Computers in Human Behavior 31 (2014) 419–424

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Do pokers players know how good they are? Accuracy of poker skill estimation in online and offline players

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ARTICLE INFO

Article history:
Available online 10 December 2013

Keywords:
Gambling
Poker
Internet
Online
Cognitive distortions

ABSTRACT

This study was a collaborative investigation between the disciplines of computing and social sciences to determine whether poker players accurately assess their relative skill level. Of particular interest was whether online poker players exhibit higher degrees of distorted thinking about skill when compared to offline gamblers, in the absence of superior proficiency. Two hundred and seventy-eight gamblers played a simulated game of Texas Hold'em poker against a computer controlled opponent. The computer program has been used in artificial intelligence simulated games against actual poker players and can mathematically estimate skill. Information was collected about player demographics, poker experience, cognitive distortions, and subjective perception of poker skills. The results of study revealed that online gamblers had a greater perception of perceived skill when compared to offline gamblers, despite showing no superiority in poker ability. General gamblingrelated cognitions and subjective rating of poker skill contributed to categorization as an online gambler. Gambling more frequently in offline formats and playing for longer periods significantly influenced the perception of poker skill for online gamblers. From a treatment perspective, it is more difficult to address games like poker because the chance component is equivocal and interpretive biases may be especially difficult to combat.

1. Introduction

In the 21st century the game of poker has experienced unprecedented growth and popularity, largely because of the advent of online poker and televised poker championships. In a large international study, the total number of regular poker players (at least once per month) in 2010 was estimated to be 44.5 million, a 13.5% increase from 2006 estimates (Poker Players Research Ltd., 2010). Research has shown that poker players have a higher gambling frequency and spend more time gambling when compared to non-poker players (Shead, Hodgins, & Scharf, 2008). In the most recent British prevalence study, problem gambling prevalence rates were highest among poker players. Respondents who had played poker were more likely to engage in a range of gambling opportunities, with 48% of past year poker players engaging in seven or more activities (Wardle, Moody, Griffiths, Orford, & Volberg, 2011). The advent of online poker in the late 1990s prompted a major increase in player interest and has since grown exponentially in player participation levels, with online poker being the fastest growing form of Internet gambling (Griffiths, Parke, Wood, & Parke, 2006). Researchers collecting data from online poker players over a 6 month period found that 6 million gamblers spent $3.61 billion (US) playing online poker, with the United States accounting for the largest majority of revenue and players (1,429,943 players with $973.3 million in net revenues; Fiedler & Wilcke, 2012).

The major distinction between poker and most other forms of gambling is that poker involves a combination of skill and chance factors to determine outcome. In as such, the propensity for illusory control increases. Gamblers with a preference for skill games have a greater illusion of control over outcomes when compared to those that prefer games of chance (Myrseth, Brunborg, & Eidem, 2010). When skill is believed to be involved in a particular gambling activity, it is more likely that a player will develop an illusion of control over the outcome (Letarte, Ladouceur, & Mayrand, 1986; Toneatto, 1999). Wohl, Young, and Hart (2005) found that gamblers endorsing problematic behaviors (more than 1 DSM criteria) were more likely to view themselves as being inherently lucky when their game of choice contained a skill component. Regular gamblers have been shown to believe that they possess above

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http://dx.doi.org/10.1016/j.chb.2013.11.006

average skills in slot machine play when compared to non-regular players (Griffiths, 1990a) and problem gamblers have an exaggerated perception of their own skill level (Toneatto, Blitz-Miller, Calderwood, Dragonetti, & Tsanos, 1997).

The idea that many players perceive themselves to be skilled is evidenced by the fact that recreational poker players assert that they can consistently generate a profit. In a 2006 prevalence study, researchers found that one in 10 respondents agreed with the statement: "Playing poker is a good way to earn extra money" (Responsible Gambling Council, 2006). Poker players were more likely to agree with the statement when compared to non-poker players (20% vs. 5%) and 42% of online players endorsed poker play as a profitable enterprise. Online poker players tend to report more financial gains when compared to online casino players (e.g., online slots), with less than one-third of Internet poker players reporting a monthly loss (eCommerce and Online Gaming Regulation and Assurance [eCOGRA], 2007). In a sample of online poker players, Hopley and Nicki (2010) found that 19% reported supporting themselves solely via online poker and an additional 15% reported supplementing their income this way. Playing to win money was listed as the primary reason for online poker gambling (48%) and playing to enhance skills was the second most endorsed reason (12%). Similarly, Wood, Griffiths, and Parke (2007) found that 50% of online poker players said they always or frequently win money. When asked about the contribution of skill vs. chance in online poker, 38% regarded it as predominantly game of skill.

Based on these findings, it is evident that poker is an increasingly prevalent activity that lends itself to common distortions of illusory control. While it is accurate that some players generate a profit, the proportion of recreational players who claim to have a positive financial outcome seems improbable. It is inherently confounding that self-perceptions of skill are often directly derived from a player's (perhaps inaccurate) recall of monetary output or (perhaps inaccurate) belief in advanced ability. It would be difficult to ascertain from player self-report data whether they possess a legitimate degree of skill in poker play. The current study employed a collaborative investigation between researchers in the social sciences area with researchers from computing science department to determine whether poker players accurately assess their relative skill level. Poker skill was assessed via a simulated game of online poker developed by the Computer Poker Research Group (CPRG; http://poker.cs.ualberta.ca/). The CPRG has developed a computer "poker bot" that became the first computer poker program to win against human competitors and the program has the capacity to mathematically estimate the skill level of players.

Of particular interest was whether online poker players exhibit a higher degree of cognitive distortions around poker play when compared to offline gamblers. Models explaining problematic Internet use have suggested that maladaptive cognitions play a critical role in moderating use (Davis, 2001). There are a number of elements in the online gambling environment that could serve to exacerbate the perception of control including lack of personal feedback, lower salience of losses in a virtual environment, player belief in skill acquired through success in demonstration games with misleading payouts (Sévigny, Cloutier, Pelletier, & Ladouceur, 2005), media portrayal of monetary successes, familiarity with an online medium, player characteristics (e.g., being male and younger) and increased control over the pace and timing of play. Research has shown that irrational thinking is more pronounced for gamblers with a preference for online gambling (Lund, 2011) and it has been demonstrated that gamblers take more risks and place higher bets when gambling online vs. in a casino environment (Cole, Barrett, & Griffiths, 2011). Internet gamblers have been shown to have higher levels of cognitive distortions when compared to gamblers who had never placed a bet online, even after controlling for differences in gambling frequency, expenditure and problem gambling severity (MacKay & Hodgins, 2012). Based on previous research, it was hypothesized that online gamblers would *not* possess superior skill in poker play when compared to offline gamblers but would deem themselves to be more skilled. It was also hypothesized that online gamblers would have more gambling-related cognitive distortions when compared to offline gamblers. It was expected that cognitions around perceptions of control (general and poker specific) would differentially predict whether a participant had gambled online.

2. Method

2.1. Participants and Procedure

Two hundred and seventy-eight participants (111 online gamblers[1], 140 males) were recruited from a large Canadian university. Post-secondary students were used as sample participants because of the higher rates of online gambling observed in this population (Griffiths & Barnes, 2008; Petry & Weinstock, 2007) compared to rates in the general population (Wood & Williams, 2009). The mean age of participants was 20 years (range = 18–52; $SD = 3.1$) with an average of 2.3 years of post-secondary education. Respondents had to speak English, be at least 18 years of age, have played poker in the past month and know how to play Texas Hold'em to be eligible to participate. Online poker players were over sampled to increase cell sample sizes for the logistic regression analysis. The sample size exceeded the recommended rule of thumb for logistic regression of at least 10 cases per independent variable (Harrell, Lee, Califf, Pryor, & Rosati, 1984) and the recommended sample size for multiple regression based on Halinski and Feldt (1970). The Conjoint Faculties Research Ethics Board granted approval for this project. The study consisted of three segments: a questionnaire, computer poker play and post-play questions. After participants signed up for the study they were directed to a page where they registered for a code. This code was entered prior to completing each section and the segments were linked by the individual code to ensure confidentiality in data collection.

Participants completed an online questionnaire to gather information about demographics, poker experience (type of play, frequency, duration), cognitive distortions (GBQ; GCI), and general self-perception of poker skill (i.e., rate your poker skill on a scale from Poor = 1 to Excellent = 7). Two simple poker questions were included as a screening measure (not included in the analysis) to ensure players had a fundamental, basic understanding of the game. When participants finished the questionnaire they were directed to the poker play segment where they played 75 hands of heads-up limit Texas Hold'em poker against a computer-controlled opponent through a web-based interface. Seventy-five hands were chosen because they provided a reasonable trade-off between the accuracy of the low-variance skill estimator and the time needed to complete the poker game. The computer opponent for this investigation was a relatively strong opponent so the overlap in variability would be lower and lead to a more accurate estimate of skill. The computer program implemented the rules of limit Texas hold'em, securely dealt cards, communicated the state of the game with players, and logged the players' actions and results of each hand. The web interface provided visual communication to the participant on the state of the hand and provided buttons for the player's options of "fold", "call", or "raise". The program was designed to present an interface similar to that used in online poker establishments and training software. When participants completed the poker segment, they were directed to the post-play

[1] It should be noted that online and offline are not mutually exclusive categories because online players also engage in offline play.

questions on the computer interface. The study took approximately one hour to complete.

2.2. Measures

2.2.1. Gamblers' Beliefs Questionnaire (GBQ)

The GBQ (Steenbergh, Meyers, May, & Whelan, 2002) is a widely used measure of gambling related cognitive distortions that is grounded in theory, reviewed by experts and validated with empirical evidence. It is a self-report measure consisting of 21 questions rated on a seven-point Likert scale with total scores ranging from 21 to 147. Respondents rate items on the scale from 'strongly agree' to 'strongly disagree' with higher scores indicating more gambling related distortions. Comprised within the instrument are the constructs of luck/perseverance and illusion of control. The test has been validated against the Massachusetts Gambling Screen DSM-IV Questionnaire (MAGS DSM-IV; Shaffer, LaBrie, Scanlan, & Cummings, 1994) and the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987). The scale has an internal consistency of .92 and a two week test- retest reliability of .77 (Steenbergh et al., 2002).

2.2.2. Gambling Cognitions Inventory (GCI)

The GCI (Holub, Hodgins, & Rose, 2007) is a measure of cognitive distortions that was validated on an undergraduate sample. Test development was based on a cognitive behavioral formulation of gambling, empirical review, and expert opinion. The measure includes 40 items where respondents rate items on a 4 point scale (strongly agree to strongly disagree). The total score is comprised of a 4 categories of distortion: Information Processing Biases, Probability Errors, Illusion of Control and Magical Thinking. The GCI has a Cronbach alpha reliability coefficient of 0.84 (Holub et al., 2007).

2.2.3. Computer poker program

The computer poker program tracked the cards dealt, the players' decisions, and the players' winnings for each hand played. This information was summarized by three statistics: empirical winnings, empirical luck and empirical skill.

Empirical winnings are the amount the player won (positive) or lost (negative) per hand. Empirical luck is the amount of the player's empirical winnings that is derived from the sampled chance events and is outside of the player's control. As the sample size gets larger, empirical luck will "even out" so that the time-average of empirical luck approaches 0. Empirical skill is a statistic developed by the CPRG that is essentially a measure of how much money the player "should" have won/lost (mathematically) relative to the computer opponent based on the player's choices. For example, on a hand where the player won $12 over the opponent, the empirical skill measure might estimate that the player should have only won $8 on that hand, given the cards dealt and mathematical probability of winning versus losing that hand. Empirical skill is the amount of the player's empirical winnings that is derived from the player's actions and has considerable lower variance than empirical winnings. As the sample size gets larger, empirical skill will approach the player's true expected winnings.

Empirical skill was measured through the statistical principle of control variates. These control variates can be thought of as empirical luck, and can be removed to get a more accurate empirical skill estimate. Empirical skill was measured in small-bets (same units as empirical winnings) and averaged over 75 hands to get a more precise estimation of player skill relative to the opponent (i.e., how much money the player would be expected to win over the opponent). Given that empirical skill has a degree of variability, the CPRG used a combination of DIVAT (Zinkevich et al., 2006) and imaginary observations (Bowling, Johanson, Burch, & Szafron, 2008) to more accurately derive the measure of empirical skill. DIVAT is a provably unbiased estimator of winnings that reduces variance through a use of carefully constructed control variants (L'Ecuyer, 1994). While being unbiased, it typically results in a sevenfold reduction in variance. Imaginary observations are a mechanism that can further reduce an estimator's variance by exploiting explicit knowledge of one player's strategy (in this case the computer opponent). This technique is also provably unbiased and results in a 1.5-fold reduction in variance, and can be combined with DIVAT. The empirical skill estimate is therefore an unbiased estimator of winnings, but with a 26-fold reduction in variance due to synergy between the two estimation techniques.

Although empirical skill is a mathematically valid measure, analyses were completed to provide further support for the validity of the measure. A comparison of professional players from the CPRG Man-versus-Machine poker competition to average players from an online poker site demonstrated a significant difference on the empirical skill measure for these two groups. The average amount of money lost (in small bets) for professionals ($M = 0.05$, $SD = 0.98$) was significantly less than that of average players ($M = 0.16$, $SD = 1.16$), $t(293{,}770) = -4.09$, $p < .001$. Analyses were also conducted to verify that participants in the current study with limited poker knowledge would score lower than participants who correctly answered the poker knowledge questions. Participants who answered both questions correctly scored significantly higher on the empirical skill measure ($M = -0.37$) when compared to participants who answered one or both of the knowledge questions incorrectly ($M = -0.44$), $t(338) = -2.12$, $p < .05$. In addition, there was a small but significant correlation between the number of questions correctly answered and empirical skill ($r = .15$, $p < .01$).

It is important to note that when referring to empirical skill in the context of this study it is in reference to relative skill and not absolute skill. Empirical skill is a measure of the player's ability against a particular opponent (in this case the computer opponent). Given that all participants played against the same opponent, it is reasonable to draw conclusions based on comparisons between players. Moreover, comparisons are being made between groups and not individual play patterns.

2.2.4. Post-play questions

Post-play questions were asked to respondents regarding their opinions specific to the simulated poker game. Respondents were asked to rate their personal level of perceived skill and that of the opponent on a 7-point Likert scale (e.g., How well do you think you played on a scale from Poor to Excellent). Participants were also asked whether they endorsed beliefs about luck (e.g., 'I should have lost more but I got lucky') and skill (e.g., 'On the whole, I played better than my opponent').

For the sake of clarity in terminology, *empirical skill* will be used to refer to the computer measure of skill, *perceived skill* will be used to refer to the players' subjective measure of general poker skill (i.e., rate your poker skill on a scale from Poor to Excellent) and the term *game-specific perceived poker skill* will be used to refer to the players' perceived skill relative to the computer opponent post-play. The term "empirical" will be used when referring to the computer-generated variables because it is the terminology used by the CPRG for the output variables.

2.3. Excluded participants and data manipulation

Four hundred and three participants correctly entered their code in all three sections of the study. Seventy-four participants were excluded based on incorrectly answering the poker validity questions. Five participants were excluded for extreme missing data. Forty-six participants were excluded from the main analysis because of a computer programming error where they played a different opponent. Females were more likely to be excluded based on

the poker validity questions where 24% of excluded participants were female and 13% were male, $\chi^2(1, N = 402) = 7.94$, $p < .05$. No other statistically significant differences existed between included and excluded participants.

3. Results

Of the 278 participants, 77% played poker with friends or family, 45% played poker at a casino and 31% played poker online. The average age at which the participants started playing poker was 17 years ($SD = 2.6$) and the mean number of times players gamble on poker was approximately once per month, with the average poker session lasting 84 min ($SD = 56.0$). The primary research question was to determine whether online gamblers inflate their skill estimation. Results revealed that online gamblers were no more skilled than offline gamblers on the empirical skill measure, $t(276) = -1.45$, $p = .15$ *but* online gamblers were more likely to perceive themselves as skilled at poker, $t(276) = -4.34$, $p < .001$, and have more distortions on the GBQ, $t(276) = -5.20$, $p < .001$ and the GCI, $t(276) = -4.39$, $p < .001$. Online gamblers were more likely to make probability errors, have magical thinking, illusions of control and information processing errors on the GCI (all significant at $p < .05$). Table 1 provides descriptive information for the comparisons related to empirical skill and the measured cognitive variables.

3.1. Logistic regression analysis to predict online poker play

To further substantiate the above findings, a logistic regression analysis was conducted to determine the relative contribution of variables differentiating online and offline gamblers related to game play, perception of skill and cognitive distortions. All assumptions of logistic regression analyses were tested including ratio of cases to variables, linearity of the logit, multicollinearity and outliers. A test of the full model with eight predictors (gender, age, empirical skill, empirical winnings, general perceived poker skill, game-specific perceived poker skill, GBQ, GCI) against a constant only model was statistically reliable, $\chi^2(8, N = 278) = 32.75$, $p < .001$. The model correctly classified 66% of gamblers (41% online gamblers; 83% offline gamblers) indicating that the final model was superior to the 60.3% predicted from the constant only model (100% offline gamblers). Table 2 shows regression coefficients with standard errors, odds ratios and p-values for the predictors. Empirical skill (computer measure) was not an independent contributor to predicting online gambling. Additionally, age, gender, empirical money (won/lost) during the game, and the perception of how well the gamblers thought they played the game did not differentiate the two groups. Two factors that did significantly differentiate online from offline gamblers were general gambling-related cognitions (GBQ) and their subjective rating of poker skill.

Table 1
Mean scores (SD) for online ($n = 111$) and offline (n = 167) gamblers on measures of empirical skill, perceived skill and cognitive distortions.

Variable	Offline (SD)	Online (SD)	*t*-Value
Empirical skill	−0.39(0.25)	−0.35(0.21)	1.45
Perceived skill	3.25(1.46)	4.03(1.48)	4.34**
GBQ	67.02(21.04)	80.17(20.00)	5.21**
GCI sub-scales			
Probability errors	26.34(6.27)	28.42(7.35)	3.61**
Magical thinking	26.13(7.80)	28.42(7.35)	2.45*
Illusion of control	21.20(4.84)	24.19(4.69)	5.11**
Information processing	10.46(2.34)	12.01(2.32)	5.42**
GCI Total	81.87(16.60)	91.22(17.10)	4.39**

Note: SD = Standard Deviation; GBQ = Gamblers' Beliefs Questionnaire; GCI = Gambling Cognitions Inventory.
* $p < .05$.
** $p < .001$.

Table 2
Logistic regression analysis for predicting online poker players ($n = 111$) from offline poker players ($n = 167$).

Variable	*B*(SE)	Odds ratio
Age	−0.04(0.28)	0.97
Gender	−0.02(0.05)	0.98
Empirical skill	−0.49(0.63)	1.63
Empirical money	0.08(0.23)	1.08
Skill rating (general)	0.22(0.11)	1.25*
Skill rating (game-specific)	−0.13(0.11)	.088
GBQ	0.02(0.01)	1.02*
GCI	0.00(0.01)	1.00

Note: $R^2 = .11$ (Cox and Snell), .15 (Nagelkerke). Model $\chi^2(8) = 32.75$, $p < .001$. GBQ = Gamblers' Beliefs Questionnaire; GCI = Gambling Cognitions Inventory.
* $p < .05$.

Table 3
Multiple regression analysis for variables predicting empirical skill and perceived skill ($n = 105$) among online gamblers.

Variable	Empirical skill		Perceived skill	
	B (SE B)	ß	*B* (SE B)	ß
Gender	−0.08(0.04)	−.19	−0.27(0.27)	−.09
Age	0.01(0.01)	.09	−0.04(0.08)	−.05
European	0.13(0.07)	.31	−0.03(0.40)	−.01
Asian	0.01(0.06)	.03	−0.49(0.39)	−.17
Offline poker (freq)	0.01(0.01)	.01	0.14(0.05)	.28*
Duration of play (min)	0.00(0.00)	.01	0.01(0.00)	.28*
Age first played	0.00(0.10)	.01	−0.10(0.06)	−.17
GBQ	−0.00(0.00)	−.15	−0.01(0.01)	−.09
GCI	0.00(0.00)	.12	0.02(0.01)	.19

Note: $R^2 = .14$ for empirical skill; $R^2 = .36$ for perceived skill. GBQ = Gamblers' Beliefs Questionnaire; GCI = Gambling Cognitions Inventory.
* $p < .01$.

3.2. Empirical skill vs. perceived skill among online gamblers

Analyses were conducted to determine the factors contributing to (a) empirical skill (computer measure) and (b) perceived poker skill (players' subjective rating of general poker skill) among online gamblers. Investigated variables included demographics, play-related variables, and gambling cognitions. Two separate regression analyses (empirical skill and perceived skill) were conducted to determine the contribution of the following variables: gender, age, ethnicity, frequency of offline poker play, duration of play (minutes), age first played, GBQ and GCI. In accordance with conventional rules for identifying multicollinearity, all tolerance values were greater than 0.1 and Variance Inflation Factors values were less than than 10 (Myers, 1990). Table 3 shows that none of the investigated variables significantly predict empirical skill among online gamblers $F(9,105) = 1.79$, $p = .115$, although ethnicity and gender are significant at the 0.10 level. In terms of perceived skill, Table 3 shows that gambling more frequently in offline formats and playing for longer periods of time significantly influenced the perception of poker skill for online gamblers, $F(10,105) = 6.03$, $p < .001$.

4. Discussion

The results of study support the hypothesis that online gamblers perceive themselves to be more skilled and exhibit higher levels of gambling-related cognitive distortions when compared to offline gamblers. This elevated level of perceived skill was demonstrated despite showing no superiority in poker ability. Factors

that significantly differentiated whether someone had gambled online included gambling-related distortions and subjective rating of poker skill. Gambling in offline formats and playing for longer periods of time significantly influenced the perception of poker skill for Internet gamblers. For games like poker, where players already demonstrate an inflated sense of control, (Myrseth et al., 2010) the online element appears to have an additive effect on influencing such perceptions. When looking specifically at online gamblers, there were no measured variables that contributed to skill. Higher levels of perceived skill, in contrast, were associated with increased gambling frequency and duration. Research has previously demonstrated that the most involved poker players, in terms of money spent, devote more time to online poker play (LaPlante, Kleschinsky, LaBrie, Nelson, & Shaffer, 2009) and engage in more online and offline gambling activities. (Gainsbury, Wood, Russell, Hing, & Blaszczynski, 2012). Shead et al. (2008) found that poker players who reported gambling predominantly for the skill factor spent a higher proportion of time playing online compared to players who preferred it for the socialization aspect. Similarly, Cotte and Latour (2009) highlighted that players in their qualitative sample with a preference for online gambling described engaging in play because of the skill-base component vs. social component.

It may be that online gamblers enjoy moving away from the socialization aspect because it allows them to focus more intently on the game. Unlike the casino, there are less external stimuli for distraction, the surroundings are familiar and the player has command over the pace and timing of play. Perception of skill could be influenced by a subjective sense of control in the online gambling environment, but is it possible that an inflated sense of skill could lead to financial success? Certainly from an entrepreneurial perspective, success may be achieved through confidence in one's abilities and persistence in the face of repeated failure. Griffiths, Wardle, Orford, Sproston, and Erens (2009) found that financial success in online poker was associated with a self-perception of being skilled, disciplined play (e.g., staying to a budget), playing at higher stakes and not overestimating the skill involved in poker. Similarly, in a study of Internet poker players commissioned by eCOGRA (2007), financial success was associated with the perception of skill.

There are a number of complicating issues involved in teasing out the factors that might mitigate accurate conclusions about the relationship between skill and financial success. For example, previous studies have demonstrated that recall of money won/lost can be inaccurate (Volberg, Moore, Christiansen, Cummings, & Banks, 1998; Williams & Wood, 2004; Wood & Williams, 2007). Moreover, the chance vs. skill nature of poker makes subjective interpretations of skill prone to the fundamental attribution error (Ross, 1977). The combination of an actual skill and luck component in games like poker changes the nature of the possible attributions in a game situation. For example, players may possess a certain amount of skill that allows them to be successful up to a point, where after relative skill is lower than competing players. Given that poker has an inherent degree of variance in outcomes (i.e., an inferior player can sometimes beat a superior player), a less skilled player may initially attribute losses to variable, external factors such as a bad hand. This losing situation may continue for an extended period of time and be attenuated by intermittently reinforcing wins. After a certain point, it will probably become apparent to the player that he or she is relatively less skilled but at the cost of financial losses. It has been demonstrated that being adaptive to strategy changes enhances one's ability to be successful in poker (Dedonno & Detterman, 2008) and strategic changes may provide additional opportunities for success.

In a similar domain, there is the matter of how skill is defined. According to researchers in the CPRG, monetary output for poker matches is a highly variable and unreliable indicator of skill and many possible factors could be included in the definition. Skill could encompass knowing which games have higher odds, understanding the rules of the game, having certain strategies or systems, making smaller wagers on a higher amount of hands over time, strategic timing of entering the game, choice of opponents, or playing at more tables so competitors gain less information. The current study only employed an operational definition of skill as a relative measure against a single opponent. When we expand the definition of skill, there may be some validity to players experiencing consistent success relative to other players. Moreover, the gamblers in the current investigation played against a computer opponent and there may be elements of skill that only exist in live situations or applicable to games with other online players.

It appears anecdotally that there is a milieu of bravado around poker that does not exist with other gambling forms that is undoubtedly influenced by the sensationalized nature of the game. The stereotype of a heavily involved poker player is qualitatively different from that of a slot machine player. As a speculative observation, it maybe the case that poker players have unrealistic expectancies about future winnings because of their assumptions of perceived skill and control. Without contrary feedback about the true nature of their ability, it would be easy for gamblers to disregard intervention strategies that highlight erroneous perceptions. The belief in a superior skill base in the absence of an actual proficiency may lead players to view persistence in the face of financial failure as fortitude and sacrifice to hone their skills. With other addictive behaviors such as alcohol or drug use, there is no possibility of a successful outcome with increased use. Conversely in poker, pre-occupation and chasing are routinely endorsed through the successes of the most adept players. Mitrovic and Brown (2009) have validly highlighted that poker players may not adhere to our previous research definitions in the domain of problematic involvement when considering factors not measured by many problem gambling instruments such as invested time, degree of disciplined play, profitability and level of clinically significant impairment.

Wohl et al. (2005) found that individuals who had problems with games that contained a skill component (such as poker) had more negative beliefs about seeking treatment than those who had problems with games of chance (e.g., slot machines). Specific to online play, researchers have found that online poker players are less amenable to responsible gambling features when compared to online casino players and skilled poker players are less likely to endorse imposed limits or self-exclusion (Gainsbury et al., 2012). If online gamblers perceive themselves to be more skilled, playing online may serve as a means to subjectively hone skills by attending exclusively to the game. This inflated sense of skill in the absence of salient feedback countering such beliefs could make online gamblers particularly intransigent to cognitive treatment strategies. From a treatment perspective, it is more difficult to address games like poker because the chance component is equivocal. What is commonly referred to as "primary illusory control" (beliefs in the able to control outcomes) is not completely illusory when players can influence the game. Research has shown that irrational beliefs exist around games that are ostensibly governed by chance (Toneatto et al., 1997). Thus interpretive biases with online poker players may be especially difficult to combat.

The relationships between variables influencing online gambling behavior are complex and multifaceted. Online gambling presents a unique challenge for researchers, stakeholders, treatment providers and policy makers. Prohibition in many jurisdictions and a corresponding lack of regulatory standards could permit unfair and illegal business practices and discourage responsible gambling controls. Alternatively, legalization could permit for economic benefits and consumer protection. Accessibility and increased potential for frequency of play makes the proliferation of

online gambling a viable concern but economic benefits and consumer protection need not be opposing goals. In a review of the evidence for the prevention of problem gambling Williams, West, and Simpson (2012)concluded that policy initiatives are an effective means to offset harm resulting from legalized gambling, particularly if governments are willing to adopt a balance between revenue generation and harm minimization. The Internet as a gambling medium provides a unique opportunity to collect data given the ubiquitous nature of play across a range of jurisdictions and populations. The Internet also provides a wide-ranging forum to implement protection and prevention programs. Adoption of legalized online gambling will require an overarching public health perspective and policy should be based on accurate empirical evidence of the associated harms and benefits.

Acknowledgments

The authors would like to acknowledge the financial support of the Alberta Gaming Research Institute. The authors had exclusive control of the study design, data collection, data analysis, data interpretation, report writing and decision to submit this article for publication.

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