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ABSTRACT

The current study presents findings of an experiment. Response time was used to investigate fast deciders' (FD) and slow deciders' (SD) behavioral differences. SDs were found to be more cognitive than FDs and this could induce an increase in average response time. Both FDs and SDs showed aversion to extreme options, but they behaved differently with option 'S' being "safer" among groups. Moreover, FDs responded more instinctively to negative feedbacks.

Keywords: Response time, decision time, risk decision, decision making.

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INTRODUCTION

In recent years, there has been a lively debate about the usefulness of non-choice data in decisions (Schotter & Trevino, 2014). One kind of non-choice by-product data which may shed light on the decision makers' deliberation process is response time (RT) (Lotito, Migheli & Ortona, 2013; Piovesan & Wengström, 2009). Rubinstein (Lotito, Migheli & Ortona, 2013; Rubinstein, 2013a; Rubinstein, 2013b; Rubinstein, 2016) is one of the first researchers who studied behaviors using subjects' RTs and found clear relationship between behaviors and RTs (Piovesan & Wengström, 2009; Schotter & Trevino, 2014). Most of these researches are based on the assumption that instinctive decision is faster than contemplative decisions (Branas-Garza, Meloso & Miller, 2012; Rubinstein, 2007; Rubinstein, 2013a; Schotter & Trevino, 2014), and RT in decision making is an agency of cognition allocation (Geng, 2015). This conclusion has been drawn from many studies (e.g. Piovesan & Wengström, 2009; Rubinstein, 2007). Emotion also plays an important part in human decision. People are more apt to behave instinctly when they are involved in certain emotions, and overcoming these emotions in decision will take them longer time (Greene *et al.*, 2001). The conclusion has been confirmed in decision neuroscience researches. For example, by employing the functional magnetic resonance imaging (fMIR) method, Sanfey *et al.* (2003) studied responders' behavior in an ultimatum game. They found rejecting a highly unfair offer belonged to the emotion part of the brain and accepting the offer belonged to the cognation part. They inferred accepting the offer would take longer time than rejecting.

We follow a similar path in this study and try to explore human's decision behaviors using RTs. The current study presents the findings of a decision game. We classify subjects according to their average response time (ART) and investigate behavioral differences. Both fast deciders (FDs) and slow deciders (SDs) showed more aversion to extreme options, and when option 'S' being "safer" among groups, they behaved differently. We find that SDs are more cognitive than FDs, because the first recurrence of the stimulus induces an increase in SDs' ART. Moreover, compared to SDs, FDs behaved quite instinctively to negative feedbacks and tended to be less risky in a following decision.

THE EXPERIMENT

The experiment was conducted at Beihang University with a total of 33 students (15 males, the average age is 23.2, SD=2.29). All participants provided written consent and then completed a decision game on computer. The experiment was programmed and conducted with the software E-prime 2.0.

At the beginning of the game, the participants were assumed to be retailers of some kind of product. In each period, demand for the product in a following quarter was estimated equiprobably to be one of the four pre-specified options, among which the participants were restricted to a choice as the retail purchases volume. In each period, a profit table showing the payoffs under each estimated demand appeared on the screen, like what is shown in Figure1. Participants had to make a decision in each period by pressing a corresponding key ('A. 'S. 'D. or 'F') on the keyboard. For all the stimuluses or tasks, 'F' was the riskiest choice, followed by 'D. and then 'S'. The most risk aversion choice was 'A'. There were 10 different tasks and they were presented randomly in both of the two rounds. That is to say, the decision game lasted for 20 periods, with 10 periods in both rounds. Once a decision was made in a period, a feedback with actual demand, the profit units that the decision brought to him/her, and the accumulated profit units were presented on the screen.

RT was measured for each of the decisions separately and was defined as the time (in seconds) between the moment the screen with a profit table appeared and the moment the subject pressed a key to make a decision. Participants could take sufficient practice to understand the game before they began the real game. But to avoid evoking emotions which would affect their

decisions in the real game, there were no feedbacks in the practice process. The game lasted for about 20 minutes. Participants were told to turn off their cellphones and were not permitted to conduct behaviors such as communicating with each other. Each participant got a 10-yuan show-up fee and each unit of profit in the decision game would bring 0.04-yuan extra reward. Participants were told about the extra reward. Average earnings were about CNY 45.

Estimated demand	Retail purchases volumes			
	1	6	11	16
1	4	-26	-56	-18
6	4	24	-6	-36
11	4	24	44	14
16	4	24	44	64
Corresponding keys	a	s	d	f

Figure 1: An example of profit table in the experiment.

DESCRIPTIVE RESULTS

33 participants' data from 660 decisions were gathered from the experiment. According to the error processing criterion, 11 exceptional RT data were excluded. Figure 2 shows the evolution of all subjects' ARTs over the 20 periods. We note great fluctuations in ART during the beginning periods and were followed by a stable level with slight decrease throughout the remaining periods. This is quite intuitive, as when subjects got more familiar with the game they would spend less time to make a decision. Paired T-test shows ARTs in the second round (M=6.13s, SD=2.96) were significantly lower than that in the first round (M=8.71s, SD=3.68), t (32) =6.219, $p<0.01$. Previous studies (e.g. Lotito, Migheli & Ortona, 2013) found females tended to take more time to make a decision. In the current study, though females' ART (M=7.90s, SD=3.06) is slightly higher than males' ART (M=6.75s, SD=3.03), the difference was not statistically significant (p=0.285).

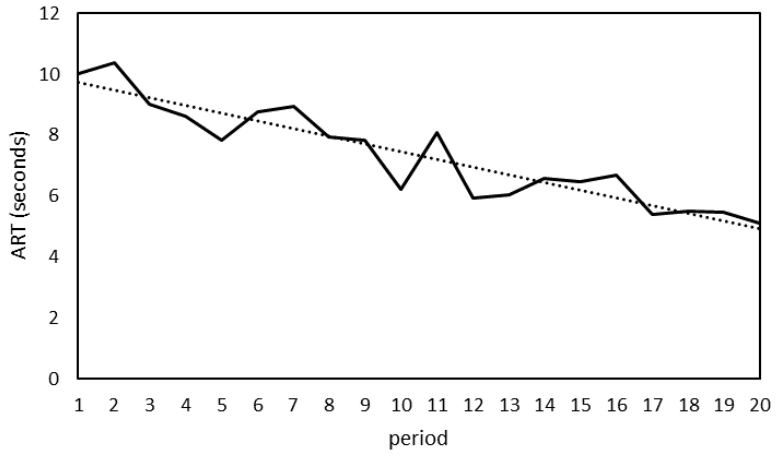

Figure 2: All subjects' ART evolution over periods.

As for subjects' decision results, generally, they showed quite different preference for the four options (Chi-square = 323.055, p=0.000). Among the four options, 'S' was chosen most frequently (N=353, 53.48%) than other options, while 'F' was chosen least times (N=59, 8.94%). The proportions for 'D' and 'A' were 25.00% and 12.58%, respectively. We compared males' preference with females. as is shown in Figure 3. We can see males' and females' preferences have similar distributions, and compared to medium risky decisions (i.e. 'S' and 'D'). Both genders showed more aversion to extreme options 'A' and 'F'. Though males showed slightly more preference for 'D' than females and females showed slightly more preference for 'S. the difference was not significant. As for the decisions in round 1 and round 2, decision results in round 2 are significantly different from that in round 1 (Chi-square=8.623, p=0.035). Subjects appeared to be more risk aversion in round 2, and the proportions for 'A' and 'S' increased in this round. ARTs for different options in the game were slightly different. The ART for 'F' (M=5.86s, SD=3.52) was significantly lower than 'S' (M=7.60, SD=5.40) and 'D' (M=7.69, SD=4.38) ($p<=0.011$). But we did not find any differences among ARTs among other options. ART for "a" was 6.39 seconds, SD=5.29.

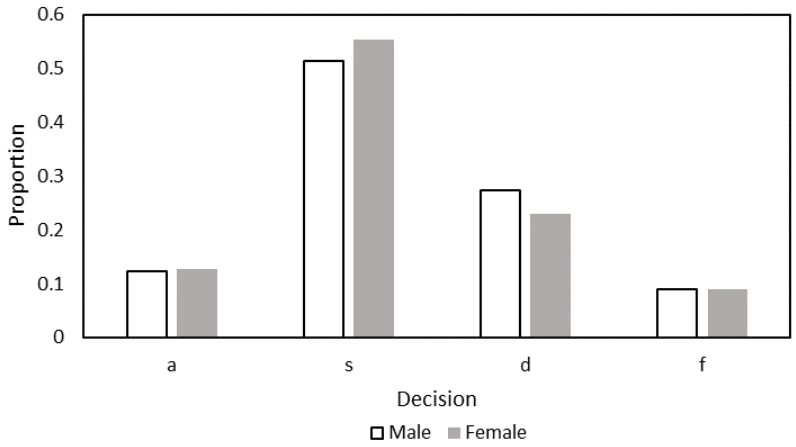

Figure 3: Option proportions of males' and females' decisions.

BEHAVIORAL DIFFERENCE BETWEEN FAST AND SLOW DICIDERS

Fast Deciders and Slow Deciders

Were there any behavioral differences between subjects deciding fast and slow? To answer this question, we employed a method to classify subjects according to their ARTs in the game, which was similar to that in Rubinstein's (2007; 2013a; 2013b; 2016) researches. Ten subjects (6 males) with shorter ARTs than other subjects were classified as faster deciders (FD), and the other ten subjects (4 males) who had higher ARTs than other deciders were classified as slow deciders (SD). We excluded 13 subjects with medium ARTs. Figure 4 shows the evolution of FDs' and SDs' general ART over periods. We can see from Figure 4 that compared with great fluctuations in SDs' ART, FDs' ART keeps constant at a lower level over the 20 periods. Especially, we can find great increase in SDs' ART from first to second period, and from 10th to 11th period.

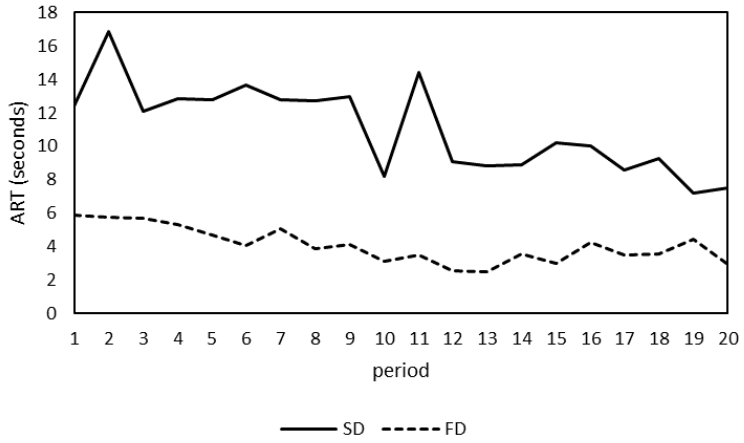

Figure 4: FDs' and SDs' general ART evolution over 20 periods.

As for the options, FDs' and SDs' decision distributions for the 10 stimuluses in the two rounds were significantly different (Chi-square=38.557, p=0.000), as Figure 5 shows. Though FDs and SDs both show great preference for 'S. SDs' options seemed to be more regular and concentrated among different stimuluses. Similar differences can be found in round 1 (Chi-square=21.555, p=0.000) and round 2 (Chi-square=17.183, p=0.001).

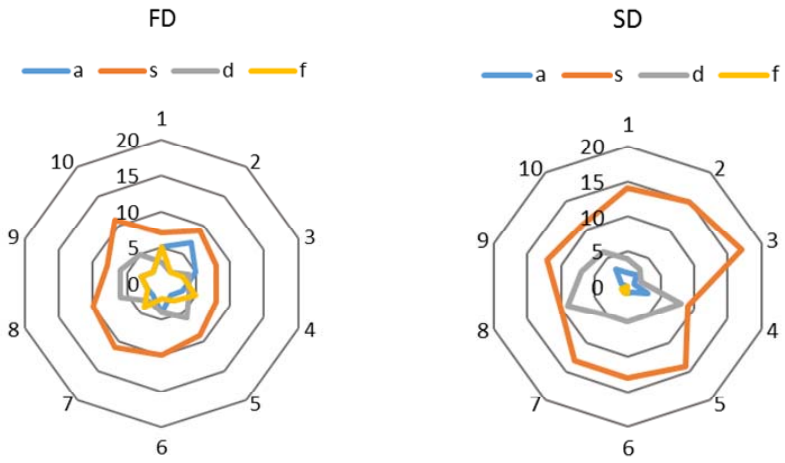

Figure 5: FDs' and SDs' decisions for different stimuluses.

The decision game lasted for two rounds, with 10 periods in each round. So, period 11 was the first period that subjects made a decision for a stimulus which they had already made in the first round, though actual demand for a same stimulus was not same in different rounds. Subjects were not told about this before the experiment. So, subjects who realized the recurrence the first time would involve more cognition in this period which would induce an increase in RTs. We expected this increase in SDs' ART. And in Figure 4 we see such a sudden increase in SDs' ART between the 10th period and the 11th period, but we do not observe similar increase in FDs' ART between the two periods. Actually, SDs' ART in the 11th (M=14.39s, SD=7.30) period is significantly higher than that in the 10th (M=8.21s, SD=3.94) period, t (9) = -3.580, p = 0.006. However, the difference between FDs' ART in the 10th and 11th is not significant. It indicates that slow subjects were more sensitive to the recurrence, and they were more cognitive than FD in the game. When familiar stimuluses were presented, they spent some time to confirm they met the same stimuluses and even tried to recall the actual demands in the first rounds to get more profit units. But for FDs, they may even do not realize this reoccurrence. So, only SDs' behaviour in 11th decision induced an increase in RTs. As for SDs' ART increasing between the 1st (M=12.24s, SD=3.33) and 2nd (M=14.71s, SD=7.56) decision, this may result from the first feedback after the first decision (p=0.093). To avoid evoking emotions before the real game, no feedback was presented on the screen in practice periods. But all the subjects had been told that their extra rewards were related to their decision results in the game. So, when they saw feedback the first time, SDs may spend some time to think about the situation and this induced an increase in ARTs. No such kind of effect can be found in FDs' ARTs. The results were consistent with many previous studies (e.g. Piovesan & Wengström, 2009; Rubinstein, 2007; Schotter & Trevino, 2014), which concluded that slow decisions were more cognitive than fast decisions and vice versa.

FDs' and SDs' Risk Preference

We also explored the difference of FDs' and SDs' risk preferences in the game. To aid us in this endeavor, 10 stimuluses were divided into three groups according to the probabilities of loss (i.e. numbers of minus profits units) in the decision. Three stimuluses with loss probability 0.25 (4/16) belonged to Group 1 (G1); three stimuluses with loss probability 0.1875 (3/16) belonged to Group 2 (G2); and the other four stimuluses with loss probability 0.125 (2/16) belonged to Group 3 (G3). In G1, 'S. 'D. and 'F' were all risky options. But in G2 and G3, only 'D' and 'F' were risky options.

We investigated SDs' and FDs' decisions in the three groups, and we found significant differences between their decision results in G1 (Chi-square=23.460, p=0.000), G2 (Chi-square=10.292, p=0.016), and G3 (Chi-square=8.835, p=0.032). But there were no significant differences between FDs' decision results in round 1 and round 2, either in SDs'. Figure 6 shows proportions of SDs' and FDs' decision results in the three groups. Both FDs and SDs showed more preference for the medium risky options 'S' and 'D. and showed more aversion to extreme options, especially the SDs. Actually, as many as 133 FDs' decisions (31 in G1, 41 in G2, 60 in G3) were 'S' or 'D. and this number for SDs was 182 (55 in G1, 54 in G2, 73 in G3).

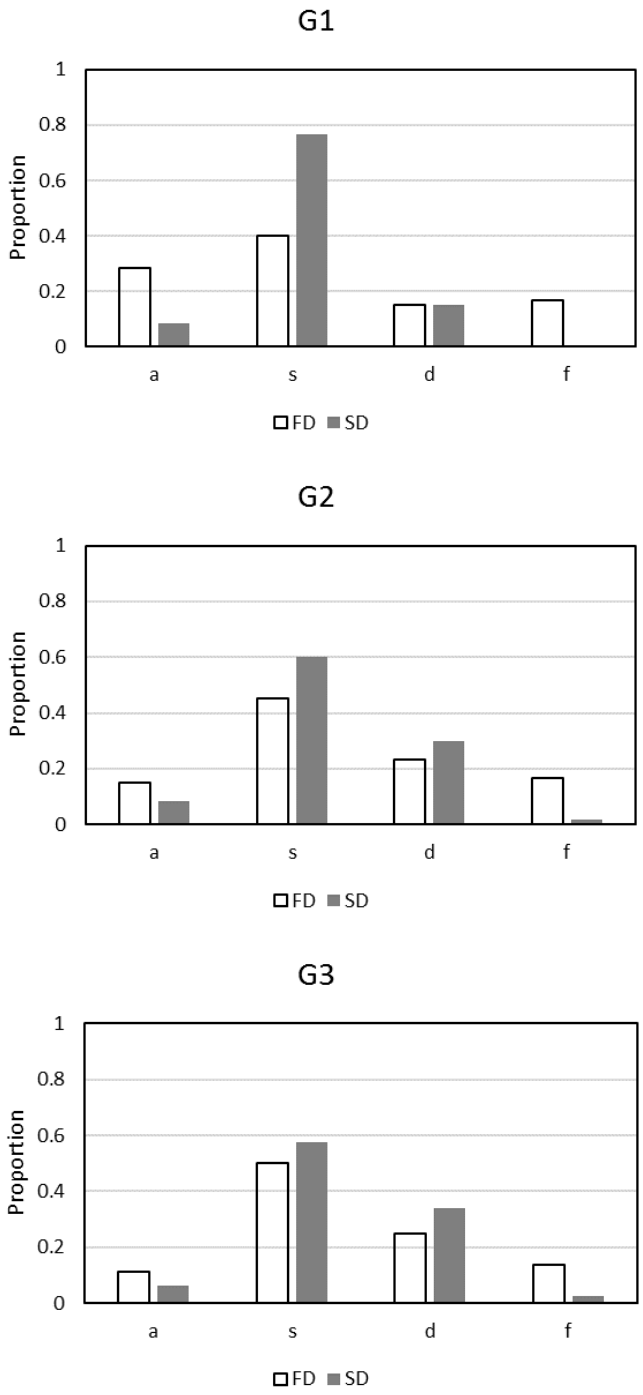

Figure 6: FDs' and SDs' option proportions in G1, G2, and G3.

We investigated SDs' and FDs' preference evolutionary tendency in the three groups, as is shown in Figure 7. We can find similar patterns between SDs' and FDs' preference for option 'A' and option 'D'. However, their preference for 'S' and 'F' showed different patterns, and actually they were inverse. When option 'S' became less risky among the three groups, FDs showed more preference to this option. While to the SDs, when 'S' became "safer", they transferred their preference to a relatively risky option (i.e. option 'D'). This may result from FDs' instinct in decision. When the option became "safer" than in the former group, they took the option quite instinctively, which was similar to that in option 'D'. Proportions for 'F' decreased from G1 to G2, and then G3. This seemed to be instinctive too, because when 'S' and 'D' became "safer", 'F' stayed as a most risky option, especially in G3 when 'D' and 'F' had the same probability of loss, and 'F' had a larger loss value. Things were different to SDs. We can see SDs tried to avoid extreme options more carefully. And when 'S' became 'safer" they showed more preference for relatively risky options 'D' and 'F'. It was a tendency of risk-taking, especially of minor risk (i.e. option 'D'). Compared with FDs' behavior, SDs' may result from more deliberate process.

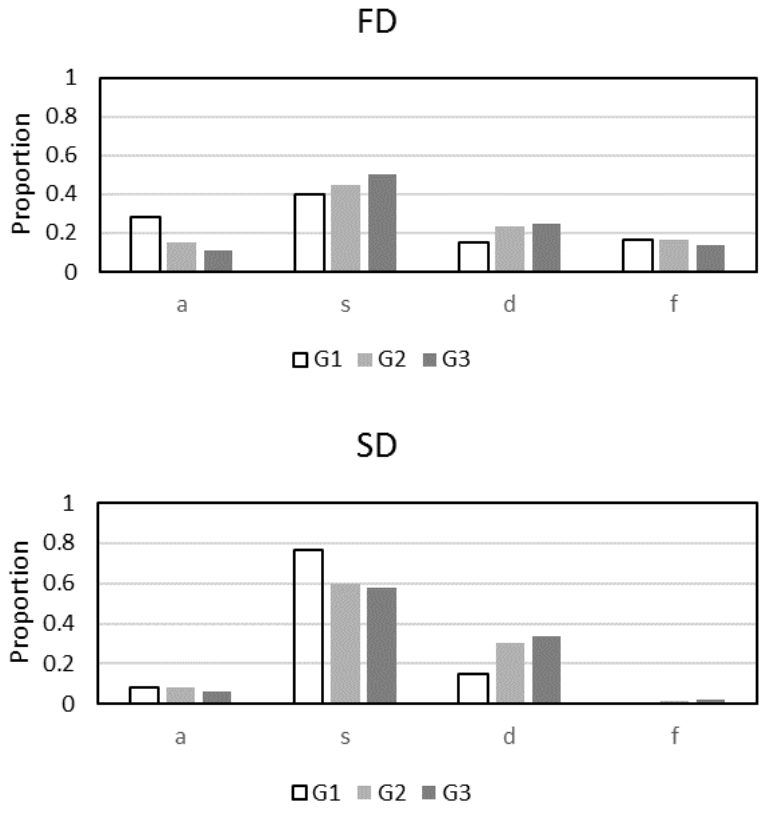

Figure 7: Evolutionary of FDs' and SDs' preferences in G1, G2, and G3.

FDs' and SDs' Response to Negative Feedbacks

Rubinstein(2013b) found that in decisions involved clear and absolute "right" options, SDs were more likely to make a "right" decision. A subject made a decision for all the ten stimuluses in both two rounds, but we do not find any difference in the behavioral consistency between FDs and SDs. It indicated that in this game subjects did not just take consistency of decisions in the two rounds as "right". This may be induced by the feedback after each decision, and subjects adjusted their decisions according to feedbacks. Subjects received feedbacks once they had made a decision, according to the decision and the pre-specified demand.

We investigated how negative feedbacks affect a following decision. To help us in this endeavor, we defined "critical option (CO)" for each stimulus and "option distance (OD)" for each option. CO was the maximum retail purchase volumes with positive profits whatever the actual demand would be. For example, in the stimulus showed by Figure 1, option 'A' is the CO. If an option is on the left first of the CO, the OD is -1; if an option is on the right first of the CO, OD is 1, and if it is on the right second or right third of CO, then the OD is 2 or 3. We defined a following behavior as "riskier", if the OD in a following decision got larger, and vice as "less risky". If the OD in a following decision kept the same, then the behavior was described as "keep". We did not include a subject's last decision which induced negative feedbacks, as there was no "following decision" for a subject's last decision. Totally, FDs received 31 negative feedbacks and SDs received 24 negative feedbacks. Figure 8 shows proportions of changes in FDs' and SDs' decisions after receiving negative feedbacks. Compared to SDs' response, FDs' change in decisions was more instinctive and tended to be less risky, the proportion is about 0.45, but this proportion for SDs is about 0.33. This can be explained by conclusions in previous studies (e.g. Greene *et al.*, 2001). When participant received a negative feedback, which would decrease the total reward, the instinctive response was taking a less risky option in a following decision. Realizing the independence of decision tasks and overcoming the emotional tendency, or intuition, would increase RTs. So, FDs' reaction shown in Figure 8, may be the result of a feeling of loss and this is quite emotional. FDs instinctively became less risky after receiving a negative feedback, while SDs behaved more cognitively, though the difference was not significant in statistics (Chi-square=1.039, p=0.595).

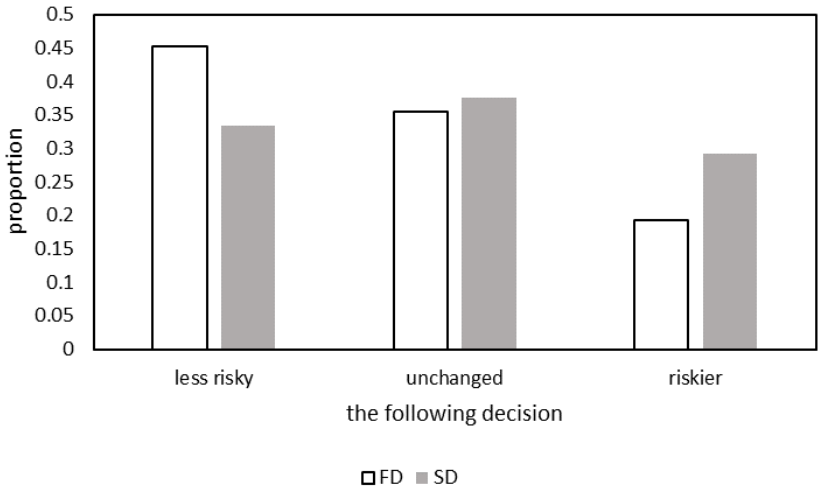

Figure 8: Proportions of changes in FDs' and SDs' behaviors after receiving negative feedbacks.

DISCUSSION

RT can shed light on people's decision process as it is an indication of cognition allocation in decision. According to previous studies, instinctive decision is faster than cognitive decision. Cognitive behaviors can induce increase in RT. Involving of emotion leads to instinctive decisions and overcoming emotion leads to increase in RT.

Based on previous studies, the current study presents results of an experiment. We employed a similar method with previous studies and classify subjects according to their ARTs. Ten subjects with shorter ARTs than other subjects were classified as FD, and the other ten subjects whose ARTs were higher than other deciders were classified as SD. We found SDs were more cognitive than FDs in the game, and they realized better than FDs when reoccurrence appeared. In addition, we also found both FDs and SDs showed more aversion to extreme options and they behaved differently when option 'S' became "safer" among groups. FDs seemed to respond more instinctively to the change. But this needs to be investigated further in the future. Moreover, FDs tended to be less risky when they received negative feedbacks which indicates a decrease in their rewards.

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REFERENCES

[1] Branas-Garza, P., Meloso, D., & Miller, L. (2012). Interactive and moral reasoning: a comparative study of response times. Working Paper, Innocenzo Gasparini Institute for Economic Research, University of Bocconi, Milano, June.

[2] Geng, S. (2015). Decision time, consideration time, and status quo bias. *Economic Inquiry*, 54(1), 433-449.

[3] Greene, J.D., Sommerville, R.B., Nystrom, L.E., Darley, J.M., & Cohen, J.D. (2001). An fMRI investigation of emotional engagement in moral judgment. *Science*, 293(5537), 2105–2108.

[4] Lotito, G., Migheli, M., & Ortona, G. (2013). Is cooperation instinctive? Evidence from the response times in a public goods game. *Journal of Bioeconomics,* 15(2), 123-133.

[5] Piovesan, M. & Wengström, E. (2009). Fast or fair? A study of response times. *Economics Letters,* 105(2), 193-196.

[6] Rubinstein, A. (2007). Instinctive and cognitive reasoning: A study of response times. *The Economic Journal,* 117(523), 1243-1256.

[7] Rubinstein, A. (2013a). Response time and decision making: a 'free' experimental study. Retrieved from https://en-econ.tau.ac.il/sites/economy_en.tau.ac.il/files/media_server/Economics/foerder/papers/2013-6.pdf (8 March 2017).

[8] Rubinstein, A. (2013b). Response time and decision making: An experimental study. *Judgment & Decision Making*, 8(5), 540-551.

[9] Rubinstein, A. (2016). A typology of players: Between instinctive and contemplative. *The Quarterly Journal of Economics*, 131(2), 859-890.

[10] Sanfey, A.G., Riling, J.K., Aronson, J.A., Nysstrom, L.E., & Cohen, J.D. (2003). The neural basis of economic decision-making in the ultimatum game. *Science,* 300(5626), 1755–1758.

[11] Schotter, A. & Trevino, I. (2014). Is response time predictive of choice? An experimental study of threshold strategies. Discussion Paper No. SP II 2014-305, Berlin: Social Science Research Center (WZB).