

The role of gender in association between inhibition capacities and risky decision making

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Background: Research on the association between decision making and inhibition abilities has exhibited fundamental controversies. Some authors claim that inhibition abilities are an integral part of the decision-making process, whereas others suggest that the decision-making process does not operate in close association with inhibition abilities. Can gender explain variations in risky decisions via inhibition influences?

Purpose: The purpose of the present study was to explore the associations between response inhibition, reflection inhibition, interference inhibition, and decision-making processes in men and women.

Methods: To this end, 46 women and 46 men were assessed by the Go/NoGo task, a measure of response inhibition, by the Matching Familiar Figure Test, a measure of reflection inhibition; and by the Stroop task, a measure of interference inhibition.

Results: No differences were detected in these measures between groups. The net score of the performance on the last section of the Iowa Gambling Task choices did not correlate with the inhibition measures in the two groups. We did not discover any significant main effects of gender on the association between these measures.

Conclusion: These findings do not support the hypothesis that risky decisions are due to impaired inhibitory control. Further studies are needed to identify the cognitive mechanisms involved in the tendency to make risky decisions.

Keywords: decision making, inhibition ability, gender differences, normal population

Introduction

One of the most crucial functions in everyday life is making choices. Decision making is the cognitive process resulting in the selection and production of a final choice among several alternative possibilities.¹ Some aspects of decision making can be related to inhibition of irrelevant information, aimed to facilitate selection of the most appropriate behavior for achieving goals in a changing environment.²

This performance involves processes relevant to both learning to choose options with long-term outcomes and learning to avoid choices associated with negative consequences. Two approaches have been proposed to explain risky choices: 1) dysfunction of the decision-making process, which reflects impaired selection among several alternatives³ and 2) inhibition deficits such as a tendency to respond rapidly to rewards without sufficient assessment of the potential consequences.⁴

The Iowa Gambling Task (IGT) is the most popular test designed to measure risk-taking decisions.⁵ Some authors suggest an association between inhibition capacities and decision making.^{6,7} In contrast, others do not find this association.^{8–13} Although

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there is some overlap between disinhibition and risky decisions,^{14,15} they may represent separate independent entities.¹⁶

Efforts to identify and understand gender differences in risky decisions and inhibition capacities have a long history. Empirical research on gender and risk has focused on behavior in different arenas: health and physical safety; finance, including investment, gambling, and insurance; and strategic decision making in a professional work context. Many studies have shown that women are generally more risk averse^{17–20} than men. Furthermore, women not only are less risk-seeking²¹ but have different ways of making decisions.²²

Other authors have found that the association between gender and risky decision making is more complicated. For example, in an abstract lottery choice experiment, women were significantly more risk averse than men in the gain domain, but the opposite result was also found, with men being more risk averse than women in the loss domain.²³ Men have been seen as more effective in the delayed rewards task, while females have outperformed males in the immediate rewards task. Females are more sensitive to reward frequency, but males are more sensitive to reward magnitude on intertemporal decisions made from experience.²⁴ Men typically focus on the probability component of risks, whereas women focus on future consequences. If future consequences are losses, women on average perceive higher risks than do men.²⁵ In a recent meta-analysis of 150 studies, males were found to express greater risk-taking decision than female participants²⁶ according to the IGT measure. In contrast, men outperformed women on a version of the IGT.²⁷ Thus, more in-depth research is needed to explore the gender-related differences in risky decision making.²⁸

Several experiments, such as the dictator game,²⁹ the threshold public game,³⁰ the duopoly game,³¹ as well as loss domain gambling games,²³ show no significant difference in performance between female and male groups. Males and females have been found to be equally efficacious at decision making in general.³²

Inhibition is defined as the ability to withhold an action, namely, the ability to control a behavior that is relatively automatic. The tendency to act with little forethought has been linked to a proclivity for various risk behaviors.³³ Recently, it is not clear if inhibition capacities influence the interaction between behavioral control and a risky decision differently in men as compared to that in women. Can gender explain variations in risky decisions via inhibition influences? Historically, there was greater pressure to inhibit emotional and sexual responses for prehistoric women than for men,

resulting in an expectation of a higher degree of inhibition ability in females.^{34,35} Numerous studies have revealed that males are two to three times more susceptible to impairment in behavior control and more involved in a wide range of risky behaviors such as alcohol consumption, smoking, illicit drug use, or violence compared with females.³⁶

In this study, we focused on the role of three inhibition capacities. The task selection was influenced by a desire to include tasks with different cognitive mechanisms. First, “response inhibition” refers to the ability to suppress dominant, automatic, or prepotent responses. The Go/NoGo task is the most widely used task to measure response inhibition and broad self-control functions associated with behavioral inhibition.³⁷ Second, the Matching Familiar Figure Test (MFFT), a measure of reflection inhibition, refers to an individual’s ability to wait before responding in a situation with several highly plausible alternatives, when only one of them is correct, and thereby creating a delay before action.³⁸ Third, a capacity to protect a delay period from disruption by competing events and responses, namely, “resistance to distractor interference” involves avoiding interference with task-irrelevant information in the external environment.³⁹ The Stroop task is the most widely used means to measure interference inhibition.^{11,40} Impulsive behavior can be attributed to weaker interference control.⁴¹

Each of these three aspects of inhibitory mechanisms helps to control different delay periods during the decision process before the response. The selection of a dominant alternative for action is dependent on the effectiveness of an inhibitory regulatory process.⁴² The assessment of each inhibition dimension is essential for the effort to identify specific mechanisms of risky decisions in different populations. Use of a single total inhibition score does not represent multiple control processes that do not correlate with each other.⁴³

Although the literature demonstrates that women show a greater inhibition capacity in inhibition associated with a social aspect,⁴⁴ in experimental situations in laboratories the results of studies on inhibition tasks have yielded mixed results. Sex differences in an inhibition control do exist, but the direction of these differences varies across specific capacities. In interruptive inhibition, women have been shown to exhibit poorer performance than males.^{45,46} In response inhibition, men have exhibited poorer performance than women.^{47,48} Other researchers, however, do not support this conclusion.⁴⁹ Previously, it was found that response inhibition, as measured by decreasing numbers of commission errors, shows that girls are better able than boys to sustain the attention and vigilance necessary to consistently respond to the Go trials

in continuous performance tasks.⁵⁰ This capacity can help exhibit better response inhibition performance. During MFFT trials, sex-related differences in performance were absent.⁵¹ MacLeod (1991) showed that there were no sex differences in Stroop interference inhibition at any age.⁴¹ These features are consistent with the position that gender differences in inhibition are relatively domain specific.³⁴ The inconsistent findings regarding men's and women's risky decision and inhibition capacities suggest that more studies are needed.

The aims of the current study are to examine the effect of gender on the relationship between inhibition capacities and decision making from the perspective of the strength of different facets of inhibition. We begin by assessing this issue in cognitive performance following the view that gender is more complicated than sex because it reflects psychological and social considerations as well as biological factors.⁵² Although previous findings have been mixed, our hypotheses arose from previous studies reporting female outperformance of men on tasks requiring inhibitory control and risky decisions.

We expected 1) that women would demonstrate better learning to avoid risky decision making during the IGT performance than men, 2) that inhibition capacities would be stronger in women than in men, particularly under conditions without time-pressure procedures. One potentially important point to mention here is that inhibition capacity was not narrowly defined in the current study. A broad pathway may exist from distinct inhibition capacities to make risky decisions, given that the response inhibition, reflection inhibition, and interference control facets independently accounted for variance in the relation between inhibition and risky decisions, and 3) that low inhibition capacities would be linked to worse performance on the IGT.

Materials and methods

Subjects

Most participants were recruited by means of advertisements posted at universities in Israel (Tel Aviv University, the Hebrew University of Jerusalem, and Ben-Gurion University), through personal contacts and through social networks (eg, Facebook) inviting them to take part in a research project investigating decision-making styles. Participation in the study was voluntary and was unpaid. As compensation for participating in the study, participants received free consultation about their decision-making style based on the tests. Data collection was conducted during individual sessions with an explanation regarding the research aims and with the subject signing a consent form. The form indicated their willingness to participate in the research, which included a

computerized neuropsychological examination and questions covering extensive background information. The duration of individual sessions was up to 1 hour. The sample size was estimated based on the difference in the IGT score between men and women. Assuming that the mean difference between the scores would be 11 with an SD of 21 in each of the groups,²⁷ a significance level of 5% (one-tailed), and a power of 80%, a sample size of 46 participants in each group was sufficient to prove that the difference is statistically significant. We expect that comorbid neurological problems, alcohol use disorders, and drug dependence would result in additive effects on neurocognitive deficiencies. Thus, the exclusion criteria for the study were neurological disorders, alcohol or substance abuse/dependence (other than tobacco smoking), major psychiatric disorders, and treatment with any psychiatric medication. All participants completed a screening interview, which covered medical history, illicit drug use, and family and personal psychiatric history. All of the subjects were free of any psychopharmacological treatments.

Decision-making measure

Computerized animation variant of the Iowa gambling test

In the IGT, participants were exposed to four decks of cards (A, B, C, D) that were placed next to each other on a computer screen. They were informed that each deck was capable of awarding them virtual money. Participants were informed that they had 100 choices with the ultimate goal of being awarded the highest possible amount of virtual money. Participants were required to make continuous selections from decks of cards with different proportions of the amount of gains and losses. After having received this information, participants were instructed to choose one of the four decks for each trial by clicking the mouse on the respective deck to indicate their choice.

At this point, unknown to the participants, two disadvantageous decks have high initial "monetary" rewards but lead to negative overall outcomes (high money loss). Other decks have lower initial "money" rewards but also lower losses over time, making them advantageous in the long perspective of task performance. Over several trials, in which participants receive feedback on their gains and losses, participants learn to avoid the risky decks and to develop a preference for the safe card decks.⁵ We applied a modified computerized animation version of the IGT – Casino, which was described previously.¹⁰ One hundred card selections for each participant is divided into five blocks of 20 cards each.

We calculate a net score for each block by subtracting the number of advantageous card selections from the number of disadvantageous card selections $([C+D] - [A+B])$ for each of the 20 cards. A score below zero signifies that subjects adopted a disadvantageous strategy overall (more card selections in decks A and B), while a score above zero implies a more advantageous deck preference (more card selections in decks C and D). We used the net score of the performance on IGT section 5 (advantageous decks $[C+D]$ minus disadvantageous decks $[A+B]$).

Inhibition measures

The Go/NoGo task

Response inhibition was assessed using a version of the Go/NoGo task, which has been described previously.⁵³ Participants respond whenever a colored rectangle was visually presented on a computer screen. There are 120 red rectangles (“Go”) and 30 black rectangles (“NoGo”) in the task. Participants were required to make a button-press response to the Go stimuli and withhold that response to the NoGo stimuli. Stimuli are presented at a rate of one stimulus per 2,000 ms on the screen in random order for 100 ms each. A constant inter-stimulus interval was chosen to minimize any orienting response caused by the unpredictability of a stimulus display. The need for inhibition to NoGo stimuli is manipulated by requiring button presses to Go stimuli by frequency of Go stimuli, ensuring the Go response as pre-potent because of its high frequency. The test lasts for 5 minutes. Optimal performance on the Go/NoGo task involves minimizing both misses (not responding to a Go trial) and false alarms (responding to a NoGo trial).

The Matching Familiar Figures Test

We applied a computerized variant of the MFFT,³⁸ as previously described.⁵⁴ In our computerized version, participants were asked to select one of six alternative pictures that matched a standard picture, with all pictures being presented simultaneously. The participants continued to select until a match was found. This performance requires a visual search and hypothesis-testing skill in addition to reflexive inhibition.⁵⁵ The MFFT contains one practice run followed by 12 experimental trials. There are two dependent measures: total number of errors and mean latency of the first response. The minimum number of errors was 0, while the maximum was 60.

The Stroop task

We used a manual key-press reverse variant of the Stroop task, as reported previously.⁵⁶ In this assessment, participants were

required to read the words and ignore the colors. Thus, the interference with word reading is caused by an incompatible, irrelevant ink color.⁴¹ Four color words (green, red, blue, or yellow) are presented individually in the center of the screen on a gray background printed in one of five colors: red, blue, green, yellow, or black. The word appears above two colored rectangles on each side. Subjects are instructed to press one of two keys. The color of the displayed word is always the same as the color of one of the rectangles, while the other rectangle carries the color of the meaning of the word. Presentation was time-unlimited: the stimuli change only if the examinee presses one of the designated keys. The task consists of 40 “neutral” trials in which the letters of the word are black; 40 “congruent” trials in which the word’s meaning and the color of the letters correspond (eg, the word “RED” is displayed in red letters); and 40 “incongruent” trials in which the word’s meaning does not correspond to the color of the letters (eg, the word “BLUE” is displayed in red letters). “Item-by-item” trials are pseudo-randomly ordered. Interference reaction time was calculated as the response time in the incongruent condition minus the response time in the congruent condition.

Ethical aspects

The study was fully approved by the local Beer-Yaakov/Ness Ziona Mental Health Review Board committee and the Ministry of Health. All subjects provided a written informed consent after the experimental procedure and the nature of the neurocognitive tests were fully explained to them.

Data analysis

The data were analyzed using the statistical software package SAS v9.4 for Windows (SAS Institute). All analyses used two-tailed levels of significance. The parametric (*t*-test) and nonparametric (χ^2) tests were performed to compare group differences in demographic and behavioral parameters. The variables age and education were categorized. The first age group contained participants of age <30 years and the second group included participants of age ≥ 30 years. Education was blocked in three groups: below university, bachelor’s degree, and postgraduate degree. The differences between groups in age and education were examined using a chi-squared test. Pearson’s correlation coefficient was calculated to assess the linear relationships between inhibition measures: 1) the first response time (RT) and total number of errors in the MFFT, 2) the Go/NoGo mean of response time (as the sum of mean response time in the two blocks of the Go/NoGo task), and 3) Stroop interference response time (response time in the incongruent condition minus response time in the congru-

ent condition) and IGT performance measure (sum of a net score for the 20 last selections: trials 80–100). Because the performance on the IGT had a strong learning component,⁵⁷ we used only the last IGT selections, which were combined into a single measure.

Group comparisons were conducted using ANOVA, with IGT performance measure as the dependent variable. We used the three-way ANOVA, with the main effects being gender, age, and education and the interactions “gender-by-age” and “gender-by-education”.

Results

The female participants were younger than the males (Table 1), and the chi-squared test demonstrated a significant age difference between the gender groups ($\chi^2=5.58$, $P=0.02$). Even though male participants were slightly more educated than female participants (Table 1), the comparison of education did not demonstrate a significant difference between the gender groups ($\chi^2=2.06$, $P=0.36$).

Intergroup comparison of the impulsivity characteristics

Both groups had impulsivity parameters in the normal range (Table 2). Univariate analysis did not find significant differences between the male and female groups of participants.

The net score of the performance on IGT section 5 did not correlate with the impulsivity parameters in either population group (Table 3). The results of the three-way ANOVA showed that there was no main effect of gender on the IGT parameter, $F(1,84)=0.02$, $P=0.88$. There were

also no significant differences in the IGT parameter among the age and education groups, $F(1,84)=0.90$, $P=0.3461$ and $F(2,84)=2.22$, $P=0.12$, respectively. Gender also did not interact with the age and education groups, $F(1,84)=1.78$, $P=0.19$ and $F(2,84)=1.91$, $P=0.16$, respectively.

Discussion

The current study examined the extent to which associations between three facets of inhibition – response, interference, and reflexive – and risky decisions varied as a function of gender. The current study did not find any significant difference in inhibition capacities and risky decisions between men and women (Table 2). The MFFT, the Go/NoGo, and the Stroop task measures were not associated with the IGT net score in either the men’s or the women’s group (Table 3). These results are concordant with previous studies that found that risky decision making was not influenced by inhibition capacities.^{8–13} The decision making and inhibition capacities represent separate cognitive mechanisms. Risky decisions are a result of a wrong solution for a dilemma among weighing the pros and cons of several alternatives.¹⁶ In contrast, inhibition control, which is most likely composed of several subtypes of mechanisms, is the ability to inhibit an overriding response in order to perform a less dominant one.⁵⁸ In addition, our results are concordant with previous findings that found no differences between women and men in being risk-prone when high levels of uncertainty are introduced in a game.⁵⁹

Table 3 Correlation between the net score of the last block of the IGT and the inhibition measures in male and female groups

Test	Variable	Male	Female
Go/NoGo	Mean RT	−0.11 (0.48)	−0.10 (0.53)
Go/NoGo	Errors of commission	0.11 (0.45)	−0.05 (0.77)
Stroop	Interference RT	0.08 (0.61)	0.03 (0.83)
MFFT	First RT	0.01 (0.94)	−0.01 (0.93)
MFFT	Errors	−0.04 (0.78)	0.12 (0.42)

Abbreviations: Go/NoGo, the GoNoGo task; MFFT, The Matching Familiar Figures Test; RT, response time; Stroop, the Stroop task.

Table 1 Population demographic characteristics

Variable	Male (n=46)	Female (n=46)
Age (years): <30 and ≥30	23/23	34/12
Education: (below bachelor’s degree, bachelor’s degree, and above bachelor’s degree)	11/6/24	12/11/23

Table 2 Between-group comparison of the inhibition and decision-making measures

Task	Variable	Male		Female		Statistics	
		Mean	SD	Mean	SD	t-value	P-value
Go/NoGo	Mean RT	331.3	65.27	331.3	48.31	0.02	0.98
Go/NoGo	Errors of commission	1.50	1.6262	1.2609	1.5338	0.73	0.47
Stroop	Interference (ms)	113.3	144.30	129.4	94.84	0.63	0.53
MFFT	First RT	14.88	9.07	12.48	7.44	1.38	0.18
MFFT	Errors	3.83	3.31	3.56	3.11	0.40	0.69
IGT	Net score last block	4.39	11.97	6.04	11.40	0.68	0.50

Abbreviations: Go/NoGo, the GoNoGo task; IGT, computerized animation variant of the Iowa Gambling Test; MFFT, The Matching Familiar Figures Test; ms, milliseconds; RT, response time; Stroop, the Stroop task.

We consider several explanations for the similar performance by gender. The degree of risk aversion shows significant cross-cultural differences.^{60,61} Israel provides an interesting context in which to examine gender-related differences for a number of reasons. For example, Jews appear to be more risk-prone than Catholics.⁶² Israel is a natural experiment field for an investigation of the contradiction between the “cushion hypothesis” and findings regarding risk aversion.⁶³ In contrast to traditional gender differences, both genders in the Israeli population are recruited by the military. Women drilling and training is similar to that of men, and they are assigned to a wide range of units^{64,65} because recently the traditional battlefield began to change due to the impact of high-tech innovations and looser definitions of battlefield and homefront.⁶⁶ These changes make the masculine advantage less relevant and foster equality between men and women in the area of combat skills and, thus, may be equally needed to control their behavior. This experience in post-army civilian life can be presented in cognitive performance. Previously, it was found that gender role identification rather than sex differences significantly determine risky decisions.⁶⁷

In addition, most of the participants in our study were master's degree university students recruited after intensive psychological and educational selection before admission to a university in Israel. Acquiring an academic education requires a certain level of self-discipline, long working hours, and many correct decisions to bring individuals of both genders closer to the desired goal. Is it possible that in a normative population the basic description of risk taking as deviant may be questionable? It is critical to keep in mind the positive side of risk-taking as it can be a great advantage in many instances. For example, risk-taking is a strategic component of effective management because managers need to take risks in order to achieve better outcomes.⁶⁸ Possibly, this type of behavior is associated with a pattern of social rule breaking.⁶⁹ Furthermore, the gap between men's and women's differences might have begun to close.⁷⁰ Women are surpassing men in terms of educational outcomes,⁷¹ but highly educated people tend to be more risk-prone than less educated people.⁷² Globalization and deregulation trends⁷³ may be hastening women's emancipation.⁷⁴ Also, the increased willingness to invest in long-duration professional degrees⁷⁵ may be causing a reduction in the traditional differences between genders in our sample regarding risk-taking attitudes. Thus, gender-related bias in the neuropsychological performance reflects the interaction of genes, hormones, and social learning on brain development throughout the lifespan, and sociocultural factors can complicate biological sex-related differences.⁷⁶

Conclusion

In this study, we have explored whether gender-related differences contribute to an association between inhibition measures and risky decision making. To do so, we compared decision-making performance and performance on three inhibition tasks. The major contribution of the present study is that 1) there is no difference between men and women in risky decision and inhibition areas in an experimental situation and 2) the IGT performance and the three inhibition measures are tape the relative independent aspect (risky decisions versus inhibition control) of cognitive functioning in accordance with previous works.^{8–13} This result supports the notion that there is no reason to assume that either gender is superior to the other in decision making. The absence of gender-related bias in risky decision and inhibition domains among highly educated Israeli participants may serve as a starting point for further research in this domain. To further study gender-related differences in decision making, we advise these studies be pursued in various other demographic groups of participants.

Disclosure

Dr Kertzman received personal fees from Animascan outside the work for this paper. The authors report no other conflicts of interest in this work.

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