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Research article

They all do it, will you? Event-related potential evidence of herding behavior in online peer-to-peer lending

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ABSTRACT

As herding is a typical characteristic of human behavior, many researchers have found the existence of herding behavior in online peer-to-peer lending through empirical surveys. However, the underlying neural basis of this phenomenon is still unclear. In the current study, we studied the neural activities of herding at decision-making stage and feedback stage using event-related potentials (ERPs). Our results showed that at decision-making stage, larger error related negativity (ERN) amplitude was induced under low-proportion conditions than that of high-proportion conditions. Meanwhile, during feedback stage, negative feedback elicited larger feedback related negativity (FRN) amplitude than that of positive feedback under low-proportion conditions, however, there was no significant FRN difference under high-proportion conditions. The current study suggests that herding behavior in online peer-to-peer lending is related to individual's risk perception and is possible to avoid negative emotions brought by failed investments.

1. Introduction

Peer-to-peer (P2P) lending is an innovative method of financial transactions where individuals can directly borrow and lend money without financial intermediaries. It has a short history but grown rapidly in recent years. From the first online P2P lending company, Zopa (www.zopa.com), launched in 2005, the number of P2P online lending platforms worldwide has grown rapidly, in China, the number has grown to 2114 by June 2017 [5].

Despite the innovative method and tremendous business profits, it also shows some problems. For example, the investors in this market have to evaluate loan applicants themselves (most of them without professional knowledge) with little objective information which results in their behavior can be easily influenced by external factors [15]. Researchers have investigated the influential factors and found investors' behaviors can be influenced by financial strength [14], personal characteristics [15], herding [1,10] and so on.

Herding is a typical characteristic of human behavior referring to observing and imitating others' behavior, which occurs especially under the asymmetric information condition in financial markets [2]. This is because under such condition, borrowers don't have sufficient information about lenders, especially in online P2P lending where borrowers can only know the lenders through limited information published on lending platform [21]. Actually, the researchers such as Berkovich (2011) and Herzenstein et al. (2011) have documented the existence of herding in P2P lending through empirical surveys and behavioral assessments [1,10].

However, these studies mainly focused on explaining herding phenomenon theoretically, little was concern for its cognitive processes. With the development of cognitive neuroscience, researchers have investigated the neural basis of herding. Chen et al. (2010) used ERPs to study the neural substrates of participants' herding decision processes during online book purchasing. They found that consumers' herding tendencies for book purchasing could be reflected in the deflection of LPP amplitude, in which higher review consistency resulted in larger LPP amplitude [3]. Investigating herding behavior at brain level can help us further understand its cognitive process. Therefore, we attempted to explore herding behavior's neural basis in online peer-to-peer lending.

We employed modified risk-taking paradigm and ERPs into current study. Specifically, we compared subjects' neural responses toward low and high participation proportion lending projects at the decision-making and feedback stages. The participation proportion refers to capital raising proportions of a certain financing project in the P2P

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platform. High participation proportion represents prior credit decisions and can attract more bids [18], in contrary, low proportion represents few prior investments. Since subjects had to make hit decisions in our paradigm, decision under high-proportion, here, is considered as herding behavior while decision under low proportion is considered as anti-herding behavior.

Error-related negativity (ERN) was the most commonly examined ERP components at decision-making stage [23], while feedback-related negativity (FRN) was reported to appear at feedback stage of risk-taking tasks [17]. Therefore, we hypothesized these two ERP components would be candidates for current study.

According to previous studies, ERN, error negativity, is a negative deflection peaking around at approximately 0–150 ms after completion of a fast or impulsive erroneous decision [23]. ERN was first explained as error detection referring to results of a mismatch between the expected and actual behavior [20]. Moreover, some researchers found ERN can reflect risk evaluation [11,12,29]. Yu & Zhou (2009) employed a gambling task where participants need to choose whether to bet, then acquired monetary feedback. They found that ERN is sensitive to evaluation of choices' riskiness, the higher level of participants' risk assessment, the larger the ERN amplitude [29]. Furthermore, since ERN is generated in the anterior cingulate cortex (ACC) [19], this is also consistent with neuroimaging study that ACC can signal risk and function as early warning system alerting brain to prepare for the potential negative consequences associated with risky actions [29]. In current study, as the paradigm was adapted from a risk-taking paradigm suggested by W. Gehring & R Willoughby [7], we suspected that the ERN can be an index of risk evaluations.

FRN is a frontal-central negative deflection that peaks at 200–350 ms after presentation of feedback and shows maximal amplitude over medial frontal scalp locations [9]. FRN is generated in the ACC by source localization analysis and fMRI analysis [6,9]. According to the brain function of ACC, the reinforcement learning theory suggested that FRN reflected outcome evaluation process [13] and encoded prediction errors [9] and motivation/affective toward the outcomes [7]. That is, when expected outcomes turned bad, the enhanced negative prediction errors and motivation/affective would be induced, which in turn initiated phasic decreases in dopamine inputs, resulting in increased ACC activity [7,13].

In the current experiment, we speculated that herding behavior in online P2P lending is less risky than anti-herding behavior. At the decision-making stage, low-proportion conditions would induce larger ERN amplitudes than high-proportion conditions. At the feedback stage, we suspected that people's expectations deviation and motivational impact would reduce after herding behavior. FRN encodes expectation violations and motivation/affective of outcomes, larger FRN amplitude differences would be elicited between negative and positive feedback from low-proportion than that of high-proportion conditions.

2. Materials and methods

2.1. Participants

Sixteen right-handed healthy (9 male, 7 female) graduates and undergraduates were recruited as participants from Ningbo University. All participants were native Chinese speakers without any history of neurological disorders or mental diseases. Their visual acuity was normal or corrected-to-normal. The age of the participants ranged from 18 to 26 years, with a mean age of 21.693 years (S.D. = 2.600). All participants provided written informed consent before experiment started, and the current study was approved by Internal Review Board of Academy of Neuroeconomics and Neuromanagement at Ningbo University.

2.2. Stimulus materials

The entire experiment consisted of 240 trials. There were 120 different capital raising proportions, and each proportion appeared twice. Among them, 50 were defined as high-proportion spreading from 90% to 100%; another 50 as low-proportion spreading from 0% to 10%; and the final 20 used for proportion integrity spreading from 10% to 90%. All of these proportions were selected from Paipai Dai, one of the most famous Chinese P2P platforms. The stimuli were edited by Photoshop 7.0 (Adobe Systems Incorporated, San Jose, California, USA). The size of the pictures was consistently 270 × 360 pixels, and they were shown on a black background. All stimuli were randomly and evenly divided into four blocks, with 60 trials in each group in the formal experiment.

2.3. Procedure

Participants sat on a comfortable sofa located in a shielded room and were instructed to minimize eye blinking and muscle movement during experiment. At a distance of 1 m from his or her eyes, there was a computer screen, on which all stimuli were presented at a visual angle of 2.588°. A keypad was provided to the participants to indicate their investment decision, either lending 1000 or 5000 Chinese yuan to the given project. Before formal experiment started, all participants were given a brief introduction about online peer-to-peer lending and the experiment process. After they fully understood the process, the experiment started.

As shown in Fig. 1, each trial began with a fixation cross against a black background for a random interval of 600–800 ms. Afterwards, the proportion of a project appeared for 1200 ms. Then, two response options together with lending project proportion appeared, and the participants had to respond whether to lend 1000 or 5000 yuan within 4000 ms. The stimuli disappeared immediately after pressing the button. The locations of different amounts of money were counterbalanced between trials. After 400–600 ms of a blank screen, the repayment situation was reported back to the participants and lasted for 2000 ms. Positive feedback was displayed in green while negative feedback was red. E-prime 2.0 software (Psychology Software Tools, Pittsburgh, PA, USA) was used for stimuli and trigger recordings. The experiment started after 6 practice trials.

2.4. Electroencephalogram (EEG) recording and analysis

EEG signals were recorded using a cap containing 64 Ag/AgCl electrodes and a Neuroscan Synamp2 Amplifier (Curry 7, Neurosoft Labs, Inc) with a sample rate of 1000 Hz with a bandpass filter from 0.05 to 70 Hz. A cephalic (forehead) location between FPz and Fz was used as ground. The left mastoid was used as reference. Electrooculograms (EOGs) were recorded from electrodes placed 10 mm from the lateral canthi of both eyes (horizontal EOG) and above and below the left eye (vertical EOG). The experiment started only when electrode impedances were maintained below 5 kΩ.

Data were referenced off-line to average of left and right mastoid references. EOG artifacts were corrected using the method proposed by Semlitsch et al. [24]. EEG recordings were then digitally filtered with a low-pass filter at 30 Hz (24 dB/octave). Data were segmented for the epoch from 200 ms before the onset of the target appearing on video monitor to 800 ms after the onset of the target, with the first 200 ms pre-target used as a baseline for the feedback stage analysis. For the decision-making stage analysis, EEG epochs from 400 ms before the execution of the decision to 400 ms after the decision were used, and the epoch from 400 ms pre-target to 200 ms pre-target was used as a baseline. Trials containing amplifier clipping, bursts of electromyography activity, or peak-to-peak deflections exceeding ± 100 μV were excluded. The EEG recordings for each recording site for every participant were averaged separately within four conditions during the feedback stage (high-proportion repays on time, high-proportion does