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Risky Decision Making and Impulsivity in Adolescents' Chess Players: Does Chess Modify or Induce Risky Decisions?

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Abstract

Background: Our main goal in this study was to evaluate impulsivity and risky decision making in adolescents' intermediate-expert chess players and compare them with non-players. We also looked at the relationship between impulsivity and risky decision making in the two groups.

Method: The present study employed a comparative-correlational method which was performed in 2019 in Tehran. Based on the previous research, 55 chess players (14-17 years old) and 79 non-players (13-17 years old) participated in the study. Impulsivity was measured by the Go/no-go task; and risky decision making was assessed via the Iowa Gambling Task (IGT). Independent t-test and Pearson Correlation Coefficient were used for statistical analysis.

Results: There were no significant differences between groups regarding age or education. In the go/no go tasks, there were significant differences between the groups in commission error, omission error and inhibition subscales. In the IGT, we observed significant differences between the groups in the net score, raw score and ratio of advantageous/disadvantageous choices in different subscales. In both groups, net scores, raw scores and ratio of advantageous/disadvantageous choices were negatively correlated with the commission error. Additionally, omission error was positively correlated with the inhibition subscale. We found that the relationship between impulsivity and risky decision making was stronger in non-chess players than chess players.

Conclusion: The results of this study might put chess in the spotlight as an option to improve impulsivity and risky decision making in clinical settings.

Key Words: Adolescents, Chess, Impulsivity, Risky decision making.

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1- INTRODUCTION

Decision-making is defined as the act of choosing between two or more courses of possible actions or solutions. In the real world, in most cases, we have to choose an option that is more profitable and less risky. In fact, the ability to make advantageous decisions under circumstances in which there is also the possibility of loss is an important component of adaptive behavior. Therefore, a better understanding of the factors affecting risky decision making can have both research and clinical significance. Various theories have explored the influence of economic, psychological, contextual, emotional, and hormonal factors on risk-based decision making.

For example contextual loss and gain framing and probability levels employed in the gamble are known as two predictors of risky behaviors (1). Several studies have explored the role of memory and decision-making content on risky decisions (2, 3). Immediate emotions, including all affective states that the decision-maker has at the time of the decision, have also been demonstrated to be directly related to the decision context (4). Moreover, evidence indicates that perceived risks affect risk-taking more significantly than perceived benefits and higher sensation-seeking tendencies are affiliated with more risk-taking (5).

Meanwhile, one of the factors demonstrated to influence decision making, is impulsivity. From a characterological point of view, impulsivity is characterized by unplanned and quick risky actions (6). Dickman proposed that dysfunctional inhibition which manifests as inadequate attention is the main cause of impulsivity (7, 8). Barratt distinguished actions without thinking, quick cognitive decision-making, and decrease in orientation towards future as three dimensions of impulsiveness (9). According to Patton et al., motor activation, inattentiveness, and non-planning are three factors contributing to impulsivity (10). From a biological viewpoint, impulsivity is characterized by inability to inhibit potentially risky behavior (11). And finally, from a cognitive perspective, impulsivity is characterized by the inability to inhibit behavioral impulses and thoughts (12).

Considerable evidence suggests that young adults who engage in risky behaviors, such as drug use and aggression, exhibit higher levels of impulsiveness as early as childhood ages (13,14). Indeed, the entire spectrum of externalized impulsive behavior seems to be related to a core set of impulsive traits appearing early in childhood. Furthermore, impulsive individuals are more likely to take risky decisions, preferring immediate but negligible rewards despite potential long-term negative consequences (15). Martin et al. used event-related potentials (ERP) to evaluate the impact of reward and punishment sensitivity on risky decision-making in impulsive individuals (16). They indicated that individuals with high impulsivity are biased towards immediate reward and are less sensitive to the negative consequences associated with their choices (16).

Several studies have reported the effect of mental training on improving the ability to control impulsive behaviors. In one of the early studies, Omizo et al. concluded that a four-session biofeedback training program increases attention to and reduces impulsivity (17). Thompson and Thompson reported the positive outcomes of neurofeedback plus training in metacognitive strategies in reducing impulsivity and hyperactivity symptoms plus improving academic and intellectual functioning in students with ADHD (18). Giel et al. proposed an effective anti-saccadic training practice to improve impulsive eating behavior of patients with binge eating disorder (19). Tarrega et al. showed that a serious video game might significantly change several measures of impulsivity and anger expression in individuals with gambling disorder (20). And, Franco et al. showed the effectiveness of mindfulness training at reducing aggressive and impulsive behaviors in a sample of high school students (21).

One of the mental training strategies that have been considered in various studies is chess. Chess is widely believed to improve cognitive abilities. Chess develops mental activities such as focusing, problem-solving, abstract reasoning, critical thinking, strategic planning, analysis, evaluation and synthesis, and creativity (22). Chess is a very calming game in which individuals must control their actions. They must wait their turn and calculate the moves as long as they can predict the best move and make the best decision. More recently, Wessel et al. indicated that extensive chess skill can be a valuable tool for frontal lobe functions such as cognitive flexibility, planning, attention control, and response inhibition (23).

On the other hand, the impact of chess on the decision making process has also been investigated in several studies. For example, De Groot et al. found that the strongest chess players make better decisions than the experts, choose better moves and examine moves more relevant to the position (24). Campitelli et al. concluded that long-term memory knowledge allows chess players to have extensive search and rapid evaluation when making decisions under time pressure. Also, in an analysis of more than 91,000 chess games, Sigman et al. suggested that skilled chess players are able to adjust their decision criteria to meet the varying degrees of complexity of the match (25).

Consequently, based on indirect evidence, chess seems to be able to modulate impulsive decisions. Therefore, our main goal in this study was to evaluate impulsivity and risky decision making in adolescents' intermediate-expert chess players and compare them with non-players. On the other hand, we also looked at the relationship between impulsivity and risky decision making in the two groups. Obviously, the results of this study, in addition to clarifying the subject, pave the way for future theoretical and applied research.

2- METHODS

2-1. Study design and population

The present study employed a comparative-correlational method which was performed in 2019 in Tehran. Based on previous research, fifty-five paid chess players (49 intermediate players and 6 experts) were included in this task. Chess Federation of Islamic Republic of Iran (IRCF) ratings for the intermediate players ranged from 1300 to 1700 and for the expert players ranged from 2200 to 2400. The mean rating in the IRCF is about 1550±180. Players ranged in the age range of 14 to 17 years. Seventy-nine individuals aged between 13 and 17 who were not familiar with chess or had little or no academic background were also included in the study as the control group. All participants reported no history of psychiatric disorders or addiction to alcohol or drugs. All participants were included in the study with informed consent, and all of their rights were protected.

2-2-. Measuring tools

2-2-1. Response inhibition

Response inhibition was measured by the Go/no-go task. This task is based on repeated execution of motor response ("go" response) to a pre-defined visual stimulus, while on some trials a visual "stop" signal (or "no-go" sign), which is presented simultaneously with or instead of the go stimulus, instructs participants to inhibit their go response (26). Each Stimulus is presented in the center of the screen for 500 ms. In our set, the go stimulus was a picture of a green circle and the no-go stimulus was a red circle. The interval between successive stimuli was 1,000 ms. Instructions were displayed on the computer screen at the beginning of the trial and the participants performed a pilot phase before the task began.

2-2-2. Decision making

Decision making was assessed via the Iowa Gambling Task (IGT). The IGT, developed by Bechara et al., is a simulated gambling task that involves presenting four virtual decks of cards on a computer screen (27). The four decks are not created equal; two decks are considered advantageous, and two decks disadvantageous. After a time most people figure out and begin to select cards from the advantageous decks while minimizing selections from the disadvantageous ones (28).

In our experiment, turning a card from deck A or B had a $100 reward and turning a card from deck C or D had a $50 reward. Penalty amounts were higher in decks A and B than in decks C and D. In terms of overall net loss, decks A and B were equivalent and in terms of overall net gain, decks C and D were equivalent over trials. Decks A and C were associated with lower but more frequent punishment than decks B and D, respectively.

The participants were given $2000 and made 100 card turns, choosing a card from any deck each time. Finally, the total time, the net score, the raw score, the number of choices from each deck, and the proportion of selections of advantageous and disadvantageous decks were calculated for each participant.

2-3. Inclusion and exclusion criteria

Inclusion criteria along with being adolescents and consent to participate in the study included being or not being chess players for the experimental and control groups, respectively.

2-4. Ethical approval

This study was approved by the Institutional Review Board. The participants voluntarily participated in the present study and written informed consent was obtained from the subjects and their parents.

2-5. Data analysis

Statistical indicators of centrality and dispersion were used to describe the results. Kolmogorov-Smirnov test was used to assess normality of the data distribution. Independent t-test was used to compare the results of the subscales of the tests between the two groups. In addition, Pearson Correlation Coefficient was used to examine the correlation between the IGT sub-scales and the go/no go sub-scales. All descriptive and analytical statistics were conducted using IBM SPSS Statistics V. 25 software. The significance level was set at $P < 0.05$.

3- RESULTS

The mean age of the chess players the experimental group) was 15.69±1.52 years and the mean age of the control group was 15.01±2.10 years. Independent t-tests did not show a significant difference between the mean age of two groups (t=0.473, P=0.637). There were 11 females and 44 males in the chess player group, and 14 females and 45 males in the control group. The Chi-square test did not show a significant difference in terms of female/male ratio between the two groups (χ=0.23, P=0.630). In the chess players group, 41 participants had undergraduate degrees and 14 participants had postgraduate education and in the control group, 49 participants had undergraduate degrees and 30 participants had postgraduate education. The Chi-square test did not show a significant difference in terms of education between the two groups (χ=2.30, P=0.183). The results of the Kolmogorov-Simonov test revealed that the data were normally distributed (all P > 0.05).

In the go/no-go task, except for the reaction time, the two groups had significant differences in all of the other subscales. The mean number of commission errors was 0.8±1.02 and 1.52±1.61 in the chess player group and the control group, respectively (t=2.91, P=0.004). The mean number of omission errors was 0.56±0.91 and 1.20±2.23 in the chess player group and the control group, respectively (t=2.00, P=0.047). The mean inhibition, which is obtained by subtracting the total number of errors from the total number of trials, namely 40, was 38.64±1.54 in the chess player group and 37.27±3.07 in the control group (t=-3.03±P=0.003) (**Table 1**).

Table-1: Comparison of the mean scores of the two groups in the subscales of the go/no go test

Variable	Group	N	Mean	Std. Deviation	Cohen's d	t	Sig. (2-tailed)
Commission Error	Control	79	1.96	1.454	1.695	8.96	<0.001***
	Chess player	55	0.16	0.373			
Omission Error	Control	79	1.47	2.229	0.806	4.23	<0.001***
	Chess player	55	0.18	0.389			
Inhibition	Control	79	36.56	2.795	1.540	-8.12	<0.001***
	Chess player	55	39.65	0.480			
Reaction Time (ms)	Control	79	374.16	62.338	0.072	-4.13	0.680
	Chess player	55	378.75	64.304			

***p<0.001

In the IGT, except for the total time, the two groups had significant differences in all of the other subscales. The mean ratio of advantageous/disadvantageous choices was 1.81±0.57 in the chess player group and 1.31±0.50 in the control group (t=-5.28, P<0.001). The mean raw score was 1617.73±1021.10 in the chess player group and 870.63±872.30 in the control group (t=-4.54, P<0.001). The mean net score was 25.60±15.73 and 9.87±18.01 in the chess player group and the control group, respectively (t=-5.23, P<0.001) (**Table 2**).

Table-2: Comparison of the mean scores of two groups in the subscales of the IGT

Variable	Group	N	Mean	Std. Deviation	Cohen's d	t	Sig. (2-tailed)
Total Time	Control	79	185.64	69.46	0.365	-2.09	0.038*
	Chess player	55	212.43	77.08			
Net Score	Control	79	9.87	18.01	0.930	-5.23	<0.001***
	Chess player	55	25.60	15.73			
Advantageous / Disadvantageous	Control	79	1.31	0.50	0.932	-5.28	<0.001***
	Chess player	55	1.81	0.57			
Raw Score	Control	79	870.63	872.30	0.786	-4.54	<0.001***
	Chess player	55	1617.73	1021.105			

*p<0.05; ***p<0.001

Correlation analysis showed that in the control group, the net score subscale significantly correlated with the commission error (r=-0.437, P<0.001), the omission error (r=-0.354, P=0.001), and the inhibition (r=0.508, P<0.001). The raw score subscale significantly correlated with the commission error (r=-0.433, P<0.001) and the inhibition (r=0.386, P<0.001). In addition, the advantageous/disadvantageous ratio had a significantly correlated with the commission error (r=-0.267, P=0.017), the omission error (r=-0.354, P=0.001), and the inhibition (r=0.424, P<0.001). In the case group, the net score subscale significantly correlated with the commission error (r=-0.569, P<0.001), the omission error (r=-0.466, P<0.001), and the inhibition (r=0.820, P<0.001). The raw score subscale significantly correlated with the commission error (r=-0.565, P<0.001), the omission error (r=-0.508, P<0.001), and the inhibition (r=0.852, P<0.001). Furthermore, the advantageous/disadvantageous ratio significantly correlated with the commission error (r=-0.534, P<0.001), the omission error (r=-0.473, P<0.001), and the inhibition (r=0.799, P<0.001) (**Table 3**). Therefore, in both groups, the net score, the raw scores and the ratio of advantageous/disadvantageous choices negatively correlated with the commission error and the omission and positively correlated with the inhibition subscale. All correlations were stronger in the control group than in the chess player group (**Fig. 1**).

Table-3: The correlations between the go/no go test subscales and the subscales of the IGT in the two groups

Control group	Statistics	Commission Error	Omission Error	Inhibition	Reaction Time
Total Time	Pearson Correlation	-0.157	-0.082	0.146	-0.051
	Sig. (2-tailed)	0.168	0.471	0.198	0.657
Net Score	Pearson Correlation	-0.437	-0.354	0.508	-0.140
	Sig. (2-tailed)	<0.001***	0.001**	<0.001***	0.217
Advantageous / Disadvantageous	Pearson Correlation	-0.408	-0.267	0.424	-0.148
	Sig. (2-tailed)	<0.001***	0.017*	<0.001***	0.193
Raw Score	Pearson Correlation	-0.433	-0.203	0.386	-0.126
	Sig. (2-tailed)	<0.001***	0.073	<0.001***	0.268
Chess player group					
Total Time	Pearson Correlation	0.068	-0.027	-0.032	-0.190
	Sig. (2-tailed)	0.620	0.847	0.819	0.165
Net Score	Pearson Correlation	-0.569	-0.466	0.820	0.130
	Sig. (2-tailed)	<0.001***	<0.001***	<0.001***	0.344
Advantageous / Disadvantageous	Pearson Correlation	-0.534	-0.473	0.799	0.153
	Sig. (2-tailed)	<0.001***	<0.001***	<0.001***	0.264
Raw Score	Pearson Correlation	-0.565	-0.508	0.852	0.150
	Sig. (2-tailed)	<0.001***	<0.001***	<0.001***	0.275

IGT: Iowa Gambling Task

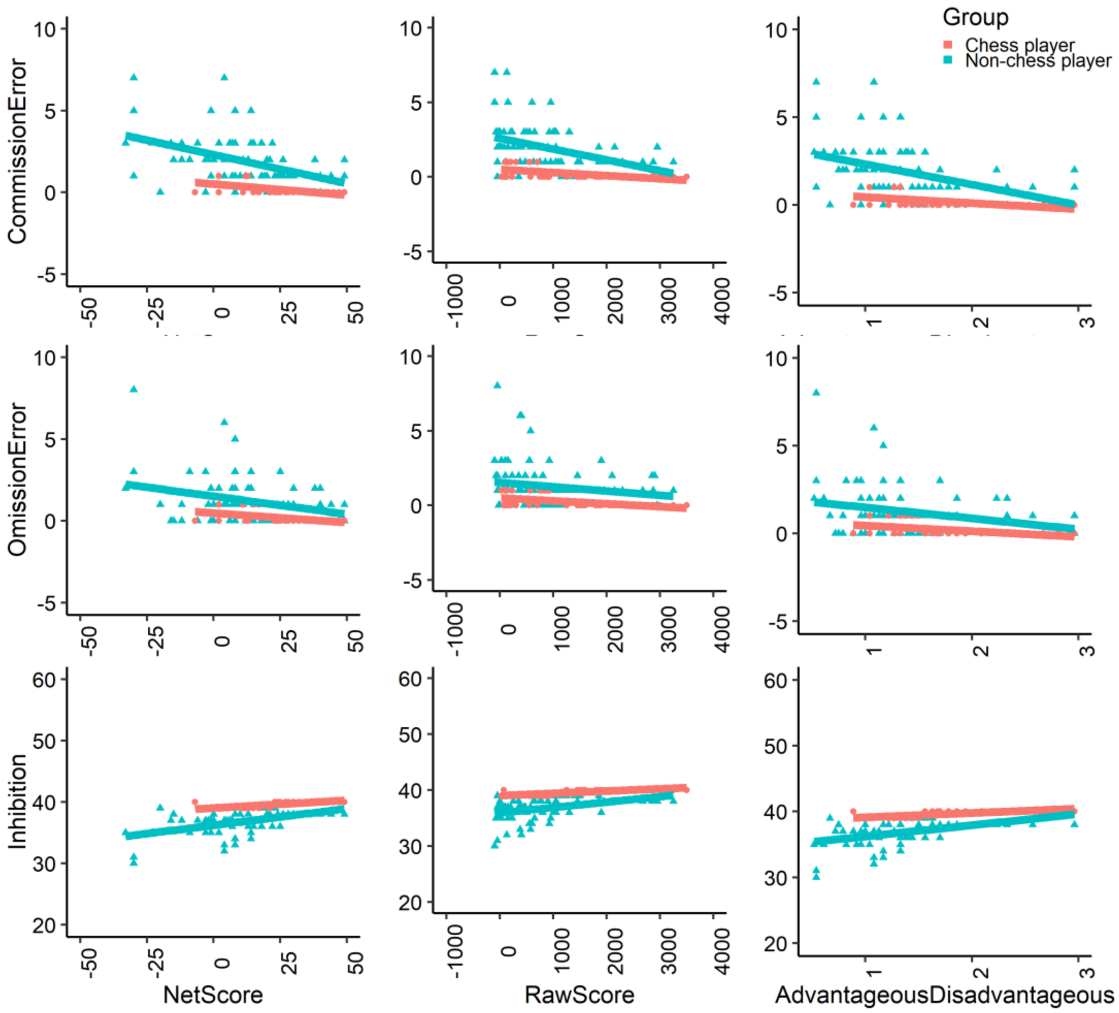

Fig. 1: The correlations between the go/no go test subscales and the subscales of the IGT in the two groups Note: All correlations were stronger in the control group than the chess player group.

4- DISCUSSION

In this study we evaluated impulsivity and risky decision making in adolescents' intermediate-expert chess players and compared them with non-players. Moreover, we looked at the relationship between impulsivity and risky decision making in the two groups. In the first stage, our study revealed that in the go/no-go task, except for the reaction time, the two groups had significant differences in all of the other subscales, including commission error, omission error, and inhibition. According to our knowledge, this is the first time that impulsivity is directly compared between chess players and non- players.

In a chess game, one has to consider a lot of possibilities for every move. Also, the player needs to calculate the probability of his/her opponent's subsequent moves. An experienced chess player knows that a risky and disinhibited move can have dramatic consequences. Therefore, the player does his/her best to reduce the chance of losing and increase the chance of earning by reducing the risky decisions. Therefore, from one perspective, chess could be considered as a long inactive game, which offers little opportunity for adventure.

However, from the other contradictory viewpoint, chess may provide an exciting opportunity for novelty seekers to experience novel situations and take a risky decision (29). Findings by Mazur et al. indicated that winning a chess game is associated with a rise in testosterone which are presumably attractive to those scoring high in sensation seeking (30). Furthermore, Joireman et al. demonstrated that experienced chess players have higher scores on both the total sensation seeking scale and the thrill and adventure seeking scale (31). They argued that chess provides less risky, and perhaps more cognitively beneficial routes to meet the needs of high sensation seekers.

The difference between the results of various studies can be due to several reasons. First, sensation seeking and impulsiveness cannot be exactly equivalent to each other, although the direct relationship between them is proven in several studies (32, 33). Second, the tools used in various studies to measure impulsiveness may be different, which in turn can affect the results. Third, impulsivity has different aspects, and in each study, a particular aspect may be emphasized on. And finally, to the best of our knowledge, so far, no study has directly evaluated chess players; and so, perhaps comparing the results of this study with the previous studies may not be informative.

It is interesting to note that the two groups did not have significant differences in the reaction time in the go/no go test and the total time in the Iowa test. Thus, although chess players consider more probabilities than non-players to make any decision, they spend little time estimating each consequence. An expert chess player is able to rapidly recognize complex patterns and choose the most effective mode (34). On the other hand, there may be a host of specific and applicable mental techniques that an expert chess player can implement with greater effect in a shorter time, as a report by Church and Church in 1983, indicating that an expert chess player spends much less time to search strategies for the selection of a move (35).

In the second phase of the study, we observed that in both groups, the net score, the raw scores and the ratio of advantageous/disadvantageous choices were negatively correlated with the commission error and the omission error and were positively correlated with the inhibition subscale. In other words, with increasing impulsivity, risky decision making increased in both groups. This result is consistent with the results of the previous studies.

For example, Cheng et al. demonstrated that the effect of prefrontal-neuromodulation in reducing risk-taking is significantly influenced by baseline impulsivity (36). Heyes et al. argued that impulsivity is significantly correlated with rapid decision-making for reward (37). Martini et al. investigated risky decision-making and associated cognitive processes in patients with impulsive control disorders (38). They concluded that impairment in the impulsive control process is associated with a reduced sensitivity to negative feedback during risky decision-making. Finally, more recently, Gabriel et al. examined the relationship between risk-taking and multiple addiction-relevant phenotypes and concluded that risk-taking is obviously associated with elevated impulsive actions (39).

In the present study, although the relationship between impulsivity and risky decision making was stronger in the non-chess player group and it was slightly moderated in the chess player group, however, this difference was not statistically significant. Perhaps future studies on larger and more homogenous sample sizes could provide clearer results. Also, evaluating different dimensions of impulsivity and risk-taking in future studies can better reflect the role of chess in modifying the risky decision-making process through response control.

5- CONCLUSION

Overall, in this study we demonstrated that in the go/no go task, except for the reaction time, and also in the IGT, except for the total time, the chess player group has a better performance than the non-chess player group. Moreover, we found that the relationship between impulsivity and risky decision making was stronger in the non-chess player group than the chess player group. The results of this study can put chess in the spotlight as an option to improve impulsivity and risky decision making in clinical settings.

6- CONFLICT OF INTEREST

None.

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