

Games and Systems

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Games and Systems

by Nigel Turner and Barry Fritz

Introduction

The focus of this chapter is on common gambling games played by people with gambling problems and the strategies or systems they use to attempt to beat these games. This chapter has several goals:

(1) As a therapist, it is not important to know the full range of possible plays for each type of game, but a general understanding of the game played by a client might help the therapist develop a rapport with the client and give the therapist some insight into the needs the game fills for that client.

(2) The results of interviews and group discussions indicate that a basic understanding of a game can improve a therapist's credibility when challenging gambling myths. Our gambling treatment colleagues caution, however, not to get into head-to-head battles with clients over their systems. Some clients have a very strong faith in their system. One of our colleagues focuses not so much on the myth but on the outcome of the belief by discussing the failure of the system (e.g., the debts that have resulted in spite of the "logic" of the client's system).

(3) We also believe that understanding the experience of the gambler is an important step towards understanding gambling problems. For example, incremental betting strategies are based on mistaken notions about the nature of random chance. A person who adopts such a strategy, however, actually experiences much more substantial positive reinforcement than one who bets the same amount each time. The strategy itself may be the cause of the gambler's problems—both the addiction and the resulting debts. Systems of play invariably push around random numbers in such a way that the outcomes no longer seem random but appear to be under the control of the player (see Turner & Horbay, 2003). Thus a system player is left with a strong illusion of control.

(4) We also believe that some understanding of the games themselves is necessary in order to understand the difference between problem and non-problem gambling.

(5) Finally, we hope that the definitions in this chapter will serve as a useful resource for the development of gambling-related education information.

Many books have been written on how to gamble. Books on how to gamble in general give relatively accurate descriptions of the games (see Turner, Fritz, & Mackenzie, 2003). Books on specific games of skill are generally accurate, but often contain some misinformation.

Books on non-skill games, or games of luck, are generally inaccurate, with a wide variety of misinformation.

The authors' knowledge of these games comes from reading books (see Turner, Fritz, & Mackenzie, 2003), attending conference presentations about game strategies (e.g., Thirteenth International Conference on Gambling and Risk Taking), conducting simulations (see Turner & Fritz, 2002) and playing the games themselves. This chapter discusses the more common games. For more information about specific games, we recommend Darwin Ortiz's *On Casino Gambling* (1986), Wong and Spector's *The Complete Idiot's Guide to Gambling Like a Pro* (1996), Reber's *The New Gambler's Bible* (1996), and Harroch, Krieger and Reber's *Gambling for Dummies* (2001). They each give detailed accounts of the rules and attempt to correct some of the common errors that people make regarding gambling. Other books, magazines and websites on "how to gamble" can also be found. Many such materials, however, contain factual errors (see Turner, Fritz, & Mackenzie, 2003).

This chapter begins with an overview in Part 1 of the types of games that people play; it also discusses the concept of the payback percentage. Part 2 covers games of chance. Part 3 covers strategies or systems that people use in games of chance. Part 4 is an introduction to games of skill. Part 5 describes in detail blackjack and card counting. Part 6 discusses the game of poker. Part 7 covers games involving subjective probability, such as horse betting, sports betting and playing the stock market. Finally, Part 8 briefly discusses betting on games that one is playing in.

Part 1: Gambling and the House Advantage

Games

Most gambling games fall into one of four categories based on the role probability plays in the outcome.

Games of Pure Chance

In games of pure chance, the underlying events on which gamblers bet are both random and independent, and the player has no real opportunity to make a profit in the long term. The outcome of the game depends entirely on the results of a random number generator such as dice, bingo balls or a slot machine. Examples of games of pure chance include:

- lotteries,
- keno,
- bingo,
- slot machines,

- roulette,
- craps, and
- baccarat.

Games of Both Skill and Luck

Although a random number generator plays an important role in these games (e.g., a shuffled deck of cards), the player's success also depends on his/her knowledge, strategies and decisions while playing. A good player can minimize losses with poor hands and maximize wins with good hands. Examples of games of both luck and skill include:

- blackjack,
- poker, and
- dominoes.

Games of Subjective Probability

These games are not actually random, and the outcome of one event (a game this week) is not independent of a later outcome (a game next week with the same players). Teams or horses differ in their actual ability to win. The complex nature of the games, however, and the inclusion of uncertain events (e.g., pitching, batting, catching and running) add some degree of random chance to the outcomes of the games. In these games a bettor is pitted, not against the actual outcomes of the games, but against the subjective guesses of the gambling industry about the outcomes (e.g., the odds, point spread, or money line set by a bookie) or against the mass habits of other bettors (e.g., parimutuel odds or the fluctuating prices of the stock market). Examples of this form of gambling include:

- sports betting,
- horse race betting, and
- stock market investing.

Games of True Skill

Sometimes people place bets on skilled games that they are engaged in. These are private bets between individuals and will only be dealt with briefly in this chapter. Unlike games of both skill and luck, such as cards and dominoes, which include a random number generator, in games of true skill, no random number generator is used. A dart or bowling ball will not always go where the player aims, but as their level of skill increases, uncertainty is reduced. Examples of common games of skill that people bet on include:

- golf,
- chess,
- hoops and one-on-one (forms of basketball),

- pool, and
- darts.

Expected Return, House Edge and Payback Percentage

Sometimes people use the expression “the odds are against you” or “those are good odds” when evaluating a particular game. In reality the odds (or more accurately, probability) of a win is not all that important in determining whether a game is a “good” or “bad” bet. If a player placed bets on all 38 slots on a roulette wheel, they would have a 100% chance of winning, but it would result in a net loss of \$2. What is important for people who gamble to know is the relationship between the chance of winning and the amount of money they get paid for a win. In all commercial gambling, the player does not get paid enough for a win to make up for their losses when they do not win. This difference is called the house edge. In the case of American roulette, the house edge is \$2 for every \$38 bet or 5.3%

There is often confusion about terms used to describe the house edge. “House edge,” “house advantage,” “payback percentage” and “expected return” are different words for describing the same basic idea: the games are set up in such a way that, in the long run, the house will make money from the game. The math is simple, but the terminology can be confusing.

The house edge is the percentage of money that the player can expect to lose on each bet, averaged over the long term. The payback is the percentage of money the player can expect to get back from each bet, averaged over the long term. If the payback rate is less than 100%, as it is in all commercial gambling, it means that on average the player will lose money. The house edge and the payback add up to 100%. In American roulette the payback percentage is 94.7% and the house edge is 5.3% ($94.7 + 5.3 = 100\%$).

To make matters a little more confusing, sometimes the phrases “player’s disadvantage” and “expected return” are also used. The expected return is simply the house edge with a negative sign in front of it and is most often used in mathematical discussion of probability. Casinos, however, are more likely to describe their games in terms of payback percentage. Their choice of terms is no doubt a deliberate ploy to emphasize what the player gets back (e.g., 94.7%) rather than what the player does not get back (e.g., 5.3%). To avoid confusion, we will use the term payback percentage

What does a payback of 90% mean? Suppose a man started with \$120, played for 2¼ hours on a 25-cent slot machine and now has \$20 left. “Where’s my 90% payback?” he asks himself. A 90% payback does not mean the player wins 90% of the time. It does not mean the player wins back 90% of what he/she has lost. It does not mean that the player is ever due to

win. It does not mean that the player gets back 90% of what he/she started with. It means that, for *each* bet, the player loses 10% (house edge).

In the process of losing \$100 on a 25-cent machine over the course of 2¼ hours (assuming 75 cents per spin, 10 spins per minute), the player will actually make about \$1,000 in bets. A 90% payback means the player loses 10% of what he/she actually bets. Ten percent of \$1,000 is \$100. A loss of \$100 is a 90% payback! So the 90% payback is 90% of the \$1,000 the player bet, not 90% of the \$120 that the player started with. The reason that people often lose most of their money, even when the payback is 90%, is that they reinvest their winnings in the game. The temporary wins in the cycle of bet-win-bet-lose that gradually eats away at a player's money is called the "churn." Players who keep reinvesting their winnings will eventually lose it all. A player can test this by using a player's card. Many casinos offer point cards that give the player 1 point per \$10 bet; the points can be redeemed for a rebate. If you played until you lost \$100 on the same slot machine, you would find that you had earned close to 100 points (good for a rebate of about \$5 in some casinos), indicating that you had in fact placed \$1,000 in bets. (Note that actual results will vary.)

A payback of 90% means losing 10%, on average, of what is actually bet. However, if gambling simply meant losing 10 cents on each and every \$1 spin of a slot machine, it is doubtful that anyone would play. But gambling involves fundamental uncertainty. Sometimes the players win, sometimes they lose. On average, players lose, but often they do in fact win, at least in the short term. The occasional win makes it difficult for the player to determine the actual house edge while playing.

The volatility of a game is the bet-to-bet variation in actual outcome. For example, on any one bet a player might lose, win back what was bet, win double the bet, or win 10 times the bet. Slots are very volatile; a player could win 1,000 times his/her bet. In any playing session, the erratic nature of the wins and losses and the volatility of the game make it impossible for the player to determine the size of the house advantage (see Turner & Horbay, 2003, for examples).

How the House Edge Works

In gambling, the house achieves its edge by paying back less than the true odds of winning. In many games, the house edge is hidden so that the player cannot exactly determine the edge from merely playing the game. The house edge is accomplished in different ways for different games, but is particularly easy to illustrate in the case of roulette.

Roulette

The roulette wheel contains 36 numbered slots that are coloured black or red (1–36) and two slots that are coloured green (0 and 00), for a total of 38 slots. If a player bet on one number, the probability of winning is $1/38$, but the payout for a win is only 36 chips. If the player bets a one-dollar chip on 17 and the ball comes to rest in slot 17, the player is paid \$36. (Note that in actual roulette play, the payback comes in the form of \$35 placed beside the player's bet, and the player gets to keep the original \$1 bet). The 2 green slots conveniently represent the house's profit per bet (2 chips for every 38 chips bet). It is not the green slots per se that determine the house edge, but the fact that the player is paid only 36 chips for a win, as if the green slots did not exist. Thus the payback for playing the roulette wheel is $36/38$ (94.7%). The difference between the payout odds and the true odds—2 chips—goes to the house.

Because of the random and unpredictable results of each spin of the roulette wheel, a player's wins and losses vary greatly. A player could win several times in a row or lose for hours and hours. The longer a gambler stays at the table, however, the more his/her betting is likely to approach the situation of a gambler who places a bet on every one of the 38 numbers. (Even if the gambler keeps betting the same number over and over, the random variations of the wheel still make this case.) As a result, the player will lose, on average, 2 chips for every 38 chips bet.

Slots, Lotteries and Keno

The same approach to payouts is used in games with multiple possible wins, such as slots, lotteries and keno. In each case, the total payouts reflect less than the true odds of winning. Figuring out the house edge in these games, however, is more complex. The odds of winning the top prize on a slot machine might be 1 in 200,000 for a payout of 8,000 times the original bet. This may seem like a very poor return—substantially less than the odds of winning—but when all the possible paybacks on every bet are added up, the total payback percentage is usually between 90% and 97%. Table 1 illustrates how to compute the total payback using the payout table of a fictitious slot machine. Notice how most of the payback is returned to the player in the small prizes, not the large prizes. A payout table for a real slot machine would have many more prizes, some smaller, some larger.

Table 1. Hypothetical payout table for a slot machine.

Match	Probability	Credits paid	Return (probability times prize)
3 Double diamonds	0.000004	\$8,000	0.032
3 Sevens	0.0000364	\$1,000	0.0364
3 Cherries	0.000122	\$300.00	0.036607
3 Bars	0.07	\$5.00	0.35
1 Cherry	0.1488	\$3.00	0.4464
Total probability of a win or hit rate	0.2181 (21.8%)	Total return (Payback)	0.901 (90.1%)

Note this is just an illustration; real slots payout tables usually have a lot more winning combinations. Note how the small prizes make up most of the payback.

Horse Race Betting

In horse racing, the racetrack takes a cut off the top of the total pool of money bet, and then distributes the rest to the winners. The clever part, however, is how the racetrack uses odds to make the bettor's chances seem better than they really are. Mathematically, odds are a means of reporting probability that expresses the ratio of chances of losing to chances of winning. A probability of 1/10 or 10% translates into odds of 9 to 1 (9 chances of losing to 1 chance of winning). The odds reported by the racetrack, however, are not an estimate of probability but a statement of the payout for each horse. If a horse's posted odds were translated into a percentage, it would be higher than the true probability of the horse winning.

A racetrack might quote a horse at 2 to 1 (a 33% chance of winning), but its true odds might be 3 to 1 (a 25% chance of winning). If the player places a \$2 bet on the horse and wins, he/she gets back \$6 (\$4 win + \$2 bet). If the player were paid according to the true odds, he/she would get back \$8 (\$6 win + \$2 bet).

If the posted odds for every horse in a race were converted into percentages and then added up, the total would be over 130%. Of course the total of all the horses' actual chances of winning must add up to 100% because only one horse can win.

Suppose 5 horses are running in a race. The favourite is quoted at 3 to 2 (a 40% of winning), another horse is quoted at 2 to 1 (33%), another is quoted at 3 to 1 (25%), one is quoted at 4 to 1 (20%), and last horse is quoted at 5 to 1 (16.6%). Adding up the percentages (40 + 33 + 25 + 20 + 16.6) gives a total of 134%. By overestimating each horse's chances, the racetrack pays out less than the true risk of each bet, thus ensuring itself a profit. The use of odds, however, to describe the horses' chances of winning hides this fact.

Other Betting Games

In other games, the house edge is achieved through a commission (e.g., baccarat, craps and the stock market), a vigorish, which is a fee charged by a bookie to accept a bet (e.g., sports betting), or a rake percentage of the win (e.g., poker). In blackjack, the house edge comes from the fact that when the dealer and the player both bust (exceed 21), the house still wins. In games such as slots or bingo, the odds are unknown to the player, but the mechanics of how the house makes its money are the same.

Table 2 gives a summary of the payback percentages of a variety of games. Note that in many games the payback can depend on how well the game is played, so Table 2 is more an approximation than an authoritative guide. A comprehensive source of information on casino games and how the bets work can be found at the internet site The Wizard of Odds (<http://www.wizardofodds.com>).

Table 2. Approximate payback percentage of different types of gambling.

Game	Specific Bets	Approximate Payback	Notes
Craps	Pass, don't-pass, come, don't-come	98.6%	Higher than 99% if the player adds an additional free-odds bet.
Craps	Other bets	84%-98.3%	
Roulette	American (0, 00)	94.7%	
	European (0)	97.4%	Most bets
		98.7%	Even-money bets with surrender
Blackjack	Any	94%-99.5%	Payback depends on skill and the specific rules used at the casino.
	With card counting	99%-105%	
Baccarat	Banker bets	98.8%	
	Player bets	98.6%	

	Tie bets	91.0%	
Slots	Line games	85%-98%	Higher denomination (e.g., \$5) slots have a higher payback.
Bingo	Any	85%-100%	Depends on size of prize and the number of bingo cards in play.
Horse racing	Ordinary bets	83%	Depends on the skill of the player and of other players.
	Exotic bets (daily double)	75%-83%	
Sports bets	Any	95.4%	Based on 9% commission charged by the bookie, but is also influenced by skill.
Poker	Casino games such as hold 'em or 7-card stud.	95% to 98%	Depends on the size of the rake (e.g., 5%). The rake percentage varies and is usually capped at some maximum. Games with larger bets usually have a smaller rake or a flat rate table fee.
Stock Market	Short term	90%-99%	Based on the size of the broker's commission. For larger investments, some brokers charge a lower commission.

Note that many of the games have variations and different bets that make a specific payback percentage difficult to pin down. In this table we have tried to indicate the approximate payback only. For stock market investments, the average return is positive for long-term investments (as high as +10% per year), but with frequent short-term investments (e.g., day trading) the commission decreases the profitability of investments.

Playing Multiple Hands, Tickets or Bets

Understanding the house edge helps explain why playing multiple hands, numbers or bingo cards provides no real advantage. The actual loss is based on the total amount of money that is gambled. If a player bought two tickets instead of one, the probability of winning doubles, but the expected loss also doubles. As discussed above, playing all 38 numbers of an American roulette wheel would guarantee a loss of \$2 per spin of the wheel. The payback percentage ($2/38$) when a player covers the entire wheel is exactly the same as when a player covers only one number. The same is true for multiple hands, tickets, cards or bets. It does not matter how many tickets a player buys, the payback percentage remains the same. Making multiple bets, however, usually means betting more money. When the bet is doubled, the expected loss is also doubled. This is an important point, if the payback is less than 100%, the more that is bet the more that is lost in the long run.

Part 2: Games of Chance

Games of pure chance are the simplest gambling activities. Anyone can win—or lose. Games of chance offer excitement and a sense of escape that is accessible to all players. Players with a gambling problem can be found at any of these games. People who like to play games with a lot of action (action gamblers) are attracted to the complexity and challenge of craps, roulette and baccarat. People who play to escape tend to gravitate towards slots and instant lotteries.

Lotteries

Lotteries are the most popular form of gambling. The basic premise is straightforward: the player buys a ticket and wins if the numbers on the ticket match the numbers that are drawn. In most lotteries, players can win smaller prizes by matching only some of the numbers drawn. In lotteries with predetermined ticket numbers (e.g., raffles), the probability of a win is determined by how many tickets are sold. In lotteries where players pick their own numbers, the odds are determined by how many unique combinations of numbers are possible.

In *Lotto 6/49* in Ontario, the player picks 6 numbers from a pool of numbers ranging from 1 to 49, which results in approximately 14 million possible unique combinations of the 49 numbers. The winning numbers are drawn without replacement from the same ball cage so that a particular number can only occur once on a ticket. Note that each draw begins with all 49 balls, so all draws are independently random of each other. In other lotteries (e.g., Ontario's *Pick 3*), each number might be drawn from a separate cage of balls so that the same number might appear more than once on the same ticket.

In many lotteries, the top prize changes with each draw. If no one wins, the prize money is rolled over so that the prize on the next draw is larger. If the *Lotto 6/49* prize, for example, reaches greater than 14 million, the expected return is positive and long-term profit is theoretically possible. However, lotteries make most of their money during the long runs when the prize value steadily increases. Since these lotteries usually allow more than one person to buy the same ticket number, there is a chance that the prize will have to be split between multiple winners. The larger the prize, the more tickets are sold and the greater the chance that the prize will be split. As a result, even when the prize exceeds the odds against winning it, the players may still be playing against a negative expected return.

Keno

Keno is a type of lottery in which a player buys tickets made up of between 1 to 15 numbers chosen from a total of 80 numbers. That is, a player's ticket might consist of 3, 4, or even 15 numbers. Twenty numbers are drawn randomly from either ball cages or a computer

generator. The player wins if some of their numbers are drawn. The more of a player's numbers that are drawn, the higher the prize. The more numbers the player bets on, the more numbers he/she must match in order to win a prize. A player who bets on only one number triples his/her money if it is drawn. But if a player selects 6 numbers, matching 1 number pays nothing. Matching 15 numbers pays a very large prize.

Instant Lotteries

Instant lotteries are sold as tickets on which the player matches 3 symbols or prize values by scratching off a removable plastic coating. Nevada tickets, pull tabs and break-open tickets are essentially the same as instant lottery tickets, but the symbols are hidden by a cardboard flap and the symbols are similar to slot machine symbols (e.g., lemons and cherries).

An instant bingo ticket has a "caller" box of hidden numbers and up to four player cards whose numbers are visible. The player scratches to reveal the hidden caller numbers and then scratches matching numbers on the player cards, which are also covered by a scratchable coating.

Instant crosswords are essentially the same as instant bingo cards except that the player matches a series of hidden letters in one box with visible letters in a crossword puzzle to form words.

In Ontario, *Instant Keno* is a ticket that essentially mimics live keno. On one side is a pre-set selection of 3, 4, 5, 6 and 10 numbers. On the other side of the ticket is a set of hidden numbers that represent the numbers drawn. The player can win by matching some or all of the numbers. The more numbers matched, the bigger the prize.

With instant bingo, keno and crossword tickets, the player can see the numbers or letters on the game card area before buying the ticket (but not the hidden numbers or letters). The visible numbers may feed an illusion of control by encouraging the player to look for lucky numbers or numbers that are due to win, or to search for biases.

Bingo

Bingo involves matching randomly drawn numbers to numbers printed on a card in a 5 by 5 grid. Before the game, the caller announces the pattern that must be completed for a win. The pattern is most often a line, 2 lines, or a completed card, but it could also be an X, T, Y, Z or box pattern. The caller draws bingo balls one at a time, each of which is marked with a number, and these numbers are posted on a board. Players stamp or cover the matching numbers on their card(s) until the matched numbers form the required pattern. The first player to complete the pattern yells "Bingo!" to claim the prize. A prize might be given out for the

first line completed after which the game continues until someone completes the entire card. If more than one player completes the pattern or card at the same time, the prize is split.

A player with well-developed memory and attention skills is able to play more cards simultaneously; the cognitive exercise of playing multiple cards may even be beneficial to some players. The first author reports having difficulty keeping up with the caller with only 3 cards in front of him and was quite impressed by the little old ladies who were happily playing 9 or more cards. Although playing more cards increases the frequency of wins, it does not improve the long-term payback for these “skilled” players. Winning at bingo is merely a matter of random chance. A player who attempts to monitor 18 bingo cards but can not keep up with the caller would actually decrease his/her payback percentage compared to a less ambitious player with only 3 cards. Recent advances in electronic bingo may allow people to play more cards, but might also remove the beneficial effect of bingo on memory and motor skills.

A bingo session is a series of about 10 individual games. A session usually takes 2 to 3 hours, depending on breaks and on how long it takes to find and verify the winners. Bingo is a social game that often serves an important social function for women and older adults; most socializing occurs between games.

Games with progressive (growing) jackpots and networked games with super jackpots are now available; however, the players’ odds of winning in these games are lower.

Slot Machines, Video Lottery Terminals (VLTs) and Electronic Gambling Machines

The following is a brief introduction to the nature of slot machines. For a more comprehensive discussion of slots, see Turner and Horbay (2004).

The basic game of a slot machine involves setting 3 or more reels into motion by pressing a “spin” button, a spin icon on a computer screen or, on older machines, pulling a lever. When the reels stop spinning, if matching symbols from all 3 line up on a payline, the player wins. Some machines have 5 reels or multiple paylines. Common symbols include lemons, cherries, lucky sevens, and diamonds. The amount of the win varies depending on the rarity of the symbol.

The wins are recorded on an LED readout (or on a video screen) that notifies the player how many credits he/she has won. If the player wins more credits than the machine can pay out, a light on top of the machine goes off notifying the casino of a big win. The payout of the machine is determined by the odds against winning, not by how recently the machine has paid out.

A slot machine can either have actual physical reels or a video display. The game play is essentially the same on either reel or video slots; however, the video display allows the programmer to incorporate a much greater variety of gambling experiences (e.g., bonus features) into the game than is possible with physical reels.

A video lottery terminal (VLT) is a gambling machine that provides a variety of games, including simulated slot machine games, video poker and blackjack. It is called a terminal because the random numbers are often generated by a central system, rather than within the machine itself. The central determination system allows such machines to be legally classed as lotteries rather than slots, but from the players' perspective this distinction is irrelevant.

There is no skill in slot play, but VLTs often include blackjack and video-poker games that do involve some degree of skill. Accordingly, in a treatment situation, it may be important to find out what types of games the player actually plays (e.g., line games or video poker) to determine which of the client's beliefs are erroneous. Laws in some states in the U.S. encourage or require skill elements in slot games. Most of these are pseudo-skill elements so that the game provides no real opportunity for skilled play (Griffith, 1993, 1999). Because of bonuses and progressive jackpots, the payback percentage will vary, but, in general, there is simply no way to beat a slot machine.

When slot machines were first invented over 100 years ago, they consisted of 3 flywheels that were set in motion by the pull of the lever. The force of the spin would, to some extent, determine how far the reels would turn. It was possible to manipulate the outcome by carefully controlling (or tampering with) the lever. Some players still believe that it is possible to win by controlling the lever. Modern slot machines are computers. The reels themselves only serve to tell the player if they have won or not; they do not determine if the play wins. A random number generator (RNG) determines the wins and losses on a slot. Before the reel is even set in motion, the computer uses a number drawn from its RNG to determine where the reel will stop. The computer predetermines that the reel should land on the symbol for, say, a cherry, and it spins it to that location.

A slot machine reel might have 22 pictures on it (oranges, cherries, diamonds, blanks between the pictures, etc.), and some pictures appear more frequently on the reel than others. There is, however, no way to tell how likely a symbol will occur based on looking at the reel. The odds of a reel landing on a particular picture do not depend on how many pictures there are, but on how many "stops" are associated with the picture in the computer's memory. Programmed into the computer is a table called the virtual reel that maps the numbers selected by the RNG to particular symbols.

Suppose the RNG was programmed to generate a number from 1 to 64. Each of these 64 possible numbers is related to a stop on a virtual reel, and the stops on the virtual reel are mapped onto the 22 symbols of the actual reel. The actual reel might have 2 double diamond pictures on it out of 22 total pictures. The virtual reel, however, might map only 2 of its 64 numbers onto double diamonds. Virtual reel weighting ensures that low paying symbols and blanks come up more often than high paying symbols. The apparent probability of a double diamond on the reel might be 1 in 22, but the actual probability of a hit might be 2 in 64. This means that instead of a jackpot coming up 1 in 10,648 spins, a jackpot's actual probability would be 1 in 32,000 spins (assuming that all 3 reels have the same probability). To make things more complex, there is no particular reason why a symbol should have the same frequency on the 3 reels, virtual or otherwise. It is important to understand that the outcome on the payline is still random, but the placement of the images on the reel itself and the neighbors above and below the payline give the player a distorted picture of his/her chances of winning.

There are numerous myths about slot machines. For example, many people believe they have to stay at a particular machine because it is due to win. Each spin is an independent random event. The history of the machine's play is irrelevant. A machine is never due to win. In addition, because a computer, not the spinning of the actual reels, determines the outcomes of a slot, there is no such thing as a near miss. A near miss is simply a loss (see Turner & Horbay, 2004, for a discussion of other myths about slots).

Roulette

The roulette wheel consists of a fixed outer rim and a rotating inner wheel. The wheel is rotated in one direction and the ball is thrown in the opposite direction around the inside of the outer rim. As the ball starts to slow down, the ball drops down off the rim, rolls around the inner wheel and eventually comes to rest on one of the numbered slots. On an American-style roulette wheel, there are 38 slots numbered 1 to 36, as well as two slots numbered 0 and 00. Eighteen of these numbers are red, eighteen are black; 0 and 00 are painted green. The numbers are scattered around the wheel in an apparently random order; however, the arrangement ensures that black and red, high and low, and odd and even alternate around the wheel. A European wheel (available in Quebec) is essentially the same, but has only one 0, giving it slightly better odds for the player. Apparently, some wheels have a third green number, often with an Indian head (Wong & Spector, 1996), giving slightly worse odds for the player, but neither authors have seen one of these wheels.

Players bet by placing their wagers on a green felt betting table. The numbers on the betting table are arranged in order from 1 to 36 in 12 rows of 3 columns. At one end are the zeros (0

and 00). Bets placed on individual numbers are called inside or straight-up number bets. These bets pay 35 to 1. A player can bet on a single number or several numbers. A player also has the option of placing a single chip across two numbers, four numbers (a corner), 3 numbers (a street) or six numbers (a double street). A player can increase his/her chance of winning by covering more spaces, but will win less. A \$10 bet on a single number pays \$350 (plus the player keeps the \$10 bet). A \$10 bet covering 4 numbers pays \$80 (plus the player keeps the \$10 bet). Around the outside of the betting table are spaces for betting on multiple numbers such as all of the red, black, high, low, odd or even numbers, which pay even money (that is, the payout odds are 1 to 1; the win equals the amount bet, plus the player keeps his or her bet). Bets on a 12-number column pay 2 to 1.

Roulette is unique in that it is the only game where the house edge is clearly marked (i.e., 2 green spaces out of 38 spaces). The math behind roulette is quite clever in that there are many different types of bets, but nearly all have the same house edge.

Craps

Craps or dice, like roulette, is a table game that gives the player a wide range of betting options, and a very slim house edge. Craps is one of the fastest, most exciting and noisy casino games. There is no skill involved in winning, but because of the complexity of the game and the fact that the player gets to hold the dice, there is a strong illusion of skill. A unique aspect of craps is that a single bet, of say \$10, can last for several rolls of the dice.

There are several types of bets, but the main ones are called pass-line, don't-pass, come and don't-come bets. The payback percentage in craps varies from 98.6% for pass-line, don't-pass, come and don't-come bets to as low as 83.3% for a bet on the numbers 2 or 12. Players can place a bet with no house edge whatsoever, called free-odds bets, but these are only available after the player has placed an initial pass-line, don't-pass, come, or don't-come bet.

We will illustrate how the game works by using the pass-line bet, or betting with the shooter, as an example. Players take turns being the shooter, that is, rolling the dice. Any player can bet on the shooter's throw by placing money on the pass line. The number that wins changes from the first roll to the second. On the first roll, if the shooter rolls a 7 or 11, he/she wins. If the shooter rolls a 2, 3 or 12 (a craps), he/she loses. However, all others numbers (4, 5, 6, 8, 9 and 10) are neither winners nor losers. If the player rolls one of these numbers, this number becomes the shooter's "point" number. In order to win, the shooter now has to roll this same number again. However, if the player rolls a 7 before rolling the point number, he/she loses. For example, if the shooter rolls a 6 on his/her first roll, then 6 becomes the shooter's point. If a 6 comes up before a 7, the bet wins; if a 7 is rolled, the bet loses. The shooter keeps rolling

until he/she rolls either a 6 (wins) or a 7 (loses). If the shooter wins, he/she has another turn rolling the dice. If the shooter loses, the dice are passed to the next player.

A don't-pass bet is the opposite of the pass-line bet. Essentially a don't-pass bet is a bet that the shooter will lose either by rolling a 2 or 3 on the first roll or by rolling a 7 before his/her point number. Note that, in order to ensure the house's edge for don't-pass bets, rolling a 12 on the first roll is a standoff (neither win nor lose). Two other bets, come and don't-come, follow the same rules as pass and don't-pass bets, but are placed after the shooter establishes a point. A player can make only one pass-line bet at a time, but can have several come bets going at the same time.

Adding to the complexity of the game, after a point number has been established, the player can increase the size of his/her bet with a free-odds bet. Free-odds bets are an increased wager on a pass-line or don't-pass bet. Free-odds bets, however, are paid out according to the true odds against winning, so there is no house edge on them (payback is 100% on the free-odds bet). Some casinos allow free-odds bets of double or even ten times the original bet. If a player has placed a pass-line bet, the free-odds bet wins if the shooter rolls his/her point number before a 7; the opposite is true for a player who placed a don't-pass bet. Free-odds bets give the player a strong illusion of skill. The addition of free-odds bets has no net effect on the player's long-term losses; they continue to lose at a rate of 1.4% of their initial pass-line bet. Free-odds bets, however, increase the player's potential short-term gain or loss. The volatility produced by these free-odds bets also enhances the roller-coaster feel of the game.

There are numerous other betting options in craps, including placing a bet that 6 or 8 will come up before a 7, betting that the next roll will be a 7, betting that a 6 will come up as a double 3 ("hardways"), or betting that a specific number (e.g., 12) will come up on the next roll. The players, including the shooter, can place several different types of bets at the same time. Most of these other bets have a lower payback percentage than the pass-line and come bets. Incidentally, the shooter does not actually have to place a pass-line bet. He/she could instead place a don't-pass bet (betting against the shooter). In this case, the shooter would run the risk of winning the roll (hitting a 7 on the first roll or making the point), but losing his/her bet, and feeling a little silly as the dice are pushed back to him/her to roll again (personal experience of the first author).

Baccarat

Baccarat, as well as its variation mini-baccarat, are card games that have attracted a fair degree of prestige. Baccarat is often shown in James Bond movies. There is no skill involved in winning on most versions of this game, but a strong illusion of skill. The object is to obtain a hand closest in value to 9. Face cards and tens are worth 0, aces are worth 1 and all other

cards are worth their face value. If a hand goes over 10, the 10 is dropped and only the remaining units are counted. A card value of 3, 13 or 23 is worth 3, a card value of 8, 18 or 28 is worth 8.

Two hands are dealt, called the “player” and the “banker” hands. Bets are placed before any cards are dealt. In mini-baccarat, the gambler can bet on either the player or banker hands. Each hand is dealt 2 cards face up. Depending on the total value of the hands, a third card may be dealt. The player hand is played out first, and then the banker hand is played. In most forms of baccarat, the casino follows rigid rules to determine if a third card is to be drawn, and neither the player nor dealer has any say about this. Because the rules for drawing cards for the banker’s hand take into account the player’s third card, the banker hand has a slightly better chance of winning. To ensure a house edge for bets on the banker hand, a punter must pay a 5% commission to place such a bet.

A win pays even money. The payback percentage in baccarat is 98.8% for betting on the banker hand and 98.4% for the player hand—one of the highest payouts of any casino game. The player can also place a bet for a tie between the two hands, but ties are very rare, so it is not a very good bet. Card counting in baccarat is theoretically possible in single-deck games, but with multi-deck games counting provides no advantage (see the discussion of card counting in “Part 5: Blackjack” below). Some European high-stakes forms of the game (e.g., where a punter stakes his own cash to bank the game) may involve some degree of skill, but most do not.

Part 3: Gambling Systems

The following information on gambling systems comes from a number of sources including research literature, books on how to gamble, websites selling gambling systems, discussions with gambling counsellors, interviews with problem gamblers (Turner et al., 2002), and personal observations in casinos and other gambling venues. Note that some books on how to gamble promote systems that are based on erroneous beliefs about random events (e.g., Jones, 1994), yet other books on how to gamble (e.g., Ortiz, 1986) give accurate warnings to their readers about the flaws in many systems.

By their very nature, games of chance involve variations in outcome from play to play; streaks occur, and it is possible in the short term for a player to come out ahead. Some gamblers translate this experience of winning into a belief that they can “beat the odds” by the way in which they play or by the system they use. Many of these systems appear to be quite reasonable and are logically derived from intuitively sensible ideas. If we dig deep enough, though, we find that they involve misconceptions about the nature of random events and

probability. The following systems are not restricted to games of chance, but are often used in games of skill as well.

Systems Based on Misconceptions About Independent Events and the Law of Large Numbers

The following systems are based on misconceptions about the independence of events and the law of large numbers:

- betting on numbers that have not come up very often;
- looking for “pregnant” machines that are due to pay out;
- betting repeatedly on the same numbers in a lottery or in roulette; and
- staying at the same machine.

These systems share the premise that the different numbers in a game come up regularly, and thus, if a number has not come up recently, it is somehow “due.” The flaw in all of these systems can be summed up by the phrase “the dice have no memory.” Numbers or machines can neither be due nor overdue to win. People expect random numbers to be consistent, but erratic (see the discussion of the representativeness heuristic in Kahneman and Tversky, 1982; the discussion in the introduction to the book is particularly relevant). If a person is asked to write down the likely pattern of heads and tails in a series of coin tosses, he/she will write a sequence that alternates erratically between heads and tails but it will not usually include long streaks of heads or tails. For example:

HTHHTTHTHHHTTTHTHTHTHTHHHTHTHHHTHTHTHTTTHTHHH

However, in reality random chance is fundamentally uncertain or erratically erratic. The sequence could quite possibly consist entirely of heads.

Suppose a person has a bag containing 4 black marbles and 1 red marble. If the 4 black marbles are drawn out, it would be reasonable to suppose that the next marble drawn would have to be red. If you did not put the marbles back after drawing them, the next marble would definitely be red. But if you replaced the marbles after each draw, would a red marble still be due to occur? On the face of it, drawing a red marble seems reasonable because, in the long term, roughly 1 in 5 draws will be red. However, if each marble were placed back into the bag after every draw and the bag shaken, each draw would be independent. There would be no relationship between one draw and the next. Theoretically the same black ball could be drawn every time. The red ball might never come up.

According to the law of large numbers, when independently random events occur, as a sample increases, the relative occurrence of events will gradually come to reflect the true probabilities of those events. If we recorded the occurrence of black and red marbles after

drawing marbles from the bag (and replacing them) several hundred times, the occurrence of red marbles would be close to 1 in 5. Many people mistakenly derive from this fact the notion that the numbers somehow correct themselves. That is, after 4 black marbles, the next should be red. As stated earlier, this would be true if you did not put the black marbles back in the bag. However, the play of slots, lotteries, roulette and dice games all mimic systems in which the numbers are drawn from an infinite population of “marbles,” the equivalent of putting the marbles back into the bag after each draw.

If the marbles were not put back, then the population of marbles would change with each draw and the draws would not be independent (random without replacement). Most gambling involves independent draws of random numbers. The exceptions are some card games in which the cards are drawn without replacement from a limited population (52 cards for a single deck; 312 cards for 6 decks). As a result, the probabilities of a particular card appearing shift each time a card is drawn. If after 10 cards have been drawn 2 kings have appeared but no ace, the relative chance of an ace being drawn increases from $4/52$ (7.7%) to $4/42$ (9.5%), whereas the probability of a king being drawn decreases from $4/52$ (7.7%) to $2/42$ (4.8%). However, even after such cards have been drawn, an ace is still not “due” to come out of the deck. Random draws without replacement affect the relative probability of an ace compared to a king, but one still cannot tell if a king or an ace will be drawn as the next card.

Beliefs that staying at the same machine, betting on the same number or betting on numbers that are due will increase a player’s odds appear to assume that the population of possible outcomes is changing with each bet. This notion is not entirely irrational, but is a misapplication of one notion of random chance (random without replacement) to a situation in which it does not apply (random with replacement). Perhaps this misapplication is a result of the early experience people have with random chance through card games. Systems such as card counting, which work with games like blackjack, offer nothing to people playing games of pure chance. Unfortunately this fact does not stop people from writing books or even computer software to track lottery numbers to predict which numbers are due to win (see Turner, Fritz, & Mackenzie, 2003).

During a conversation between the first author and a regular gambler, the gambler emphatically stated that, if in the long term the odds of a coin toss coming up heads equaled 50/50, after a streak of 20 heads in a row there must be a bias to get the final total to equal 50/50, even if it is only a small bias. The truth is that no bias is needed. After a million tosses, there might still be 1,000 more heads than tails, but the ratio of heads to tails would still approximate 50/50. Short-term deviations from the true odds are not corrected; they are washed out as more events occur. The average occurrence of an event will rarely exactly

equal the true odds, but will be correct to several decimal places after a few thousand events have occurred.

Suppose a series of coin tosses starts with 10 heads in a row (100% heads), and then another 90 flips are added with 46 heads and 44 tails. After 100 flips the total number of heads would be 56 (56%). The average has regressed towards the true mean of 50% (from 100% to 56%), even though the subsequent 90 flips showed no bias towards tails. In fact, this “correction” occurred even though in the subsequent 90 flips there were slightly more heads than tails.

If something is random with replacement, the only thing that a 1-in-5 chance tells the player about the next event is that it is a 1-in-5 chance. No matter what has happened before (e.g., 10 wins in a row or 1,000 losses in a row). If the chance of winning is 1 in 5, then the probability of a win on the next draw is still 1 in 5.

Systems Based on the Misconception that Random Patterns Are Reliable

Predictors

Systems based on the belief that patterns that appear in random events can help predict future patterns include the following:

- the search for “hot” or lucky tables or lucky seats;
- selecting “hot” or lucky numbers;
- the belief in lucky players;
- betting on numbers that come up a lot; and
- the search for biases, patterns or sequences.

These systems are the opposite of systems based on the belief that infrequent numbers are due to come up, but the same players often endorse both types of systems. The premise of the systems under discussion here is that there is a reason that a particular number has been coming up frequently. For example, the number might be lucky or the lottery balls might be biased toward a particular number.

As stated above, many people do not understand the independence of random events, instead they expect random events to always occur according to the true odds, that is, to be consistently erratic and self-correcting. When an outcome occurs more often than expected, people infer that there is a bias towards it or that the particular outcome is a lucky one. As one player with a gambling problem interviewed by the authors said, lottery numbers are “random, but not truly random.” He based his belief on patterns he saw in the winning numbers drawn. In essence, we invent beliefs about luck, biases or hot numbers because random numbers sometimes appear to be predictable. Many people are unwilling to accept that random events can fail to be consistently erratic.

A belief in biases may be the result of observing that random chance does *not* correct itself. Unfortunately this accurate observation can lead people, not to reject the belief that random results somehow self-correct, but instead to adopt a second, parallel theory: the bias or luck theory of chance. In essence, gamblers who have applied an incorrect model to predict random events and found that it does not always fit their experience, turn to luck or bias as an explanation for deviations from their model. The idea of luck is needed only because they started out with a faulty model of random chance.

Looking for Patterns and Sequences

Gamblers tend to search for complex patterns in lottery, slot machine and VLT game results. For example, a person might search for numbers that “predict” the next winning number. One individual struggling with a gambling problem told us how, after tracking the *Pick 3* lottery numbers for a three-year period, found that whenever a 5 was drawn, on the next draw, either a 0 or a 9 would be drawn (this is not exactly his system, but describes his method for determining what bet to place). With this information, he believed he was able to narrow down the number of possible tickets to help him select the winner. This strategy is logical and evidenced based, but will nonetheless simply not work.

Looking for a Bias

The search for a bias involves doing “historical research” into previous outcomes of a specific game on the assumption that patterns indicate that there is a defect in the device (e.g., a tilt of the roulette wheel, a repeated pattern in a computerized random number generator). Casinos encourage players to look for patterns by posting past numbers and providing players with note pads and pencils at the roulette table to keep track of the numbers. In contrast, casinos do not allow the use of note pads at the blackjack table where keeping track of past numbers might actually be an effective strategy. The popularity of bias systems may be due to the success of blackjack card-counting systems, where diminishing stacks of cards actually produce opportunities for bettors to improve their chances.

In some games—roulette, for example—it is theoretically possible to find a game with an actual bias (see Barnhart, 1992; Bass, 1985). A wheel might have a slight warp or not be correctly leveled. According to Barnhart (1992), many teams of wheel trackers have successfully profited from biased wheels. The most successful attempts, however, were criminal scams that involved tampering with the wheel. One European group paid a factory worker to insert the wrong size screws in the frets that divide the numbers, making some frets slightly loose (Barnhart, 1992). In the early 1980s, a group of engineering and physics students at University of California at Santa Cruz attempted to beat the wheel by using a concealed computer device to predict the outcome of the wheel (Bass, 1985). Their scheme

ultimately failed due to the practical limitations of using a concealed computer in a casino. Another variation on this theme is to track how the croupier throws the ball to determine his/her “signature” (Bass, 1985; see also Barnhart, 1992). To counter this possibility, some casinos require that their employees not look at the wheel when they throw the ball.

Most bias tracking systems fail to take into account the complex and chaotic effects of initial uncertainty, and the extent to which random numbers often mimic patterns by pure chance. Such systems rarely consider the possibility that an apparent bias is in reality simply the result of random chance. Detecting bias may be possible in theory; in practice it is extremely difficult, particularly if the player has to do it undetected and without the aid of a computer (see Ortiz, 1986). In addition, in today’s casinos electronic sensors record every roll of the wheel, so that the casino would most likely detect an apparent bias (real or random), from either the wheel or an employee, before a player could have a chance to profit from it. Thus bias systems are really a thing of the past (Ortiz, 1986). Bias systems are also used in lotteries, horse races, blackjack and other types of gambling (see Turner, Fritz, & Mackenzie, 2003, for examples).

Jamming the Machine

Some players believe that they can win by jamming the buttons of a VLT or slot machine so that it plays continuously. In the past this was done by using a toothpick to hold down the spin button. Some manufacturers have redesigned their machines to prevent jamming. In Britain, however, some machines now have an auto-play button for the gambler’s convenience (Griffiths, personal communication). In some cases, jamming the machine may be based on a misunderstanding of the meaning of the payback percentage or on the belief that the machine is due to pay out. In other cases, it may be an attempt to “crack the code” of the random number generator by observing the results and deciphering patterns. Technically speaking, jamming the machine reduces the randomness of the play by eliminating the variation in the delay between spins; however, the sequence of random numbers generated may be longer than 4 billion numbers, so it would cost a fortune to crack the code (see Turner & Horbay, 2004).

Incremental Betting Strategies

Some common incremental betting strategies are the following:

- increasing bets after a loss;
- decreasing bets after a loss; and
- increasing bets after a win.

Understanding incremental betting strategies is particularly important because, unlike many other types of systems, they do increase the chance of winning—in the short term. The flaw in these strategies is the belief that it is possible to know when to quit. When incremental systems fail—which, given enough time, they invariably will—the gambler is left with a very large loss. Although they have no effect a gambler’s long-term success, these systems manipulate random numbers in a manner that leads to a strong illusion of skill (Turner & Horbay, 2003).

Martingale, or “Doubling Up”

Perhaps the most common, and also potentially most disastrous, of the incremental betting strategies, the Martingale system involves doubling the size of the bet after a loss. This is most often used with even money bets (bet \$1, win \$1) such as blackjack, reds vs. blacks on a roulette wheel, or pass-line and come bets in craps. Turner (1998) has shown that the outcome of this system is often positive; that is, most of the time a player wins soon enough to make back their losses. When this does not occur, however, the results can be devastating. One gambler described how he amassed \$90,000 by doubling after each loss. Then he hit a losing streak and lost it all, plus another \$250,000. Turner (1998) also found that, if the belief that random numbers correct themselves were true, this system would be very successful.

Table 3. Sample betting sequence (Martingale)

Bet	10	20	10	10	20	40	80	160	320	640	1,280	10	10
Outcome	lose	win	win	lose	lose	lose	lose	lose	lose	lose	win	win	win
Profit	-10	10	20	10	-10	-50	-130	-290	-610	-1,250	30	40	50

In the series shown in Table 3, the player wins 5 times and loses 9 times. In spite of losing more often than he wins, at the end of the session he is up \$50. Theoretically, if a person had an unlimited bankroll and there was no limit to the size of bet, he/she could make money with this system. In practice this seldom happens because (1) most casinos have upper and lower limits on bet sizes, and (2) the gambler is likely to run out of money and thus will not be able to continue betting.

As a rule, a player will use this system until they hit one of those “impossible” long losing streaks and then will then get burnt badly. The danger of this system is that it often does work in the short term, so players quickly become convinced that it will always work. In therapy sessions, it is a good idea to find out if a client is using this system because the system is rewarded so often that a client might never truly understand its fundamental flaw, even after losing \$100,000. One gambler that the authors interviewed was so utterly shocked when his

system stopped working that he was grasping at all kinds of alternative explanations for what had happened to him—not realizing that the explanation was in the system itself.

D’Alembert

The d’Alembert system is a milder or more conservative version of the Martingale system. Instead of doubling after a loss, the player only increases his bet by a single unit. Table 4 illustrates the betting sequences that might be followed by a player following a d’Alembert system.

Table 4. Sample betting sequence (d’Alembert)

Bet	10	20	10	10	20	30	40	50	60	70	80	70	60	70
Outcome	lose	win	win	lose	lose	lose	lose	lose	lose	lose	win	win	lose	win
Profit	-10	10	20	10	-10	-40	-80	-130	-190	-260	-180	-110	-170	-100

With this system the gambler is less likely to reach the house’s upper limit and is also less likely to go bankrupt. However, the gambler is also less likely to be able to recoup his losses after a moderately long losing streak. The flaw with this system is that when the player encounters a particularly long losing streak (as is likely if play continues long enough), the player will lose more than he/she will win (as shown in Table 4). The d’Alembert system does not have the extreme wins or losses of the Martingale system, but in the long run the player is still most likely to lose money.

Pushing a Winning Streak

Gamblers who follow a strategy of “pushing” their wins increase their bets after a win rather than after a loss. On the surface, this is less harmful than the Martingale and d’Alembert systems, but ultimately leads to giving back all that is won. Attempts to prevent this by “locking” in a win by reducing the bet after a series of 2 or 3 wins (Patrick, 1986) are in the end also doomed to fail. “Locking in wins” leads to more conservative play, but it also produces a strong illusion of success, so it is unclear if such a system is in the end helpful or harmful.

Other Systems

There are a large number of variations on these basic systems. One, the cancellation system, involves starting with a series of numbers, using these as the basis of bet sizes, calculating new increased bets based on those that do not win, and then crossing out those bets sizes that do win. These systems can be remarkably complex and in the end a complete waste of time. Other variations involve hedging one’s bets by placing an additional bet on some other option. For example, one gambler described his plan to run the d’Alembert system, placing

“banker” bets in a game of baccarat but also hedging his bet by betting a smaller amount on the “player” hand (see description of baccarat). The idea is that if he loses on one side, he makes up for the loss on the other side. This strategy does increase the frequency of winning in the same way as buying multiple lottery tickets does, but in the long run it leads to greater losses. The flaw with all these systems is that, in the long term, it is simply not possible to beat the house edge by increasing bets.

Beliefs and Attitudes

In addition to following systems, gamblers engage in many other activities they think will help them win. These include concentrating on winning, keeping a positive attitude, being aware of their gut feeling, and looking for lucky numbers, places or things. Some gamblers regard these behaviours as part of the skill of gambling. Some gamblers even consider having or finding luck to be a skill. In one sense, these mental activities are skills. If you were working on your career, maintaining a positive attitude and putting in a lot of mental effort would be very helpful. Mental attitude may indeed assist in games such as poker where skill does play a role.

Gut feelings may, in fact, be based on past experience. That is, something feels right because it somehow reminds us of previous circumstances (see Reber, 1993). When the past experience is informative, gut feelings can be accurate guides to behavior (e.g., a police detective might have a gut feeling that a particular suspect is lying), but in gambling, gut feelings are irrelevant because the past is irrelevant to a specific bet or play. The ability to pick out what works and stick to it is a useful skill. When events are random, however, past success has no bearing on future success.

It is theorized that superstitions are often the result of chance occurrences that reinforce the superstitious belief (see Skinner, 1953, for additional comments). On one occasion, the first author was at a slot machine and just about to press the spin button when a friend distracted him for a couple of seconds. When he looked back at the machine he had won \$5. After that he started hoping to be distracted again. Call it luck, skill, a system or a gut feeling, it will not help the player win. The simple truth is that in the long term nothing can help someone beat a game of pure chance.

Part 4: Games Involving Both Chance and Skill

There are a number of games in which the player has some control over the probability of winning or losing. Although such games involve skill, this does not necessarily mean that any given player has a better chance of winning. In fact, if a person does not have the requisite skill, he/she might be better off playing a game of pure chance (Turner & Fritz, 2002).

Games of skill fall into three categories:

- (1) There are games in which there is some degree of dependency between trials. In card games, the cards that have been drawn change the odds of any remaining card appearing.
- (2) In games such as poker and dominoes, opponents can use various strategies, such as bluffing and intimidation, to gain an advantage over other players.
- (3) In games, such as horse racing, sports betting and stock market investments, the outcome is only partly random. The non-random elements of these games, such as the skill of the players, the speed of the horses, or the true value of an investment, are partly compensated for by a subjective estimation of the chances of a win. The subjective estimation is usually provided by a bookie, by the collective guesswork of the gambling public, as in parimutuel bets, or by the market forces of supply and demand. With stock market investments, a strong potential for future earnings or growth will drive up the cost of a stock. Therefore the future prospects of a stock are generally factored into its price.

The role of skill in these three types of games overlaps considerably. In all three cases, the estimation used to compensate for the non-random elements of the game is subjective and therefore less than 100% accurate. An astute gambler can find opportunities where the bookie has misjudged the odds or where the collective guesswork of the gambling public is mistaken. People who pay close attention to the game may find an edge. Moreover, knowledge of the true value of a bet is not distributed evenly. Outthinking other players plays a role in sports and horse betting, but the battle in these cases is not between individuals, but between an individual and the rest of the market. The play of poker and dominoes also includes factors that affect a player's ability to win. In all cases, the key to winning in the long run is information. Armed with a lot of information (e.g., previous draws, odds and strategies, "tells," or insider information), a gambler can make a profit, but only if few other people have the same information.

Systems for Skill Games

By definition these games require skill, so the optimal playing strategy should more correctly be called a skill, not a system. Nonetheless, the logic behind systems for luck games and skill games is often similar. Systems designed to spot biases and patterns in pure-luck games are based on a logic similar to card counting, where the changing distribution of cards left in the deck actually makes it effective.

The key to all systems or skills for skill-oriented games is information. Skilled gamblers know how to obtain information and how to interpret it. Less skilled gamblers either do not have the information or do not know how to utilize it to its full potential. The gambler also

has to fight against what in stock trading is called the efficiency of the market. An efficient market is one in which information about a product is immediately absorbed into the price of that product. Once information becomes generally known, it ceases to provide an edge. No markets are truly efficient, but finding opportunities requires knowing something that the rest of the market is unaware of. The best opportunities come from insider knowledge, but just as it is in stock trading, using such information in gambling games is generally illegal.

Games of skill attract skilled players, some people even make a living as professional players. Many skilled players are as obsessed with their game as pathological gamblers. The key difference is that skilled players do not bet impulsively, but are very selective about their bets (Turner & Fritz, 2002). In addition to obtaining and interpreting information, emotional control is another key factor in games of skill. In all games of skill, successful players avoid feeling desperate when they experience a long losing streak and avoid feeling too lucky when they experience a long winning streak. Skilled players base their decisions on the odds rather than on hunches. They also practice self discipline and money (or bankroll) management (Warren, 1996). Many less-skilled gamblers also use the same strategies to varying degrees of success. Turner and Fritz (2002) discuss how even a skilled gambler can ultimately lose in the long run. A player can only win in the long term if he/she plays against less skilled players.

Gambling systems for games that involve skill are specific to each game. Parts 5, 6, and 7 that follow will discuss blackjack, poker and games of subjective probability, respectively.

Part 5: Blackjack

The object of the card game blackjack is to get a hand that scores as close to 21 as possible without going over. The players play against the casino. If a player's hand is closer to 21 than the dealer's, then the player wins; if the dealer's hand is closer, the dealer wins. If both player and the dealer have the same number, they tie, or "push," and the player neither wins nor loses. If the dealer and the player both exceed 21, or "bust," the dealer wins. The house edge in blackjack comes from the fact that if both dealer and player bust, the dealer wins. Face cards and tens are worth 10, aces are worth either 1 or 11, and all other cards are worth their face value. A "blackjack" or "natural" occurs when a player gets any combination of an ace with a ten, jack, queen or king.

The dealer deals two cards to each player and to him/herself. Usually all players' cards are face up, but sometimes the players' cards are face down. The dealer presents one card face up and one face down. If the dealer has a blackjack, then all players automatically lose unless they have one as well, in which case the game is a push (the player neither wins nor loses).

If the dealer does not have a blackjack, the dealer then proceeds clockwise around the table asking the players if they wish to “hit” (take another card) or “stand” (not take another card). If the player has a blackjack (and the dealer does not), it is an automatic win. Otherwise the player indicates a hit either verbally or by scratching the table towards him/herself. The player can continue to draw cards until his/her total exceeds 21. If a player’s total exceeds 21, the player loses.

If a player is happy with the total points of his/her hand, then he/she can stand. The player also has the option of doubling down (doubling the bet, but only drawing one more card), or splitting a pair (e.g., turning 2 eights into 2 separate hands). Some variations of the game, such as Spanish 21, allow the player to surrender (giving up 2 units of his/her bet and quitting the hand). Once the dealer has dealt additional cards to all the players, the dealer draws cards for his/her hand. The dealer must stand on 17 or higher and hit below 17. A win generally pays even money; however, if the player wins with a natural, the natural pays 3 to 2, or 1.5 times the bet.

There are numerous systems for playing blackjack, many of which work. They all rely on the fact that the dealer has to play using rigid rules, but the player can make choices. For example, the player can hit or stand based on the odds that the dealer will bust given the dealer’s current face-up card or on the composition of the cards remaining in the deck.

The Basic Strategy

The Basic Strategy (Thorpe, 1966) gives players a series of rules for how to play given their combination of cards and the dealer’s face-up card. Thorpe worked out an elaborate system to guide the player’s decision in a game of blackjack. For example, if a player has 16, and the dealer has a 10 card showing, the player should draw another card; however, if the dealer has a 6 showing, the player should stand. These rules are based on probabilities and were worked out using computer simulations (for a detailed explanation of the Basic Strategy, see Thorpe, 1966; Wong & Spector, 1996; Patterson, 1990; Ortiz, 1986). The player needs only to memorize—and stick to—the Basic Strategy.

Under ideal circumstances, with a single deck, a player following the Basic Strategy plays against no house edge (see Thorpe, 1966). With a multi-deck game, a player who meticulously follows the rules of the Basic Strategy can achieve a payback percentage as high as 99.5% in ideal circumstances. An exact figure for payback depends on the number of decks in use, the casino rules for the game, and how well the player follows the strategy.

In practice, most blackjack players only partially follow the Basic Strategy (Wagenaar, 1988) and in so doing achieve a return somewhere between 94% and 99%. Many players copy the

dealer, standing on 17 and hitting below 17. Other people avoid busting because they know that the house advantage comes mostly from the fact that when both the player and the house busts, the house still wins. Their belief is that, if they avoid busting, even by standing on very weak card totals such as 12 or 13, they can beat the edge, but in fact in some circumstances standing on a 12 decreases the payback percentage. Some people play based on what feels “right.” In interviews we have heard gamblers actually complain that the rules of the Basic Strategy are actually wrong, because they can recall episodes where they lost money following the Basic Strategy or won money not following it. Some players complain that following the rules is a boring way to play.

Card Counting

Card counting is a playing system that tracks the relative numbers of different cards that have been played (high cards vs. low cards) in order to predict which cards are left in the deck. The system takes advantage of the changes in the relative probabilities of the cards remaining in the deck(s) as more cards are dealt. Card counting was used as far back as the eighteenth century to predict which cards were the best bets in the game of faro (see Turner, Howard, & Spence, 2006). It was not until 1962, however, that Thorpe was able to develop and test a comprehensive system using computer simulations of card counting for use in blackjack (see Thorpe, 1966).

As cards are dealt, the relative number of high and low cards remaining in the deck sometimes changes. By random chance, more of the low cards might have ended up in the first half of the deck and more high cards might have ended up in the second half of the deck. If numerous high cards remain in the deck, a stiff hand (e.g., a 10 and a 6) is likely to bust if another card is drawn. When lots of face cards (ten, jack, queen and king) are left in the deck, the player has an advantage over the dealer because the player is free to hit or stand, but the dealer must hit on any total of 16 or less. On the other hand, if a lot of face cards have been dealt, then the remaining cards have relatively fewer face cards and the player is less likely to win. In addition, more aces in the deck provide the player an advantage because the player wins more when he/she scores a blackjack.

Card counting usually requires the player to keep track of the relative number of face cards vs. cards with lower numbers (2, 3, 4, 5 and 6). To run the system, the player keeps a running score based on the cards that have been drawn. A face card or ace is scored as -1 and a lower card is scored as +1. The player bets the minimum amount following the Basic Strategy, but when the card count is in the player’s favour (e. g., +5), the player increases his/her bet. In addition, players can adjust their choices to hit, stand, split or double down based on card-counting information.

An important consideration is that, the player has to run this system in such a way as to not get caught since card counting is considered cheating by the casino. In the past, successful card counters have been banned from casinos for life.

Card counting requires a lot of skills and patience. A player also needs a fairly substantial bankroll in order to withstand the occasional losing sessions that occur by chance. Many card counters work in teams to help each other spot opportunities, increase their available bankroll and reduce the impact of short-term variabilities in the game. To many ordinary players, card counting is a boring way to gamble. I know of a problem gambler who was a fantastic card counter, but would end up losing because he would become too excited or start to feel lucky and stop following the rules. Furthermore, the “house” takes active steps to prevent card counting, including banning suspected card counters, using larger numbers of decks and reshuffling the decks whenever a counter increases his bet (Patterson, 1990). Some casinos have engaged in cheating to ensure that the card counter loses (Thorpe, 1966). Rule changes have made card counting more difficult (Patterson, 1990) and recent developments in gaming technology such as automatic shufflers and computerized dealers may completely eliminate the possibility of card counting.

Part 6: Poker

Poker appears to have been derived during the nineteenth century from a variety of different games, which may have included *brag*, *as nas (dsands)*, *post and pair*, *primero*, *gilet*, *breelan*, *bousilotte*, *ambigu*, and *poque*. These games merged in the fertile Mississippi valley to form the very popular game we now call poker (Asbury, 1938). Jackpots and stud poker (that is, playing with some cards face-up) were American additions to the game (Asbury, 1938, p. 20). Its varied sources likely explain the incredible variety of games included in today’s concept of poker. Poker is played around the world, and Anthony Holden (1990) estimates that 50 to 60 million people play poker in the U.S. alone. In recent years, its popularity has increased tremendously as a result of the highly publicized huge prizes awarded at the World Series of Poker.

Poker is important in a discussion of gambling problems because it is commonly the first real gambling that a lot of young people engage in. In recent years, poker tournaments have made their way onto television. Due to the large prizes now offered in tournaments, the game is more popular today than it has ever been.

There are probably several hundred different ways of playing poker. Casino poker games can be divided into “house” games played against the casino and true poker played against other players.

Playing Poker Against the Casino

There are several variations of poker that have been modified so that the player plays against the dealer (the casino) rather than against other players. As in blackjack, the dealer must play according to strictly defined rules that spell out how to play, given the cards in the player's hand and those of the dealer, which are face up. The games are designed to ensure a payback of around 95%.

In these games, a player can reduce the house edge by carefully judging odds but, unlike in blackjack, the player cannot eliminate the house edge. Games in this category include Caribbean stud, pai gow, let-it-ride and joker poker. Video poker also belongs in this category, making it one of the only video gambling machine games for which it is possible to significantly reduce the house advantage (see Wong & Spector, 1996).

True Poker: Playing Against Other Players

True poker is played between players. Poker games can be found in kitchens, bars, the backrooms of restaurants, card casinos, poker rooms in large casinos, and on the Internet. Most players learn to play recreationally at home games, sometimes called "kitchen table" poker. In Ontario, home games of poker are legal as long as the entire pot goes to the winner of each hand. That is, no third party takes a percentage of the pot as profit. When poker is dealt in a casino, the house rents chairs to the players either as a percentage of the pot or at an hourly rate. This is known as the rake.

In recent years there has been a rapid growth in the popularity of poker tournaments. The World Series of Poker held in Las Vegas, for example, attracts thousands of players from around the world and offers prizes in the millions.

The Different Poker Games

The most common games dealt in a casino are 7-card stud, Texas hold 'em and Omaha hold'em. Kitchen poker includes a wide variety of games, many of which are some version of 5-card draw poker; usually the choice of the game is up to the dealer.

In 7-card stud poker, a player is dealt 7 cards and makes the best poker hand using 5 of his cards. The player is dealt an initial 3 cards, 2 down and 1 up. Betting occurs after these initial cards are dealt out. This is followed by 4 additional cards, dealt face up one at a time, and the last card is dealt face down. There is betting after the 3rd, 4th, 5th, 6th and 7th card.

Texas hold 'em, often simply "hold 'em," is played at a table that seats up to 10 players. Each player gets 2 cards face down. These are the player's pocket or hole cards. After players bet on their pocket cards, 3 cards are placed face-up in the middle of the table. These cards are

called the “flop.” They are community cards that all players can use to make a hand. A second round of betting occurs. A fourth community card (the “turn”) is then dealt followed by a third round of betting. Finally, the fifth and last community card is dealt (the “river”), and a final round of betting occurs. Players make their hands by selecting the best 5-card combination of their pocket cards and the table cards. The winner is the player who can make the best 5-card hand. A player can use 1, 2 or even none of his/her pocket cards to make a hand. If two players have an equal combination of cards, the pot is split between them.

In Omaha hold 'em, or simply “Omaha,” each player receives 4 pocket cards, and 5 community cards are placed in the middle of the table. In Omaha, players must use 2 pocket cards and 3 table cards to make their hands.

In 5-card draw, players receive 5 cards, bet, and then discard some of their cards and draw new cards, followed by a final round of betting. This game is rarely found in casinos anymore, but variations of 5-card draw are often played at kitchen tables. In home games, wild cards are often used.

In most forms of poker the ace is the highest card, while 2 is the lowest, and the players try to obtain the highest hand possible. The rules of each game vary, but the status of the various hands are inversely related to their probability of occurrence and are the same for most poker variations. The hands, ranked from highest to lowest, are a royal flush (ten to ace in the same suit), a straight flush (sequential cards with no gaps, e.g., 4, 5, 6, 7, 8 all in the same suit), 4 of a kind, a full house (3 of one kind, 2 of another), a flush (5 cards in the same suit), a straight (sequential cards with no gaps, e.g., 4, 5, 6, 7, 8), 3 of a kind, 2 pair, 1 pair, no pair with highest card. Two pair is a weak hand in a game with wild cards or several draws, but can be a fairly strong hand in a game such as Texas hold 'em.

In some games, called low ball, the players try to obtain the lowest possible hand. A winning hand would have no pairs, and be made up of low cards (e.g., 2, 3, 5, 7, 8 would be a winning hand). In some low ball games, ace is a high card, while in other low ball games ace is a low card. In other forms of poker, such as Omaha high-low split, players can try to win with either a high-card or a low-card hand using combinations of their pocket cards and the community cards. The highest and the lowest hands split the pot. In Omaha high-low, however, to win the low, a player cannot have a pair and must have no card higher than an 8.

Poker Skills

To a large extent, poker is a game of skill, but if the players are well matched it becomes more like a game of chance. Poker is a game of incomplete information. Unlike games such as chess, in which both players can see the position of all the pieces, poker players must deal

with two unknowns: the cards in their opponents' hands and the cards remaining in the deck. Thus players must develop the ability to figure out what their opponent is doing while preventing their opponents from figuring out what they are doing. There are several skills that improve a player's poker game.

Card Skills

Card skills include knowing the chances of completing a particular hand and the odds of winning with a particular hand, and weighing those odds against the size of the bet and the potential win (the pot odds). Being able to keep track of the cards as they are dealt, rapidly compute the odds of a particular card being drawn and make a decision about the next action based on this information are crucial to being able win at poker, especially in 7-card stud. The optimal play depends on the type of game. In hold 'em, for example, the value of the starting cards and knowing how to play them in different positions is crucial to winning. A person with an ace and 9 might fold if he/she is the first to bet, but might raise when one of the last to bet if it appears the other players have weak hands (see Warren, 1996). The single most important card skill is limiting the number of starting hands the player will continue to play (i.e., not fold) to those where he/she has an above average chance of winning.

Assessing Other Players

Experienced players attempt to determine if there are players at the table they think they can beat. They become knowledgeable about the style and skill of other players and seek to find games where there are weaker players. Experienced players may also attempt to manipulate their own image at the table, sometimes acting as if they are inexperienced and other times trying to ensure that the other players think that they are very good.

Bluffing and Slow Play

An important skill is the ability to convince the other players that one has a good hand when one doesn't (a bluff) or that one has a weak hand when one actually has a strong hand (slow play). According to the movie *Rounders* (Stillerman, Demme, & Dahl, 1998), novice players often try to act weak when they are strong or strong when they are weak, inadvertently providing the other players a strong clue about what they have (see "tells" below). The key to a successful bluff is that the other players must not know what one has. Consequently, the bluff must be used sparingly. If overused, bluffing loses its effectiveness or even becomes a trap. For example, if a player habitually raises when holding weak cards, it provides other players with the opportunity to slow play their hands. A somewhat less risky variation is a semi-bluff, used when a player has a fairly decent hand that by itself could win, but also has the potential to improve into a much stronger hand. A bluff is most effective when used

against timid players or overly cautious players. Slow play works well against overly aggressive players.

Identifying Tells

In the film *Rounders* (Stillerman, Demme, & Dahl, 1998), during the final showdown at the movie's climax, the main character, Mike, notices that his rival, KGB, always eats an Oreo cookie in a particular way when he has a good hand. The Oreo cookie is a tell. A tell is a verbal or non-verbal clue about what a player is thinking. The Oreo cookie itself is an absurdly obvious clue in the film; usually tells are more subtle. Players identify tells by watching other players' reactions to their cards and how they bet. The goal is to find telltale signs that give away a player's hand.

Identifying tells requires carefully observing a player over the course of many hands. Of course, if the other player is a skilled player this is very difficult. In hold 'em, players usually leave their cards face down on the table and only glance at them briefly. If a player picks up his/her cards after the flop has been dealt and then quickly makes a bet, it is a sign that the flop might have given the player a better hand than he/she expected. If a player hesitates before betting, his/her hand may be weak or a long shot. Tells are often unique to the individual, making them difficult to identify. In addition, some gamblers try to fake tells. According to Caro (1986), trying to fake a tell is not a good plan because only good players will notice it, and they are the players most likely to be able see that it is fake.

Emotional Control

Another poker skill is the ability to control one's own emotions, both in order to hide one's hand from one's opponents (the poker face) and for long-term survival at poker. Sometimes, when confronted with an unexpected loss (e.g., holding a full house of aces and kings, but losing to a hand of 4 twos), a player might become upset and go "on tilt" (Browne, 1989). A player on tilt starts to play desperately or chases losses. Being upset may make it difficult to hold a poker face. In addition, poker is often predatory. The second author once watched a player put on an act as if he were an obnoxious drunk. He irritated and angered the other players at the table and suckered another player into a large pot. A skilled player must avoid feeling desperate when losing. There is a common saying in poker rooms, "Scared money always runs away." Conversely, a successful player must avoid feeling too lucky when he/she wins.

Problem Poker

Accurate statistics about the percentage of poker players who suffer from a gambling problem are not available. The authors hypothesize that with traditional, live cash poker (either in a

kitchen or a casino) fewer players may exhibit gambling problems than for slots or other table games. Hayano (1982) suggests that peer pressure in poker may moderate extreme behavior. Kitchen poker with friends in particular is self-limiting in that excessive gambling is not likely to be encouraged or tolerated. Even in a casino, poker players will criticize foolish actions made by other players or offer advice or playing tips. Both authors, however, have witnessed problematic behavior from poker players, so it is not rare. Basil Browne (1989) found that a lot of players go in and out of tilt, ranging from non-problematic to problematic at different times. Poker can be very predatory, and some players will purposely try to put other players on tilt in order to take their money.

The advent of on-line poker may have changed poker into a much more problematic game. With on-line games there is no longer a social barrier to excessive play because on-line players do not know each other and are unlikely to offer advice. They have no reason to discourage foolish play. In addition, on-line games are much more widely available and the stakes that are available range from bets with pennies up to hundreds of dollars. The low stakes make it easier to initiate a habit, the higher stakes make chasing losses possible. Another distinct feature of poker today is the game that most people are playing: no-limit Texas hold 'em. The very name "no-limit" reveals the main problem with this game. At any point in the game any player may push all of their chips into the middle of the table.¹ This particular version of poker may be more dangerous than other forms because the players can either suffer substantial losses very quickly or, potentially worse, substantial wins.²

Fritz and Horbay (1998) compared successful poker players with those in treatment for gambling problems and found that successful players consider skill more important and luck less important compared to players in treatment. Successful players also reported that they would leave a game if they had won or lost a predetermined amount, if they were tired, or if they felt that they were going to lose more money. Players in treatment reported that they left when they ran out of money or the casino closed. Fritz and Horbay also found that immigrants from cultures where card playing and/or poker is not common are at risk because they appear to view poker as a game of luck and are not aware that poker skills can be improved through reading books or studying the odds.

¹ In these games the players do have a minimum bet (e.g., 50 cents for the first two rounds of betting, and \$1 for the third and fourth round of betting); however, there is no definite maximum on the player's bet. Low stakes tables on-line, however, do impose a maximum amount that a player can cash in with (e.g., \$50) which technically does limit the size of bets.

² A big win early in one's gambling career is one of the main factors that leads to pathological gambling (Turner et al., 2002).

Luck and Skill

Luck is something many poker players believe in. This is indicated by the number of players who use lucky charms, have lucky seat positions, lucky dealers and lucky casinos. When players begin to lose they may try to alter their luck by moving to a different table or game, asking for a change in card decks or asking for extra shuffles. The authors' observations are that superstitious players are often weaker players.

A skilled poker player can expect to make a profit over the long run if he/she is playing with less skilled players (Turner & Fritz, 2002). Most players are recreational, but Hayano (1982) estimates that a small number of players play purely for the income. Hayano, an anthropologist, was a participant observer in a California card room for ten years. He identified four types of professional players: (1) the worker professional whose gambling supplements an income from a regular job; (2) the outside-supported professional who has an outside source of income like a pension or trust; (3) the subsistence professional who earns only a minimum wage from playing and is squeaking by; and (4) the career professional whose entire income is derived from poker and is strongly identified with poker as an occupational choice. Only a very small percentage of players make more than a subsistence income from poker.

Part 7: Games of Subjective Probability

In all the games discussed so far, repeatable events (e.g., dealing cards or rolling dice) play a large role. When we move to football games, horse races or stock trading, we are talking about events that are not repeatable under identical conditions. These games are not random, but the action is so complex and chaotic that the outcomes include a great deal of uncertainty and thus a large component of randomness. In sports betting, horse racing and the stock market, however, the true odds are not known, and the payout is based instead on a subjective analysis by those setting the odds (bookies) or by the mass behavior of the bettors. This is accomplished in a number of different ways.

In horse racing, the odds are a floating value derived from the overall pool of bets; this is called parimutuel odds. In horse racing, the players set the odds for a race by buying a ticket for a particular horse. If no one wants to bet on a horse, the payout for that horse goes up until it becomes attractive to some bettors. If everyone bets on a particular horse, the payout for it goes down. A favourite horse that perhaps has a 20% chance of winning will only pay a small amount for a win (e.g., 2 to 1), while a long shot with a merely 1% chance of a win might pay out a lot of money (e.g., 30 to 1). Racetracks using parimutuel odds make money by taking a profit first and then distributing the money in the betting pool among the winners.

In sports betting, a similar process is typically performed by a bookie who sets and then adjusts the odds depending on demand. The bookie initially sets the odds based on information about the teams. Setting odds is not done to cheat the player; it is done to ensure that the house, whether a bookie, racetrack or casino, gets action (bets) on both sides of a game. If a bookie underestimates a team's ability too much, the bookie can lose money. If a bookie balances his books correctly, he will make money no matter who wins. The upshot of the process is that the differential value of the bet is removed from the contest (e.g., a horse race or football game) so that the outcome of the bet approximates betting on a random event.

In the case of the stock market, demand for a stock and its underlying value, that is, the profit potential of the company, operate together in a manner similar to parimutuel odds. When people buy the stock of a company they think has a profit potential, its price increases, effectively reducing the potential payout odds for other people who may want to buy that stock. Breaking news about a company, such as record profits or a profit warning, are quickly factored into the stock price. One difference from parimutuel betting is that stock prices fluctuate independently. That is, at some point all stocks might be overvalued, such as in the tech boom of the late 1990s or they might all be undervalued, after the crash of 1929, for example. Another key difference is that stocks are not one-time bets with a definite end point, but long-term entities that fluctuate over time. As such, stocks that are a bad bet today might become a good bet a year from now.

In games of subjective probability, winning is possible if the player can estimate the odds, point spread or values better than the book makers or other players. The difficulty for the gambler in each of these types of gambling is market efficiency, that is, the speed with which news or other information is factored into the price. By the time the average player has heard about a factor that might affect the outcome of the race, it has already been factored into the price or the payout. However, information is never distributed evenly, so that with careful study the bettor can get an edge.

Horse Racing

One of the oldest forms of gambling is betting on the outcome of a race. Before the race, a player places a bet on a horse. The player can place a bet to win (finish first), place (finish first or second) or show (finish first, second or third). A bet to win pays out more than a bet to place or show. An exacta is a bet on the first and second horses to finish the race; the player wins only if the 2 horses picked finish in the exact order specified. Other bets involve selecting the winner of 2 or more consecutive races. The minimum bet for a horse in Canada is usually \$2. If the odds are 2 to 1, the winning bettor gets back roughly \$6 (a win of \$4, plus the original bet of \$2). The payout, however, is based on the odds at the beginning of the race,

not the odds posted in the Daily Racing Form. If too many people bet on a particular horse, the payout drops.

As stated above in “How the House Edge Works”, the posted odds usually overestimate a horse’s chances of winning, which results in the payout odds being less than the true odds against a horse winning. By overestimating every horse’s chance of winning, the bookie or racetrack underpays the bettor for a win.

Odds in horse racing rely directly on the behavior of the betting public. The parimutuel method makes the payoff odds inversely proportional to the amount of money wagered on each horse. The track operators remove about 17% of the amount bet on each race and the rest of the money is distributed among the bettors who selected winning horses (Stern, 1998). It takes quite a while for the track to work out exactly how much each winner gets for his/her win.

The art of handicapping is the process by which a horse race bettor tries to figure out the true odds of a horse and identify horses that are undervalued in the posted odds. A horse’s past performance is usually given in the Daily Racing Form, available for a small fee at the racetrack. However, a horse’s ability is factored into the payout, so the only way to win money is to predict the outcome better than the odds makers and better than most of the betting public. For example, if a lot of people bet on popular horse because it is the offspring of a particularly successful horse, its posted odds may be different from its true odds.

There are an enormous number of variables that can be used to predict the outcome of a race. These include a horse’s past performance (wins vs. losses), its pedigree, its class, its adjusted speed in previous races, its temperament, its breeder, its trainer, the track conditions, the weather and the mix of other horses in the field.

Andrew Beyer (1983), a racing columnist for the *Washington Post* and the author of four books on how to pick winners in horse racing, bases most of his betting decisions on his studies of the speed of horses. Before he made his method public, the speed factor had been underused by bettors because only raw times (the time it took to complete the race) were available, and these times did not accurately reflect what horses would do on tracks of different lengths and under different conditions. Beyer’s method produced a measure that factored in the distance and condition of the track. Once these speed figures became widely known, they became one of the variables on which bettors based their choices and thus were taken into account in the odds (Greenhouse, 1998, pp. 48–51; see also Beyer, 1983). Thus speed handicapping is no longer a reliable method of earning money because the market efficiently incorporates this information into the payout odds.

The payout for a horse is inversely proportional to the value of bets placed on a particular horse. Players base their bets on their estimate of the horse's ability from its past performance. Consequently the only way a player can make money in the long term is by knowing something that the other players do not know. According to Beyers (1983), trip handicapping is a means of acquiring information that is not commonly available. It involves a detailed study of the track, the specifics of past races, and the other horses, and is used to adjust the interpretation of the speed figures. Suppose that in its last race horse A ran on the outside of the track, which is the longest distance around, or was "boxed in," that is, blocked by other horses, during the first quarter of the race but overcame these problems and still came in fourth. This horse might be posted at 10 to 1, but its true odds might be closer to 8 to 1. In contrast, suppose that in its last race, horse B started in the first position and had a very easy win because weaker horses blocked the other strong contenders. In the current race, horse B may be the favourite among average players, but to the trip handicapper, horse A would represent more of an opportunity because it is undervalued and horse B may be overvalued.

By searching for this trip-related information, a player can theoretically get an advantage over other players. Like card counting, such a system takes a great deal of time and patience as well as a suppression of the excitement and gut instinct that gamblers tend to feel when anticipating a win.

Sports Betting

Although sports games are games of skill, betting on their outcome involves a lot of chance. Sports betting is quite similar to betting on the horses: the gambler studies the past performance of the teams and notes the current health of the players to determine which team has the upper hand. Rather than by odds, betting on sports teams is most often equalized by an estimate of how much a team will win by; this is called the point spread. Suppose the Toronto Maple Leafs are playing against the Montreal Canadiens and the Canadiens have won a lot more games than the Leafs. Bookies might estimate that the Canadiens will win by 3 goals. In such a case, a bet on the Canadiens only wins if the Canadiens win by 3 goals or more, but a bet on the Leafs wins if the Canadiens win by 2 goals or less, that is, the Leafs "cover the spread." If done correctly, the point spread has the effect of making the outcome of the bet essentially random. Some sporting events are wagered in the same manner as horse races. Other games, such as baseball, use a system called the money line instead of a point spread, but the goal is essentially the same: to balance the betting action on both sides of the game.

As a general rule, in most point-spread bets the player must wager \$110 to win \$100. The difference between the bet and payout (\$10) is the vigorish or house edge (4.55%), which results in a payback percentage of 95.4%.

Because the point spread is computed subjectively, it is never perfect and therefore the bettor has a chance of winning if he/she can figure out the true odds more accurately than the bookies and the general public. There are numerous methods a player can use to compute the most likely winner. Sports statistics are available in newspapers and online.

The only way for a bettor to beat the odds is to find a factor that has been undervalued by the sports bookie or the betting public. Unfortunately, this quest runs up against market efficiency. Any knowledge about a team that is not insider knowledge, that the player could use to increase his/her chance of winning, would also be known to others and would be taken into account in the final point spread (Stern, 1998). Market efficiency is never perfect, however, and as long as enough non-professional players make bets on their favourite teams, there will be opportunities for professional players.

Playing the Market: Stocks, Options and Commodities Markets

Technically, the stock, options, currency and commodities markets are not games. Stocks and options are a means by which companies raise money to finance their operations. In return for purchasing a company's stock, the investor receives a percentage of the company's profit in the form of dividends, as well as capital gains on his/her investment. Commodities are simply raw products, such as wheat, coffee, nickel and electricity, traded on regulated exchanges. Currencies likewise are traded on regulated exchanges. A diversified portfolio of stock investments is usually a relatively safe investment with a positive, long-term expected return.

In the past few years, however, the markets have appeared to become more and more about gambling and less and less about investment. Investors try to buy stocks that are undervalued or buy new unknown stocks with potential and then sell them for a profit.

There is no real house edge in the market, but the investor has to pay a commission to his broker for each purchase. The commission varies depending on the size of the purchase, the account value, the customer and the volume of the customer's transactions (Schneider, 1997, personal communications).³ Small investors are often working against a fairly large commission. But traders who can deal in large volumes can reduce the commission to a very

³ Jim Schneider was interviewed by the first author in 1997. He has worked in the stock market and at one point ran a brokerage firm. He provided a great deal of the information on the topic of stock market gambling that is presented in this section.

small percentage. Long-term investors can usually expect a positive return of as much as 10% per year (a payback of 110%) or more. Due to the cost of commissions, short-term investors on the other hand are often working against a negative return.

Since gamblers want the big payoff, they are likely to purchase more speculative investments, such as small or new companies or commodity futures. An investment in a new company is risky, but has the potential for extraordinary growth.

“Going long” means buying and holding a stock. In addition to buying a stock, an investor can buy an option to purchase a stock on a future date, in a few months, for example, at an agreed price. If in the intervening time the stock goes up in value, the investor can exercise the option and buy the stock at the agreed price to make a profit. If the stock price goes down, the investor loses only the price of the option. Buying options is cheaper and less risky than buying the actual stock, but the cost of the option somewhat cuts into the profit margin.

“Selling short” is selling, at an agreed price, a stock that the seller does not actually own (hence the seller is selling “short”). At some point, the seller has to make good on the investment, actually buy the stock, and hand it over to the purchaser. If the value of the stock goes down before the short-seller must acquire it to give to the purchaser, the short-seller makes money because the stock is now worth less than the amount he/she sold it for. Suppose a stock is currently listed at \$110, and Sam arranges to sell it to Joe for \$100, but Sam does not actually own that stock. A week later the stock’s price goes down to \$50; Sam buys the stock on the open market and hands it over to Joe. The extra \$50 Joe pays is Sam’s profit. If Sam guesses wrong, however, he could lose a potentially unlimited amount of money because there is no limit on how much a stock can increase. As a precaution, before short-selling the stock to Joe, Sam could purchase an option to buy the same stock at a reasonable price. This decreases his profit a little (by the cost of the option), but it “hedges his bet” to avoid possible ruin.

In the commodity or currency markets, an investor buys or sells futures on a commodity or a foreign currency. “Futures” are contracts to purchase a commodity at an agreed price on a specific date in the future. An investor buying futures will make money if the price of the commodity increases and lose if the price of the commodity decreases. An investor can also sell commodities “short,” in which case he/she will make money if the price declines.

Recent advances in technology now make it possible for small investors to buy and sell stocks, bonds and commodities instantly over the Internet. Previously, such instant trading was available only to relatively large investors over the phone. Consequently, a new breed of market gamblers called day traders has emerged. These day traders try to emulate the traders on the floors of the exchanges who are typically in and out of their market positions in the

course of a trading day. They attempt to make money by capitalizing on the transitory ups and downs of a stock.

Day traders make buy and sell decisions based on the movement of a stock's price, looking for a larger-than-average spread between the bid price (the price at which a broker will buy a stock for a client) and the ask price (the price at which the broker will sell), or they follow the value of a stock and try to predict where the stock's price will go on a moment-by-moment basis. To a large extent this sort of prediction is based on hunches, but experienced traders are supposedly able to "read" the market (predict its behavior).

Another day-trading strategy is to take both long and short positions on the same stock to hedge the bet. If the stock goes up, the day trader cancels the short position in the hopes that the long position will make money, and vice-versa. Profits come from short-term fluctuations in the stock's price—often day traders will hold a stock for only a few minutes. The long-term value of a stock has no place in the day trader's analysis, and it is quite common for a trader to know nothing more about the company than its stock exchange symbol. Stocks prices can vary greatly over the course of a single day, and theoretically an investor could make a large amount of money buying at the dips and selling at the peaks. Some day traders will keep track of who is buying and selling stock and copy their lead. The problem for the small investor is that the big investment houses, who buy and sell stocks in huge blocks, have the ability to actually move the market. If they buy a stock, the price goes up because the supply has decreased. If the market, like a pack of sheep, follows the leader, a single large purchase could trigger a buying frenzy. Small investors can not move the market; they become the sheep that allow the large investors to make money.

Part of the attraction of day trading is the adrenaline rush. It can be all consuming; during the hours when the market is open, a day trader may feel he/she cannot afford to leave the computer.

Is it possible to make money as a day trader? According to the U.S. Security and Exchange Commission (2005), most day traders will lose some or all of their capital in the first few months, and many will never go on to make a profit. Day trading is at best a zero-sum game in which one investor's loss is another's gain. When the commission is factored in, however, day traders are in fact playing against a payback percentage of less than 100%. There are individual traders who mostly win, and others who mostly lose. It is an open question as to how much of the difference is due to chance and how much to skill. Many investment advisors suggest that the best strategy for "winning" on the stock market is to buy and hold for the long term. In a study of 35,000 customer accounts of a large U.S. brokerage, researchers from the University of California found that on average male account holders

traded 45% more often than females, but that the men's average risk-adjusted returns were 1.4% less (Barber & Odean, 2001).

Stock Market Systems

The conventional theory of the stock market, the efficient market model, holds that all available information about a stock is factored into its price. Companies release annual reports that are available from a stockbroker. This information can be used to evaluate the potential of a company. For example, a company might have a very favourable price-to-earnings ratio. If the market is efficient, this news is quickly factored into the value of its stock (Peterson, 1999). By the time the individual investor hears about the information, the potential advantage of the purchase has been washed into the market.

According to this view, price fluctuations are merely a “random walk.” The random walk theory says that stock values follow a wholly random path; the chance of a stock's price going up is the same as it is for going down. Over a period of time, however, prices maintain an upward trend. While the market often behaves as if stock prices were on a random walk (Heakal, 2002), we believe that the market is more accurately described as a complex and chaotic system (Gleick, 1987). Complex systems are not in fact random, but are so complex that they appear to be random.

The efficient market hypothesis is only partly true; not all information is known or used properly by all investors. In addition, every investor does not learn about new information at the same time. The first people to learn new information will benefit more than others. There are opportunities, but finding them takes research. In addition, investors do not always act rationally, but might buy a stock because it has already skyrocketed in price or sell in a panic because of a temporary dip in the price. Making a profit on the stock market is similar to poker or sports betting; the successful player has to outthink the rest of the market by finding stocks or commodities that are undervalued or have potential for growth. In recent years much effort has gone into developing models which demonstrate that market values are influenced by the psychology of investors—in particular a tendency toward herd behaviour (Peterson, 1999). Proponents of the behavioural approach base their investment decisions on an analysis of historical patterns of investment behaviour, on the assumption that there is enough regularity in the behavior of investors to allow them to make money.

Part 8: Betting on One's Own Performance in a Game of Skill

In addition to the games described above, there are a wide variety of other skill games that people bet on. We include here only games where the players bet on their own performance. The rules of these various games are beyond the scope of the present chapter. Since this type

of gambling involves private bets, there is usually no house edge (unless we count club fees or pool table rentals as a house cost). In these games, long-term winning is possible if the player is skilled. As with poker, however, the player must find opponents who are weaker but willing to bet on the outcome of the game. In the movie *The Hustler* (Rossen, 1961), a man who is a very skilled pool player earns a living by pretending to be less skilled than he really is. Popular games of skill include bowling, golf, fishing, shooting hoops and one on one (forms of basketball), chess and checkers. These games differ from poker and dominoes in that they do not use a random number generator (no shuffling of cards or tiles). As such, random chance plays only a small role in the outcome of these games. Some players will give other players a handicap to make the bet more even (more random). For example, in golf, if two players are playing against each other and one usually takes 5 holes more to complete the course, the weaker player might be given a handicap of 5, that is, the weaker player would win the bet if he/she lost by only 4 shots. It is unlikely that many problem gamblers who present for treatment will list such private bets as their major problem; however, these private bets are very common amongst adolescent problem gamblers. It is likely that games of skill were the first serious form of gambling that many male pathological gamblers engaged in. In addition, problem gamblers often feel that they cannot enjoy games of skill without placing money on the outcome, so a therapist should consider such games as potential relapse risks. Interestingly, *The Hustler* (Rossen, 1961) and *White Men Can't Jump* (Lester, Miller, Rappaport, & Shelton, 1992) are both films about pathological gamblers whose main problem is betting on their own play in a game of skill (Fritz & Turner, 2002).

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Some key messages for clients

- Casinos, bingo halls, lotteries and racetracks are designed to make money.
- Las Vegas was not built on winners—it was built on losers.
- It is possible to win, but all commercial games are designed to *guarantee* that the house (e.g., the casino) will make money in the long term.

Lotteries

- The chance of winning the grand prize in *Lotto 6/49* is 1 in 14 million.
- If a person bought 1 ticket every day, he/she would have a 50% chance of winning the grand prize within the next 26,000 years.
- When a lottery advertises that the odds of winning are 1 in 7, it is referring to the small prizes, not the large prizes..
- The payback percentage on most lotteries ranges from 20% to 80%, with an average payback of about 60%.
- A payback of 60% is like paying a credit card interest rate of 40%, compounded per bet.

Casino Games and Slots

- Casino games (e.g., craps, roulette and slot machines) have a higher payback percentage than lotteries (e.g., from 90% to 99%).
- Don't be fooled by the higher payback, the casino would not offer these games if it was not making money from them.
- These games make money because people play fast and continuously until their money is all gone.
- In the long run, people tend to lose money faster on a slot machine or at a blackjack table than by buying lottery tickets.
- Your chances of turning \$1 into \$8 million by playing roulette, for example, is about 1 in 29 million, worse odds than some lotteries.

Games Involving Some Skill

- Games of skill (e.g., poker, horse race betting, and sports betting) are games at which some skilled players can make money in the long term.
- Casinos and bookies make money from skilled games; most players lose money at games of skill.
- If a game has a skill element, it means that the players not only have to beat the casino, but they also have to beat the other players.
- A player who is less skilled than the others will lose more than he/she would in a game of pure chance.

- If all the players in a poker game are equally skilled, the outcome becomes a product of pure chance.
- In horse racing, the payback percentage is about 83%, so even fairly skilled players will lose money.