decision in the immediate outcome measure. This supports the view that attrition does not bias results.

Overall attrition in the endline was 30.4 percent. This attrition rate is relatively high, but it was primarily due to a hardware failure: all data from certain geographic clusters was lost when the digital devices used to conduct the surveys failed to synchronize. This hardware error reduces the precision with which researchers can estimate outcome measures collected at the endline. However, table S2.1 in the

15 Within the treatment group, random assignment was stratified along whether participants needed above-median vs. below-median number of rolls.

16 For the midterm outcome, a binary measure is used of whether participants chose the lottery, independent of the assigned odds. Note that the results are robust to just using outcomes for participants assigned the low odds, which mimics the odds of winning the lottery jackpot. This index has a mean value of 0.06 and standard deviation of 0.58. For observations without data on intermediate or endline outcomes, this measure is excluded from the index. This is unlikely to bias results since attrition is independent of the treatment status.

supplementary online appendix shows that the attrition rates did not vary significantly between treatment and control groups (column 5) or between the early and late groups (column 6).

### Specification

The main regression specification is as follows:

$$y_i = \alpha_0 + \beta_1 T_{early} + \beta 2 T_{late} + \gamma X_i + e_i \tag{1}$$

$y_i$ refers to the outcome of person *i*. $T_{low}$ and $T_{high}$ are indicator variables for gambling debiasing participants that took below-median and above-median numbers of rolls to get 2 sixes, respectively. Coefficients $\beta_1$ and $\beta_2$ estimate the average effect of being in the early and late treatment group compared to the control group, respectively. $X_i$ is a vector of baseline covariates including gender, age, education levels, income level, and indicator variables for whether the person gambled before and uses formal financial services. The study controls for these covariates to increase the precision of treatment estimates. Regressions are estimated using heteroscedasticity-consistent Eicker-Huber-White robust standard errors $e_i$. F-Test $p$-values of equality are also reported between $\beta_1$ and $\beta_2$.

As further discussed in section 3, the study tests whether treated individuals became more sensitive to changing winning odds of a lottery. This is done by estimating the following specification:

$$y_i = \alpha_0 + \beta_1 T_{early} + \beta 2 T_{late} + \eta odd_g + \delta_1 T_{early} * odds_g + \delta_2 T_{late} * odds_g + \gamma X_i + e_i \tag{2}$$

The variable $odds_g$ refers to the randomly assigned better winning odds in the midterm outcome. Estimates of $\delta_1$ ($\delta_2$) show how the odds sensitivity of the early (late) treatment group compare to the control group. F-test $p$-values of equal coefficients ($\delta_1 = \delta_2$) are also reported.

## 3. Results

### Gambling Behavior

Table 2 reports results from an ordinary least squares (OLS) regression using both the lottery index and individual survey measures as the dependent variables. Column (1) shows that the average treatment effect is close to zero and statistically insignificant. This suggests that in the aggregate, gambling behavior did not change in the treatment group.[17]

This aggregate analysis masks the fact that the treatment participants' experience is very different depending on how long it takes them to obtain the sixes in the rolls of dice. Columns (2) to (4) report results of regression model 1, which estimates differential treatment effects between the early and late treatment groups. (Figure S3.2 illustrates these results graphically.) Column (2) shows that results vary significantly between the two groups – the early group, where individuals needed fewer attempts to get 2 sixes, gambled significantly more than the control group, while the late group gambled significantly *less*. The treatment coefficients (compared to the control group) are statistically significant at the 5 percent and 10 percent level, respectively. The difference between the early and late treatment coefficients for the lottery index is also significant at the 1 percent level as indicated by the $p$-value of the F-test reported in table 2. Results do not change in magnitude or statistical significance when thye stud controls for additional baseline covariates in columns (3) and (4).

Table 2 also reports results of the same regression specification estimated separately for the three gambling outcomes that comprise the lottery index. All gambling outcomes show a consistent picture: the late treatment group gambled less, and the early treatment group gambled more relative to the control group. Individuals in the late treatment group gambled 19 percent less in a lottery offered after the debiasing

17 One caveat for the interpretation of the average results is that participants' experience is not fully representative of the true probability distribution due to the early stoppage rule. This may have created a sense that getting multiple sixes is easier than it in fact is.

**Table 2.** Gambling Analysis

| | Lottery index | | | | Immediate outcome | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Gambling debias | 0.001 | | | | 0.0294 | | |
| | (0.041) | | | | (0.092) | | |
| Above-median rolls | | −0.084** | −0.081** | −0.082** | | −0.146 | −0.126 |
| | | (0.040) | (0.040) | (0.040) | | (0.095) | (0.094) |
| Below-median rolls | | 0.103* | 0.102* | 0.099* | | 0.241* | 0.227* |
| | | (0.060) | (0.058) | (0.058) | | (0.132) | (0.130) |
| Control variables | Y | N | Y | Y | Y | N | Y |
| Financial education | Y | N | N | Y | Y | N | Y |
| R-square | 0.000 | 0.013 | 0.08 | 0.082 | 0.001 | 0.011 | 0.061 |
| N | 813 | 813 | 813 | 813 | 813 | 813 | 813 |
| Control mean | 0.063 | 0.063 | 0.063 | 0.063 | 0.775 | 0.775 | 0.775 |
| Standard deviation | 0.579 | 0.579 | 0.579 | 0.579 | 1.315 | 1.315 | 1.315 |
| $\beta_1 = \beta_2$ ($p$-value) | | 0.002 | 0.002 | 0.002 | | 0.004 | 0.007 |
| | Intermediate outcome | | | | Endline outcome | | |
| | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Gambling debias | 0.0125 | | | | −0.001 | | |
| | (0.044) | | | | (0.022) | | |
| Above-median rolls | | −0.0164 | −0.036 | −0.038 | | −0.026 | −0.026 |
| | | (0.053) | (0.054) | (0.055) | | (0.023) | (0.023) |
| Below-median rolls | | 0.0404 | 0.0513 | 0.049 | | 0.034 | 0.040 |
| | | (0.055) | (0.059) | (0.060) | | (0.032) | (0.033) |
| Control variables | Y | N | Y | Y | Y | N | Y |
| Financial education | Y | N | N | Y | Y | N | Y |
| R-square | 0.000 | 0.002 | 0.075 | 0.076 | 0.001 | 0.006 | 0.113 |
| N | 384 | 384 | 384 | 384 | 585 | 585 | 585 |
| Control mean | 0.236 | 0.236 | 0.236 | 0.236 | 0.074 | 0.074 | 0.074 |
| Standard deviation | 0.429 | 0.429 | 0.429 | 0.429 | 0.261 | 0.261 | 0.261 |
| $\beta_1 = \beta_2$ ($p$-value) | | 0.372 | 0.190 | 0.195 | | 0.071 | 0.049 |

*Source*: The data for this study were collected by a survey field team directly supervised by the authors. The data were collected for 841 individuals over 3 rounds of surveys (baseline, midline, and endline) from June 2011 to November 2012.

*Note*: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The lottery index measures the average value of the (standardized) immediate, intermediate, and endline outcome measure. Columns (5)–(7) measure the treatment effect on the number of rounds that participants decide to gamble immediately after the intervention. Columns (8)–(10) report outcomes for the subset of the sample offered the low winning odds lottery, which presents the odds of winning the lottery jackpot. Column (11) pools lottery choices of participants with low and better winning odds. The endline outcome (columns 12–14) measures whether people played the national lottery in the past 6 months. Control variables include all covariates listed in table 1; $p$-values are reported of a test of equal coefficient for the above-median and below-median treatment group. Results are estimated using Ordinary Least Squares. The minimum detectable effect size is 0.19 standard deviations for the aggregate treatment and 0.27 s.d. for the comparison of above-median vs. below-median number of rolls.

intervention, while the early treatment group gambled 29 percent more compared to the control group in a lottery offered immediately after the intervention. A similar pattern emerges for the intermediate lottery choices, although differences are not statistically significant. It is noteworthy that the effects persist one year after the intervention – in the final follow-up, 10.7 percent of people in the early treatment group reported playing the lottery compared to 7.4 percent in the control group. The equivalent figure for the late treatment group is 4.7 percent. The $p$-values on the F-tests are statistically significant, hence showing that the differences between early and late groups are significantly different from each other (although they are not statistically different from the control group). The magnitude of these effects is remarkable, especially given that the debiasing game only takes 10 minutes to complete.

As discussed earlier, the study's main specification divides the treatment into above-median and below-median number of rolls because of differential stoppage rules used by enumerators. In addition to showing that the number of rolls is not correlated with participant characteristics, a battery of robustness tests is provided. First, it is confirmed that results are robust to excluding observations from surveyors who tended to stop the debiasing game early (i.e., after less than 10 rolls). Second, it is found that treatment effects do not differ significantly for participants at the spike of the distribution compared to those immediately to the left or right of the spike.[18] Third, treatment effects are estimated through a continuous measure of dice rolls. Columns (1) and (2) in table S2.2 show that the relationship is negative and statistically significant. Fourth, treatment effects are estimated non-parametrically for different quantiles of the dice roll distribution. A negative monotonic decline in treatment effects is found with increasing quartiles (table S2.2, cols. 1 and 2). Last, fig. S3.3 shows a graphical representation of the relationship between the full distribution of dice rolls and the lottery index non-parametrically. Fitting a local polynomial function using an Epanechnikov kernel confirms a monotonic negative relationship between the number of rolls and gambling behavior. The graph shows that effect sizes are a roughly linear function of the number of rolls; the specific cutoff choices that are made in the analysis do not change the qualitative results.

### Odds Sensitivity

Next, the study explores whether the treatment led to a change in the sensitivity to winning odds, which has important implications for the interpretation of mechanisms. As described above, the study design randomly varied the winning odds of gambles offered to the sample at midterm. Figure S3.4 shows the effect of improving the winning odds (from having to get all six numbers right to having to get at least four right) on the probability that a participant would choose the lottery over a certain amount, separately for the early and late treatment groups. Improving winning odds induces individuals in the late group to increase the take-up of the lottery from 13 percent to 30 percent (middle panel), whereas there was no such change for the early group (right panel).

Table 3 reports these results in a regression framework. Column (1) shows that when winning probabilities in the full sample are pooled, higher winning odds are associated with a higher probability of choosing the lottery. As shown in the graph, the early group was more likely and the late group was less likely to choose the gamble compared to the control group. While large in magnitude, these estimates are not significant. The *p*-value of a test of equal coefficients between the two treatment groups is 0.234. The specification in column (2) includes interaction terms between the treatment groups and the better odds dummy. The coefficients on these interaction terms suggest that the early group is less sensitive and the late group is more sensitive to changing winning odds than the control group. However, the test of equal coefficients of these interaction terms ($\delta 1$ and $\delta 2$) cannot be rejected at conventional levels ($p$-value $= 0.209$). While the statistical power is not sufficient to provide conclusive evidence, these results provide suggestive evidence that the change in gambling behavior is influenced by a change in sensitivity to winning odds.

### Changing Risk Beliefs or Risk Weighting?

Kahneman and Tversky (1979) observe that people have "*people are limited in their ability to comprehend and evaluate extreme probabilities*." It is commonly overlooked that this statement captures two distinct concepts: comprehension and evaluation of unlikely events. Fox, Rogers, and Tversky (1996) model decision making as a two-step framework: first, individuals assess the probability of events and second, they make decisions based on the assessed likelihood (Barberis 2013).

In the context of the present study, the question is whether people change their beliefs of winning odds and/or whether, conditional on assessed probabilities, participants change how they weight these

18 The study finds that treatment effects are slightly larger in magnitude (about 10 percent of the control mean) at these round numbers. This is in line with what is expected: if the enumerators stopped at 20 rolls, obtaining sixes would seem more difficult than if participants obtained sixes at roll 19 or 21. However, the sample size is not sufficient for statistically significant estimates: the *p*-value of the test of equivalent treatment effects is 0.64.

**Table 3.** Odds Sensitivity (Midline Survey)

| y: 1 = airtime lottery, 0 = fixed airtime | (1) | (2) |
|---|---|---|
| 1 = Better odds | 0.0770* | 0.111* |
| | (0.046) | (0.061) |
| Above-median rolls | −0.0360 | −0.0452 |
| | (0.054) | (0.066) |
| Below-median rolls | 0.0449 | 0.124 |
| | (0.061) | (0.088) |
| Better odds × Above-median | | 0.0161 |
| | | (0.106) |
| Better odds × Below-median | | −0.156 |
| | | (0.122) |
| Financial education | 0.0331 | 0.0341 |
| | (0.047) | (0.047) |
| Control variables | Y | Y |
| $R$-squared | 0.071 | 0.077 |
| N | 384 | 384 |
| Control mean | 0.236 | 0.236 |
| $\beta1 = \beta2$ | 0.234 | 0.074 |
| $\beta1 = \delta1$ (>median) | | 0.694 |
| $\beta2 = \delta2$ (<median) | | 0.152 |
| $\delta1 = \delta2$ (equal Interaction) | | 0.209 |

*Source*: The data for this study were collected by a survey field team directly supervised by the authors. The data were collected for 841 individuals over 3 rounds of surveys (baseline, midline, and endline) from June 2011 to November 2012.
*Note*: Standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
"Low" and "high" in the equation correspond to "below-median" and "above-median" in the table. The table shows results of regression specification (2) using OLS: $y_i = \alpha_0 + \beta_1 T_{low} + \beta_2 T_{high} + soddg + o1T_{low} * oddsg + o2T_{high} * oddsg + X_i + e_i$
The bottom rows show $p$-values of an F-test of equal coefficients to specification (2). The dependent variable is an indicator variable measuring whether participants chose the lottery over airtime in the mid-line.

probabilities in their decision making.[19] The difference between these two mechanisms can be visualized in fig. S3.5 using a probability-weighting function that translates objective probabilities $p$ into weights $\pi(p)$ used in decision making (Kahneman and Tversky 1979). It is possible to observe a decrease in gambling because people change their beliefs about the odds of winning (depicted by a change from $b$ to $a$ due to a change in assessed probability $p$) or because participants change their risk weighting for given winning odds (depicted by a change from $a$ to $c$ and $b$ to $d$ due to a vertical change in decision weight $\pi(p)$). The distinction between changes in beliefs and preferences is important because "*overestimation is a mistake; it is less clear that overweighting is a mistake*" (Barberis 2013).

Results in the previous two sections provide support for a change in risk beliefs as an underlying mechanism for the reported effects. If the effects were solely driven by a change in risk weighting, the number of rolls it takes to get sixes would not matter as people already understand the correct winning probabilities. Yet, it is found that the treatment effect goes in opposite directions depending on how long it takes participants to obtain 2 sixes (section 3). Second, there is suggestive evidence that people are more

19 In theory, participants in the present study could compute the probability distribution of obtaining 2 sixes and of winning the lottery jackpot. As such, it would constitute a decision under risk (instead of ambiguity) in which updating of risk beliefs is irrelevant. However, the math skills demonstrated by participants suggest that calculating precise probabilities may be challenging. Pilot results showed less than half of the participants knew what 10 percent of 400 is. The average level of education in the present sample is 6.3 years (table 1). Lejarraga (2010) confirms that as decision problems become more complex and people need to exert more effort in assessing the probability distribution, they are more likely to rely on learning from experience.

sensitive to changes in winning odds, which points to a better understanding of winning probabilities (section 3).

As an additional analysis, the study directly observes whether the intervention led to a substitution to other forms of gambling. If the lottery effect is driven by a change in risk weighting of small-probability events (or an overall change in entertainment utility from gambling), prevalence of other forms of gambling would be expected to move in the same direction as changes in playing the lottery. Conversely, if individuals update beliefs on lotteries' winning odds through a new heuristic, they may decide to substitute to other forms of gambling (e.g., scratch cards) that do not deal with lottery odds. Results reported in table S2.3 show that individuals indeed substitute between different types of gambling based on the number of rolls. The early treatment group is more likely than the control group to play the lottery but less likely to play scratch cards while the late treatment group is significantly more likely to switch and play scratch cards instead of the lottery. This substitution between different forms of gambling suggests that the intervention changed beliefs about winning odds for the national lottery. From a policy perspective, this result suggests a more holistic approach towards debiasing individuals against all forms of gambling is needed in order to address potential negative welfare effects of gambling.

### How Did Individuals Learn?

A natural question that arises is whether the present intervention would yield similar effects among other samples and in different settings, since individuals differ in how they process experience. The data in this study makes it possible to shed some light on how individuals learn.

This study is particularly interested in whether participants gain an intuitive understanding of the relatively sophisticated concept that rolling additional sixes gets *exponentially* more difficult with each die added. The study takes advantage of the fact that it has two independent treatment indicators for each participant: the number of times to roll a six with one die (round 1) and the number of times to roll simultaneous sixes with two dice (round 2). To give an intuitive sense for the test of learning mechanisms, imagine two participants who both needed 15 rolls to get both sixes in round 2. Person A takes 10 rolls to get a six in round 1, while Person B rolls a six in two turns. In theory, the overall treatment could be more effective for either person. For person A, both rounds convey the same message – that it is very difficult to roll sixes. For person B, the treatment may be more effective because the larger difference in the number of attempts in the two rounds better conveys the message that getting all sixes becomes increasingly difficult with each additional die. This is particularly relevant because the treatment message of the study, comparing the odds of winning the lottery jackpot to the odds of rolling all sixes with nine dice, is based on the concept of this exponential increase in difficulty as dice are added.

To distinguish between these two possible learning mechanisms, the sample is divided in each round along the median number of rolls, and the study compares the four possible combinations of a subject's experience in the toss of the single die and the toss of the two dice. Table 4 shows the results of this analysis. Column (2) reports results of the previous analysis of round 2 (two dice). Column (1) shows results of the same econometric specification using only the information of round 1 (one die). The coefficients in column (1) are of the same sign as in column (2) but not statistically significant. As expected, the coefficients are much smaller in magnitude, as the treatment of rolling one die is weaker than rolling two dice.

Next, column (3) repeats the analysis with the treated individuals divided into four subgroups depending on whether participants need an above-median (AM) or below-median (BM) number of rolls in the two rounds. The only significant coefficients are for people that need more than the median number of rolls in both rounds (AM/AM). The difference with those that need below-median rolls in both rounds (BM/BM) is highly significant ($p$-value = 0.004) suggesting that reinforcement is more effective. Comparing participants in the study's motivating example corroborates this conclusion. Person A

**Table 4**. Learning Mechanism Analysis

| y = lottery index | | | |
|---|---|---|---|
| | First die | Two dice | Interaction |
| (one/two dice) | (1) | (2) | (3) |
| <median rolls | 0.026 | 0.096 | |
| | (0.048) | (0.059) | |
| >median rolls | −0.022 | −0.074* | |
| | (0.051) | (0.040) | |
| <median / <median | | | 0.844 |
| | | | (0.061) |
| >median / <median | | | 0.113 |
| | | | (0.104) |
| <median / >median | | | −0.043 |
| | | | (0.061) |
| >median / >median | | | −0.096** |
| | | | (0.043) |
| *R*-squared | 0.036 | 0.046 | 0.046 |
| N | 813 | 813 | 813 |
| Control mean | 0.063 | 0.063 | 0.063 |
| *p*-value:<med. = >med. | 0.398 | 0.004 | |
| *p*-value:</< = >/> | | | 0.004 |
| *p*-value:</> = >/> | | | 0.398 |

*Source*: The data for this study were collected by a survey field team directly supervised by the authors. The data were collected for 841 individuals over 3 rounds of surveys (baseline, midline, and endline) from June 2011 to November 2012.

*Note*: Robust standard errors in parentheses. Regressions control for gender, age, marital status, years of education, and WDB vs. burial society group.

$* p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

(AM/AM) gambles less than person B (BM/AM). However, this difference in coefficients is not statistically significant.

Overall, these results suggest that reinforcement of the same lesson in both rounds is the most effective treatment. The study acknowledge that analyzing a third round in the experiment design would serve as a stronger test of learning mechanisms, and is an interesting avenue for future research.

## Discussion and Concluding Remarks

This paper tests whether experiential learning about lottery odds through a simple and interactive dice game can lead to meaningful impacts on gambling behavior. Significant heterogeneity is found in impacts depending on how long it took participants to roll simultaneous sixes: the early (late) treatment group exhibits increases (reductions) in gambling behavior and reduced (increased) sensitivity to winning odds. These results are consistent with a model where individuals update their beliefs about lottery winning odds through the experience of the game.

Given that most previous studies in the financial education literature have found only modest results, it may be surprising that a simple experiential learning treatment that takes 10 minutes to complete leads to large and persistent treatment effects. The intervention may have been more effective in changing beliefs on gambling winning odds for at least two reasons. First, while experiential learning techniques that solely build on preexisting knowledge make behavior changes less costly, they also do not create much enthusiasm and are more likely to get ignored (Heath, Larrick, and Klayman 1998). The present study combined both novel and familiar elements: while participants were generally familiar with the concept of rolling dice, they were unfamiliar with linking it to winning probabilities of the lottery. Second, the treatment had elements of a "counter-biasing" strategy (Jolls and Sunstein 2006). Field workers reported that participants were very engaged and often showed strong emotional reactions. The intervention may have been effective by forming an easily retrievable memory about either the ease or difficulty of winning the lottery (Slovic and Lichtenstein 1971; Rabin 2002).[20] Consistent with this explanation, previous lab studies have found that more recent experiences have a particularly large effect on behavior (Atkinson and Shiffrin 1968; Hertwig et al. 2004), especially if participants actively sample rather than merely observe (Koehler 1994; Rakow et al. 2008).

The present study is one of the first pieces of field research confirming evidence from lab experiments that experiential learning in general and experiential debiasing in particular have the potential to be a promising alternative to the traditional method of conveying information.[21] Yet, the perverse results for the early treatment group serve as a caution that debiasing instruments can potentially exacerbate biases. Friedman (1998) argues that "appropriately structured learning environments" can effectively address every choice anomaly.

This raises the question of how to design any intervention to harness the potential of experiential learning but avoid the pitfalls demonstrated in the present study. Research suggests that forcing people to draw more experiences than they intend to can help to address the over-inference from random draws (Gottlieb, Weiss, and Chapman 2007; Hau et al. 2008), although Humphrey (2006) demonstrates that not all choice anomalies necessarily diminish with experience.[22]

Early research further showed that experiential learning is accurate and very efficient if participants experienced representative samples of events (Estes 1976). One way to increase the accuracy of experiences is to increase the underlying sample size from which an observation is drawn (rather than just the frequency). In the present setting, a more effective intervention design might include having participants observe the share of sixes from simultaneously rolling nine instead of two dice. In addition, the intervention would likely be more effective if it had not applied the early stoppage rule resulting in a substantial increase in the number of rolls.

Future research should explore whether similar interventions can prove to be effective in changing behaviors in other domains, such as technology adoption. Small-scale agriculture or other sectors with limited division of labor may offer particularly promising opportunities for experiential learning interventions. For example, Hanna, Mullainathan, and Schwartzstein (2014) show that although seaweed farmers in Indonesia can potentially observe the relationship between varying pod sizes and outcomes, they often fail to notice this important feature of the data they possess. Experiential learning may offer one promising avenue through which information can be conveyed in an effective way and thus lead to sustained behavior changes.

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20 Findings of earlier research showing that emotional events are particularly effective in creating cognitive biases (Nisbett and Ross 1980) are supported by the fact that the effects of the early treatment group (which may have led to an overestimation of the jackpot winning odds) are consistently larger in magnitude than effects of late treatment group.

21 Cole et al. (2014) show that the financial literacy intervention led to small increases in self-reported savings, and reduced loan applications, but did not improve other types of financial knowledge or practices. It also did not change gambling behavior: the treatment effects on the lottery index is −0.03 (*p*-value: 0.56). However, the financial literacy curriculum did not include gambling, which limits this analysis as a comparison of experiential vs. traditional teaching methods.

22 This strand of the literature also argues that the "rational" or expected utility maximization approach may not be the appropriate framework for decision-making in all settings. Alternative frameworks include ecological rationality, which posits that violations of rational choice theory might still be optimal in certain environments (Gigerenzer 2008).

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