Group Effect and Its Influence on Economic Decision-making Based on Brain Evoked Potential Analysis

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ABSTRACT
To explore how group effect generates and how it influences individual's economic decision-making from the two levels of psychological cognition and behavior choice, as well as the prerequisites for differentiating into two different effects, this study compares the individual different acceptance degree of fair/unfair offer from inside and outside the group in making economic decision through designing the model of ultimatum bargaining game based on decision-making neuroscience. What's more, the study attempts to explore the preconditions of the two completely different phenomena of in-group preference and black sheep effect and uses ERP technology to find the cranial nerve basis of this effect so as to reveal the brain's thinking process.

Key Words: Economic Decision-making, Social Interaction, Group Effect, ERPs

Introduction
Research of ERP can trace back to the experiment conducted by Berger in 1929. He found that the electrical activity of the human brain can be measured by placing electrode points on the scalp and amplifying the signal (Grecucci et al., 2013). Berger pointed out that the magnitude of the voltage would be affected by external events stimulating the sense organs and drew a variation diagram of the voltage change over time, which is known as Brain evoked potential). Brain evoked potential was proved to be an effective tool for recording brain activity and was popular in the academic world for the following decades. However, there are some deficiencies in Brain evoked potential. Brain evoked potential can only conduct a roughly comprehensive measure of brain activity but it is difficult to isolate a single neurocognitive process, making it impossible to assess a highly specific neurological process (Ma et al., 2015). Therefore, a technology, called ERP technology, that uses simple averaging technology to extract specificity, cognition, and motor processes has been proposed (Molenberghs et al., 2014).

At present, Brain evoked potential and ERP researches generally adopt the positioning standard of 10-20 electrode lead marked by the International Electroencephalography Institute (Qu et al., 2013). In the experiment, ERP data is collected by using a multi-lead electrode cap through the effective contact between the electrode and the scalp, as shown in Figure 1. The other end of the electrode is connected to an amplifier, and the collected data is converted into digital signals and saved in a storage device (Zhou et al., 2014). Potential sampling frequency range ranges from 100 to 10,000 Hz (Liao et al., 2015).
There are mainly three kinds of electrodes in the Brain evoked potential amplification system: active electrode, reference electrode, and grounding electrode. The electrode placed on the scalp is called the active electrode, and the electrode placed on the zero potential point of the body is the reference electrode. Usually, earlobe, apex nasi or mastoid is taken as a reference electrode. The recorded Brain evoked potential signal is the difference between the active electrode and the reference electrode. Grounding electrode is usually placed at the midpoint of the front of the head, which helps eliminate 50-week interference (Xue et al., 2015). ERP data is generally analyzed by Neuroscan. The main analysis steps include: merging multiple Block data, previewing and removing significant inferior data, removing EOG, digital filtering, Brain evoked potential segmentation, baseline correction, removing artifacts, and superimposing the average (Xue et al., 2013). The analyzed ERP waveform consists of a series of positive and negative voltage fluctuations. The amplitude and incubation period of ERP components are usually analyzed. In the specific analysis, the amplitude has the peak amplitude and the average amplitude. The peak amplitude refers to the maximum amplitude in a certain time window (Li, 2015). The average amplitude is the average amplitude in a certain time window. The incubation period of the ERP components usually uses the incubation period of the maximum amplitude peak as the incubation period of the corresponding component. Compared with behavioral experiment, ERP technology has significant advantages. First of all, ERP can lock the Brain evoked potential signal under specific stimuli and can measure accurately to the millisecond-level time course while behavioral measurement can only observe the common output of multiple cognitive processes, making it difficult to determine to a specific behavioral process (Wang et al., 2013). Second, behavioral measurement requires that the subjects must have a certain behavioral response while ERP technology does not have this limitation.

Through ERP experimental research and by designing the ultimatum bargaining game paradigm, this paper explores the influence of group effect on economic decision-making in the social interaction scenario from the perspective of the recipient. Then through the different judgments of individuals on the uncertainty of group intentions, the regulating effect of the uncertainty of intentions on group effect is discussed. The conclusions of this study help managers to more clearly understand how group effect affects individual decision-making, thus providing theoretical guidance for managers to establish healthy and positive group norms, clear assessment standards, and reasonable rules. At the same time, it can also help decision-makers take effective coping styles or avoid unnecessary irrational behaviors.

Methods
At present, there are two completely different phenomena of in-group preference and black sheep effect. This study hopes to reproduce these two effects, find the behavior and Brain evoked potential characteristics of these two phenomena, and reveal their prerequisites and formation mechanism so as to try making further in-depth exploration of the existing group effect theory.

27 healthy students from Zhejiang University volunteer to participate in the experiment as paid subjects. They are all loyal fans of one NBA team. All of them are right-handed with age ranging from 20 to 25 years old. In order to well simulate the regulating effect of group effect on economic decision-making and to explore how individual judgment on infringement intentions affect the generation of group effect, the experimental flow chart is designed as shown in Figure 2.

The experimental stimuli for this study mainly include identity information pictures, distribution scheme, selection tips, and results feedback pictures.

As shown in Figure 3, the first line is a user m on CC98 (a largest student forum in Zhejiang University). The instruction will be informed to the subjects before the experiment. Parter data is collected by a large-scale questionnaire survey initiated in 1998.
To enhance the authenticity of the experimental scenario, m is placed in the identity information. And for the privacy of Partner, the last digit or letter is replaced by “*”. The second line is group identification information. When recruiting subjects, there will be a simple interview to ensure that the subjects are fans of a certain NBA team.

The distribution scheme shows allocation scheme proposed by Partner as shown in Figure 4.

Questionnaires are published on the questionnaire website. The questions are “The other party wins 10 yuan and you get 10 yuan, will you accept it?”, “The other party wins 11 yuan and you get 9 yuan, will you accept it?”, “The other party wins 19 yuan and you get 1 yuan, will you accept it?”… “The other party wins 19 yuan and you get 1 yuan, will you accept it?” These questions are presented in turn until the subjects refuse to choose.

There are 45 students of 18-21 years old from Zhejiang University (the mean and standard deviation are shown in Formula 1 and 2) participating in behavioral experiments. The experimental results show that the mean and standard deviation of the minimum remuneration that is acceptable to the subjects are shown in Formula 3 and 4. Therefore, this study sets 19-1 (the other party wins 19 yuan, the same below), 18-2, 17-3, and 16-4 as an unfair distribution scheme, and 10-10, 11-9, 12-8, 13-7 as a fair distribution scheme, and the ratio of the two schemes is 1:1. In order to make the boundary between the two become clear enough, the number of occurrences of the intermediate distribution schemes, namely, 16-4 and 15-5, is controlled to be small. When dealing with Brain evoked potential components, it will not be analyzed because of the small number of overlaps.

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\bar{X} = 19.7 \quad (1)
\]

\[
\sigma = 0.17 \quad (2)
\]

\[
\bar{X} = 4.80 \quad (3)
\]

\[
\sigma = 0.49 \quad (4)
\]

After the subjects see the distribution scheme, they can accept or refuse it by pressing the key. For the habitual effect, the key needs to be made into counter balance. That is, half of the subjects accept by pressing 1 and refuse by pressing 3. On the contrary, the other half of the subjects accept by pressing 3 and refuse by pressing 1. After pressing the key, a feedback picture will be presented as shown in Figure 5. Although the Brain evoked potential response presented after the selection is not examined, the feedback to the results is also a necessary flow for the completeness of the experiment. After the subjects choose, the experimental program will

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**Figure 2.** Experimental flow chart

**Figure 3.** Partner identity example diagram

**Figure 4.** Distribution scheme example diagram
give the corresponding feedback result according to the choice of acceptance or refusal by the subjects.

Figure 5. Results feedback examples

Results and discussion
This paper explores the influence of group effect on economic decision-making in the social interaction scenario from the perspective of the recipient through ERP experimental research and by designing the ultimatum bargaining game paradigm. Besides, through the different judgments of individuals on the uncertainty of group intentions, it discusses the regulating effect of the uncertainty of intentions on group effect.

Influence of group classification on economic decision-making under the social interaction
Through adapting the ultimatum bargaining game, this research studies the influence of different group classifications on economic decision-making under the social interaction. The research finds that different group classifications induce P2 components with different amplitudes during the presentation of the other party’s identity. When the subjects see the other party belonging to the same group, a greater P2 is induced, indicating that the decision-makers pay more attention to the partners from the same group and invest more attention resources.

Figure 6. The influence of a person with or without clear malice

In the presentation phase of the other party’s proposal, for both the perceived non-malicious group and the perceived malicious group, there are interactions between groups and fairness as shown in Figure 6, showing that group classification has different effects on different levels of fairness. It can be said that the group effect is ubiquitous in economic decision-making, and it makes people have a different influence on the degree of tolerance of unfair decision-making.

Regulation of individual intentional perceptions to group effect
In the feedback phase of distribution results, different judgments on infringement intention will lead to different group preferences as shown in Figure 7.

For the perceived malicious group members, FRN component with larger amplitude is induced in the face of the unfair distribution scheme proposed by the same group of members than that of the different group members. This indicates that in the face of the same infringement behavior, when the subjects think the infringement behavior of the same group members is malicious, the subjects feel greater harm, resulting in more intense rejection, disgust, and anger. That is, when the subject thinks that the other party has a clear intention, black sheep effect will appear in psychological cognition obviously.

Therefore, the research believes that in the face of an uncertain infringement intention, different individuals will have different cognitions of intentions, and the subjects of perceived non-malicious group will show typical in-group
preference psychologically while subjects of perceived malicious group show typical black sheep effect.

**Separation of Brain evoked potential and behavior**
Different from the previous researches on the regulating effect of intentional ambiguity on group effect, this research holds that individuals have different judgments on the uncertainty of intentions, and then finds that in the FRN components, the perceived non-malicious group shows typical in-group preference while the perceived malicious group shows typical black sheep effect.

However, different from the strong contrast between the two effects in the previous researches, the behavioral choice consistently shows preference for members of the same group in this research for both subjects of the perceived non-malicious group and the perceived malicious group. This shows that there is an inconsistency between cognition and behavior under the condition that individuals perceive uncertain infringement intentions. Subjects respond immediately to the cognitive processing of the brain due to perceived differences in the uncertainty of the intentions, resulting in a certain emotional response and in-group preference and black sheep effect psychologically. However, there is a time lag between the cognitive processing of the distribution scheme and decision-making, so decisions after rational thinking all show tolerance for in-group members.

**Conclusions and outlook**
Through the use of ERP technology, the following conclusions have been drawn: under social interaction, the social distance will affect the economic decision-making process and results; the subjective perception of the distribution intentions will have a regulating effect on the group effect; the decision-making behavior is a rational choice after overcoming emotional impulse in specific situations. In addition, the regulating factor of group effect is certainly more than intentional uncertainty. There are researches believing that cognitive load and group-based emotions such as anger and shame affect the occurrence of two effects. Therefore, researches in the future can broaden the scope of preconditions and study the regulating effect of many other factors on group effect.

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