The Relationship between Digit Ratio, Illusion of Control, and Risk-Taking Behavior among Chinese College Students

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An Exploratory Study of the Relationship between Digit Ratio, Illusion of Control, and Risk-Taking Behavior among Chinese College Students

Abstract

Previous studies on the relationship between digit ratio and risk-taking mainly focused on Western subjects. Moreover, no researcher has examined the concurrent effect of digit ratio and illusion of control on gambling behavior. This exploratory study investigates the relationship between digit ratio, illusion of control and risk-taking behavior of Chinese subjects. Sixty-six students from a Chinese university were invited to answer a questionnaire and play a purposefully-designed betting game. The results show that the subjects' risk-taking level, measured in terms of average betting amount, is negatively correlated to their digit ratio but not to their illusion of control score. Moreover, there is no significant association between the subjects' digit ratio and illusion of control score. These preliminary findings will have useful implications to gaming regulators and businesses.

Introduction

Research on risk-taking is varied. A wide range of theoretical perspectives and methodological approaches is used in risk research (Taylor-Gooby & Zinn, 2006). More recently, biological factors in risk taking are subjected to increasing examination (Garbarino, Slonim, & Sydnor, 2011). In particular, researchers propose that individuals' prenatal testosterone can have an influence on future risk-taking behavior (e.g. Stenstrom et al., 2011). According to Fink et al. (2006), prenatal testosterone may influence the development of certain personality characteristics such as sensation seeking. In fact, Fink et al. (2006) found a significant negative relationship between men's prenatal testosterone and their sensation seeking score. In another study, high testosterone has been found to have a link to behavior that intends to dominate (Ronay & von Hippel, 2010).

A close proxy to prenatal testosterone exposure is the 2D:4D ratio, also called digit ratio (Anderson, 2012). It is defined as the ratio of length of an individual's second to his/her fourth finger (Fink et al., 2006). Recent research such as Stenstrom et al. (2011) found a significant negative correlation between digit ratio and financial risk taking. In other words, a small second-to-fourth finger length ratio is associated to higher risk taking. However, this observation is only found in men. In another recent study, Hönekopp (2011) also found that digit ratio is negatively correlated to risk taking and aggression.

Gambling embraces the essence of risk-taking (Colllins, 2003) which includes involving outcomes not only uncontrollable, but also largely unpredictable (Frank & Smith, 1989). So far, most existing studies on digit ratio and risk-taking are centered on western subjects. Research in this area conducted on Chinese subjects is currently lacking and few, if any, can be found on gambling-specific issues. This is despite the fact that Chinese people are known to have a high propensity to gamble (Lam & Ozorio, 2013; Lam, 2007). For example, Macau, the only city in China with legalized casinos, is only around 30 square kilomters in size but hosted more than 30 casinos of varied sizes (DSEC, 2014). Together, these Macau's casinos took in almost US$45 billion in gross casino gambling revenue in 2013 (DICJ, 2014). This figure is more than the gross revenue of all the casinos in USA combined. As such, current research is undertaken to fill this gaps. In this study, we examine the relationship between the digit ratio, illusion of control and Chinese gambling behavior.

Literature Review and Hypotheses

According to Garbarino, Slonim, & Sydnor (2011), circulating testosterone may be related to risk-taking in a positive manner. Testosterone is a steroid hormone that influences not only the reproductive function of males, but also helps modulate their behavior (Dixson, 1998; Nelson, 2005; Wingfield et al., 1990). Circulating testosterone has an immediate (or transitory) activational effect on behavior (Arnold & Breedlove, 1985). For example, Garbarino, Slonim, & Sydnor (2011) found that both men and women exhibited a negative relationship between the digit ratio and risk-taking.

Other than the transitory effect on behavior, Arnold and Breedlove (1985) proposed that testosterone could have permanent effects on brain development. These effects are termed "organizational effects" and the digit (or 2D:4D) ratio - the ratio of the length between the second and the fourth finger - has been increasingly adopted to measure the effects. Digit ratio is regarded as the persistent marker of exposure to prenatal androgens (Manning, 2002). It is negatively associated to prenatal testosterone exposure (Pearson & Schipper, 2012). Prenatal androgens are said to affect brain development and so are more likely to pose dominant influences on human behavior (Goy & McEwen, 1980). According to McIntyre et al., (2005), digit ratio is developed even before birth. Thus, when compared with circulating testosterone, the digit ratio possesses higher explanatory power of human behavior (Garbarino, Slonim, & Sydnor, 2011).

So far, there are several studies on the relationship between the digit ratio and risk-taking, and the results of these studies are mixed. On the one hand, Apicella et al. (2008) found that testosterone is positively related to risk-taking among male undergraduates in an experimental study. On the other hand, Sapienza, Zingales, and Maestripieri (2009) did not find any positive correlation between circulating testosterone and risk-taking among male MBA students. The researchers did report a positive correlation finding among female MBA students. Yet, Zethraeus et al. (2009) administered a medical manipulation of circulating testosterone among a group of healthy postmenopausal women and find no significant effect of testosterone on the subjects' risk-taking behavior. Dreber and Hoffman (2007) found that the digit ratio is positively correlated with financial risk aversion among Caucasian men and women in Sweden. But the same results were not found in a heterogeneous sample of American men and women in Chicago. More recent studies by Stenstrom et al. (2011) and Hönekopp (2011) all found a significant negative correlation between digit ratio and risk taking. Based on previous studies on western subjects and recent results, the following hypothesis is formulated:

H1: Digit ratio is negatively correlated with the level of gambling among Chinese subjects.

Besides biological factors, individuals' perception of control (i.e. illusion of control) over independent events is often found to be an important factor in examining excessive gambling. According to Langer (1975, p.311), illusion of control is "*an expectancy of a personal success probability inappropriately higher than the objective analysis would warrant*". Illusion of control has always been found to be associated positively with gambling involvement (Dickerson, 1984; Gilovich, 1983; Gilovich & Douglas, 1986; Langer, 1975; Langer & Roth, 1975; Levitz, 1971; Strickland, Lewicki, & Katz, 1966). Situational variables like availability of choice, sequence with which outcomes are presented, familiarity with the task, degree of involvement, and provision of information have always been found leading people to misattribute successes to themselves rather than chance (Presson & Benassi, 1996). However, biological factor like testosterone has never been explored to see its association with individuals' illusion of control. While the digit ratio has been hypothesized above as negatively related to risk-taking, illusion of control is found to be positively correlated to risk-taking among Chinese subjects (see Oei, Lin, & Raylu, 2008; Loo, Raylu, & Oei, 2008; Lam, 2007; Hong & Chiu, 1988). Hence, the following hypothesis is formulated:

H2: Illusion of control is positively correlated with the level of gambling among Chinese subjects.

Method

To test the hypotheses, 66 students from a university in Macao were invited to participate in the study. The study proceeded in three stages. Chinese students were first fully briefed about current study during class and then given the option to participate. Among all, only one student refused to take part because of privacy concern. Participants to current study first completed a questionnaire that includes items on illusion of control and simple demographics like gender and age. Illusion of control was measured with three items adapted from Gambling Related Cognition Scale (Raylu & Oei, 2004). The items were (1) "Praying helps me win", (2) "Specific numbers and colors can help increase my chances of winning", and (3) "I have specific rituals and behaviors that increase my chances of winning". Participants indicated in a 7-point Likert scale (1 = strongly disagree; 7 = strongly agree) the extent to which they agreed with each of the statements in this 3-item scale.

After the survey, the participants took part in an experimental betting game. The purpose of the game was to measure the risk-taking behavior of the participants. According to Anderson (2012), many studies on risk-taking use self- report instruments to measure risk-taking behavior. This can have negative consequences to the research findings and, hence, actual real life decision-making is preferred.

[Insert Figure 1 about here]

Before the start of the game, each participant was first distributed an odds table and a scorecard on which betting choices, selected numbers, and the winning numbers were marked (Figure 1). The participants told that they have MOP 1,000 (~USD 125) credit on hand and the purpose of the game is to increase this amount as much as possible within five rounds of the game. Besides, the participants were told that the final winners would be announced in class by the end of the game. The purpose of this form of acknowledgement of success and social incentive was to stimulate their intrinsic motivations towards risk-taking. Each participant will play five rounds of betting, with a maximum of 330 (5 x 66) decision-makings.

In each round, the participants were given 40 seconds to place their bets which ranged between 1 and 5. Participants were noted that betting 1 involved no risk as the chance of losing was zero. Participants were then asked to pick their desired number that ranged between 1 and 9. A Microsoft Excel spreadsheet was used to generate a random winning number from 1 to 9, which the participants could all view through a large classroom projector. If the number selected by a participant coincided with the winning number, the participant would win according to how much he or she bet. Before the game started, three trials were

arranged to get the participants understood and familiar with the game. At the end of the game, the scorecards were collected and the figures were checked for errors. An average bet is then calculated based on bet made from round 1 to 5.

Lastly, participants' hand images were captured with a specially designed stand with an attached iPad so as to measure their digit ratios. Digital images were captured as they allow repeated measurements and so more precision measurements are obtained (Garbarino, Slonim, & Sydnor, 2001). Autometric software developed by DeBruine (2004) was used to measure the lengths of the second and the fourth fingers. Software-based measurement has been shown to give the highest precision and interrater reliability (Kemper & Schwerdtfeger, 2008). Measurements (right hand only) were made from the central point of the basal crease of the digit to the central point of the fingertip. Three individuals rated the length of each finger independently. The inter-reliability among the three independent measurements for 2D is 0.974 and for 4D is 0.978.

Results

There are more female (71.2%) participants in the sample than male (28.2%) and the average age is 22.05 years old. Table 1 shows a simple correlation matrix of the variables used. Pearson correlation tests reveal a negative association between average bet and digit ratio (r = -0.318, $p < 0.01$) and a positive association between average bet and illusion of control scores (r = 0.285, $p < 0.05$).

[Insert Table 1 here]

The Cronbach alpha for the 3-item illusion of control scale is 0.853. Preliminary examination using independent t-test found no gender differences in average bet made (t = 0.880, df = 64, $p > 0.05$), illusion of control score (t = -0.928, df = 64, $p>0.05$) and digit ratio (t = -1.944, df = 64, $p > 0.05$). The overall average bet made is 1.530 (S.D. = 0.593); male = 1.632 and female = 1.489. The overall average digit ratio is 0.959 (S.D. = 0.028); male = 0.949 and female = 0.963. All key variables captured were then added to a proposed structured equation model created using AMOS 19.0. A structural equation modeling technique (using AMOS) is chosen because it facilitates the use of multiple indicators that can account for measurement errors and enables the simultaneous analysis of all variables in a model (Byrne 2001). Average bet is a dependent variable, while digit ratio and illusion of control are the independent variables. Figure 2 shows the estimated solutions for measurement and structural

model. The resulting goodness-to-fit indices of the model show good fit (i.e. CMIN/DF = 0.213, RMR = 0.007, GFI = 0.995, AGFI = 0.981, RMSEA = 0.000, Hoelter = 725).

[Insert Figure 2 here]

Referring to Table 2, the results show that average bet is negatively correlated to digit ratio (standardized regression weight estimate = -0.240, $p < 0.05$) but not correlated to illusion of control score (standardized regression weight estimate = 0.123, $p > 0.05$). In addition, the correlation between subjects' illusion of control score and their digit ratio is statistically insignificant (r = -0.191, $p > 0.05$). R^2 for average bet is 0.084.

[Insert Table 2 here]

Discussion

Previous studies on western subjects have found a negative association between digit ratio and financial risk-taking (e.g. Hönekopp, 2011; Stenstrom et al., 2011; Dreber & Hoffman, 2007). In current exploratory study, the results of a betting game and survey show that Chinese subjects' digit ratio is negatively correlated to their risk-taking behavior measured in terms of their average bet. This relationship concurs with hypothesis H1; hence, H1 is supported. However, although loaded in the right direction and found significant in simple correlation test, illusion of control is not significantly correlated to average bet. H2 is, thus, not supported. Past research found that higher illusion of control tends to lead to greater gambling involvement (e.g. Oei, Lin, & Raylu 2008; Dickerson, 1984). But similar result is not observed in current study. One explanation is that the simplicity and structure of the betting game (i.e, requiring participants to select a small set of numbers in a very short period of time and over five rounds only) may have alleviated the participants' illusion of control. Another possible factor that leads to a lack of association in the structural equation model may be due to missing monetary incentives. Since the credits earned in the game were not translated into real monetary value, participants' motivation to win may not be sufficient to activate a connection between their general illusion of control and betting level. Lastly, this exploratory study found no significant correlation between digit ratio and illusion of control scores of the Chinese subjects.

Current findings, particularly on the relationship between digit ratio and gambling level, may have important implications to public policy makers, gaming regulators and gaming businesses. A possible connection between individuals' digit ratio and their betting level would suggest some biological factors in the prevalence of Chinese gambling. This opens up the possibility of using measured digit ratio to pre-determine the gambling propensity of an individual and, hence, the propensity for excessive gambling. It would potentially allow gaming regulators and problem gambling counselors to identify at-risk gamblers. Similarly, it may help gaming businesses to identify customers who may be more likely to gamble more.

However, readers of current exploratory study need to be cautious with its findings. This study merely reports the preliminary findings of a limited exploratory study. The study's sample size is small and it is conducted in a single Chinese city (Macao) within a large country (China). Besides, males are under-represented in current study. Future studies should strive to enlarge the sample size and broaden the diversity of the sample by including more male subjects and actual Chinese gamblers. Moreover, the association found between digit ratio and average bet may be due to other reasons. Since the digit ratio is determined before birth, other factors after birth may be more influential in shaping an individual's risk-taking character (Pearson & Schipper (2012). These factors may relate to our social and cultural environment.

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Table 1: Simple Correlation Matrix of Key Variables

Variable	Age	Digit Ratio	Average Bet	Illusion of Control
Age	1	-0.041	-0.039	-0.007
Digit Ratio	-	1	-0.318**	-0.168
Average Bet	-	-	1	0.285*
Illusion of Control	-	-	-	1

NB: * - $p<0.05$, ** - $p<0.01$

Table 2: Measurement and Structural Model Results

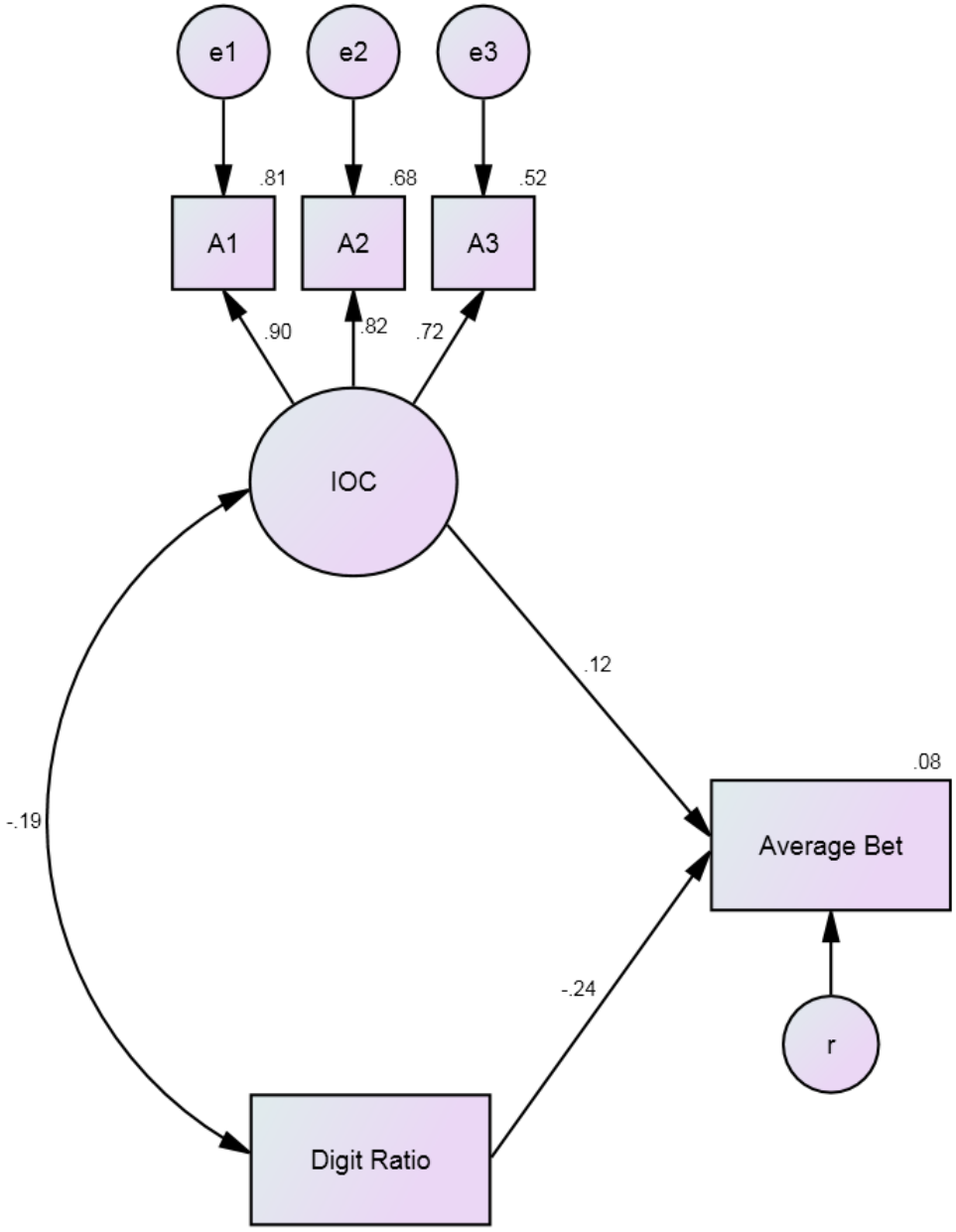
Measurement Model			**Unstandardized Estimate**	**Standardized Estimate**	**Standard Errors (S.E.)**	**p-value**
A1 - Praying	<--	Illusion of Control (IOC)	1	0.897	-	-
A2- numbers	<--		0.998	0.824	0.143	***
A3 - ritual	<--		0.779	0.722	0.126	***
Structural Model						
Average Bet	<--	Illusion of Control (IOC)	0.066	0.123	0.070	n.s.
	<--	Digit Ratio	-4.423	-0.240	2.239	*
Digit Ratio	<-->	Illusion of Control (IOC)	-0.005	-0.191	0.004	n.s.

NB: *** - $p < 0.001$, * - $p < 0.05$, 'n.s.' – not significant

MOP	Starting Amount	R1	R2	R3	R4	R5
2,000		O	O	O	O	O
1,900		O	O	O	O	O
1,800		O	O	O	O	O
1,700		O	O	O	O	O
1,600		O	O	O	O	O
1,500		O	O	O	O	O
1,400		O	O	O	O	O
1,300		O	O	O	O	O
1,200		O	O	O	O	O
1,100		O	O	O	O	O
1,000	O	O	O	O	O	O
9,00		O	O	O	O	O
8,00		O	O	O	O	O
7,00		O	O	O	O	O
6,00		O	O	O	O	O
5,00		O	O	O	O	O
4,00		O	O	O	O	O
3,00		O	O	O	O	O
2,00		O	O	O	O	O
1,00		O	O	O	O	O
0		O	O	O	O	O
	Your Bet =					
	Your Number =					
	Winning Number =					

Betting Choice	Reward if you win (MOP)	Cost if you lose (MOP)
1	100	0
2	300	300
3	500	500
4	700	700
5	900	900

Figure 1: Game Odds Table and Scorecard



*NB: IOC means Illusion of Control

CMIN/DF = 0.213, RMR = 0.007, GFI = 0.995, AGFI = 0.981, RMSEA = 0.000, Hoelter = 725

Figure 2: Final Model with Results