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Individual Differences in Investor Decision-making: Examining Representativeness Heuristics and Cognitive Reflection

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Abstract

Due to limited cognitive resources, investors often utilize mental shortcuts to make quick judgments. This study examines the impact of representativeness heuristics (Conjunction Fallacy, Gambler's Fallacy, and Stereotypes) and the Cognitive Reflection Test (CRT) on investor decision-making. The population of this study consists of a sample of investors in the Tehran Stock Exchange. The study employs a Chi-Square test (χ^2) to explore the relationship between heuristics and CRT, along with T-tests, one-way ANOVA, and correlation analyses to identify individual differences. Results indicate that proper utilization of cognitive resources can partially prevent the Conjunction Fallacy from occurring. Moreover, investors tend to consider the high probability of consecutive results for an event regardless of cognitive resource usage. Interestingly, this study also found that investors with lower CRT scores made decisions less influenced by stereotypes. We conclude that reducing the impact of representativeness heuristics can be achieved through knowledge and experience gained from similar situations and appropriately utilizing cognitive resources.

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1. Introduction

In the face of uncertainty, people look for familiar patterns and use the representativeness heuristic to determine the probability of events occurring (Kahneman and Tversky, 1972). The heuristic representativeness theory stresses the importance of specific developments, reports, or statements without giving them careful attention (Fromlet, 2001). Objects are compared based on similarity and then organized based on a mental prototype (causes and effects must have similar characteristics) (Gilovich and Savitsky, 2002). Consequently, people are more likely to make incorrect decisions when they utilize the heuristic of representation as a criterion for making judgments, as similarity does not increase probability (Kahneman and Tversky, 1983). As a result, people rely on their mental abilities to accurately predict the likelihood of an event. This case may lead to ignoring reality or creating other cognitive biases (Fortune and Goodie, 2012).

Generally, the representativeness heuristic is a mental shortcut for estimating probabilities. Our decision to assess an event's likelihood is often based on its similarity to a mental prototype we already possess. Our tendency to rely on representations can result in errors as we overlook other information. Cognitive biases, such as the conjunction fallacy and gambler's fallacy, may explain this phenomenon. Individuals' ability to adhere to cognitive skills when making decisions is influenced by their thinking tendencies (Cokely and Kelley, 2009; Frederick, 2005; Oechssler et al., 2009; Parker and Fischhoff, 2005; Peters and Levin, 2008; Stanovich and West, 1998, 1999, 2000; Peters and Levin, 2008).

According to the theoretical literature in this field (Heckman et al., 2006), individuals with higher cognitive abilities make better decisions. Additionally, individuals with higher cognitive skills are more likely to analyze situations and take fewer risks (Shamosh and Gray, 2008; Frederick, 2005). As an essential component of judging and decision-making, cognitive ability has a significant relationship with behavioral biases (Campitelli and Labollita, 2010; Toplak et al., 2011) and individual utilitarian ethics (Paxton et al., 2012), Supernatural Issues and Theology (Gervais and Norenzayan, 2012; Pennycook et al., 2012), Individual performance (Dilchert et al., 2007; Finn and Hall, 2004; McGloin and Pratt, 2003; Engle et al., 1999), labor market participation (Kirsch, 1993), job success (Murray and Herrnstein, 1994), and individuals' income (Griliches, 1979; Griliches and Mason, 1972).

In addition to predicting people's reasoning, judgment, and decision-making abilities as well as what they believe, the reflective theory is considered an essential measure of cognitive skills (Pennycook et al., 2015a; Oechssler et al., 2009; Campitelli and Labollita, 2010; Hoppe and Kusterer, 2011; Besedeš et al., 2012; Moritz et al., 2013). Based on Frederick's (2005) description, the reflexive test is a valuable tool for analyzing individual differences in thinking, judgment, and decision-making. Individuals approach issues and decisions differently in their thinking, and these differences have a variety of consequences daily (Pennycook et al., 2015b). A cognitive reflection test is most commonly used for assessing individual differences in performance in this area (Frederick, 2005).

As with other cognitive and heuristic biases, we rely on representation to make sense of our limited cognitive resources. Our brains are designed to process thousands of decisions daily while conserving energy. Often, we rely on shortcuts when making quick judgments about the world—however, the heuristic of representativeness results from how we perceive people and things. Because categorization is fundamental to understanding the world, it is difficult to avoid the representativeness heuristic altogether.

The first step in correcting this problem is to be aware of it. The research results have shown that people often revise their judgments when informed that they use a heuristic. Several researchers have attempted to reduce the effects of representational detection by encouraging individuals to "think like statisticians." These movements improve people's ability to think in judgment, but the problem is that

even educated individuals do not employ their knowledge effectively. Due to this, we focus on whether people use their cognitive resources to reduce the effects of the representativeness heuristic during judgment and decision-making.

Lack of attention to decision-making and cognitive abilities by the researchers, as well as the deep research gap in behavioral finance, is something that behavioral finance research requires. As part of our contribution to behavioral financial literature, we inform researchers and investors that the representativeness heuristic cannot be avoided even with knowledge and experience. Investors will also understand that the necessity of similar situations does not increase the probability of their occurrence. In addition, this wrong mentality, which proper cognitive resources can prevent, is also eliminated. This study examines how cognitive reflection affects the representativeness heuristic among investors on the Tehran Stock Exchange. Nevertheless, we expect to present a new perspective on this research by reviewing the reflection on the representativeness heuristic.

The remainder of the paper is organized as follows. The following section discusses the related literature and outlines the main testable hypotheses. Our survey methods and data are summarized in Section 3. The main empirical results are presented in Section 4, and a brief discussion of the results is provided in Section 5.

2. Theoretical literature and development of hypotheses

Several researchers believe that representativeness heuristics underlie other heuristics and biases that influence how we process information.

Conjunction Fallacy occurs when we assume several things are more probable to occur than one thing alone. It is statistically impossible for this to be true. Another example of conjunction fallacy can be found in Tversky and Kahneman's work. According to one experiment, participants were given the following description:

Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with discrimination and social justice issues and participated in anti-nuclear demonstrations. After reading this, Kahneman and Tversky (1981) asked people to rank several statements in order of their probability of being true. The list included the following three: "Linda is active in the feminist movement," "Linda is a bank teller," and "Linda is a bank teller who is active in the feminist movement." People believed the third option (being a bank teller and a feminist than if Linda was just a bank teller) was more likely for Linda. This stems from the representative heuristic. The fact that Linda fits people's initial image of a feminist skews their perception of possibility (Kahneman and Tversky, 1981). Although logically, we should not choose option three; we are more inclined to choose option 3. This is because Linda did the same thing as a student. Due to her particular background, Linda qualifies as a feminist. As a result, the probability of two events occurring in a sequence is always less than or equal to the possibility of each event happening separately.

Gambler's Fallacy tends to apply long-term probability to short-term events. For example, there is a fifty-fifty chance of getting a head or tail when tossing a coin. However, that does not mean that if you toss the coin twice, you will get tails once and head the next time. Generally, this probability only applies to long sequences, such as flipping a coin 100 times.

Despite that, human beings believe that short-term sequences (probabilities of outcomes occurring in the short term) should reflect long-term cues (so that the very possibility would also exist in a long time), which leads to the gambler's fallacy (Fortune and Goodie, 2012). It should be noted that this bias can have severe consequences for gamblers; for example, if someone believes that they have lost

consecutively at a gamble, their chances of winning are now more significant. The sequence of results of a decision does not indicate the likelihood that the same decision will be made in the future or vice versa.

Stereotypes: Our tendency to rely on categories can easily lead to prejudice, even when we do not realize it. Minority groups are often represented in the mass media in a way that reinforces common stereotypes about them. For example, black men are overrepresented in coverage of crime and poverty, while they are underrepresented as experts or consumers of luxury goods. According to these stereotypes, Black men are portrayed as violent and lazy, which viewers, including Black viewers, can internalize and incorporate into their concept of the exemplary black individual and proto-criminal (Donaldson, 2017). The bias can be attributed to representativeness heuristics, which contributes to discrimination. The police may disproportionately search for blacks in a crime because of representational heuristics (and stereotypes), which lead them to believe that blacks are more likely to be criminals than members of other groups (Bordalo et al., 2016).

As a result of high levels of cognitive reflection, Oechssler et al. (2009) claim that logical biases can be prevented more effectively than low levels of cognitive reflection. The correlation between cognitive reflection and decision-making (Cokely and Kelley, 2009; Frederick, 2005) is positive in high-risk choices (based on time choices). It has been shown that cognitive reflection can help predict sensitivity to cognitive biases and errors caused by inherent cognitive processes (Tversky and Kahneman, 1974; Toplak et al., 2014). Researchers have shown that individuals with high cognitive reflex scores are less susceptible (less sensitive) to biases (Toplak et al., 2011). However, these biases are accompanied by rational reasoning and deductive reasoning (biases such as confirmation bias, anchoring bias, and availability bias) (Liberali et al., 2012; Sirota et al., 2014; Toplak et al., 2011, 2014).

According to Pennycook et al. (2012), people who score higher on cognitive reflection tend to be more focused, rational, pessimistic, and less religious and hold fewer absurd beliefs. According to Campitelli and Labollita (2010), higher scores on the cognitive reflection test have been associated with better results in deciding and selecting the optimal option. When updating probabilities (mental accounting), a low score on the cognitive reflex test indicates that a variety of biases (mental accounting) may exist, including availability, risk aversion, confirmatory bias, and conservatism (Oechssler et al., 2009; Liberali et al., 2012; Achtziger et al., 2014; Frederick, 2005). Our hypotheses based on the theoretical research literature:

1. Investors who exhibit high cognitive reflection are better at preventing conjunction fallacy than those with low cognitive reflection.
2. Investing with a high level of cognitive reflection can prevent the gambler's fallacy more effectively than investing with a low level of cognitive reflection.
3. Investors who exhibit a high level of cognitive reflection are more likely to avoid stereotypes than those who show a low level of cognitive reflection.
4. Investors with high cognitive reflection are likelier to prevent representativeness heuristics than those with low cognitive reflection.

3. Research Methodology

Due to the nature of the variables and the objectives of this study, a questionnaire would be the most appropriate method for collecting data. This study aims to examine how cognitive reflection affects individuals' representativeness heuristics. The population of this study consists of a sample of

participants in the Tehran Stock Exchange, whose exact number, based on Cochran's formula, is 414 participants. Also, online and offline questionnaires were distributed in 2022. We examined individual differences using T-tests, one-way ANOVA, and correlation analyses. To determine the average difference between men and women in their responses to CRT questions, we used the two independent samples (T-test) test. A T-test only shows the difference between two independent groups of men and women. To compare the average of two or more independent groups (education and profession), you should perform a one-way analysis of variance. Furthermore, correlation coefficients were used to determine whether there was a relationship between the variables. Consequently, we decided if there was a relationship between respondents' age and the mean correct answer to CRT questions. Also, In the survey, we asked and tested four structured questions according to the theoretical foundations of representativeness bias. Further, reflective cognitive intelligence tests require participants to solve three simple math problems with incorrect intuitive and fundamental answers. According to Frederick, the test score varies due to the ease with which a person can check for wrong intuitive answers. This is because an individual can reflect upon a logical rather than an intuitive answer. There is an assumption that the correct answers must overcome the initial intuitive answer in this test, which has misleading first answers (Frederick, 2005). One needs to reflect on one's thinking to overcome the intuitive response. In this short test, a person is tested on their ability to ignore their immediate and direct answers and think more logically (Kokis et al., 2002). The questionnaire is shown in Appendix 1.

Firstly, the collected data do not have a normal distribution or a constant variance. It is common for our questions to be answered with A or B; they are nominal data. Therefore, parametric techniques are unsuitable for our case because our data cannot meet their requirements. Second, our data are consistent with these two assumptions in nonparametric procedures. Our samples are randomly selected and do not influence each other's responses and behavior. Therefore, we believe nonparametric methods are appropriate for our study. For our analysis, we divided our questions into two subsamples concerning CRT achievements. We hope to explore the relationship between these two CRT groups. We will examine whether investors in the high CRT group perform better on confirmation bias than investors in the low CRT group. For this reason, we use the Chi-square test to explore the relationship between categories, compare the observed frequencies or proportions of cases in categories, and determine whether there is a relationship between two measured variables (Pallant, 2020). Through the above explanations, we conclude that the Chi-square test is very suitable for testing the differences between our samples in this bias.

4. Result

4.1 CRT and individual differences

These statistics provide a general overview of how research data are distributed. By this, the following Table presents the percentage of responses to each of the three CRT questions and the mean scores and their standard deviations. The majority of respondents were unable to select the correct answer. The mean total correct response was 0.88, much lower than what Frederick (2005) and Oechssler et al. (2009) found in their studies.

Table 1. Mean scores CRT

CRT Questions	% Correct answers	% Wrong answers	Mean
Bat & ball	51.000	49.000	0.510
Machine	63.000	37.000	0.630
Lily pads	61.600	38.400	0.620

The following Table reports the results regarding the effects of four demographic characteristics.

An analysis of the impact was carried out using T-tests, one-way ANOVAs, and correlations.

Table 2. Mean Scores CRT by Gender

CRT Questions	Bat & ball	Machine	Lily pads	Mean
Man	0.510	0.650	0.630	1.781
Woman	0.520	0.690	0.580	1.692
t	-0.298	1.075	0.911	0.712
Sig. (2-tailed)	0.766	0.283	0.363	0.477

Based on the Prob, A two-tailed statistic greater than 0.05 for all CRT questions indicates no significant difference between men and women. As a result, the null hypothesis of this test is accepted. Therefore, men's scores in all questions are not different from women's scores. This result does not support the findings of Oechssler et al. (2009) and Stanovich and West (2000).

Table 3. Mean scores CRT by Age

CRT Questions	Bat & ball	Machine	Lily pads	Mean
More than 65 years	0.610	0.670	0.670	1.940
51-65	0.590	0.590	0.480	1.660
36-50	0.620	0.760	0.620	2.000
25-35	0.500	0.630	0.650	1.785
Less than 25 years	0.460	0.600	0.580	1.640
r	-0.092	-0.049	-0.015	-0.074
Sig.	0.061	0.317	0.762	0131

According to the correlation test, older people have higher mean scores than younger people. This is true only for the first question, and there is no relationship between age and response scores on the other CRT questions.

Table 4. Mean scores CRT by Education

CRT Questions	Bat & ball	Machine	Lily pads	Mean
Ph.D.	0.710	0.680	0.570	1.964
Masters	0.600	0.660	0.570	1.828
Bachelor	0.520	0.670	0.660	1.855
High school	0.450	0.580	0.600	1.628
F	2.786	1.280	0.666	1.545
Sig.	0.041	0.281	0.573	0.202

In light of the one-way ANOVA table results, we conclude that at least one of the study groups has different mean scores on the Bat & ball questions. Also, the analysis of the variance test cannot determine exactly which averages are different from the rest, so the average scores in the above Table should be used to detect such differences.

Table 5. Mean scores CRT by Profession

CRT Questions	Bat & ball	Machine	Lily pads	Mean
Retired	0.500	0.570	0.500	1.571
Manager, Employee	0.670	0.700	0.630	2.000
Researcher, Academic	0.510	0.660	0.600	1.771
Student or Housewife	0.490	0.610	0.630	1.730
F	1.091	0.567	0.352	0.627
Sig.	0.353	0.637	0.787	0.598

According to the results, the mean score for this question increases as the level of education increases. However, in the following two questions, the mean of all educational levels remains the same.

Based on the one-way variance analysis table results, we conclude that the mean scores for all CRT questions are not significantly different. There is no difference between people's jobs and their scores on cognitive reflection tests. Also, based on the results of Frederik's test (0 correct answers belong to the low CRT group; 1 and 2 correct answers belong to the medium CRT group: 3 correct answers belong to the high CRT group), the percentage of correct answers and intelligence of people based on these levels was measured in the Table below.

Table 6. % Correct answers for CRT groups

CRT	Frequency	Percent	Valid Percent	Cumulative Percent
low	79.000	19.100	19.100	19.100
1	95.000	22.900	22.900	42.000
2	88.000	21.300	21.300	63.300
high	152	36.700	36.700	100.000
Total	414	100.000	100.000	

4.2. CRT and types of the representativeness heuristic

The following tables show the results of the low and high CRT groups for each type of representativeness heuristic. The reported value is the percentage of patients who chose the patient option or the mean response. The subscripts indicate the total number of respondents in the low and high CRT groups who answered the item. A chi-square test (for dichotomous responses) is used to determine the level of statistical significance of group differences. In the rightmost column, the p-values indicate the level of statistical significance.

Table 7. CRT and the conjunction fallacy

Item	CRT Score		Chi-square value (χ^2)	P-value	Phi
	"Low"	"High"			
Sarah loves Apple products and is also active in the stock market; which one is possible? 1) Sara is an analyst in the stock market. 2) Sara is an analyst in the stock market and has shares of Apple in her stock portfolio.	60.8% $_{48}$	45.4% $_{69}$	6.989	0.072	0.130

The basis of this question is the fallacy of correlation, which occurs when we assume that several things are more likely to occur than one thing alone. It is statistically impossible for this to be true. According to the results of Table 7, the significance of the Chi-square value (6.989) indicates a significant relationship between the two variables CRT and the conjunction fallacy. Since the chi-score test cannot detect the intensity of a relationship, we use the Phi coefficient to determine the relationship's strength when each row and column variable has only one (yes) value. In this case, as well as according to Cohen's W table, this relationship has a weak effect.

Table 8. CRT and the gambler's fallacy

Item	CRT Score		Chi-square value (χ^2)	P-value	Phi
	"Low"	"High"			
The Real Madrid football team in 2022 has never lost in all their past games (12 games). How do you evaluate the result of this team's next match with Rayo Vallecano? Win or Draw Loss	48.1% 38	53.3%81	8.021	0.046	0.139

The gambler's fallacy is another bias caused by the representativeness heuristic, which causes people to apply long-term probabilities to short-term sequences. The likelihood of Real Madrid winning consecutive matches does not increase due to successive victories. Based on the results of Table 8, as indicated by the significance of the Chi-square value (χ^2) (8.021), we can conclude a significant relationship between the two variables CRT and the gambler's fallacy. In the context of Cohen's W table, we can say that this relationship has a weak effect.

Table 9. CRT and the stereotypes

Item	CRT Score		Chi-square value (χ^2)	P-value	Phi
	"Low"	"High"			
Do you think the owl is wise? • YES • NO	40.3% 34	59.9% 91	6.823	0.078	0.128

Our reliance on groups can easily lead to prejudice, even if we are unaware. As the wise animal of the forest, the owl frequently appears in children's stories. These beliefs have their origins in the mythologies of ancient Greece and Rome. According to Western cultures, the legend of the wise owl began with Athena, the Greek goddess of wisdom, who is often depicted holding an owl in her hand. It is interesting to note that owls are considered a symbol of stupidity in Indian culture. Is it true that owls are intelligent? According to studies, despite popular belief, owls are not imaginative animals. In contrast to birds such as crows, parrots, and pigeons that can be trained, owls cannot be trained; they cannot solve problems, and they cannot associate words and phrases with objects or events. Based on Table 9, the significance of the Chi-square value (6.823) indicates a significant correlation between the two variables CRT and Stereotypes. It is clear from Cohen's W table that this relationship has a weak effect.

Table 10. CRT and the representativeness heuristic

Item	CRT Score		Chi-square value (χ^2)	P-value	Phi
	"Low"	"High"			
Imagine a person with an IQ of 200 who went to college at age 15 and graduated with honors from the University of Chicago at age 19. Also, he has studied 15 languages, is fluent in five languages worldwide, and is recognized as an ornithologist. Do you think this person is more likely to be a scientist or a murderer?	59.5%47	43.4%66	8.731	0.033	0.145

This question accurately describes a murderer genius named Nathan Leopold (November 19, 1904 - August 29, 1971) who, along with Richard Albert Loeb (June 11, 1905 - January 28, 1936), is often referred to as "Leopold and Loeb." They were privileged and wealthy students at the University of

Chicago. Attempting to commit the "perfect crime," murdered 14-year-old Robert "Bobby" Franks in 1924. In 1958, Leopold was released from prison and spent the remainder of his life in Puerto Rico. He died of heart failure in 1971. From the results in Table 10, which indicate a significant correlation between the two variables CRT and the representativeness heuristic, we can conclude a substantial relationship between them. The association, according to Cohen's W table, is weak.

5. Conclusion

We first examine the individual differences between investors regarding obtaining points for the cognitive reflection test. Furthermore, based on the results of this study, there is no significant difference in cognitive reflection between men and women. Additionally, the results of one-way ANOVA indicate that the average cognitive reflection score increases with the level of education and that people's professions do not differ in their scores. According to the correlation test results, older individuals have higher average scores than younger individuals. Due to this, we are focusing on finding the root of the representativeness heuristic and then discovering how cognitive resources can be utilized to reduce these heuristics effectively. This led us to divide the representativeness heuristics according to the relationship between events (Conjunction Fallacy), the likelihood of consecutive outcomes for an event (Gambler's Fallacy), and the indiscriminate use of stereotypes as well as a specialized examination of representativeness heuristics.

The representativeness heuristic can occur even with adequate cognitive resources and is deeply embedded in people's subjective intuition. Despite our sample mean's success in suppressing early responses, they also suffered. Therefore, due to limited cognitive resources, investors often use mental shortcuts to make quick judgments (simulating various situations and categorizing events) and willfully make mistakes in rational decision-making. Our study measured the relationship between conjunction fallacy and people's cognitive resources using Kahneman and Tversky's "Linda," which they used in their research and used as the criterion. As shown in Table (7), most people who received a higher score than CRT were less affected by this bias. This means that 55.6% of people with a high CRT score could control their initial mental responses and were not subject to this bias. Consequently, using correct cognitive resources can partially prevent this from occurring.

Also, investors consider the probability of consecutive results for an event regardless of the use of high cognitive resources so that they can obtain definitive results and avoid uncertainty in the facts of the decision by applying a mental basis based on a series of events. The same thing that gamblers have experienced many times in that situation. Table (8) shows no difference between people involved in the gambler's fallacy in their CRT scores. Thus, people with different levels of cognitive resources are equally interested in this process. As a final and most exciting result of this study, we found that people who scored low on the test (roughly 60%) were less likely to make decisions based on stereotypes. While 60% of investors with higher cognitive resources and patiently answering the questions experienced this bias, only 40% of those with low scores did.

Based on the results of Table (10), we concluded that the representativeness heuristic could be reduced by acquiring knowledge and experience in similar situations and utilizing cognitive resources appropriately. Accordingly, 57% of people who could suppress their initial mental responses and doubt the association between events, the probability of consecutive outcomes for an event, and common stereotypes were able to reach the correct answer.

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Appendix 1.

You have been provided with a survey to conduct research. Please help us conduct this research by providing a few minutes. Your responses are greatly appreciated. Please note that you have been selected randomly, and your personal information will not be included in the survey.

Gender: male☐ female☐
Age: more than 65☐ 51 to 65☐ 36 to 50☐ 25 to 35☐ less than 25 years☐
Education: Ph.D.☐ Master☐ Bachelor ☐ High school☐
The Profession: Retired ☐ the manager, employee ☐ Academician, researcher☐ Student, or housewife☐

Read the following sentences carefully and mark the answer that best matches your thoughts or feelings.

1. A bat and a ball cost $1.10 in total. The Bat costs $1.00 more than the ball. How much does the ball cost? _____ cents
2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes
3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take to cover half of the lake? _____ days
4. Imagine a person with an IQ of 200 who went to college at age 15 and graduated with honors from the University of Chicago at age 19. Also, he has studied 15 languages, is fluent in five languages worldwide, and is recognized as an ornithologist. Do you think this person is more likely to be a scientist or a murderer?
5. Sarah loves Apple products and is also active in the stock market; which one is more possible?
6. Sara is a stock market analyst.
7. Sara is an analyst in the stock market and has shares of Apple in her stock portfolio.
8. The Real Madrid football team in 2022 has never lost in all their past games (12 games). How do you evaluate the result of this team's next match with Rayo Vallecano?
9. Do you think the owl is wise?