



Cognitive Mechanism of Economic Management Risk Based on Correlation Potential Neuroimaging

Lei Zhi*

ABSTRACT

Intuition and reasoning are two major types of human decision-making and judgments. With the development of behavioral economics and decision-making neuroscience, more and more scholars are no longer satisfied with simply studying intuitionist decision-making from the perspective of speculative and theoretical framework. Instead, they introduce the idea of experimental science into decision-making research in management science. From the aspects of behavioral science and neuroscience, the existing intuition decision-making research is summarized. The main contributions of the experimental research on the intuition decision-making mechanism and the experimental design of the intuition decision-making task are summarized. Finally, an event-based Potential (ERP) technology to determine the experimental design of intuition, designed a risk management experiment of economic management to study the neural basis behind decision-making, the use of ERP technology features high temporal resolution, focusing on the analysis of the key aspects of economic management process and Found in all aspects of treatment based on the composition of EEG.

Key Words: Cognitive Mechanism, Economic Management Risk, Potential Neuroimaging, Event-based Potential, EEG

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Introduction

Intuitive decision-making is featured with "being quick, subconscious, used in decision-making involving multiple dimensions, based on a great deal of previous experience, mostly used by experts, difficult to explain the reasons after decisions are made, and usually made with high self-confidence." Accordingly, the reasoning decision-making is slow, constrained and controlled by rules, and it is necessary to make energies in the decision-making process. In his literature review, Bai (2008) divides the related research of intuitive decision-making into four stages: the embryonic stage of intuitive decision-making theory, the behavior research stage of intuitive decision-maker, the development stage of intuitive decision-making theory; the empirical stage of intuitive decision-making.

Through sorting out the researches of intuition, management and decision-making theory, it is not difficult to find out that the research of intuitive decision-making in the field of management at present still remains on the level of thinking and theoretical framework, and few scholars introduce the idea of experimental science and study the behavior characteristics of intuitive decision-making and the underlying neural mechanism from scientific and rigorous experimental design. This paper focuses on the experimental research of the intuitive decision-making mechanism and summarizes the literature on the intuitive decision-making mechanism by using the experimental method after the behavioral economics and the decision-making neuroscience are put forward. On the basis of discussing the feasibility of intuitive

Corresponding author: Lei Zhi

Address: School of Management, Zhengzhou Institute of Technology, Zhengzhou 450000, China

e-mail ✉ zhilei19811203@126.com

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decision-making research and concluding the characteristics of intuitive decision-making by means of behavioral science and neural science and technology, the study summarizes the experience and existing problems of experimental research on intuitive decision-making mechanism from the viewpoint of experimental design and looks forward to the prospect of academic research on intuitive decision-making mechanism under specific circumstances in the future.

The Basic Theoretical Research and Concepts

The main research tool used in this study is Event-Related Potential (ERP) technology. Therefore, this section will focus on some basic concepts related to ERP, including data acquisition, measurement of ERP components, and ERP technology characteristics.

ERP related concepts

The event-related potential, in essence, is a special type of brain evoked potential. When people give or cancel an obvious psychological stimulus externally, a change in the potential in the brain area will occur, which is the source of E (Zhao, 2004). In 1964, when modern ERP research began, Greywater *et al.* discovered the first cognitive ERP component, which they called the contingent negative variation or CNV; and in 1965, the other major advance in ERP was that Sutton *et al.* discovered P3 component and it's found that when the subject could not predict the type of the next stimulus, a strong and positive P3 component would occur. The amplitude appears around 300 after stimulation, and when the subject is able to predict the type of stimulation, the component is significantly reduced.

Collection and processing of ERP data

ERP data collection includes two parts: Recording and amplifying EEG signals, in which recording EEG signals from scalp requires effective contact between electrodes and scalp. Electrodes are metal conductors placed on scalp (Du *et al.*, 2017; Sun *et al.*, 2017). According to different functions, they can be divided into action electrodes, reference electrodes and ground electrodes. The function of the action electrodes is to record the EEG signals, the function of the reference electrodes is to set the reference points, i.e. the points where the reference electrodes are located are zero potential points of the body, and the function of the ground electrodes is to eliminate interference, so the EEG signals collected through

the electrodes is actually the difference between the action electrodes and the reference electrodes. Because the EEG information collected directly is very weak, the amplifier is needed to record it on the corresponding software via amplification. In addition, the ERP signals are relatively weak and easily submerged in other larger EEG signals, so it is important to separate the ERP signals through reducing the noise of other EEG signals after collecting the ERP signals.

ERP component type

After many steps of iterative averaging, the ERP component we see is a waveform consisting of a series of positive and negative voltage fluctuations. "When we draw the ERP waveform, we are used to make the negative voltage upward and the positive voltage downward." Therefore, the upward peak is usually referred to as negative wave (N) and the downward peak is usually referred to as positive wave (P). According to the order or time of each peak, we can use PZ! NZ or N400! N170 to name each component. The specific nomination in each experiment is slightly different.

Characteristics of ERP technology

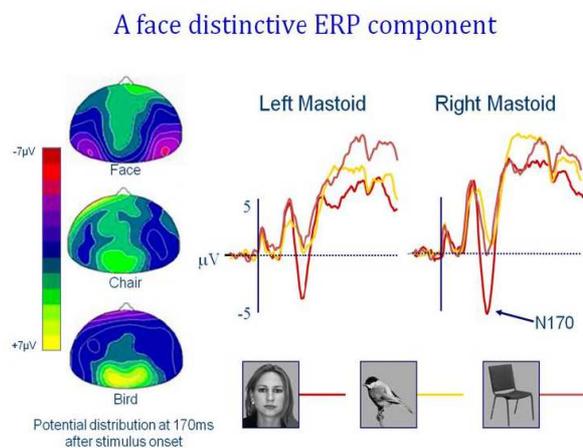


Figure 1. A face distinctive ERP component

Compared with the traditional questionnaire or other neuroscience research tools, ERP technology has the following two characteristics: First, the time resolution is higher, which helps us to study the questions from the time course; second, it helps us to study the hidden question, and because in terms of individuals, the usual questionnaire or interview cannot really get the answers, on the one hand, the reason is that the subjects are unwilling to answer the questions,

and on other hand, the subjects are not aware of their own knowledge of the problem, and all of these difficulties can be overcome to some extent by the event-related potential." Figure 1 shows the common facial ERP differentiation process.

The Theoretical Framework of the Study

Uncertain decision-making can be divided into risk decision-making and vague decision-making. Since Knight (1921) first put forward the difference between ambiguity and risk, a large number of scholars from various fields have carried out deep researches on risk and ambiguity. "The representative of traditional decision-making researches is expected utility theory (EU) and subjective expected utility theory (SEU)." Ellsberg (1961) first proposed the difference between ambiguity and risk. He found that compared with ambiguous uncertainty of probability unknown, individuals tend to choose risk uncertainty with known probability, even if the choice is contrary to the expectation of the individuals, compared to uncertainty with unknown probability. On this basis, Fox and Tversky (1998) introduced belief into decision-making model, and proposed an uncertain decision-making model based on belief.

Decision-making information processing (DSS)

Risk decision-making and ambiguity decision-making in bank economic management are two important factors in decision-making research (Song *et al.*, 2016; Zaccone *et al.*, 2017;). The dual-system theory of conscious cognitive processing decision-making shows that system 1 is a parallel, unintentional, implicit and emotional process without will effort, while system 2 is serial, intentional, explicit processes without effort (Camerer *et al.*, 2005). It can be seen that ambiguity decision-making is usually related to system 1, while risk decision-making is related to system 2. These researches show that there are different mechanisms of risk decision-making and ambiguity decision-making in brain processing, respectively corresponding to different brain circuits." The study of event-related potentials (ERP) shows that the PZ component is mainly related to early attention bias (Dennis and Chen,

2007; Yuan *et al.*, 2007), reflecting the allocation of attention resources and the attention needs of experimental tasks. In the study of negative bias, negative events occupy more attention resources than positive events and neutral events (Huang and Luo, 2006)." The study by Yuan *et al.*, (2007) shows that under a single negative condition, extreme negative stimulus can induce the smallest PZ. This study envisages that risk decision-making and ambiguity decision-making are different in negative degree as two kinds of different decision-makings. Therefore, it will occupy different attention resources, which mainly shows the difference of attention information processing process in time course, and the difference is mainly reflected in the early P2 component. Therefore, it is assumed that there is a difference in the information processing process between risk decision-making and ambiguity decision-making in the expected decision stage, and the difference is mainly reflected in P2 component.

Research on the application of uncertain decision-making ERP in bank economic management

1. Data sources

Business risks faced by commercial banks in China

(1): Risks of non-performing loans. One of the important indexes to measure the asset quality of commercial banks is the non-performing loan rate, which can also measure the risk of commercial banks, which is mainly because the loan is the most important business of commercial banks in China. Net Interest Income Ratio of Top Five State-owned Commercial Banks in 2013-2016 as shown in table 1.

Because main business of commercial banks in China still is loan, non-performing loan will inevitably cause hidden dangers to operating risk management of commercial banks in China.

Risks of term mismatch. Inter-bank lending, personal deposit and unit deposit are the main resource sources of commercial banks in China, and the capital businesses are mainly loan and securities, while the traditional business is mainly debt business, its asset business is mainly loan business, the loan term tends to be a long-

Table 1. Net Interest Income Ratio of Top Five State-owned Commercial Banks in 2013-2016 (Unit: %)

	ICBC	ABC	Bank of China	Construction Bank	Bank of Communications
2013	84.9	80.1	79.5	86.5	77.4
2014	82.4	81.2	78.4	80.2	80.5
2015	81.5	86.3	80.9	81.7	81.3
2016	83.2	84.5	81.3	83.4	82.2



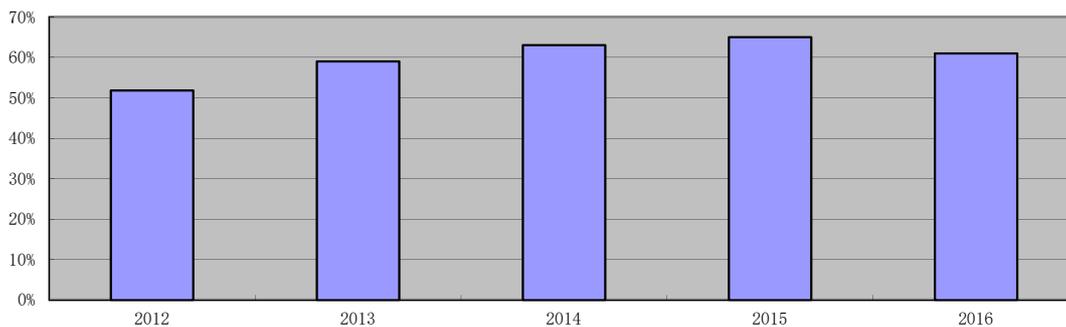


Figure 2. Chinese commercial banks 2012-2016 loans as the proportion of assets

Table 2. The four different risk factors of different levels of repeated tests correspond to different variances (Source: According to the annual report of five state-owned commercial banks from 2013 to 2016)

	Risk perception					
	Nega-tive	Neutral	Positive	Total	F	P
Credit risk	623	624	601	621	9.69	0.001
Market risk	661	651	640	648	10.47	0
Liquidity risk	663	626	607	629	4.618	0.014
Operation-al risk	693	652	644	667	6.14	-
t/f	2.098	1.313	2.399	7.48	0.024	0.698
P	0.038	0.194	0.019	0.001		

term, and the deposit term is short-term generally.

(3): Risks of the asset structure. At present, the commercial banks in China still take the loan as

2. Experimental materials

In the experiment design, we design four types of stimulating factors as starting, among which credit risk, market risk, liquidity risk and operational risk respectively present ambiguity decision-making with unknown win-loss probability, and risk decision with 50% win-loss probability. Table 2 shows the different variance corresponding to repeated test of four risk factors at different levels.

Experimental process

The experimental flow of this study consists of two parts: firstly, recording and analyzing various EEG data and behavioral data during the experiment; secondly, self-test of the questionnaire after the experiment to understand the correlation between relevant potential technology and economic management risk during the experiment.

In this experiment, the STIM software of American Neuroscan Company is used to realize the random presentation of stimulation on computer screen. This experiment is designed for a repeat measurement experiment of single factor at three levels. The EEG differences of emotional valence responses at negative, neutral

and positive levels of economic management risk are observed. SPSS19.0 software is used to test behavior performance by paired t-test. The time and accuracy of economic management risk response at three levels are analyzed by variance. The statistical software package of ERP system is used to carry out the variance analysis of the ERP data for single factor at five levels, and the corresponding statistics t value of each electrode can be calculated based on the 19-channel ERP wave amplitude sample. After spatial interpolation, the SPM (t) is obtained. The statistical parameter map (SPM) is drawn by the statistical software of spatiotemporal pattern.

the key point in the capital operation mode, and the proportion of the loan in the assets from 2012 to 2016 is always as high as 50% -65%, as shown in Figure 2 below.

Data analysis

1. Analysis of the results of the questionnaire
 After each subject completes the test, a simple self-evaluation questionnaire will be filled in to understand the emotional processes of the subjects facing four different stimuli during the experiment. "Through the questionnaire, the self-evaluation of the subjects can be verified with the previous studies, so that the researchers can acquire more accurate emotional money in the experiment in order to obtain more reward after the experiment, and "this experimental paradigm only includes two kinds of amounts, Qiao 0 and



20 respectively.” The amount of >50 can arouse the tendency of gambling compared to 20, so that the psychology of the subject becomes less calm, and thus arouse the higher emotional experience. Therefore, in the analysis of the expected phase of decision making, the classification of emotional arousal will be used to measure decision amounts of different sizes.

2. EEG data analysis

According to the data analysis method mentioned in the experiment process, the time period of data analysis is set to 1,000ms, that’s, from 200ms before stimulus presentation to 800ms after decision-making stimulus presentation. Then it’s superimposed according to different types of variables, and in different decision-making stages, the classification variables to be investigated will be slightly different. In addition, in the process of selecting electrode potential for data analysis, there are two common methods internationally: one is to select regional potential, that’s, to select multiple electrode points for analysis, and the other is to discuss one electrode point separately, which is based on the most representative or the most obvious difference.

Example analysis

China CITIC Bank, formerly known as China CITIC Industrial Bank, was founded in 1987. It is one of the earliest emerging commercial banks in China. It was officially renamed as China CITIC Bank in August 2005, and was simultaneously listed on the Hong Kong Stock Exchange and Shanghai Stock Exchange in April 2007. In order to make the risk management of commercial banks in China more concrete, this paper focuses on the analysis of the operating risk of Shanghai CITIC Bank, which has more than 1,000 employees, with a total foreign currency deposit of RMB84.234 billion and a loan balance of foreign

currency of RMB57.428 billion in 2014. Although Shanghai CITIC Bank attaches great importance to risk management in operation, there are still many problems in risk management.

Problems existing in the management of operating risk of China CITIC Bank

(1): Excessive concentration of credit space. In 2013, manufacturing industry, transportation, storage and postal industry, wholesale and retail industry, water conservancy, environment and public facilities management industry, and the real estate industry are still the top five industries of Shanghai Citic Bank in terms of credit availability, accounting for 77.76%, which is basically equal to that in 2011 and 2012, greatly increases the credit risk of Shanghai Bank. The non-performing loan rate of Shanghai CITIC Bank from 2011 to 2012 is 0.9%, 0.63% and 0.6% respectively. The non-performing loan rate of manufacturing industry from 2011 to 2013 was 0.99, 0.95, 0.59 percentage points higher than the average non-performing loan rate respectively. The non-performing loan rate of wholesale and retail was 0.61, 0.55 and 0.81 percentage points higher than the average level respectively, which indicates that Shanghai CITIC Bank has more non-performing loans in five industries, such as manufacturing, wholesale and retail, due to the excessive concentration of credit (as shown in Table 3).

(2): Uneven quality of assets. Shanghai CITIC Bank’s rating method to credit customer is relatively backward, mainly reflecting in such aspects as credit customer rating structure group, information collection, rating harmony, and overall structural design. Shanghai CITIC Bank divides the credit customer level into four levels, which are AAA level, AA level, A level and BBB level respectively, while in foreign countries, there are generally eight levels.

Table 3. Shanghai Citic Bank’s 2012-2016 NPLs (Unit: ten thousand yuan, %)

	2012		2014		2016	
	Amount	Non-performing rate	Amount	Non-performing rate	Amount	Non-performing rate
Manufacturing	395500	1.89	304221	1.31	2981003	1.19
Transport, storage and postal industry	74285	0.10	68470	0.08	117142	0.91
Wholesale and retail trade	119584	1.51	142891	1.18	147968	1.21
Water conservancy, environment and public facilities	14304	0.06	11580	0.08	48509	0.68
Construction industry	84208	0.48	97671	0.17	113027	0.22



Table 4. Bank economy management risk response time repeated measures of variance analysis (Source: Sorting out the Internal Credit Report of Shanghai CITIC Bank)

	Risk perception index					P
	Average reaction time	Positive error rate	Negative error rate	Total error rate		
Credit risk	642	0.24	2.71	4.27	.32	0.57
Market risk	648	0.78	2.57	4.48	.27	0.524
Liquidity risk	663	0.47	2.47	4.29	.218	0.514
Operational risk	653	0.52	2.44	4.67	.14	
t/f	0.307	0.871	0.270	0.548	.0254	0.618
P	0.760	0.387	0.788	0.585		

(3): Lack of adequate attention to risk control. Generally, the value evaluation of the bank to the credit pledge has a strong timeliness, the value of the mortgage is relatively high in the rising stage of the economy, and will shrink greatly when the economy is in the downward expectation. Therefore, the value evaluation of the mortgage has an important pre-effect on the credit risk control of the bank.

Discussion of results

According to the different probability states, the decision-making can be divided into certain decision-making and uncertain decision-making, and according to whether the probability is known or not, uncertain decision-making can be divided into risk decision-making and ambiguity decision-making. The risk decision-making means that the decision maker has the complete information of probability, and the ambiguity decision-making means that the decision maker partly or completely does not know the probability information of decision. The results of bank economy management risk response time repeated measures of variance analysis as shown in table 4.

(1): Lack of internal management power of banks. According to the risk management situation of commercial banks, at present, commercial banks in China mostly accept "external supervision," and the CBRC usually chooses the single index which is easy to operate to restrain the commercial banks' operation activities, so it has certain "short-term behavior" in the aspect of supervision.

(2): Some limitations in the index system. The mixed operation has already become the important development mode of the commercial banks in China, so the business mode of the commercial banks in China continues to expand, and the use of funds also presents the trend of "diversification", especially the proportion of the

spread income in the commercial banks' profits is declining.

(3): Lack of enough attention to cash flow. Since innovative financial products and services are insufficient comparatively, the transaction scale of "derivatives" is very limited, and the bank operation risk is not isolated but related to each field, each link and each aspect of operation activity of commercial banks. If the commercial bank cash flow is "exhausted," the commercial banks will inevitably lead to the risk. But at present, commercial banks and the regulatory authorities fail to pay attention to the cash flow of commercial banks, so it is very easy to cause business risks.

Conclusions

In this study, ERP difference analysis of gender differences in different emotional titers showed that the significant difference in gender main effects first started at about 120ms, and significant differences in risk-economic management risk cognitive interaction reflected the mid-late left frontotemporal scattered in the brain. Although with the continuous deepening of the reform of banking financial institutions in our country, commercial banks in our country are relatively mature in operational risk management. However, there are still many constraints at present. Especially since the global financial crisis, commercial banks in our country have been suffering from bad loans, the risks of asset structure and the lack of internal management motivation in the bank, the index system has some limitations, and the problem of insufficient attention to cash flow. The problems of operational risk management have begun to appear. Especially through the case of Shanghai CITIC Bank's operation risk management Analysis, there is credit space is too concentrated, uneven quality of assets exist, the lack of attention to risk control problems, and the reasons for these problems in the final analysis is the concept of business risk management is



relatively backward, increased external risk factors, the quality of risk management team Caused by poor. In this paper, the use of ERP recognition technology for our country to implement a new round of financial reform, all kinds of commercial banks at all levels must attach great importance to management of risk management issues, scientific analysis. The method can make a sound management development concept, improve the effective mechanism of risk management, optimize the bank credit management system, establish the bank credit responsibility system, improve the quality of bank managers and strengthen the supervision of commercial banks, so that the management of commercial banks risk management Into a more scientific, standardized, institutionalized and efficiency of the track.

References

- Akyuz N, Kekatpure MV, Liu J, Sheinkopf SJ, Quinn BT, Lala MD, Kennedy D, Makris N, Lester BM, Kosofsky BE. Structural brain imaging in children and adolescents following prenatal cocaine exposure: preliminary longitudinal findings. *Developmental neuroscience* 2014; 36(3-4):316-28.
- Donald KA, Eastman E, Howells FM, Adnams C, Riley EP, Woods RP, Narr KL, Stein DJ. Neuroimaging effects of prenatal alcohol exposure on the developing human brain: a magnetic resonance imaging review. *Acta Neuropsychiatrica* 2015; 27(5):251-69.
- Donald KA, Fouche JP, Roos A, Koen N, Howells FM, Riley EP, Woods RP, Zar HJ, Narr KL, Stein DJ. Alcohol exposure in utero is associated with decreased gray matter volume in neonates. *Metabolic Brain Disease* 2016; 31(1):81-91.
- Du X, Shi Z, Peng Z, Zhao C, Zhang Y, Wang Z, Li X, Liu G, Li X. Acetoacetate induces hepatocytes apoptosis by the ROS-mediated MAPKs pathway in ketotic cows. *Journal of Cellular Physiology* 2017; 232(12): 3296-308.
- Horton MK, Margolis AE, Tang C, Wright R. Neuroimaging is a novel tool to understand the impact of environmental chemicals on neurodevelopment. *Current Opinion in Pediatrics* 2014; 26(2): 230-36.
- Mark K, Desai A, Terplan M. Marijuana use and pregnancy: prevalence, associated characteristics, and birth outcomes. *ARCHIVES of Women's Mental Health* 2016; 19(1): 105-11.
- May PA, Baete A, Russo J, Elliott AJ, Blankenship J, Kalberg WO, Buckley D, Brooks M, Hasken J, Abdul-Rahman O, Adam MP. Prevalence and characteristics of fetal alcohol spectrum disorders. *Pediatrics*. 2014 Nov 1; 134(5): 855-66.
- Migliorini R, Moore EM, Glass L, Infante MA, Tapert SF, Jones KL, Mattson SN, Riley EP. Anterior cingulate cortex surface area relates to behavioral inhibition in adolescents with and without heavy prenatal alcohol exposure. *Behavioural Brain Research* 2015; 292: 26-35.
- Song Y, Li N, Gu J, Fu S, Peng Z, Zhao C, Zhang Y, Li X, Wang Z, Li X, Liu G. β -Hydroxybutyrate induces bovine hepatocyte apoptosis via an ROS-p38 signaling pathway. *Journal of Dairy Science* 2016; 99(11): 9184-98.
- Sun X, Yuan X, Chen L, Wang T, Wang Z, Sun G, Li X, Li X, Liu G. Histamine induces bovine rumen epithelial cell inflammatory response via NF- κ B pathway. *Cellular Physiology and Biochemistry* 2017; 42(3): 1109-19.
- Treit S, Zhou D, Lebel C, Rasmussen C, Andrew G, Beaulieu C. Longitudinal MRI reveals impaired cortical thinning in children and adolescents prenatally exposed to alcohol. *Human Brain Mapping* 2014; 35(9): 4892-903.
- Zaccone R, Sacile R, Fossa M. Energy modelling and decision support algorithm for the exploitation of biomass resources in industrial districts. *International Journal of Heat and Technology* 2017; 35: S322-29.

