



# Research on Brand Trust and Financing Risk Preference of E-commerce Based on Neuroeconomic Experiment

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## ABSTRACT

Brand trust and financing of e-commerce are two key factors for the development and success of e-commerce enterprises. This paper takes the relationship between brand trust and financing risk preference of e-commerce as the research objective, and adopts the research methods such as literature research, questionnaire survey and neuroeconomics experiment. Based on the research conclusion of laboratory behavioral economics, this paper introduces the latest brain nerve stimulus technique-transcranial direct current stimulus (tDCS) in the field of neuroeconomics. Through analyzing the experimental data obtained after regulating the nerve activities of the dorsolateral prefrontal cortex (DLPFC) of the brain, it reveals from neural network of the brain that the investment behavior of brand trust of e-commerce isn't based on rational calculation of financing risk, which are different intrinsically. The research in this paper provides a new neuroeconomic basis for the management of brand trust and related financing decision-making for e-commerce managers.

**Key Words:** Brand Trust of e-commerce, Financing Risk Preference, Neuroeconomics, tDCS Technology

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## Introduction

With the development of internet and information technology, e-commerce has gradually become the main force of global economic development. In order to win the market, e-commerce enterprises need a large amount of funds to promote the market. In order to win the recognition of consumers, e-commerce enterprises must let their own e-commerce brands get the trust of consumers and financiers (Karimov and Brengman, 2014). Therefore, the relationship between brand trust of e-commerce and financing risk preference has always been the focus of attention and research in the economic field in order to make the enterprise in a benign operating state. Trust, on the other hand, plays an important role in human economic activities. Domestic and

foreign economists, psychologists, brain scientists and so on have done a lot of scientific researches on trust, with significant research results. The trust game experiment designed by Berg *et al.*, in the 1980s and 1990s based on behavioral economics and experimental economics has become the classical paradigm of trust measure (Mcknight *et al.*, 2002). However, this conclusion deviates systematically from the hypothesis of "rational man" in neoclassical economics, and some researchers hold that trust is essentially equivalent to venture capital game. However, many researchers, such as Houser, Eckel, and Fetschenhauer, have proven that trust cannot simply be equated to risk. Therefore, the risk preference theory is proposed to supplement and

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revise the hypothesis of "rational man" (Kaplan and Nieschwietz, 2002). Of course, a small number of experimental results that prove that there is a significant correlation between trust and risk preference, but these theories and researches cannot fundamentally explain the relationship between trust and risk preference. However, with the development of neuroscience, brain imaging technology has been widely used in various fields. Neuroeconomists have been able to use brain imaging technology to explain the neural mechanism of human trust behavior from the neural network level (Kim *et al.*, 2009). The latest brain nerve stimulus technology makes it possible to test the causal relationship between human trust behavior and financing risk preference.

Therefore, this paper focuses on the relationship between brand trust and financing risk preference, and adopts transcranial direct current stimulus (tDCS) (Lowry *et al.*, 2008) to test subjects and the experimental data obtained after regulating the neural activities of the DLPFC are analyzed (Kaufmann *et al.*, 2013). It is proven from the neuron level that although changing the neural activities of rDLPFC can change people's investment behavior of financing risk, the trust behavior to e-commerce brands does not change, which shows that people's investment behavior of

trust to e-commerce brands is not based on rational calculation of financing risk. On the neuron level of brain, there are essential differences between trust decision-making and financing risk decision-making of e-commerce brands.

### Relevant Theoretical Basis

#### Brand trust

Regarding the definition of trust, the Oriental is different from the West. The Oriental is focused on trust and honesty, while the West is more focused on economic business behavior. Some researchers define trust from different perspectives, such as sociology, psychology and economics. This paper adopts the definition of trust from behavioral economics (Matthew *et al.*, 2009), that's, the agent voluntarily gives the resources to the principal without his or her promise in order to obtain some kind of return.

The earliest concept of brand trust was proposed by Howard *et al.*, (Glimcher and Rustichini, 2004). Trust is considered as one of the determinants of buying intention. It's found that factors affecting people's trust in brands include preference, motivation and belief, hormone - oxytocin, and cranial nerve basis (Kenning and Plassmann, 2005), as shown in Figure 1.

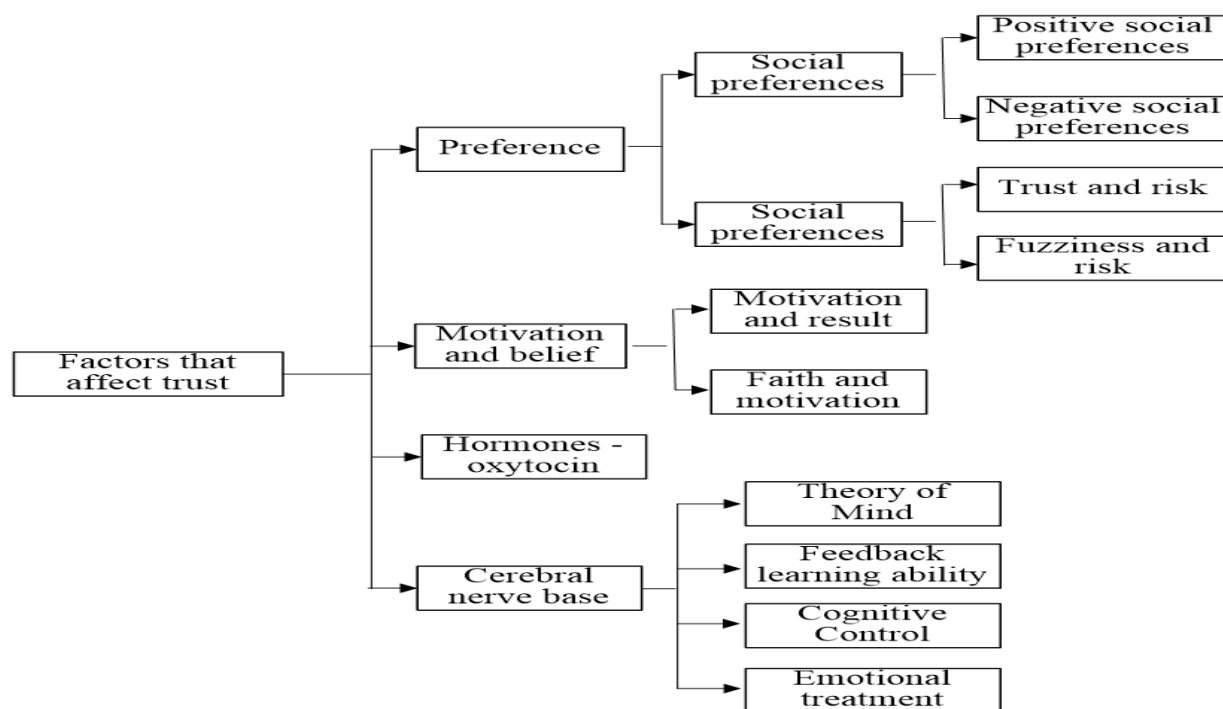


Figure 1. Factors that affect trust

For the measure of trust, psychology adopts the method of questionnaire, while economics adopts the method of behavioral experiment. Through a large number of comparative experiments, it is proven that there is correlation and consistency between the two methods (Hawley and Fujii, 1994).

**Behavioral Experimental Research on Trust Behavior and Financing Risk Preference of E-commerce Brand**

In the behavioral experiment, in order to verify whether risk preference affects investment and return behavior in brand trust of e-commerce, some researchers conduct standard BDM trust game experiment and venture capital game experiment to test subjects' trust, trustworthiness and financing risk preference respectively (Coren L *et al.*, 2008). The results show that there is no significant correlation between trust investment and venture capital investment, and the decision-making behavior of financing risk cannot explain the trust investment behavior of subjects, and trust is not a rational calculation similar to risk (Drichoutis and Nayga, 2015).

**Brain science research on trust and financing risk**

(1) Brain imaging study on trust and financing risk

The development and popularization of brain imaging technology make it possible to study the nature of trust and financing risk from

the neural functional level of brain by using nuclear magnetic resonance imaging technology. The researches show that brain regions related to human trust include (Camerer, 2013) prefrontal cortex, nucleus amygdalae, cingulate gyrus, and dorsal striatum, while nucleus amygdalae, orbital gyrus, nucleus accumbens and anterior thalamus are activated in financing risk decision-making, which can promote or inhibit the choice of financing risk decision-making to some extent.

(2) Brain stimulating research on trust and financing risk

The development and maturity of transcranial direct current stimulus (tDCS), the latest brain nerve stimulus technology in the field of neuroeconomics, enable people to separately stimulate and study the neural activities of specific brain regions, which also provides technical support for verifying the causality of trust and financing risk decision-making in specific brain regions. Many researchers have found that in the trust game experiment (Stanton *et al.*, 2011), regulating the dorsolateral prefrontal cortex (DLPFC) and orbitofrontal cortex has certain influence on human trust decision-making, while in the risk game experiment (Patton and Jøsang, 2004), people will make different risk decision behaviors when adjusting double-sided DLPFC, left-sided DLPFC (lDLPFC) and right-sided (rDLPFC). These results demonstrate that there is

**Table 1.** The basic conditions of each stimulus group and stimulus location

Type of Stimulus	Stimulus Points	Number of subjects	Average Age
Yang stimulus group	Anode :Rdlpfc(F4), Cathode: Visual neural cortex(Oz)	30	21.36
Yin Stimulus group	Anode : neural cortex(Oz), Cathode: Visual Rdlpfc(F4)	30	21.40
Pseudo-stimulus group	30s Yang or Yin stopped after stimulation	30	21.35

**Table 2.** Correlation between trust and risk among the three stimulus groups

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		Pseudo-stimulus group	Yang stimulus group	Yin stimulus group	Pseudo-stimulus group	Yang stimulus group	Yin stimulus group	Pseudo-stimulus group	Yang stimulus group	Yin stimulus group
Trust	Correlation coefficient	1	---	---	-0.186	-0.104	-0.059	0.188	-0.017	-0.103
	P value	---	---	---	0.327	0.581	0.750	0.317	0.923	0.578
	Bayesian factor	---	---	---	0.243	0.261	0.237	0.364	0.227	0.262
Risk	Correlation coefficient	-0.186	-0.104	-0.059	1	---	---	0.420*	-0.077	0.202
	P value	0.327	0.581	0.750	---	---	---	0.020	0.683	0.281
	Bayesian factor	0.243	0.261	0.237	---	---	---	5.777	0.245	0.398
Readme	Correlation coefficient	0.187	0.017	-0.103	0.420*	-0.077	0.202	1	---	---
	P value	0.316	0.923	0.578	0.020	0.683	0.281	---	---	---
	Bayesian factor	0.364	0.227	0.262	5.777	0.245	0.398	---	---	---



a causal relationship between specific brain regions and decision-making on trust or financing risk. However, the previous experiments are conducted separately from the trust and financing risk, which cannot directly indicate whether there is a causal relationship between them. This paper uses tDCS technology to regulate the DLPFC (single-sided stimulus test rDLPFC) of brain area which influences trust and financing risk decision simultaneously, and carries out trust game experiment and financing risk experiment simultaneously to verify whether the brain area can affect trust and financing risk decision simultaneously and whether there is causality between them.

### **Neuroscience Research on Trust Behavior and Financing Risk Preference of E-commerce Brand**

#### *Experimental techniques and target regions*

In order to study the relationship between trust behavior and financing risk preference of e-commerce brands, 90 subjects are divided into 3 groups (30 persons in each group, half male and half female) by using technique of direct current stimulus (tDCS) of neuroeconomics. The basic conditions of each stimulus group and the position of stimulus points are shown in Table 1. The stimulus time is 20 minutes, and the stimulus current is 2mA. The sponges are fixed in the corresponding target area of the subject's head with bandage. In the whole experiment, the stimulus cap is not allowed to be removed. In order to guarantee the quality of the experiment and the accuracy of the data, the subjects cannot do anything unrelated to the experiment, and only need to rest quietly.

#### *Task and procedure of the experiment*

The subjects should do two tasks on computer as required: trust game experiment and risk investment experiment. Each experiment consists of 10 people, 2 people for a group. The subjects sit on the seats with the partition and curtain in the form of random numbers to ensure the anonymity and privacy of the experiment.

##### (1) Trust game experiment

In order to test the trust and trustworthiness of the subjects, this paper adopts the standard trust game experiment, in which each test subject needs to take turns to play the roles of principal and agent, the roles will be given the same initial endowment (10 chips), and when acting as the principal, the trust investment decision (with X

chips) is the trust degree of the subject, and then the agent will have 3X chips and predict how much the counterparty can return (with Y chips returned). The return measure is the trustworthiness of the subjects, when the error between the actual value and the expected value is equal to or less than 1, additional 1 chip will be obtained; when acting as an agent, it shall be able to make a decision on the amount returned according to the investment of the principal. At the end of the experiment, the final remaining chips of the principal and the agent are calculated.

##### (2) Financing risk investment experiment

The task and procedure of financing risk investment experiment are basically similar to trust game experiment. The difference is that all the subjects will play the role of principal in the experiment, and the financing risk investment amount is the risk preference of the subjects, and the other role is called the intermediary, which is played by the computer, that's, after the principal makes the investment decision, the Y value of the returned chips is randomly determined by a computer in accordance with the probability of uniform distribution. In addition, a self-risk preference type questionnaire is conducted for each subject. The risk preference types are divided into six types: ranging from 0 to 5 with 0 representing very cautious, and 5 representing very risky.

#### *Analysis of experimental results*

(1) Relationship among trust investment, financing risk investment and individual self-reported risk type

In order to verify that relationship among trust investment, financing risk investment and individual self-reported risk type, the data collected of subjects in the experiment are statistically analyzed, and the statistical results are shown in Table 2, and the follow conclusions are drawn after the correlation analysis:

A: From the results of stimulus and pseudo-stimulus experiments on subjects, it can be concluded that there is no significant correlation between trust and risk preference and self-reported risk preference in both cases, while there is significant correlation between risk preference and self-reported risk preference.

B: Through the pseudo-stimulus experiment data, we can find that there is a positive correlation between the risk degree obtained in the game measurement experiment and the result



obtained in the questionnaire survey, which shows the consistency and validity of the two measurement methods.

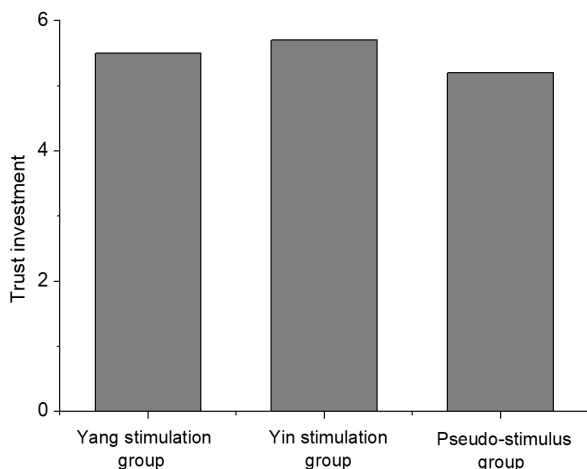


Figure 2. Trust investment in different stimulus groups

C: The experimental data of the stimulus group show that when tDCS stimulated rDLPFC brain region, the risk preference degree of the subjects is different from that of the self-reported risk preference degree, which indicates that stimulus may change risk investment decision-making, but the degree of self-reported risk preference of the subjects is not significantly affected by stimulus.

(2). Relationship between trust degree and neural activity of subjects' rDLPFC brain region

By using the method of variance analysis, the trust degree of the three stimulus groups is compared and analyzed; the results:  $F(2,87) = 0.102, p = 0.901, \eta_p^2 = 0.002$ , which don't indicate that there are significant differences in trust investment among different stimulus groups; Figure 2 shows the trust investment in different stimulus groups. The results show that tDCS stimulates activity of rDLPFC brain region could not change the trust level of subjects, and there was no significant correlation between tDCS and rDLPFC.

(3) Relationship between risk preference and neural activity in the rDLPFC brain

By using the method of variance analysis, the behavior decision-making of risk investment in three stimulus groups is compared and analyzed. The results are as follows:  $F(2,87) = 8.235, p < .001, \eta_p^2 = 0.03158$ ; Bayesian factor = 56.7, which indicates that there is a significant correlation among different stimulus groups in the financing risk investment behavior decision-making. The average value of the three groups of

financing risk investment is positive stimulus group (5.1), pseudo-stimulus group (7.16) and negative stimulus group (7.06) from high to low, and there is no significant correlation between the two groups ( $p = 0.981$ ). The results show that using tDCS to positively stimulate neural activity of rDLPFC brain can make the risk decision-making behavior of the subjects conservative. In addition, because the difference between the financing risk investment experiment and the trust game experiment is only the return decision made by computer or the subjects, the paper makes the repeated measure variance result test after the task change, and the results are basically the same. Figure 3 shows the difference between the trust investment and the financing risk investment among different stimulus groups.

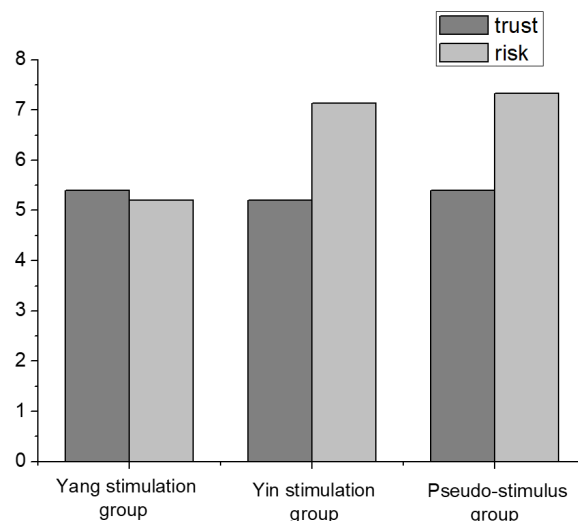


Figure 3. Difference between trust investment and financing risk investment in different stimulus groups

Conclusions

This paper takes the relationship between brand trust and financing risk preference as the research object, and uses the transcranial direct current stimulation (tDCS) technology in neuroeconomics to carry on the experiment research from the brain neural network level. After the comparative analysis of the experimental data, the following conclusions are obtained:

(1) According to the experimental data of the subjects in the three stimulus groups, it can be concluded that the trust of e-commerce brands is independent of the financing risk preference, that's, the investment behavior trusted by e-commerce brands is not based on the rational calculation of financing risk, and the two have different forms of expression and neural basis.

(2) Using tDCS to stimulate the neural activity of





rDLPFC brain region could not change the trust investment behavior of the subjects, which indicates that there is no causal relationship between the brain region and trust investment behavior.

(3) Using tDCS to stimulate the neural activity of rDLPFC brain region can change people's decision-making behavior in face of financing risk decision-making.

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