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Analysis of Influence Mechanism for Cognition of Trust and Decision-making Behavior: Based on Game Neurology

Yang Hongtao, Xue Caihong, Li baizhou and Li Sulei

School of Economics and Management, Harbin Engineering University, Harbin, P.R. China, 150001, China

Abstract: Partnership venture is currently the countries out of the economic abyss main means to achieve entrepreneurial economy. However, the failed reality of Part Partner entrepreneurship let people gradually aware of the trust relationship to partnership cooperation success or failure play an important role. Firstly, on the bases of the game theory and ERP experiment, the relationship model about trust considered factors is built, individual risk preference, and partner behavior and trust relationship with the investment behavior. Secondly, using interviews and SEM amend test-amend to the model. Through the analysis about the game's the experimental results, the flaws of the experiment and a comprehensive analysis of the actual story, we summarize the shortage existing in the experimental study. Use interviews to discuss issues related to the model of enterprises and the Combs, an amendment to the model. Test the models with SEM and discuss the further amendments to the model by experimental study on path coefficient.

Key words: Game theory, neuroscience, decision-making behavior, trust, ERP

INTRODUCTION

According to the previous analysis, we know that decision-makers' risk preference and the behavior of partnership influence investment decision. The trust definitely influences the decision, but the decision can't explain trust. In order to study the process of trust cognition and decision-making behavior, and to clarify the relationship between them, the factors are subdivided in the game neurology experiment of trust (Li *et al.*, 2005). Then, a more scientific system is built to explain the relationship on the basis of the behavior and brain wave data. Seeking risk and avoiding risk are reflected in the difference of the level of trust one to another and then making a different decision (Fetchenhauer and Dunning, 2009; Holt and Laury, 2002). Individual's risk preference not only influences the perception of decision-maker under the same circumstances, but also influences the decision speed and decision behavior. Not only discovers the influence of mutual trust to the investment behavior of decision-maker, but also finds out the relation between the active level of caudate nucleus and the intention of trust by combining the FMRI with game experiment. As FMRI measures the brain blood flow volume, which has time limit, so only under the distinct stimulation can we observe the active level of brain. In 2007 Fabiametal proposed that different relative potential layer of ERP can reflect different cognitive action. Relative potential

technology(namely ERP) can observe brain wave of the mentally activity of decision-maker in a few milliseconds, which is of great significance to the study of trust cognition (Ma, 2006; Shu, 2009).

LITERATURES REVIEW

According to the related research of scholars at home and abroad: the generation of trust comes from reliability and risk, the existence of risk brings about trust (Inkpen and Currall, 2004; Zheng, 2011). However, under the existence of the same risk, decision-making behavior differs in our preference towards risk. (Eckel and Wilson, 2004). In the element of ERP(event-related potential), N2 is the key index of cognitive control and conflict detection, the amplitude of N2 reflects the chances of risk information triggering the cognitive conflict. The incubation period of the peak value of N2 component is 200-350ms after the presenting of stimulation, reflecting the conscious processing level of brain to information, which is the relative index in the information conflict. Cognitive control is a processing procedure that people react to the limited information of the external world. The greater the decision conflict caused by risk information process, the greater the amplitude of the N2 component. Therefore, we can find the diversity of the decision conflict caused by risk information through the analysis of N2 component. P3 is a relevant index of the formation

Corresponding Author: Yang Hongtao, School of Economics and Management, Harbin Engineering University, Harbin, P.R. China, 150001, China

of attitude. After the conflict information processing, it will produce decision-making attitude, its peak value incubation is about 300-600ms, there is a inverse correlation between amplitude of P3 and decision attitude,which means when the decision-maker is not in the mood, it will decrease the amplitude of P3.

EXPERIMENT IDEAS

Experiment includes two sections
First section: Tell the difference of individual risk preference of testers by using risk preference scale and group them in order to analyze the effect of risk preference on trust cognition and decision-making behavior.

Second section: Investment decisions experiment. Before investor decides the investment cost, it should offer both positive and negative stimulation to trust evaluating factors, let the decision-maker (tested) make investment decision under the different factors, then detects the change of brain wave of decision-maker. Analyze the effect of positive and negative cognition on the attitude of the decision-makers. Each tester takes 6 experiments randomly, which comes from18 programs. In the first round of decision, unknowing the ways of return of investment, decision-makers totally rely on the cognition of decision information, so they will have a credibility to their partners, and the make investment cost choice. After 6 experiments, according to the return of the investment of test subject, they can get different prizes.

Tested: The experiments select 82 MBA and EMBA postgraduate students from H University, 44 males, 38 females, age range from 25 to 35.

Experiment tools
Risk preference scale: Hsee and Webber (Low, 2001) design a questionnaire that can measure personal risk preference, and design RPI so as to calculate risk preference index (Wu, 2010). The questionnaire contains two parts, profit and lost, range of each risk preference RPI:1-8, the bigger the number, the greater the preference risk.(appendix 2).

ERP components record: The subjects enter the neurology lab during the decision experiment, adopting 64 EGG record system and scan 4.3 EGG record analysis produced by Neuroscan, and recording the EGG in the scalp by using the electrode paste and electrode cap (Ma, 2006). Filter pass-band is 0.05-100HZ, frequency is 500Hz, the resistance between electrode and scalp is less than 5000 ohm.

Materials
Stimulation materials: Through the previous study, economy, fame and sinter personal relationship have outstanding impact on the trust between partners. So we select these three factors as the experiment index. According to the analysis of cognition neuroscience, decision-makers will emerge different cognition, decision attitude and behavior in response to different stimulation. Therefore, taking the following experiment cognition conflict information Table 1.

Investment game: Adopting Berg's trust game experiment, the subject has 100 yuan as decision fund (5 as unit), after given the stimulation, the subject will give the partner a certain amount of investment based on his own judgment, and E-prime language program system will give the investor Y yuan as the return on investment, Y stands for the credibility of the partner, the range of Y is 0-3X.

The subjects will be given cognitive hint of relevant information, he makes his judgment only by the information hint in the first decision-making, while in the investment process, computer will give the following three feedbacks: (1) each round gets profit, namely giving the investor a higher investment return than investment cost no matter how the information is, (2)every round is lost, namely giving the investor a lower return than the cost no matter how the information is, (3) profits and lost, after the first investment, investor will gain profit, if the investor invest a lower amount than the last one in the next round, he will lose, if higher, he will get profit, as Table 2.

Relevant potential: In the investment experiment, we detect the N2 and P3 component of brain wave of the subjects, and before the subject makes a decision we will use E-prime to conduct, give information hint and collect

Table 1: Basic factors table

	Positive Information	Negative Information
Economy		
Fame	Prosperous of global economy	Impact by the financial crisis
	Established a business	Has betrayed your partner
Interpersonal relationship	Someone has genetic relationship with you	Conflict with he or she

Table 2: Design assembly table

Economy	Positive	Positive feedback (1) negative feedback (2) exchange feedback (3)
	Negative	Positive feedback (4) negative feedback (5) exchange feedback (6)
Fame	Positive	Positive feedback (7) negative feedback (8) exchange feedback (9)
	Negative	Positive feedback (10) negative feedback (11) exchange feedback (12)
Interpersonal relationship	Positive	Positive feedback (13) negative feedback (14) exchange feedback (15)
	Negative	Positive feedback (16) negative feedback (17) exchange feedback (18)

data. At first, the subject type in his number, ensuring its after 500ms, then presenting information hint 6000ms, and next presenting the investment decision 1500ms, after typing the amount of investment, it will show you the return of the investment, and then presenting next information hint, at last turn it off.

The peak value of N2 component will be about 300 ms after the presentation of decision information, the biggest peak value is in the frontal area. Adopting base-to-peak method, analyze 275-325ms amplitude. The peak value of P3 component is presented in 400-600 ms, the biggest peak value is in the top area and center area. Adopting base-to-peak method, analyze 400-600 ms amplitude.

COOPERATION DECISION-MAKING BEHAVIOR AFFECTING FACTORS RESEARCH

Research design
Variable index: A. Risk preference (High, Low), (b) Trust evaluating factors: External factor (Economic environment), E (Positive, Negative); Trait factors (Fame), F (Positive, Negative); Relationship factors(Interpersonal relationship), R (Positive, Negative), (c) Ways of return: Positive feedback; Negative feedback; Exchange feedback Experiment builds 18 cooperation decision-making scenes, every subject will encounter 6 scenes. According to his own cognition to the scene and make investment decision.

Result and analysis
Risk preference: Test the objective's level of risk preference by using risk preference questionnaire and PRI, statistics results as showed in Table 3.

To make the comparison more obvious, 16 of them get the median(MD = 8), so they don't continue to the next round game, to test the high and low risk preference, correlation coefficient of two test results p<0.001, showing that this 66 risk preference group have a good distinction.

Effecting factors of different trust evaluating factor on decision investment behavior: Before the first decision round, the subject will receive trust evaluating factors stimulation, namely sending signal, and the decision-maker will make his prediction to his partners' credibility, that is to say the investors will benefit or lose. Without receiving the feedback, the subject will be influenced in on the cognition judgment, so, to some extent, the investment amount in the first round explains the impact on different information on investment decision.

From the data above, we can see that different information stimulation has different impact on the

Table 3: Scores

		N	Avg.	S.D.	Min	Max
Risk preference	Male	44	7.73	2.235	2	14
	Female	38	7.65	2.997	2	13

Table 4: Group statistics

Median	Risk preference	Number	Median
Md = 8	High	31	Md = 9.83
	Low	35	Md = 5.32

investment amount, however the different stimulation level of every type of information is also embodied in the different investment. Under the same information stimulation, the investment of different risk preference decision-makers has a remarkable different (Table 4).

From the Table 6 and Fig. 1, we can see that information make the investor have a different cognitive expectation on the partners credibility, the data shows that both high and low risk lover are sensitive to the fame factor, the gap of amount of investment under that positive and negative factor is much greater than other factors. And they show less sensitive to the economic factor. This means that most investors believe that the partner's fame is more vital to his future benefit, and not value too much on the economic environment:

- Experiment H1: Decision-makers of similar risk preference will have a distinction on the amount of investment when facing with different trust evaluating factor
- H1a: Trust evaluating factors have influence on the trust cognitive process of decision-maker
- H1b: Trust evaluating factors have impact on the formation of decision-makers' attitude
- Experiment H2: When decision-makers of different risk preference facing the same information cognition, there will be a different on the amount of investment
- H2a: Risk preference has impact on the formation of trust cognition progress of decision-makers
- H2b: Risk preference has impact on the formation decision attitude progress of decision-makers

For H1a, H1b and H2a, 2H2b, we will use ERP to analyze the two hypothesis further.

EGG analysis of the first decision investment progress: In the first decision, the subject will only be influenced by the evaluating factors, to some extent, its amplitude of EGG component N2 and P3 explain cognition control and decision attitude of decision-maker. Keep recording the original EGG, then process it offline.

There is no obvious distinction about individual risk preference on N2 amplitude, but outstanding distinction
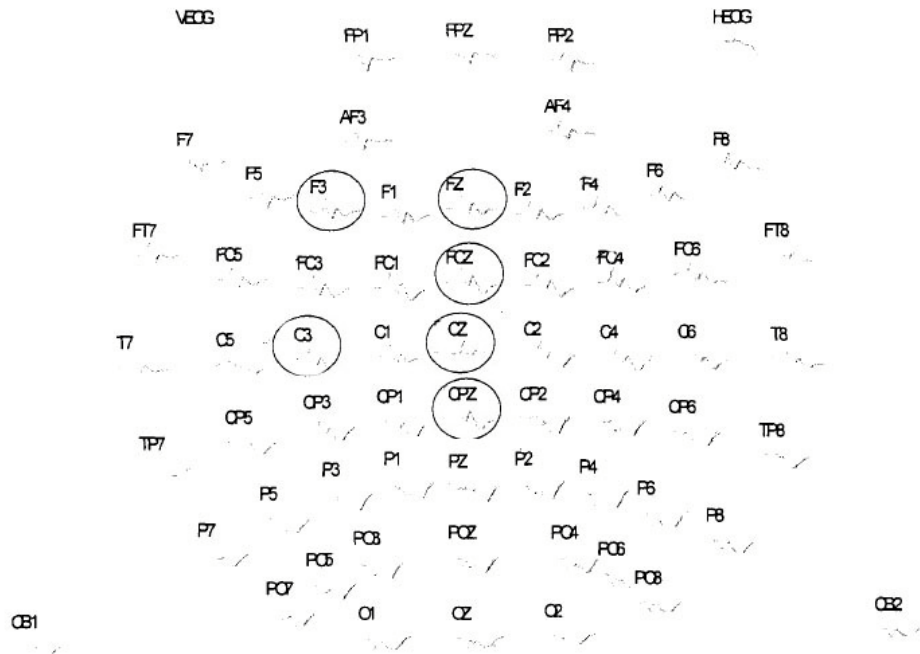
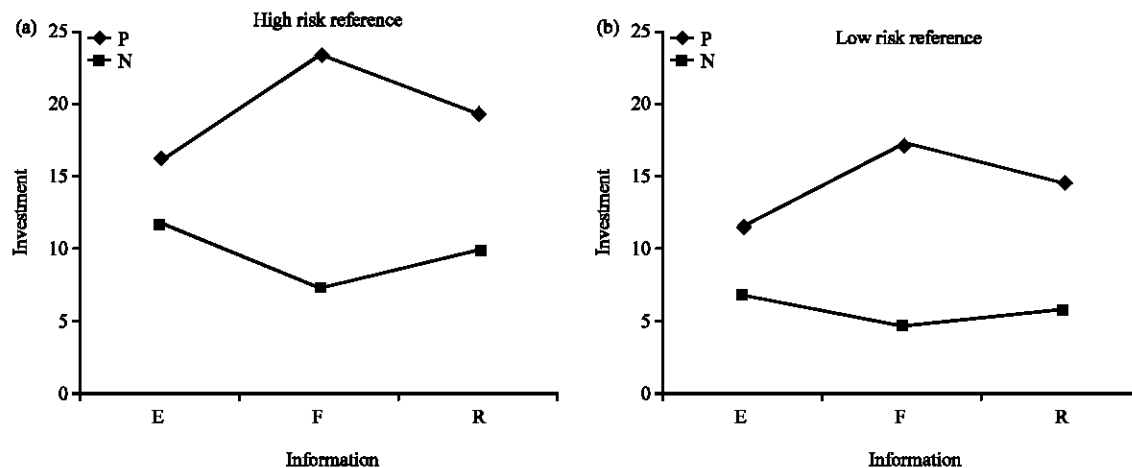Fig. 1: Same type of investment difference contrast eigure

Fig. 2(a-b): Electrode point distribution

on P3 amplitude. The stimulation of positive and negative information on decision-makers is represented on the differences N2 and P3 amplitude. ERP average data use 30hz filter, we get the curve comparison chart.

From the brain response photo we can see that there is no difference on N2 amplitude when the different risk lover meet the same information stimulation, but obvious difference on P3 amplitude. And all the subjects shows the difference of N2 and P3 component when they meeting both positive and negative information.

Analysis of differences of N2 component: According to the analysis of the photo of brain area activity and the electrode scattergram, this article select F3 FZ FCA electrode points of N2 component and then analye the amplitude differences, the result is illustrated in Table 5.

From the data above, we find that positive and negative influence under the same factor has a difference on N2 component, fame factor is stronger and economic factor is weak, interpersonal relationship shows strongly outstanding on FZ electrode points, F2 and FZ show

Table 5: Under different information cognition between high and low risk investment

Risk reference	Factor	Information	Average amount	Standard deviation	t	p
H	E	Positive	16.230	14.326	2..092*	0.020
		Negative	11.420	13.135		
	F	Positive	23.450	24.331	4.175	***
		Negative	7.310	11.332		
	R	Positive	19.360	15.424	2.768**	0.004
		Negative	9.980	10.796		
L	E	Positive	13.350	12.314	2.106*	0.018
		Negative	7.820	9.787		
F		Positive	19.950	20.168	3.988	***
		Negative	5.330	9.021		
R		Positive	16.740	19.721	2.778**	0.005
		Negative	6.690	7.312		

Table 6: N2 amplitude under different factors of cognitive differences compared to the results

Factor	Electrode	Information	Mean	Standard deviation	Samples No.	t	p
E economic							
	F3	P	0.81	5.163	20	1.511	0.078
		N	-0.52	5.421	20		
	FZ	P	-1.13	4.979	20	1.265	0.132
		N	-2.18	5.092	20		
	FCZ	P	-1.07	4.324	20	1.175	0.141
		N	-2.01	5.322	20		
F Fame							
	F3	P	0.73	5.768	20	4.855	***
		N	-3.64	5.147	20		
	FZ	P	-1.25	6.016	20	4.495	***
		N	-5.52	5.478	20		
	FCZ	P	-1.79	4.788	20	3.983	***
		N	-6.04	5.842	20		
R Interpersonal relationship							
	F3	P	0.86	5.249	20	3.272	0.003
		N	-2.02	5.031	20		
	FZ	P	-1.21	4.157	20	3.316	***
		N	-3.83	5.276	20		
	FCZ	P	-1.70	6.149	20	2.352	0.016

moderate difference. From the table below, we can see there is obvious difference of the amplitude stimulated by the information.

N2 component is from Anterior cingulate area, is the detective component of feeling conflict, reflects conflict feeling. If the conflict between perception induced by information and decision is big enough, relevantly it will trigger the amplitude of N2. From the experiment result, we can find out negative information can bring a greater perception conflict. Compared to the interpersonal relationship and economic environment, the negative cognition of fame brings a stronger perception conflict to decision-makers, which proves that during the cooperation, decision-makers' are mainly influenced by fame on the future benefit. And the brain area response photo shows that there is no obvious difference of N2 component on both high risk lover and low risk lover. This means personal risk preference will not influence decision-makers on the cognition of conflict led by the trust evaluating factors:

- Experiment result proves H1a. Trust evaluating factors have impact on the trust cognitive process

Table 7: Different factors of N2 components significance test

Factor	Electrode	t	P
F-E	F3	3.545	***
	FZ	3.285	***
	FCZ	3.258	***
F-R	F3	3.309	***
	FZ	2.112	0.019
	FCZ	2.209	0.013
E-R	F3	1.724	0.042
	FZ	1.941	0.031
	FCZ	1.413	0.082

- Experiment result denies H2a. Risk preference will not have impact on the cognitive process

Analysis of P3 differences of component: Activity level of subject EGG shows that when similar risk preference subject face positive and negative information, there is a obvious difference about p3, and there is no apparent difference about different type evaluating factors, it's hard to tell. The article selects C3 CZ CPZ three electrode of P3 component to analyze factors, the result is illustrated Table11.

P3 is relative with the formation of decision attitude, it is attitude evaluating index. the amplitude increases along with the decision-makers' attitude. Similar risk

Table 8: P3 component difference compared to the results

Electrode	Information	Risk reference	Mean	Standard deviation	Samples No.	t	p
C3	P	H	5.65	4.31	20	2.016	0.1320
		L	4.13	4.73	20		
	N	H	4.92	3.94	20	3.165	<0.0050
		L	3.01	3.46	20		
CZ	P	H	7.05	4.45	20	2.440	<0.0250
		L	5.31	4.10	20		
	N	H	5.22	3.22	20	2.232	<0.0250
		L	4.03	3.39	20		
CPZ	P	H	10.72	4.61	20	4.583	<0.0005
		L	6.91	5.34	20		
	N	H	8.02	5.07	20	3.699	<0.0005

preference subjects, they don't show obvious difference when meeting the positive and negative stimulation of information. This means after the cognition of information stimulation, whether information clue is positive or negative, it lower the uncertainty of decision, which makes the collaborator with similar individual risk preference have decision confidence.

As decision-makers face positive information, the difference of individual risk preference is more obvious on the difference of P3 amplitude, which means that the difference of individual risk preference has a low impact on the decision attitude led by the different positive information, high risk lover and low risk lover both have the willingness of collaboration:

- Experiment result denies H1b. trust evaluating factors won't impact on the formation of decision attitude
- Experiment result proves H2b. individual risk preference will have impact on the formation of decision attitude

EGG analysis of feedback: Negative feedback under positive information cognition leads the difference of N2 component, apparently the amplitude is bigger than the negative feedback of negative information. This means the feedback that go against the decision-makers' expectation will contribute to the bigger cognition conflict (Shu, 2010).

EGG result proves that H3a partner behavior has impact on the trust cognition of decision-maker. P3 in the prefrontal reflects the attitude to the unanticipated event of environment, P3 is relevant to the stimulation evaluation and uncertainty, its amplitude increases go along with decision confidence. In the experiment, the positive feedback of positive information leads to the increase of P3 amplitude, the negative feedback contributes to the decrease of P3 amplitude. This shows that the partners' behavior have influence on the investment's trust and decision behavior. Whereas the amplitude of individual risk preference doesn't have obvious difference with the influence of feedback method, this indicates that trust between collaborators less rely on

the trust evaluating factors, but more rely on their behaviors, and the following investment can't be influenced by individual risk preference, but by the behaviors of collaborators.

The EGG result proves H3b: collaborators' behaviors have effect on the formation of decision-makers' attitude.

RESULT DISCUSSION

The experiment first make the subject of similar risk preference into a group, then having investment experiment. Experiment finds during the trust cognition process to partners, the subjects' decision attitude have obvious difference on its formation process. According to the cognition of trust evaluating factors clue, subject have cognition of initial trust or distrust, through further processing of forehead brain area, subject has the feedback anticipation of collaborator, the formation of the attitude is influenced by individual trait risk preference, and then get different attitude in the same information clue, which contribute to the difference of the P3 component in prefrontal lobe. The test proves:

- Evaluating factors of trust only influence the trust cognitive process, not in the formation of decision attitude
- Risk preference only influence the formation process of decision making attitude, not in the trust information cognition
- Collaborators' behaviors both influence the trust cognitive process and decision attitude' formation

PROBLEM DISCUSSION

Through cognitive game neurology experiment, we have a better understanding of neurology mechanism of trust cognition and decision behavior in the collaborator process. Among the trust evaluating factors, the experiment believe that the fame factor is more important than other factors in the collaboration decision, which is a little different with empirical study, the following may be the reasons:

- The formation of trust can be influenced by a lot of factors, the limit of factors in game experiment may contribute to the difference
- As the experiment only select single factor of three types factor as the stimulation factor, so there may be shortcoming in the selection and stimulation
- In real collaboration process, trust and investors' decision behavior not only have effect on the partner's behavior, but also on the management behavior of partner business. The experiment can't measure the business management behavior. Therefore, it is necessary to have a deep discussion about the interaction about trust, investing behavior, partnership behavior, decision-making management behavior and individual risk preference

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