Decision-making Neuroscience-based Research on Stock Herd and Anti-herd Behavior

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ABSTRACT
The purpose of this paper was to help investors understand the nature of the current situation of financial market so as to make correct investment decisions. The methodology adopted was mainly applying decision-making neuroscience to study the neural mechanisms behind the two types of informational herding decisions and their mechanisms. Results showed that under the condition that the net flow of funds was positive, the act of choosing to purchase stocks can be considered as a herd behavior, and the opposite behavior can be considered as an anti-herd behavior. A conclusion can be drawn that individuals' perception and assessment of information about other people's behaviors, attitudes, or evaluations influence the behavior of individuals during the decision-making stage.

Key Words: Decision-making Nerves, Stocks, Herd and Anti-herd

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Introduction
Decision-making is a common phenomenon in real life and an important part in management field. Decision-making is the heart of management. Management is composed of a series of decisions. Management is decision-making. Decision science, as an important part of management science, has been focused on by disciplines other than management, such as economics, psychology, and cognitive neuroscience (Mutz, 1992). Human decision-making mainly includes property-related decision-making and health-related decision-making. Therefore, in this paper, we mainly study the herd behavior in property-related decision-making and health-related decision-making.

Information is the basis for decision making, and the perception of information is closely linked to people's behavior. In modern society, due to the development of network technology, it has become increasingly easy for the public to obtain and disseminate information. The influence of information cannot be ignored. For example, for decision-making in financial investment, access to national policies, business prospects, and stock comment expert information affects the behavior of stock trading; while in the food consumption field, after food safety incidents such as "melamine milk powder" and "clenbuterol", people pay more attention to food risk information in the food purchase decision, for example, more importance was attached to the impact of food additives and contaminants on foods (Bearden et al., 1982). Many times, due to the appearance of one piece of information, panic behavior from people may be caused. Therefore, researching how individuals perceive information and how information influences behavioral decision-making had profound significance in understanding people's behavior and dealing with crisis brought by irrational behavior of people. Information plays an important role in stock purchase decision in property decision-making and food purchase decision in healthy decision-making, and herding effect appearing based on specific information had a profound
influence on economic and social development and stability (Bechara et al., 1997).

In property-related decisions, investment decision-making behavior was closely related to economic stability and prosperity. Finance was an important part of national economy. Investment decisions were the most basic behavior of traders in the financial sector (Sodjahin, 2013). The stability of the stock market was an important aspect of the country's economic stability. The stock price was an important legal and economic indicator and had the function of an economic barometer. However, reality proves that financial markets were often in a state of shock (Bettman, 1973). The United States economic crisis in 1929-1933 was the most serious moment in history for Wall Street. The unemployment rate in the United States hit a new high in nine years. On the “Black Monday” in 1987, the Standard Poor's Index fell by 20%, and countless investors were in pain; The 1997 Southeast Asian financial crisis that originated in the stock market swept across Asia; and since 2008, the financial crisis triggered by the bank sub-prime crisis had spread throughout the world (Bikhchandan et al., 2000). Historical facts showed that when large shocks in the financial markets cannot be controlled, unpredictable losses to the country's economic stability and development would be caused (Bond et al., 1996).

Investors are the basic unit of the financial market. Their investment behavior can be compared to the vector that determines the development of the market. The decisions of all investors in the market eventually converge into a comprehensive vector. The size and direction ultimately determined the ultimate direction and shock status of the stock market. (Botvinick et al., 2001). The herding behaviors (or herding effects) existing in investment decisions were closely related to the stability and prosperity of the stock market, therefore, investigating investors' investment decisions was conducive to understanding the nature of the current status of the financial market. So far, the theoretical background of this study mainly involved three aspects of rational decision science, behavioral decision science and cognitive neuroscience. These three aspects were closely linked, gradually deepened, and can promote each other. This was the theoretical background proposed by this research.

### Methods

This paper mainly uses the method of decision-making neuroscience to study the neural mechanism and the occurrence mechanism behind the two types of information-based herding decisions, respectively. Figure 1 is the technical route diagram of this paper.

**Neuroscience experimental methods**

In order to study the neural mechanism of informational herding under the two decision-making scenarios of stock purchasing decision and food purchasing decision, this paper had to use neural science research method to carry out laboratory research. The study relied on the neural management laboratory of Zhejiang University and selected the ERPs research method. ERPs had high time resolution. We can analyze the expected stages of decision-making, decision-making stage and feedback evaluation stage from time course, and the neural mechanisms of herd or anti-herd decision-making to provide objective evidence for individual behavior. The carrying out of neuroscience experimental research needed to include the following parts: First, during the experimental preparation stage, we needed to prepare experimental materials according to research questions, and wrote experimental procedures, and then conducted pre-experimentation. If there were any problems, corrections were made in time to ensure that the experiment was feasible and correct. Second, during the experimental stage, subjects were recruited to use ERPs data collection equipment to complete data collection. During this process, attention was paid to the standardization of operations and abnormal phenomena were recorded in time to ensure good data were collected. Third, the processing and analysis of experimental data, after the completion of data collection, EEG data and behavioral data should be processed and analyzed. NeuroScan's EEG analysis software and SPSS software were mainly used.

**Technical route**

The first is experimental study 1 of neuroscience (ERPs research). Through laboratory operations, the mechanism of informational herding in property-related decision-making was studied. That is, under the background of stock purchase decision, how to perceive and evaluate capital flow information in informational herding behavior in the expected stage of decision-
making, how the herd or anti-herd was implemented in the decision-making stage, and how the herd or anti-herd decision evaluated feedback result in the stage of decision-making feedback. This paper analyzes the above from the perspective of behavioral science and neuroscience, and introduces gender and investment experience factors.

The second was experimental study 2 of neuroscience (ERPs research). Through laboratory operations, how information that induces herd behavior in health decisions was perceived and processed was analyzed. That is, in the context of food purchase decision-making, others evaluate the risks contained in food additive, how this information was perceived? evidence from the behavioral science level and neuroscience level was provided, and physical attributes factors of foods (flavor factors of food) were introduced to study the above regulatory effect.

The third was the experimental study 3 of neuroscience (ERPs research). Through experimental operations, the mechanism of informational herding in health decision-making was analyzed. That is, in the context of food purchase decision-making, how the herd behavior and anti-herd behavior were implemented in the decision stage, whether there were cognitive differences in different feedback results after the herding behavior and anti-herding behavior in the feedback stage, and the impact of the feedback information on the next stage decision was explored. Sub-study IV also explained the above issues from the behavioral level and the neuroscience level.

Taking into account the factors of gender and investment experience of the subjects, we conducted a three-factor repetitive analysis of variance within the subjects: gender (male or female) X investment experience (with or without) X herd behavior (herd behavior, anti-herd behavior), and four-factor repetitive analysis of variance within the subjects: gender (male or female) X investment experience (with or without) X flow of funds (funds net flow positive or negative) X buy or not (choose to buy or not to buy), analysis results were shown in Table 2.

Taking into account the gender factor and combining with the statistical results in Table 5.2, we found no significant difference in the ratio of herd and anti-herd selections of male and female subjects, i.e., the gender factor can not significantly regulate herd and anti-herd effects, which was consistent with the results of research 1. In addition, there were no significant difference among the interaction effects of gender factor and capital flow factor, the interaction effects of

Results and discussion

Results of behavioral data research
Research 2 mainly studied the neural mechanism behind the herd behavior based on net flow information of funds on the basis of study 1. In the course of the experiment, the behavior data of the first two subjects was not recorded successfully, so there were 35 valid behavior data, including 21 male subjects and 17 experienced subjects.

Results of stock purchase decision selection
The analysis of the results of investment purchase decision was the most direct research and explanation of behaviors. For decision-making selection results, we mainly analyzed the percentage of people who chose to buy or not to buy, which did not include the number of trials that the subjects did not respond. Table 1 gave descriptive statistics of the selection results under different scenarios.

Table 1. Descriptive statistics results of stock purchase decision-making results

<table>
<thead>
<tr>
<th>Decision result type</th>
<th>No. of subject</th>
<th>Min. value</th>
<th>Max. value</th>
<th>mean value</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-buy</td>
<td>35</td>
<td>23.99</td>
<td>48.17</td>
<td>34.62</td>
<td>0.057</td>
</tr>
<tr>
<td>P-not buy</td>
<td>35</td>
<td>1.83</td>
<td>25.67</td>
<td>15.40</td>
<td>0.056</td>
</tr>
<tr>
<td>N-buy</td>
<td>35</td>
<td>0.17</td>
<td>35.01</td>
<td>21.62</td>
<td>0.090</td>
</tr>
<tr>
<td>N-not buy</td>
<td>35</td>
<td>15.01</td>
<td>49.83</td>
<td>28.37</td>
<td>0.091</td>
</tr>
<tr>
<td>Herd</td>
<td>35</td>
<td>47</td>
<td>92</td>
<td>62.99</td>
<td>0.114</td>
</tr>
<tr>
<td>Anticonformity</td>
<td>35</td>
<td>0</td>
<td>53</td>
<td>37.01</td>
<td>0.114</td>
</tr>
</tbody>
</table>

Table 2. Multi factor ANOVA analysis of stock purchase decision results

<table>
<thead>
<tr>
<th>Variable factor</th>
<th>F (df,error)</th>
<th>Statistic</th>
<th>Significant P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>money flow</td>
<td>F (1, 31)=0.057</td>
<td>0.813</td>
<td></td>
</tr>
<tr>
<td>Choose to buy or not</td>
<td>F (1, 31)=11.212</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Herd effect</td>
<td>F (1, 31)=44.489</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Gender X capital flow</td>
<td>F (1, 31)=0.013</td>
<td>0.911</td>
<td></td>
</tr>
</tbody>
</table>
gender factor and buying or not factor, and the interaction effects of three factors of the gender factor, the capital flow factors, and buying or not, which indicated that the gender factor had no significant influence in the decision-making selection results in this experiment.

**Results of EEG data research**

Under the condition that the net flow of funds was positive, the act of choosing to purchase stocks can be considered as a herd behavior, and the opposite behavior can be considered as anti-herd behavior; under the condition that the net flow of funds was negative, the act of choosing not to purchase can be classified as a herd behavior. Therefore, we can analyze the difference between N400 of herd behavior and N400 of anti-herd behavior when the fund flow stimulus occurred (expected stage). Figures 2, 3, and 4 showed the total waveforms of ERPs under herding condition and non-herding condition.

For N400 wave amplitude, we conducted 2 (gender: male, female) X 2 (investment experience: yes, no) X 2 (herd behavior, anti-herd behavior) X 9 (nine electrode points) multifactor repetitive analysis of variance within subjects. As a result, it was found that the herd behavior and anti-herd behavior had significant marginal differences in N400 wave amplitude, and the anti-herd N400 amplitude was even more negative. It was found after further simple effect analysis that for male subjects, there was no significant difference between herd and anti-herd behaviors in N400 amplitude. For female subjects, there was a significant difference between herd and anti-herd behaviors in N400 amplitude. The negative trend of N400 amplitude of the anti-herd behavior was more obvious. The main effects of the electrode points in the statistical results and associated interaction effects were not significant.

**Conclusions and prospects**

The conclusion of this study was that individuals often made contact with information about other people’s behavior, attitudes, or evaluations at a previous stage before making property-related or health-related decisions. The individual needed to perceive and evaluate this information. When the perceived conflict can be reflected by the N400 component, the difference in the degree of emotion arousing induced by the information can be reflected by the LPP component. Individuals' perception and assessment of information about other people’s behaviors, attitudes, or evaluations affected the behavior of individuals in the decision-making stage.

**References**


