Does Insight into Gambling Fallacies Impact Upon Gamblers' False Beliefs?

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Ethical Clearance: All human studies have been approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and all persons gave their informed consent prior to their inclusion in this study.

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Abstract

This paper uses the focus group paradigm to assess the extent to which people who play Roulette have beliefs around the future pattern of outcomes on the Roulette wheel which differ from the objective reality of real Roulette play. These false beliefs regarding the expected future outcome of a random process are a key factor in determining the psychological attractiveness of games of chance and a core factor leading to problem gambling. In this paper we consider the effectiveness of exposing regular Roulette players to a software program which simulates actual Roulette play. In this way players can play the game without incurring actual gains or losses but can objectively assess the longer time effects of using various betting strategies which they believe can help them "beat the system". A group of regular Roulette gamblers from Gauteng province were assessed using focus-group methodology to assess the attitudes and understanding of players to the game of Roulette before and after being exposed to the simulation software The paper assesses the extent to which players understanding of the fundamental principles of game play and associated outcomes have been improved through exposure to the simulated reality of actual Roulette. The results indicate that players improve their understanding of the statistical nature of games such as Roulette and indicate their intention to modify their approach to gambling on the basis of such exposure. It is posited that exposure to software which simulates gambling reality is a useful therapeutic tool for affecting player knowledge and perceptions and hence for mitigating pathological gambling behaviour.

This paper describes the use of interactive software to simulate the game of Roulette, as a didactic tool to familiarise gamblers with the precise statistical principles underlying the game. Of interest is whether a simulated game of chance can be used as an educational and therapeutic tool to demonstrate long run expected outcomes of different betting strategies. Participants' levels of false beliefs before and after exposure to the simulated gambling processes were assessed by questionnaire and through open discussion, with a view to considering whether exposure to such virtual gaming experiences could affect attitudes to gambling risk and alter their understanding and beliefs regarding how casino games work in practice. The software was developed and piloted on student subjects and subsequently used in a series of focus group workshops encompassing 37 regular Roulette gamblers. Overall 65% of participants revised their responses in the questionnaire in a way which showed evidence of learning about the probabilistic principles underlying Roulette through the simulation exercises and discussions. Those individuals who did *not* change their minds about their initial responses in the questionnaire were those more likely to be frequent players, have lower levels of education and to report a strong belief in a winning 'system'. The majority of participants (73%) rejected the notion of effective Roulette betting 'systems' subsequent to the workshop.

Keywords

Gamblers' false beliefs; simulated gaming as therapy;; focus group

Introduction and Background

In a series of focus groups held with regular gamblers in Gauteng province of South Africa[1] Scott and Barr (2011) found that, across a wide range of socio-economic categories, as measured by LSM[2], the majority of adults who gambled had strongly held (false) beliefs on the operational mechanics of games of chance. For example, the fact of statistical independence in a game process, whereby each outcome is determined independently of the next, was disbelieved by the focus group participants.

Most participants were vociferously of the opinion that if a particular number came up in Roulette or Lotto (as one of the sequence of numbers), then the chances of this number being drawn again, in the next Roulette spin or Lotto draw, are greatly reduced. A logical extension of this notion is that many players strongly believe that winning numbers in such games of chance are predictable; and therefore these games offer a real opportunity for players to develop systems that "work" and enable them to "outwit" the operators, casinos or otherwise, of such games.

These beliefs appear to be particularly strongly held by those workshop participants whose game of choice was Fafi, an illegal numbers game widely played by poorer black South Africans residing in townships. Scott and Barr (2012) found that the practice of using dreams to predict winning numbers in Fafi, as well as Lotto, was widespread and that gamblers were not predisposed to see gambling as a dispassionate, mechanistic process which leads to outcomes with fixed, predetermined probabilities. Their findings also indicated that, over and above the 'superstitious' basis of using dreams to attempt to manipulate games of chance, players who actually observed other gamblers receiving large winnings, were drawn in by the idea that gambling is a way to change one's life. Such gamblers frequently became obsessed with finding a way to direct this process, i.e. finding the elusive "system" to crack the game.

Drawing on these ideas around gamblers' beliefs, this paper attempts to explore the extent to which, and how, gamblers are able to negotiate the conflict between demonstrable statistical principles underpinning games of chance and deeply held convictions which could be loosely termed "gamblers' fallacies".

Objectives and Methods

It is hypothesised that exposure to demonstrated statistical principles could significantly enhance a player's understanding of the fundamental principles of game play and associated outcomes.
This paper explores the following aims:

(1) The extent to which people get hooked attracted to (and sometimes addicted to) gambling on the basis of misunderstandings or misperceptions of the statistical concepts of odds, probability, randomness and independence.

(2) The extent to which gamblers' views of games-of-chance alter if some of the fundamental principles underlying these games are unambiguously demonstrated to them.

To test these hypotheses, a series of software programs have been developed which can be used to simulate games of chance. That is, these simulation games can replicate quite precisely the

[1] Gauteng is the smallest province of South Africa. However, it is highly urbanized and is the most populous province, and includes the metropoles of Pretoria/Tshwane and Johannesburg.

[2] Living Standards Measure (measured on a scale from one: lowest living standard to ten: highest living standard) , is widely used in South Africa to indicate market segmentation on the basis of degree of urbanization and ownership of assets (http://www.saarf.co.za/LSM/lsms.asp)

behaviour of casino games such as Roulette, Lotto and slot machines. By repeatedly playing the simulated games of chance, keeping a record of wins and losses and monitoring their accumulated wins and losses, players can test out any personal gambling strategies they have as if they were playing the games in a casino or playing a game of Lotto, but without the anxiety associated with playing with real money. This paper focusses on the findings associated with a Roulette simulation program written for MS© Excel in VBA by the authors which can be used as a both a pedagogicand a therapeutic tool to familiarise players with the precise mechanisms of games of chance. A selected number of regular gamblers were exposed to this simulated gaming exercise in a facilitated workshop setting.

The software presented to the gambler focus groups was developed, piloted and tested using groups of undergraduate and postgraduate students and the insights gained in this development process are included in this paper.

In this study participants were given the opportunity to explore repeatedly the mechanics of this game of chance and view long-term outcomes associated with different betting strategies. Pre- and post- questionnaires as well as directed, open-ended discussions were used to interrogate the participants' levels of false beliefs before and after exposure to the simulated gambling software.

Both sets of participants (gamblers and students) were specifically selected on the basis of having sufficiently high levels of education that they might be expected to grasp the basic principles of probability that underpin Roulette. The workshops comprised gamblers (who had tertiary education at some level) and the student groups comprised students of statistics (who may or may not have been gamblers).

A limitation of this study is that it cannot replicate the thrill and anxiety of playing for real money.Players know that any gains or losses are hypothetical and thus the key "thrill" component of gambling is absent. However, the very fact that gains or losses ARE hypothetical allows players to have repeated and lengthy exposure to the game with the attendant internalisation of expected long-term trends of expected losses. This allows consolidation of the intended therapeutic effect, namely that the longer the exposure to a money-based casino game, the higher the chance of loss.

Target Groups

(1) Student groups: Second year (105 students spread over two discussion groups held once students had completed a tutorial exercise using the Roulette simulation) and postgraduate students (15 students in two separate groups). One of the postgraduate groups was a group of tutors and their perceptions were captured during a preparatory exercise for tutors prior to undergraduate tutorial sessions. The second postgraduate group were also tutors on an introductory statistics course and their views were captured during a post tutorial review session.
(2) Roulette gamblers: participants for these workshops were purposively selected (at casinos in Gauteng) according to the following selection criteria: over 18yrs of age; regular casino Roulette player (at least once a month); possessing matric (12 years of formal schooling) and some level of formal tertiary education (completed or continuing). There was an attempt to ensure a representative spread of gender and race groups in each of the four workshops. A total of 37 gamblers participated in the workshops.

Of interest in each of the above groups were the following broad themes with respect to beliefs and motivation:

- The extent to which the participants see the outcomes of games of chance as governed by powers beyond their control. That dreams or Lady Luck or the supernatural or that the unknown or uncontrollable is an important force in determing gambling outcomes.
- The extent to which the above beliefs affect individuals' predisposition to gamble.
- The extent to which participants gamble to actually make money.
- The extent to which players can internalise a set of statistical concepts associated with gambling and contrast these with their own beliefs about gambling and gambling strategies.

Gambling and Probability

A well-established phenomenon; see, for example, Delfabbro (2004), with problem gamblers is that they frequently assess and interpret gaming outcomes from a perspective of "false beliefs". It is not clear whether these individuals are simply not well versed in the principles of probability, or whether they do not believe that the principles of probability apply to casino games, or to them in particular! Scott and Barr (2011) report that many gamblers believe casino games are manipulated by casino houses in such a way that the outcomes of each game are (able to be) controlled. In order to challenge these beliefs, a simulation which replicates the expected probabilistic outcomes of the game of Roulette played in casinoshas beens created. In this research we focus on the house advantage of the casino to demonstrate that whatever the player's bet, the player's expected return is the same and that the longer the player plays, the closer their actual return will converge on this expected value. This demonstration generally provokes an interesting discussion and an opportunity for reflection on individuals' different playing strategies. Of interest is to interrogate with participants whether, in fact, it is possible to play a casino game such as Roulette in a rational attempt to make a positive return on one's capital.

Human learning is very often mediated through repeated experimentation, observation and reflection; see Kahneman (2011). If the outcome being observed is affected by multiple factors then it may be quite difficult for an individual to glean a principle through observation, unless they are able to conduct repeated, controlled experiments. When outcomes are not deterministic but are affected by random variation (such as games of chance) then an observer would at best be able to determine an expected (long-run-average) outcome, but to do this they would need to have access to a large number of observations (repeated experiments). Human reasoning is also affected by known biases which make us prone to such traps as underestimating the chances of poor outcomes and overestimating the chances of favourable outcomes, as well as problems associated with selective recall, as extensively reported by researchers such as Kahneman, Slovic and Tversky (1982). Our brains also take shortcuts via heuristics which can mislead genuine attempts to make rational, informed choices. Allowing gamblers the opportunity to explore games of chance by collecting large numbers of "observations" in a simulated environment, where they are not constrained by any financial concerns, and are not defending their attachment to a particular heuristic (or "system"), provides a platform for rational evaluation of strategies for maximising return.

The game of Roulette provides a repeated experimentation tool which can demonstrate the theoretical statistical concepts of probability, odds, risk and return, expected value, random variable, statistical distribution of a random variable and statistical variability. It is hence a rich environment within which to teach statistics. The simulated Roulette game allows these concepts to be demonstrated, named, discussed and related to everyday decision making, without requiring quantitative skills beyond basic arithmetic. This makes the simulated Roulette game a powerful

educational platform on which to tackle broader statistical illiteracy. The false beliefs that are challenged in this research amongst gamblers would also of course pervade individuals' decision making in other areas of life. Consequently, empowering people with an understanding of the principles which govern decision making under uncertainty will have wider societal benefits.

The Simulated Roulette Game

A virtual spinning wheel on which one can place various bets is created in an MS Excel spreadsheet. Some simplifications are adopted, viz. no split bets are included and only the following bets: *red:black, even:odd, 1st12 ; 2nd12: ; 3rd12* and pure number bets are accommodated, as shown in the layout of Figure 1. "Gamblers" are able to place bets, spin the wheel by clicking on the "play" button and observe the dynamic outcomes of their bets.

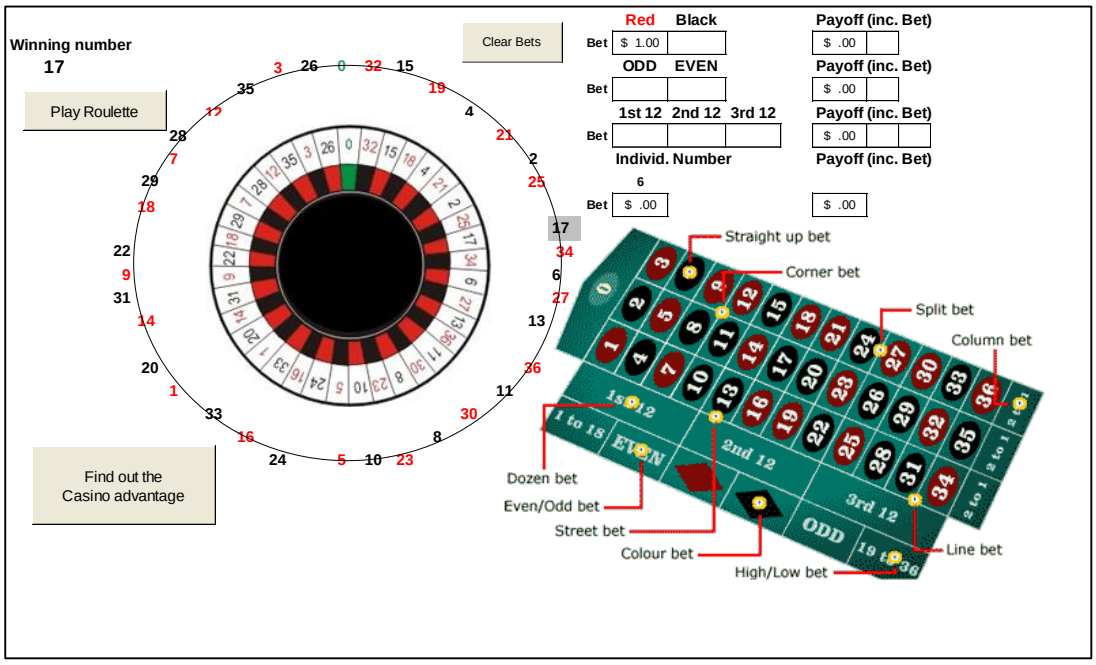

Figure 1 Lay-out of Roulette Wheel and basic betting window in Roulette simulation

The House Advantage of the Game of (European) Roulette

Viewed objectively and from a purely probabilistic perspective, it might not seem sensible for someone to spend a lot of time playing Roulette in a casino. We illustrate this with reference to so-called European roulette, the game with one "zero". The game in this form is played in casinos in, *inter alia*, the UK, Europe, Australia and South Africa. The statistical results indicate, for example, that, whatever the bet or array of bets, the house (casino) can expect a constant expected return of 2.7% per spin of the wheel. Moreover, the standard deviation, or so-called volatility, of this return, decreases steadily, the greater the number of plays. Hence the casino can expect that, over multiple plays, their actual return will steadily converge to this number of 2.7%. Casinos can expect to have a 2.7% return of the total quantum (or "handle") bet, and the greater the number of plays, the higher the chance that the casino's realised return will be close to this expected positive return. Commensurately, the realised loss of participating players must also converge on this figure. How does this affect the gambler? It effectively means that the gambler can play any array of bets and often show a net positive return in the short-term, but it becomes increasingly unlikely that the player will show a net positive return as the period of play increases. The old adage of "when up, head for the door" applies! The problem with this strategy, of course, is that it is not clear if the

gambler should ever return (if they are attempting to maximise return). If a gambler wins on the first play, the strategy which maximises expected return would be to leave the casino for ever. However, that's not much fun if the gambler enjoys gambling. If the gambler doesn't find gambling fun and is there to attempt to win money, the statistics of the exercise are against him.

The pith of the above characteristic of the game of Roulette is demonstrated through the following: *If the gambler just likes to participate and wants to be certain to constrain his losses, he could place a bet on each number (including zero). This way he always wins exactly $36 but it has cost him $37 so he has a certain loss of $1 per play. The volatility of this strategy is zero and the casino is happy to collect the cash each time.*

Of course this "riskless", but sure-fire-way-of-making-a-loss strategy isn't followed very often. A more exciting option might be to place a bet on a number. This way it is quite possible the gambler could have a big win in the short term. In fact such a strategy wouldn't be very popular for the casino because of the high volatility of the return. A worst case scenario for a casino would be one and only one player playing at a Roulette table and betting the maximum bet on a single number at each play. In such a case either the gambler, or the casino, would win big on a particular night. The casino, of course, is interested in realising their expectation of securing 2.7% of the handle over some period, with the lowest volatility (greatest certainty) possible. In fact, to limit the problems associated with patrons winning big on low-odds bets, the casino always imposes a maximum allowable bet on the Roulette tables.

The maximum bet limit scuppers one apparently simple winning strategy; that of simply "doubling up" each time one loses. So, for example, suppose the maximum bet on "*Red*" is set at $200. A "doubling up" strategy, from a starting bet of $1, would require a bet of more than $200 if there was a run of more than 7 losses. Note that a run of exactly 8 losses has a probability of $\left(\frac{19}{37}\right)^8$, about 0.5%, so a 1 in 200 probability event. It would then take more than 200 winning plays to recover from the loss; thus although the "doubling up" strategy has received lots of attention, it is clearly foiled by the maximum bet imposition and thus ceases to be of interest as a rational approach to maximising financial gain.

Development Phase: Student Discussion Groups

The software developed in a bid to educate players in the realities of casino-based games of chance was tested in a series of pilots using student groups. The selected students had spent some weeks learning basic descriptive statistics and had covered introductory level probability theory. The software was developed to be used in a facilitated session focussing on the concept of house advantage in the Game of (European) Roulette[3].

(i) In the initial phase of the exercise, the game of Roulette was explained to the participants and they were encouraged to work in pairs and then were given free range to use the simulated Roulette game[4] to examine the return they receive on (repeated) contrasting bets of their choice. In order to demonstrate the fact that their expected return will remain constant but the variability of that return will differ greatly, it was suggested that they try contrasting bets; for example, play and compare the returns of a *Red* or *Odd* bet versus a *Number* bet.

(ii) The above exercise generally opened up a discussion on the merits of different Roulette strategies. Some players held firm convictions about the efficacy of *particular* strategies and would typically remain unconvinced after laboriously playing the simulated Roulette wheel a number of times. The facilitator suggested to the participants that it would be preferable to observe a large number of plays before reaching any conclusions about the efficacy of these strategies. The participants then proceeded to the option[5] in the software which records and tabulates the results of large numbers of simulated plays. At this stage the cogent point about constant expected value across different bets generally became clearer. If the players continue to use the contrasting bets suggested above, although the observed % profit/loss, referred to as the house advantage, varies across *n* plays, it is much more stable for the low risk bet (*Red* or *Odd*) than the high risk (*Number*) bet. A typical spreadsheet output is shown in Fig 2. The greater the gambler sets the number of plays, the more their loss will converge towards 2.7% . This convergence is much faster in the case of the low risk bet (*Red* or *Odd*).

[3] Available on the website of the South African Responsible Gambling Foundation's National Responsible Gambling Programme on the webpage, **http://www.nrgp-gambling-handbook.co.za/research.htm**

[4] First worksheet (tab *Play_Roulette*)

[5] Second worksheet (tab *MultiplePlays*)

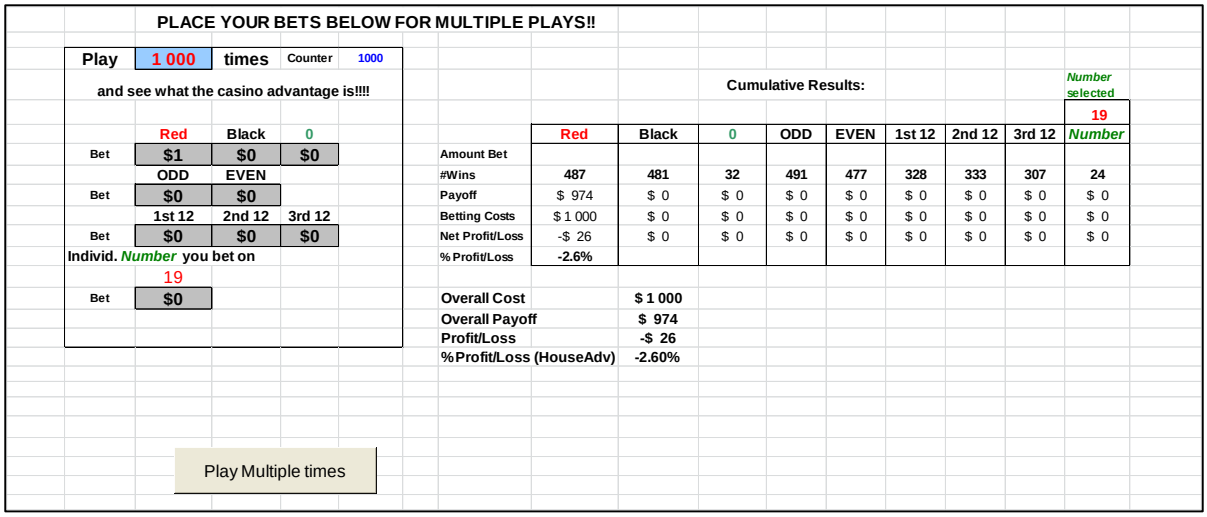

Figure 2: Spreadsheet showing % Profit/Loss for player who makes repeated bets of the same type

(iii) The software has a third level[6] which allows players to empirically build the distribution of the house advantage. The empirical results for selected bets can be observed, followed up by a demonstration that these findings in fact reflect the theoretical concepts of expected value and variance of a random variable. This level has been added in order to challenge those who have grasped the first two levels and who wish to pursue a deeper understanding of the statistical concepts.

Ensuing discussion on the findings of this simulated gaming exercise had players attempting to find a strategy which might defy expectations, and also trying to find the least variable betting strategy. Our experience with this approach during the pilot phase was that participants frequently arrived at the realisation that the casino's profitability hinges on the fact that its house advantage is driven towards certainty as the total number of monetary bets made by all patrons, the so-called casino "handle", increases. Interesting points of discussion that arose included the realisation that the casino would always prefer large spreads of different bets to be placed in Roulette, as they would be at greatest risk when large bets are placed on high pay-out bets, for example a single player at a table playing a high bet on one number. This then leads the casinos to impose maximum bets (limits on the betting). The facilitator ensured that the following general points were highlighted during the discussion groups and through the use of an online quiz at the end of each exercise session:

a) Whatever the bet or combination of bets, the house advantage will, on average, be -2.7%. (We are here assuming no *en prison* or *la partage* rules in this representation of Roulette. These rules operate at some casinos and allow betters on *Red/Black* or *Odd/Even* or *High/Low* to recover their stakes after a spin outcome of *Zero*; such rules lower the house advantage).
b) The larger the number of plays the closer (on average) the house advantage will be to -2.7%
c) The chances of wins, long run expected returns and their variances can be calculated using simple probability rules.

[6] Third worksheet (tab *CasinoAdvantage*)

d) The (empirical) outcomes (of the long run average returns) mirror the expected theoretical results provided sufficient plays (number of bets) are "observed".

Furthermore, participants were encouraged to articulate and debate the role of the following:

- the amount bet,
- the number of plays (reflecting on the Law of Large numbers),
- the probability of a win (betting on say *Red vs* a *Number*),
- the number of simulations,

and the resulting effect on the overall profit/loss and the variability of this profit/loss both from an absolute monetary perspective and a percentage perspective (% profit/loss relative to the outlay). As indicated above, the exercise that was piloted with students progressed from the basic mechanics and probability structure of Roulette (covered in worksheets 1 and 2) to that of exploring the distribution of the casino house advantage. The experience of using this extension with students indicated that appreciation of these concepts required a higher level of statistical training than could be expected from the general gambling public and so this was not included in the gambling workshops.

Focus Groups

A total of four focus group sessions were held in Johannesburg, with a total of 37 participants. Participants were all regular Roulette players (played at least once a month), were mostly black, in full-time employment and with an average age of 31 years (ranging from 21 to 48 years). Sixty per cent of the participants were male and most participants engaged in other forms of gambling besides Roulette; mostly Black Jack and slot machines. All participants had completed their secondary education and had some form of tertiary training, with 80% of them possessing a degree or diploma. Most participants (70% of participants) played Roulette twice a month on average, with around 20% playing weekly and only three individuals (less than 10%) playing *more* frequently, i.e. two to three times a week.

Respondents were asked to complete a questionnaire (a summary version of which is shown in Appendix 2) at the start of each focus group session. They were then asked to revisit the questionnaire at the end of the workshop and to respond to the questions afresh after their experiences with the Roulette simulation.

The workshop began with a brief discussion , with respondents indicating where they played Roulette and whether they played according to some type of "system". About 65% of respondents had some type of formalised approach to their gambling which included the following:

- *play my favourite numbers which include significant dates, etc*
- *play the middle numbers after the ball has fallen on the outside numbers about 3 times in a row*
- *split my chips over half the table*
- *alternate between Red and Black*

- *analyse the table, looking at the frequency of bets and winnings*
- *look at the way the croupier spins*
- *wait for the croupier to spin ten times to see which numbers "come up" and record numbers*
- *play 11 streets* [there are 12 possible "street bets" (each covering 3 numbers, {1, 2, 3}, {4, 5, 6}, …] *and leave out the {16, 17, 18} street*
- *cover 80% of table using 5 chips*
- *wait until early hours of the morning and then attack when the croupiers are tired…*
- *play on someone else's hand*
- *it all depends on whether the croupier spins fast or slow*
- *spread your bets; steam the house and take the potload*
- *I have a complicated number system*

Most respondents indicated that they played for fun (challenge, thrill, excitement, social interaction), with only around 20% of respondents indicating that cash was a motivating factor. Interestingly, those who did indicate that they played to make money had a far higher frequency of play and all of the very high frequency players fell into the group who played to make cash.

After the introductory discussion, the group were shown the MS Excel Roulette simulation and some time was spent on exploring the different possible playing strategies that could be played in the simulation. The participants had varying levels of expertise with, and understanding of Excel and no prior expertise was assumed or found to be necessary. The facilitator encouraged participants to use the software to evaluate different strategies and showed that outcomes of individual spins of the wheel were unpredictable due to the random nature of the spinning process. Thus any evaluation of a strategy could only be based on observing the net position of a player playing a particular strategy over many spins (the long run average return over repeated plays).

The discussions that were provoked by the repeated plays covered a number of interesting themes, including the belief that the casino has the ability to control individual outcomes (via mechanical devices or through skilled spinning) and the widespread view that the quantum of the house advantage was not fixed but was thought to be of the order of 70% (of the total amount bet). Discussion and simulation were interspersed by many stories of observed, uncanny abilities of players to 'beat the house' and of extraordinary wins. The participants in all of the workshops were engaged, focussed and interested in discussing the results of the simulations. The facilitator attempted to address the claims of the participants by focussing on the elements of the Roulette game as captured by the MS Excel simulation and by showing that if the outcomes of the Roulette spins were random we could use simple tenets of probability to determine long run outcomes. All the group discussions post the simulation exercises resulted in a broad dismissal of the idea that the casinos actively controlled the outcomes of individual spins although a couple of individual gamblers had strongly held views on this subject which appeared unshakeable. Analysis of the before and after questionnaires is summarised in Table 1. This table summarises the beliefs of the workshop participants as reflected in their Questionnaire responses before and after being exposed to the simulation exercises.

Question	% of respondents who showed an understanding of the right answer to the question before and after the simulation workshop:	
	Before	After
Do you believe Roulette is a game of chance or controlled by the casino?	51%	57%
Do you believe the casino can be beaten and that you can consistently make money by having a system?	51%	73%
If you have a system, do you believe it ALWAYS works?	38%	60%
What approximate cut (%) of the total amount bet do you think the casinos take in the game of Roulette?	Median response 70%	Median response 2.7%
	Overall 43% showed deeper understanding of house advantage after the workshop	
Do you think the casino makes money EVERY night on the Roulette tables?	Very few individuals showed understanding of the fact that there is a non-zero probability that the Casino loses money on a particular night on the Roulette tables.	
Do you think a casino would prefer (i) one player betting large bets on one number or (ii) 10 players betting small bets on different numbers (where the total amount bet in (i) and (ii) was the same) …or do you think (iii) they wouldn't really care either way?	41% (answered (ii)) Very few individuals grasped this concept	35%

Table 1: Percentage of participants who showed deeper understanding of fundamental concepts underlying Roulette

Overall 65% of participants revised their responses in the questionnaire in a way which showed evidence of learning about the probabilistic principles underlying Roulette through the simulation exercises and discussions.

Those individuals who did *not* change their minds about their initial responses in the questionnaire were more likely to play more frequently (median response: twice a week as opposed to once a week), have lower levels of education (median response: diploma as opposed to degree) and to report using a 'system' which 'worked all the time'.

Discussion

The opening discussions with the workshop participants revealed a variety of approaches to Roulette gambling. Many revolved around playing favourite or 'significant' numbers (birthdays, etc.) which presented as a way of 'personalising' the entertainment experience rather than a reflection of deep attachment to numerology beliefs. Some of the participants made initial attempts to justify a systematic approach to their playing but when probed easily admitted that it was all just 'a bit of fun' and a way of giving over to a world of make believe. Many of these participants responded to the probability revelations quite readily and declared them interesting but unlikely to impact on their playing, given that they really played for fun, were prepared to pay for the associated entertainment, and preferred the veil of magic associated with pursuing 'Lady Luck' rather than the correct, but rather dull, view of Roulette as a game of pure chance, in which a monkey has as much chance as a seasoned gambler of making money.

There were, however, significant elements of each workshop with firmly held convictions around (i) the predictability of winning numbers *("numbers came up in particular patterns…one has to just watch long enough to be able to detect these patterns*") and (ii) the idea of the croupier (on behalf of the casino) as a skilled and active "opponent" in the game who "works on the side of the casino". These gamblers tended to vigorously promote particular systems and defend stories of sustained wealth, earned through skilled and considered Roulette play.

(i) Predictability of winning numbers: The fact that casinos keep a continuously updating display of the winning numbers from previous spins, plays into this fallacy, luring players into attempting to predict the next winning number.

(ii) Players who believe the casino is able to control the outcome of each spin of the wheel through the croupier having the requisite degree of skill, when releasing the ball, that it would settle on a desired number, were likely to play on numbers which were not (or thinly) backed by other players. There were also views that this control could be effected through some sort of trick mechanism (magnets, etc.) which could make the ball settle on a desired number. These gamblers were of the view that part of the casino's strategy in providing free drinks was to put gamblers off their stride in detecting such mechanisms or patterns. They were also likely to include 'watching how the croupier spins' as part of their strategy.

Thus, the Roulette players in the workshops could be regarded as comprising two broad groups:

Group 1: likely to play primarily for entertainment; may or may not have an understanding of the probability mechanisms driving the outcomes; may have a 'system' but not heavily invested in defending it.

Group 2: likely to play for cash (may also play for entertainment), may or may not have an understanding of probability; believe strongly in 'systems' and/or believe strongly in the active role

of the casino in controlling the outcomes (i.e. do not believe the game is governed by chance alone); more likely to play more frequently and play a variety of games.
The latter group appears to have characteristics in common with groups identified by the CPGI as problem gamblers (Barr and Scott, 2010).
An attempt was made to classify participants into these two groups (using 'reason for playing Roulette' and 'do you believe you have a system that works'). Table 2 shows the characteristics of the players grouped according to these criteria. It can be seen that players from Group 2 are far less likely to be influenced by the simulation exercise.

	Group 1	Group 2
Number of participants	13	23
Number of other games played (average)	1.6	1.8
% who changed their responses after the simulation exercises	78%	43%
Average frequency of play	Once a month	Once a week

Table 2: Characteristics of the two types of gamblers (Group 1 and Group 2)

The facilitator concluded that on the basis of both the responses to the questionnaire and the group discussion, 3 participants' responses appeared to show complete lack of understanding of the proceedings of the workshop and responses given were difficult to interpret; 24 individuals held initial views which indicated false beliefs which changed after the simulation; and 10 individuals held initial false beliefs which didn't change at all.

Those individuals who didn't change their minds were more likely to believe they had systems which would work (50%, as opposed to those who did change their minds, where 38% *initially* believed they had a system that always worked, but only 25% believed this *after* the simulation). Those individuals who didn't change their minds were more likely to say that the reason they played Roulette was to make money (40%, as opposed to 4% of those who changed their responses after the simulation).

It is of interest to explore the reactions of players to the simulation exercise. The concept of a house advantage is a non-trivial one, which, it could be argued; one might not expect people to readily grasp. The pilot studies for this project, undertaken with university students studying statistics, indicated that the formula for calculating house advantage may be relatively easy to explain to students who have some basic understanding of the rules of probability, but even these students do not fully comprehend the implications of the statistics they are able to generate. It was particularly interesting to observe the fact that even students with several years of formal study in statistics did not have an intuitive grasp of the expected outcomes of different Roulette strategies. They were only really able to understand (and explain in non-technical language) the implications of house advantage after observing (and exploring) the simulation software. This gave us confidence that gamblers could, through using the simulation software, observe and develop a practical appreciation of probability and a sense of how it governs games of chance, without needing to know the basic tenets of probability. To a large extent it proved to be the case that gamblers could develop an appreciation of probability, and how outcomes of games of chance are linked to probability rules. Participants did probe the results of the simulations, did ask questions about

probability rules, and did appear to consider the implications of the simulations to be interesting and informative. Some participants took longer to convince, but none of the participants disputed the evidence that Roulette is a game of chance which is transparently set up such that, in the long run, the Casino expects to make a return of 2.7% of the value of the bets placed. Many of the participants expressed surprise at how low this figure was (the median estimate for this figure before the simulations was 70%). It was necessary, of course, to emphasise that house advantage is an expected erosion effect operating on the total amount bet. Thus if a gambler plays Roulette with an initial amount of $1000, plays 100 times, betting $50 each time, by the end of the betting she will have gambled a total of $5000 but of that may have won back $4 600 and so will leave the session. with $400. However, the 60% which this amount represents (of the starting funds) is not an estimate of house advantage, which remains at 2.7% It merely indicates how much an individual player was up or down on a particular occasion at the point at which they stopped gambling – for example because they had run out of time.

Many of the participants were surprised and a little disappointed at the fact that the simulation exercises indicated that there were no systems which could "work" (i.e. deliver a positive expected return) in Roulette. Those who had indicated that they played Roulette in order to make money, and who had not appeared to change their minds after exposure to the simulations, remained unmoved. Interestingly, they did not challenge the evidence, except to say that they still believed that casinos would always make money because they 'rigged' their Roulette tables which meant that it was no longer a game of pure chance. On arguing that this was not necessary as the game was transparently set up to deliver a long run profit to the casinos, which would be subject to audit and scrutiny by regulatory boards, again this was not disputed but it appeared not to influence the opinion of those who held that view.

There was a pervasive belief that croupier's can "place" a ball in an area of the table. The counter argument that casinos could never offer Roulette if such a skill were indeed possible, because the casino would be open to abuse from betting friends of the croupier who can "place" a ball, was ineffective in challenging this belief.

When asked whether, subsequent to the simulation workshops, participants felt they would change their gambling behaviour, most respondents responded that, despite having learnt facts about Roulette which surprised and interested them, they would probably continue as before, except perhaps with lower expectations! In each workshop, however, there were a few participants (7 in total) who said that they would probably gamble less frequently, more cautiously, spend less on gambling and/or gamble with less enjoyment!

Conclusions and Future Work

A question which arises is, given that many participants indicated they now had new insights into gambling, why would many of them not change their gambling habits? In part, the answer may lie in the fact that most of the Roulette players included in the workshops appeared to have systems (such as limiting the amount of money they took to casinos or using other stopping rules) to regulate their gambling, which, although a frequent activity, did not impact negatively upon their lives. They thus did not have any reason to moderate their gambling behaviour further. Probably a more important part of the answer lies in the fact thatthe Group 1 gamblers, at least, did not have strongly held beliefs about systems and were quite easily persuaded that these systems could be shown not to

work. What motivated them was the fact that they were enthralled with the magic of gambling and the make-believe world of casinos in such a way that they preferred not to have the secrets revealed in all their dull predictability. Part of the entertainment that they were prepared to pay for was the mystique of magical number sequences and the telling of stories of big wins and clever systems. The casinos play into this with the boards which display numbers, giving an air of 'systematics' as well as creating an ambience of make-believe world using evocative lighting effects and sounds, free drinks and glamour. For many gamblers this is what they pay for, and a tutorial on probability is like switching on the lights and turning off the music; it causes the spirit of what they are prepared to pay for to evaporate. Most of the gamblers (the Group 1 participants) were not seemingly at risk of becoming problem gamblers and appeared to be able to assimilate some important probability concepts whilst still choosing to behave as if they weren't aware of them. A few gamblers appeared genuinely to shift their views on gambling to the point where it may well change their gambling patterns. One such participant, when asked whether he felt his gambling would alter, responded by saying, *"Yes. Maybe I'll rather choose one of my friends, or a charity, and donate my 2.7% to them!"* However, gamblers in Group 2 appeared to have characteristics which could put them at risk of problem gambling and were less likely to examine their firmly held convictions on gambling strategies and their efficacy.

This paper described the use of a short, one-off simulation exercise in teaching gamblers about the probability basics of games of chance. It is suggested that future work in this area concentrate on exploring the effect of longer term exposure to learning about these concepts through simulation, and on following up the long term impacts on gambling behaviour.

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Appendix 2: Questionnaire for Workshop respondents (abridged).

1 Name

2 Age

3 Gender

4 Email address

5 How often do you play Roulette?

6 What other forms of gambling do you regularly practice?

7 What is your highest level of education?

8

Employment Status	Unemployed
	Occasionally employed
	Part-time employed
	Fully employed
	Other……

9 Do you believe Roulette is a game of chance or controlled by the casino?

10 Do you believe the casino can be beaten and that you can consistently make money by having a system?

11 Can you describe any systems?

12 If you have a system, do you believe it ALWAYS works?

13 Have you ever tried the strategy/system known as “doubling up”? What do you think of this?

14 What is the main reason why you play roulette?

15

How would you describe your Roulette playing? Has it been….	Always enjoyable?
	Mostly enjoyable?
	Mixed (both enjoyable and unpleasant times)?
	Mostly unpleasant?
	Always unpleasant?

16 What approximate cut (%) of the total amount bet do you think the casinos take in the game of Roulette?

17 Do you think the casino makes money EVERY night on the Roulette tables?

18 Do you think a casino would prefer

(i) one player betting large bets on one number or

(ii) 10 players betting small bets on different numbers

(where the total amount bet in (i) and (ii) was the same) …or do you think

(iii) they wouldn't really care either way?

I think there's plenty of interesting material here which other people have never looked at, which has potentially important implications for addressing problem gambling issue world-wide and which should therefore br disseminated through the peer-reviewing process. I syupposes trhat means playing the "research paper" game – on ehat, as I've said before – I personally hate and despise and thin gives academica a deservedly bad name for triviality, peuso-science and general uselessness from the point of view ogf those who pay for the work.

I think the paper would benefit from a clearer statement at the beginning of what it is proposing to do and why (i.e. 1. To start testing a hypothesis about beliefs and gambling and 2) to show the usefulness of the software in both teachiong contexts and CBT-type therapeutic contxts. (These too obejctives need to be plausibly kinked somehow within a ssealess argument qwithin the paper and I can think of different ways of doing that – e.g. by say that the one purpose is incidental to the other and therefore the emphasis in *This* paper is on the hypothesis –testing. I don't know what it's possible to do about the standard touresome literature review which journals insist on out of editorial laziness. I also think you should put in something about the limitations of the research to the extent that applies to all experimentsal lab-based testing of human behaviour in non-real situatuions.

The two questions this paper most usefully suggest to me are 1. That people who get into trouble are people who are boht refuse or are unable to shed demonstrably false beliefs which underpin their reason for gambling as being to make money; and 2) the question of the extent to which the suspension of bisbelief is part of the healthy enjoyment of gambling as is watching scary moveies or, in some sense riding roller-coasters. For another day, is the question of what is the role of the illusion of skill in playing roulette compared with its role in poker or even blackjack.

Let's talk further when I have digested this. P.