The Influence of Cranial Nerves on the Financial Risk Selection and Trading Behavior of Investors

Huaquan Zhang*1, Yicheng Chen2, Junhui Shi3

ABSTRACT
In the past, most of the researches on the financial risk selection and investment behavior of people in the academic circles usually took the "social people" developed over the course of time as research objects. In recent years, new researches have begun to shift to the perspective of the "natural person", focusing on "innate" factors of anthropological characteristics, such as the influence of cranial nerves on investors' financial risk selection and trading behavior. Foreign scholars in the field of neurology or anthropology use experimental and empirical methods to verify the effect of investors' cranial nerves, voice and appearance features, and timbres among human "innate" factors on investment and financial behavior. Based on the summarization of related studies abroad, this study uses social experiments to further verify the effect of the cranial nerves on investors' financial risk selection and trading behavior in hopes of promoting interdisciplinary development.

Key Words: Cranial Nerves, Investors, Financial Risk, Trading Behavior

Introduction
The unique organ structure of the human brain allows one to observe all the changes that occur in and around the world, and to judge, identify and analyze what is seen, such as to identify others and infer other people's thoughts and intentions from their language, intonation, expression, and posture. It can be explained through three aspects. First, from the cognitive perspective, the importance of vision lies in the fact that it allows people to recognize the surrounding environment and the characteristics of their peers, so as to explore their thoughts through their looks, expressions, etc., as we all say, "one's mind is shown in his face". Second, from the linguistic point of view, human cranial nerves' expression of human behavior and thinking signs cannot be separated from the "explicit" tool, language (Boas, 1989; Bolton, 1998). Language is not only a tool for human's expression of desire or thought, but also a tool for accumulation and inheritance of all kinds of knowledge. Third, as the evolution of vision enhances the scope of human vision, and the evolution of language strengthens people’s dependence on the social environment and historical traditions, the accumulation of knowledge becomes increasingly important, and the cerebral cortex and nervous system must meet this need accordingly (Li, 2017).

According to research results of physical anthropology, the volume of human brain has increased from 1,224 cc in the late Homo erectus to 1,350 cc in the modern population, and the structure and nervous system of the brain have also undergone tremendous changes. With the increase of brain volume, the evolution of brain structure and the further strengthening of nervous system, human cognitive abilities have been gradually improved and human behavior...
Has become more and more diversified. The rapid development of neuroscience and molecular biology has also led to the rapid development of researches in this Homo erectus to 1,350 cc in the modern population, and the structure and nervous system of the brain have also undergone tremendous changes. With the increase of brain volume, the evolution of brain structure and the further strengthening of nervous system, human cognitive abilities have been gradually improved, and human behavior has become more and more diversified. The rapid development of neuroscience and molecular biology has also led to the rapid development of researches in this Investment transaction or risk preference behavior is also an integral part of human behavior, which is influenced by the economic, social and cultural environment, as well as the biological characteristics of human beings. However, it is as Rousseau (2012) pointed out: Among human knowledge, the most useful and incomplete is knowledge about 'humans'. Investment transaction or risk preference behavior is also an integral part of human behavior, which is influenced by the economic, social and cultural environment, as well as the biological characteristics of human beings. However, it is as Rousseau (2012) pointed out: Among human knowledge, the most useful and incomplete is knowledge about 'humans'.

The scientific researches on the behavior of biological population from the angle of brain science and cranial nerves are the most thorough and convincing ones. Over the past two years, some studies have shown that various types of human behavior are controlled by their cranial nerves, and in specific areas of the human brain, different changes in nerve activity can change the external behavior of the human (Gonçalves, 2017). Some scholars use simulation techniques that do not invade the human brain to study the micro-foundation of human economic behavior, such as the most popular Functional Magnetic Resonance Imaging (FMRI), Transcranial Magnetic Stimulation (TMS), and Pharmacological Interventions. Most of these studies confirm that there is a causal relationship between human brain activity and economic consequences. As a part of human economic behavior, investors' participation in investment transactions and risk preferences are no exception. At present, studies on the relationship between cranial nerves and investors' investment behaviors focus on two aspects, one is on whether cranial nerves have an influence on the financial risk selection of investment managers and corporate executives, with the representative topic of "whether the level of neural activation associated with the expected effect can predict financial options" (Ruhnken and Knutson, 2005), the other is on using human cranial nerve data to test investors’ trading behavior, with the representative topic of “analysis of some actual situations related to investment transaction behavior” (Frydman et al., 2014).

**Human Cranial Nerves and Financial Risk Selection**

Previous studies have shown that human brain images show that when a person is expected to gain or face loss, his or her response will exhibit neurological characteristics (Li and Chen, 2017). Specifically, when it is expected that financial investment returns can be obtained, the nucleus accumbens (NAcc) and the mesial prefrontal cortex (MPFC) of the ventral striatum of the human brain will appear certain activation. This kind of activation is related to people's positive reaction. Conversely, when a loss is expected to occur, the person's Anterior Insula (AI) region will also be activated. From the perspective of behavioral finance, the positive reaction associated with the gain will form an incentive for investors to take risks, while the negative reaction associated with the loss will make investors “naturally” choose to avoid risks (Song et al., 2016). Therefore, theoretically, it is possible to predict the choice of financial investment risk preference by analyzing the positive and negative effects of cranial nerve activity (NAcc and MPFC or AI).

In order to analyze the influence of cranial nerves on investors’ financial risk selection, the author conducts the following experiments. First of all, the behavioral investment strategy is designed for this experiment, consisting of 20 groups, with 10 experiments in each group. In each experiment, each participant is asked to choose between 2 stocks and 1 bond. This is the first stage of the experiment. 20 minutes later after they have made a choice, their earnings will be displayed, which is the profit and loss stage. Finally, the results of each yield of all selected stocks and bonds are announced, which is the market stage. It needs to be pointed out that the stock is assigned good or bad randomly, and the participants do not know before making a choice.
The probability distributions of profit of those stocks and bonds are as follows:

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<th>Table 1. Profit probability of various stocks and bonds</th>
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A total of 20 doctoral students aged 24 to 40 years old from Sichuan Agricultural University and Southwest University of Finance and Economics are invited to the experiment, with male and female in equal share and an average age of 28. All the participants are right-handed.

For each participant, the reward is paid 200 yuan per hour (fixed payment) as a reward, and also 1/10 of the final total income of the experiment. The 20 participants are divided into two categories: professionals and non-professionals, the former refers to the Ph.D. students majoring in finance, economics, or financial management, while the latter refers to those majoring in humanities disciplines such as history, sociology, political science, and others. It is assumed that the professionals have a better grasp of financial knowledge such as stocks and bonds. During the stages of prediction, buying and selling, and waiting for the final outcome, the brain images of each participant will be scanned with the medical facility to obtain the relevant neural data (NAcc and AI). Human brain images are obtained through the General Electric 1.5T magnetic resonance imaging (MRI) scanner. The 24 and 4 mm films (3.75 × 3.75 mm in resolution) extend from the pons to the top of the skull. The software used for analysis is mainly functional neural image analysis software. The data analysis mainly deals with the changes of the brain image data of the participants in the prediction stage, profit and loss stage and market stage, which mainly includes two steps. The first step is attribution, where multiple regression equations are used to construct statistical criteria for each group to identify points of interest and to verify the expected pattern of the activated cranial nerves (Li, 2016). The second step is anticipation, where the brain activation level obtained in the first step is used to predict the investment strategy. As shown in the results, in the stage of profit and loss, the profitability of the stock is indeed related to the activation level of NAcc and MPFC, while its correlation with AI is not significant. At the market stage, when participants know that the stock they choose is profitable, their NAcc and MPFC activations are significantly increased, on the other hand, when their selected stock loses, their AI will also be activated. In the prediction stage, logistic regression analysis shows that the level to which the expected NAcc and AI are activated depends on the results of the previous selection and also has a certain relationship with the subsequent choices. For example, only when a bond is previously selected would the expected NAcc be activated, which would increase the chances of investors choosing stocks. The study also finds out that there is a correlation between the expected cranial nerve activation level and the subsequent optimal and sub-optimal selections. Thus when the previous option is to invest in low-risk financial products (such as bonds), the increase in the activation of the expected NAcc would increase the probability that investors would take "radical" risks and then make mistakes. Similarly, the decrease in the expected NAcc activation level will reduce the risk of investors making mistakes of missing profit increase only to avoid risks. When the previous choice is venture capital (such as buying stocks), AI activation would increase the probability of investors making mistakes for avoiding risk.

**Influence of Cranial Nerves on the Trading Behavior of Investors**

In the past, most of the literature on investors' trading behavior was based on field data (Barber and Odean, 2001; Grinblatt and Keloharju, 2009). After the research methods of medical anthropology were introduced, scholars began to use functional magnetic resonance imaging (fMRI) techniques to analyze investors' trading behavior. Hsuetal (2005) used this technique earlier in the application scenario with missing or asymmetrical information as the neural basis for the study on investors' financial investment decision making.

In general, for the researches in the field of humanities and social sciences, the standardized decision-making theory assumes that the only factor that influences people is the estimated probability of various outcomes, which ignores investors’ different confidence in the estimated probability (Dogaru, 2016). From the "natural person" point of view, there are actually differences in the cranial nerves between people.
who are clear about the risk and those who are not. Compared to the situation where the risk is certain, in the case where the risk is uncertain, the active regions of the human brain include the orbital frontal cortex (OFC), the amygdala and the dorsal medial prefrontal cortex (DMPFC). Compared to the situation where the risk is uncertain, in the case where the risk is certain, the active regions of the human brain include dorsal striatum and caudate nucleus. From previous studies, the activity of the dorsal striatum correlates with the investor’s expected result of financial investment, while there is no such correlation with the orbitofrontal cortex and the amygdala. From this point of view, the standardized decision-making theory infers that “the investors will make the same decision in these two cases” without determining whether the risk is certain or not. Logically, this inference is irrational.

Based on FMRI technology, some scholars, such as Frydman et al. (2014), began to directly test the well-known realization utility theory of trading in behavioral finance. The most important role of realization utility theory of trading is to explain the “disposition effect” of investors in trading behaviors. Disposition effect “means that there is a strong incentive for individual investors to sell stocks when they make profits rather than when they lose.” In the past, it was difficult to define or quantify each person's investment behavior, even if there were individual empirical tests; they were indirect (Oden, 1998).

With FMRI technology, we can conduct the direct test on the realization utility theory of trading in three aspects. There are three reasons. First, neurology has confirmed that when humans make decisions, activities in the Ventromedical Prefrontal Cortex (VmPFC) region of the human brain participate in the calculation of the value of monetization for the selection; Second, the level of vmPFC activity in the human brain has been shown to correlate with potential investment gains and losses; Third, investment gains will increase the activity of certain areas of the ventral striatum in the brain, while losses will reduce the activity. To this end, Frydman et al. (2014) collected so-called Blood-Oxy-genated Level Dependent Functional Magnetic Resonance Imaging (BOLD-FMRI data). This indicator measures the neuronal activity of the entire human brain through the brain cell response of the so-called voxel.

To better validate the above conclusions and better use FMRI technology, the author draws on the experimental methods of Frydman et al. (2014) and establishes a set of experimental application scenarios for the stock market. In this scenario, the experimental rules are as follows: Each participant could invest in three stocks, A, B and C. The experiment is divided into two identical parts, with 16 minutes for each part, and 1 minute intermission. In each part, the experiment is performed for 108 times. Prior to the start of each experiment, each participant is paid 500 yuan. Each participant can buy one share of the stock at an initial price of 30 yuan per share. The computer screens are used in the experiment: a quotation screen and a transaction screen. Participants can check the dynamic information of the price of each stock from the quotation screen, and then trade on the transaction screen. In the first to the ninth time of experiment, participant can only see the quotation screen to get familiar with the transaction rule and environment, starting from the 10th time to the last time of experiment, participants can see the quotation screen and the transaction screen simultaneously, then they can determine their trading behavior based on the updated price. After each transaction is completed, the shareholding of each participant and the profit and loss of his transaction shall be summarized, and the corresponding incentive scheme shall be given according to the calculation results.

A total of 28 volunteers from Sichuan Agricultural University, aged between 18 and 60 with an average age of 25.6 years old, are enrolled in the experiment, 22 of whom are female. In the experiment, BOLD-FMRI data and HD structure scan data are acquired from the participants' brains using a MRI 3.0 scanner with 8 channels of phased array coils of 3.0 Siemens Tesla Tri0 borrowed from medical institution (Dutta and Kumar, 2017). According to the experimental data analysis, the following conclusions are drawn: First, some participants are really influenced by the realization utility theory of trading, and each participant has a "disposition" effect, but there is a significant difference in the intensity of the "disposition" effect among different participants; Second, the evidence of the "disposition" effect found in the human brain is significantly stronger than that of the data found in field studies, which proves the validity and applicability of realization utility
theory of trading. Third, 27 voxels are significantly positive in the vmPFC target regions displayed by 429 voxels associated with the decision value calculations. In the vmPFC between each participant and different participants, the correlation between the costs incurred by different voxels is significantly negative. Fourth, there is no significant correlation between the net expected value of shares sold by participants and the ratio of losses incurred or likely to be incurred. There is a positive correlation between the activity of the ventral striatum area of the human brain and the realized capital gains, which also validates the theoretical model of trading realization utility, that is, selling stocks at the time of profit generates hedonism, while at the time of loss, it causes negative emotions. Fifth, the ventral striatum region of the human brain that encodes information such as expected life cycle utility presents a positive response when participants make a profit on their investments.

In recent years, the research methods of brain science have been gradually introduced into the field of behavioral finance or financial investment (Frydman et al., 2014). However, due to the immaturity of technical means and the limitations of brain science theory and its technical applications, general researches can only find the physiological responses of the brain stimulated by external signals and make rough speculations on this, or to give a relatively reasonable physical evidence for the capital market investment behavior or the alienation of financial behavior, but fails to explain it in detail. However, the study on human behaviors such as investment transaction behavior from the perspective of the cranial nerves can help to make up for the current academic community's inadequacy in studying the choice in economic behavior, which is only based on the assumption of "rational economic person". Because the primary scientific data obtained from the researches from the perspective of the cranial nerves are highly reliable and can better reflect the human "instinctive" response, which can free ourselves from the complex and complicated factors and mechanisms of action, and at the same time, points out the direction that can be explored for the development of the disciplines concerning investors' risk selection and investment transactions in the future.

Conclusions and Prospect
In general, investment science and finance disciplines increasingly focus on drawing on theories and methods of other disciplines in their development. New perspectives or research methods need to be found to make scientific explanations for new issues and new phenomena emerging in areas such as investment science, financial behaviourology, financial risks, and corporate finances. The study on influence of "endogenous" biological characteristics of investors based on "natural person" on investors' financial risk selection and trading behavior can be derived through the integration of cranial nerves and other anthropological disciplines, from the microscopic to the macroscopic, and from the natural geographical environment and religious culture to the "extrinsic" characteristics of investors. Although the research in this field is still in its initial stage, it is of great value. At present, sociological experiments are still the mainstream method in the extremely limited literature on the intersection of brain and investment finance. However, in view of the limitations of sociological experimental methods in sample selection, it is difficult to avoid errors. The limitations are manifested in the following: The experimental method is not reproducible, and it is difficult to fully realize the same conditions and experimental scenarios while avoiding the impact caused by the difference of external conditions. Compared with the theoretical derivation of the normative research, the "model" evidence and experimental method of empirical research only provide intuitive explanation for small samples. However, with the maturation of technologies in medicine, Internet or others, the study of cranial nerves can be expanded but not limited to the research on the financial investment behavior of investors, and the acquisition of cross-sectional research data on cranial nerves and humanities and social sciences does not need to be subject to simple experimental scenarios. Therefore, the future study of the investment behavior and the selection of risk preference driven by the big data of cranial nerves will depend more on the social experiment method.

As far as the future research direction is concerned, as the investors' selection of financial risk preference and trading behavior is more influenced by neuroscience, such as cranial nerves, or human science, more emphasis will be placed on the role of physique in related studies,
focusing on human biological structure and population variability, from which to explore the impact of human physiological structure on environment and behavior. It can be predicted that with the increasing application of medical technology in the social sciences, some scholars will focus on how the changes in brain structure and cognitive ability affect the financial behavior of investors’ enterprise in the next step.

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