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Non-sympathetic FRN responses to drops in others' stocks

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Previous neuroeconomic studies have observed that people display sympathetic neural responses toward others' misfortunes. We argue that the reverse emotions, such as gloating or *schadenfreude*, may also emerge in certain circumstances. To examine this theory, we recorded feedback-related negativity (FRN) toward others' large or small gains or losses in a stock market context. We adopted the framework of social distance, according to which we hypothesized that because others in the stock market are far away, unidentified, and indistinct, people would show less sympathy or even *schadenfreude* toward others' large losses. The results indicated that FRN at Fz was significantly less negative when observing larger decreases in others' stock, indicating that others' large losses are not unexpected negative events in the stock market and suggesting the existence of *schadenfreude.* Our research contributes to the understanding of social neurofinance by demonstrating the *schadenfreude* effect in relation to the stock market. This study also provides new information regarding the relationship between FRN and the social emotions that form the expectations of gain and loss.

Keywords: Event-related potential; Feedback-related negativity; Sympathy; *Schadenfreude*; Social neurofinance.

The current body of work in neuroeconomics suggests that humans are highly empathetic and even altruistic toward others' negative feedback outcomes. For example, Yu and Zhou (2006) observed similar feedback-related negativity (FRN) patterns when people are faced with their own gains and losses and the gains and losses of others. As FRN is generally elicited toward unexpected negative outcomes, Yu and Zhou concluded that such findings indicate an observational learning effect whereby similar neural mechanisms underlie the evaluation of one's own and others' feedback outcomes.

However, an investigation of the literature reveals that this may be far from the truth. When facing others' losses, human beings may either feel sympathy or feel negative, unsympathetic emotion such as *schadenfreude* (pleasure in others' misfortunes). The feeling of *schadenfreude* has been demonstrated both in neural (Takahashi et al., 2009) and behavioral (Feather & Sherman, 2002) investigations. Why, then, are negative reactions and emotions such as selfishness, envy, and *schadenfreude*, which are widely documented in psychology, absent in current neuroeconomic work? Without investigating and understanding the negative emotions, we can know only half of the story of the neural foundation of human economic behavior.

In some circumstances, human beings show less sympathy or more negative emotions. Imagine someone losing $100; we may feel sympathy. However, if it was not $100 but $1,000,000, what would we feel? Thinking that greedy rich people deserve the loss, we may gloat rather than feel sympathy. Such a circumstance suggests the quantity effect. If we see someone

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we know crying over his loss, we feel sympathy; however, a loss suffered by a stranger living far away may elicit less sympathy. This circumstance suggests the distance effect. In the current study, we identify a special situation the stock market that combines both the quantity effect and the distance effect. Studying the stock market offers us an opportunity to examine people's negative reactions toward others' losses. Based on theoretical reasoning and empirical evidence, we hypothesize that in the financial markets, people may show *schadenfreude* when others experience losses.

First, we argue that financial markets are quite different from previously used empirical situations in economic games because the quantity of money involved in stock markets is so large. Slonim and Roth (1998) observed that players reduced the amount of their offers when the stakes were high in an ultimatum game as they developed experience but did not change their offers when the stakes were low. Such findings suggest that the quantity of outcomes plays some role in determining subjective responses to the outcomes of others.

Second and more important, we argue that financial markets are quite different from situations in economic games in prior studies because both physical and psychological distances between the self and other players are much greater in stock markets than that in other economic games. The construal level theory (CLT) of physical distance (Fujita, Henderson, Eng, Trope, & Liberman, 2006; Trope & Liberman, 2010) demonstrates that people mentally represent or construe events and objects at different levels of abstraction. The CLT suggests that nearer objects are perceived as relatively more concrete (low level construal) and distant objects as relatively more abstract (high level construal). Because other players are numerous and far away from the self, we argue that the level of sympathy may be low when viewing others' losses in the stock market for two reasons: (1) according to the CLT, we may adopt a high level construal process that is global, abstract, and concept-dependent. We may ponder the risk and uncertainty of unpredictable stock markets, and the consequence of our careful thinking helps us accept the fact that loss is highly possible and that gain is unlikely for ourselves and maybe even less likely for others. Therefore, the expectation of others' losses may maintain itself at quite a high level, and we may perceive the loss as a common result rather than as a type of misfortune. (2) The target persons to whom we would like to show sympathy are not focused and vivid. Lab studies demonstrate the relationship between physical closeness and interpersonal positivity, termed "positivity–closeness hypothesis", and vividness acts as a mediator between closeness and positivity, termed "positivity–vividness hypothesis" (Alter & Balcetis, 2011). Therefore, when the target persons are numerous, unknown players in the stock market rather than one or several distinct players in empirical economic games, it is difficult for us to show sympathy.

Some empirical evidence supports our arguments. First, meta-analysis shows that long-distance communication that is not face-to-face is generally more harmful to integrative agreements than face-to-face communication (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; Stuhlmacher & Citera, 2005), which implies that when psychological and physical distance is great, pro-social motivation and behavior may decrease. Second, studies have reported that increasing the number of competitors (*N*) can decrease competitive motivation, termed the "*N*-effect" (Garcia & Tor, 2009). Because the number of competitors is quite large in stock markets, the competitive motivation may decrease, which may further decrease the expectation of gain but increase the level of tolerance for loss both for our own and others' stocks. These results imply that the greater the distance, the less the sympathy we may show.

According to this evidence and argument, we generate our hypothesis that in the financial market, we may show unsympathetic or even negative responses to others' losses.

The present study sought to capture the non-sympathetic and negative responses to large losses in others' portfolios using FRN. FRN is an event-related potential (ERP) component characterized as negative amplitude in brain activity following the presentation of feedback-related stimuli. Evidence from source localization suggests that FRN is generated in areas of the medial prefrontal cortex such as the anterior cingulate cortex (Gehring & Willoughby, 2002; Holroyd, Coles, & Nieuwenhuis, 2002). In terms of responses to outcome feedback, previous studies have observed that FRN is generally more pronounced for negative than for positive feedback (Miltner, Braun, & Coles, 1997) and more negative for unexpected than for expected outcomes (Nieuwenhuis, Holroyd, Mol, & Coles, 2004).

Specifically, based on the above reasoning and the features of FRN, we infer that if the FRN response to others' loss is more negative than the response to others' gain, this response reveals the existence of sympathy; an FRN response to others' loss that is not different from the response to others' gain indicates less sympathy or non-sympathy. An FRN response to others' loss that is considerably less negative than the response to others' gain may suggest a negative emotion such as *schadenfreude* because this

response would indicate that we do not expect others' gain; instead, we predict others' loss.

The stock exchange in the financial market provides an excellent situation in which both the quantity effect and the distance effect may occur. A huge number of people are involved in the stock market, living all over the world. Thus, even a small change in stock prices could lead to large-scale gains or losses.

Because we hypothesize that participants may show non-sympathetic or negative responses to larger losses in others' stocks, we predict that FRN should be less negative when one observes larger drops in the value of others' stock.

METHODS

Sample

Twenty healthy university students (9 males, 11 females; mean age 21.55 ± 2.46 years) participated in the study. Participants were reimbursed for their time with USD16. The experiment is in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

Design

The experiment adopted a 2 (stock outcome: increase vs. decrease) × 2 (levels of price change: large [9%] vs. small [3%]), within-participant design. Generally, individual investors in the stock market believe that a 5% change in stock prices is a marginal index, a change lower than that indicates small gains or losses and a change higher than that indicates large gains or losses. Accordingly, we used 3% and 9% to represent small and large changes in stock prices, respectively.

Procedure

Participants were told that the experiment comprised three tasks: a training task, an observation task, and a question-answering task.

The training task

Participants completed a 5-minute training session prior to the observation task.

The observation task

Participants were asked to carefully observe the outcomes of three stocks (A1, A2, and A3) that belonged to others. To ensure that they paid close attention, participants were told that upon finishing, they would be prompted to answer questions relevant to the stock's behavior. A total of 156 trials were divided into 4 different conditions, 2 (stock outcome: increase vs. decrease) × 2 (levels of price change: large [9%] vs. small [3%]); each condition had 39 trials. The order of the four conditions was randomized. Each trial began with a fixed cross at the center of a black screen for 500 ms. Then, one of the three stock names was presented for 1000 ms. Then, an 800 ms feedback frame was displayed. The frame comprised an arrow representing the stock outcome (increase or decrease) and a percentage (3% or 9%) indicating the degree of change. Participants' electroencephalography (EEG) signals from −200 ms to 800 ms of this screen were extracted for analysis. Then, the next trial was presented. We established a jittered interval of 200 ms, 300 ms, or 400 ms between each screen (see Figure 1). Participants were provided with a 3-minute break mid-session.

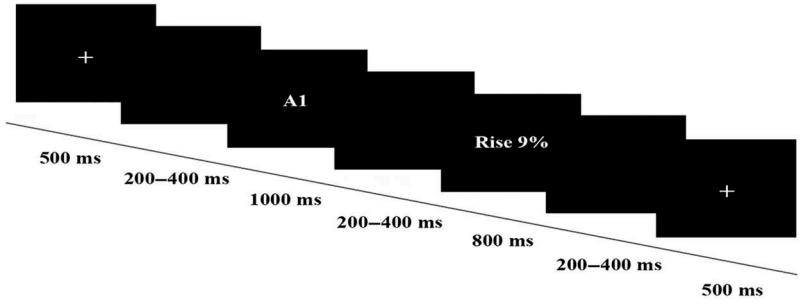

Figure 1. The procedure of the ERP experiment. Each trial began with a fixed cross at the center of a black screen for 500 ms (Slice 1). Then, one of three stock names was presented for 1000 ms (Slice 3). Then, an 800 ms feedback frame was displayed (Slice 5). Then, the next trial was presented. We set a jittered interval of 200 ms, 300 ms, or 400 ms between each screen (Slices 2, 4, 6). Participants were provided with a 3-minute break mid-session.

The questionnaire-answering task

After the observation task, participants completed a 7-item perspective-taking questionnaire taken from Davis's subscale of interpersonal reactivity index (IRI) (Davis, 1980). Cronbach's α was 0.69 in this study. Participants also completed the 40-item mini-marker scale of big-five personality (Saucier, 1994), which comprises five factors (extraversion, agreeableness, conscientiousness, emotional stability, and openness). This is a widely used measure of Big Five Personality, particularly because it is short and can be easily used in experimental settings. The Cronbach's α of the big-five personality test ranged from 0.81 to 0.92 in this study. We particularly tried to use the trait of agreeableness combined with perspective-taking to double-check the relationship between behavioral and neural measures.

EEG recording

EEG signals were recorded continuously from 32 scalp sites using tin electrodes mounted in an elastic cap (Brain Products, Munich, Germany). Impedance was maintained below 5 kΩ. The EEG and electro-oculogram (EOG) were amplified using a 0.05–100 Hz bandpass and continuously sampled at 1000 Hz/channel for offline analysis. The vertical EOG (VEOG) was recorded supraorbitally from the right eye. The horizontal EOG (HEOG) was recorded from electrodes placed at the outer canthus of the left eye. All EEG and EOG signals were referenced online to an external electrode that was placed on the tip of the nose and was re-referenced offline to the mean of the left and right mastoids. EEG epochs of 1000 ms (with a 200-ms pre-stimulus baseline) were extracted offline for ERPs time-locked to the onset of the degree of the stock price change. Ocular artifacts were corrected with an eye-movement correction algorithm that employs a regression analysis in combination with artifact averaging (Semlitsch, Anderer, Schuster, & Presslich, 1986). Epochs were baseline-corrected by subtracting from each participant the average activity of that channel during the baseline period. All trials during which EEG voltages exceeded a threshold of ±80 μV were excluded from further analysis.

FRN was measured separately for each participant using a peak-detecting program in each condition of stock performance approximately 320–360 ms after the onset of feedback. The amplitude and latency of the peak were recorded. In all analyses, the Greenhouse–Geisser correction for nonsphericity was applied where appropriate.

FRN was quantified at Fz based on previous studies (Hajcak, Moser, Holroyd, & Simons, 2006).

RESULTS

We first examined the differences among the latency of FRN in different types of conditions: others' small increases (*Mean* = 325.15 ms, *SD* = 40.78), small decreases (*Mean* = 323.15 ms, *SD* = 38.32), large increases (*Mean* = 336.35 ms, *SD* = 37.90), and large decreases (*Mean* = 329.95 ms, *SD* = 41.88). Repeated analysis of variance (ANOVA) revealed no significant interaction between stock outcomes and levels of price change and the latency of participants' FRN at channel Fz [$F(1, 19) = 0.08$, $p = .779$]. The main effect of stock outcome [$F(1, 19) = 0.32$, $p = .576$] and levels of price change [$F(1, 19) = 1.24$, $p = .279$] were not significant.

Repeated ANOVA revealed a significant interaction between stock outcomes and levels of price change and the amplitude of participants' FRN at channel Fz [$F(1, 19) = 8.22$, $p = .010$, partial $\eta^2 = .302$]. With large price changes (9%), participants' FRN amplitude for others' losses (*Mean* = −3.08μV, *SD* = 3.20) was significantly less negative than the FRN amplitude for others' gains (*Mean* = −4.50μV, *SD* = 4.16), $t(19) = 2.50$, $p = .022$. With small price changes (3%), participants' FRN amplitude for others' gains (*Mean* = −3.72μV, *SD* = 2.86) was less negative than for others' losses (*Mean* = −4.03μV, *SD* = 3.09); however, the difference was not significant, $t(19) = 0.05$, $p = .490$ (see Figures 2 and 3).

Participants' FRN when viewing large drops in the prices of others' stocks was significantly and negatively correlated with the agreeableness of the Big

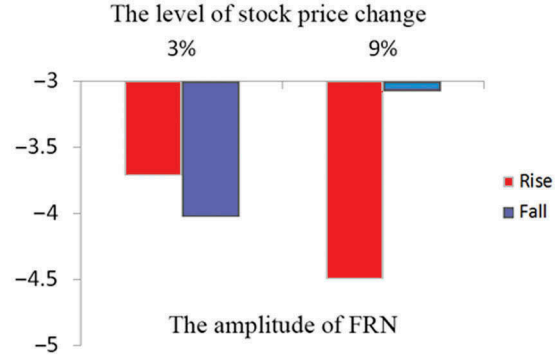

Figure 2. The interaction between the stock outcome and the level of the stock price change on the amplitude of FRN when observing others' stock performance. When price changes were large (9%), participants' FRN amplitude for others' losses was significantly less negative than for others' gains. When price changes were small (3%), no significant difference was observed between others' losses and gains.

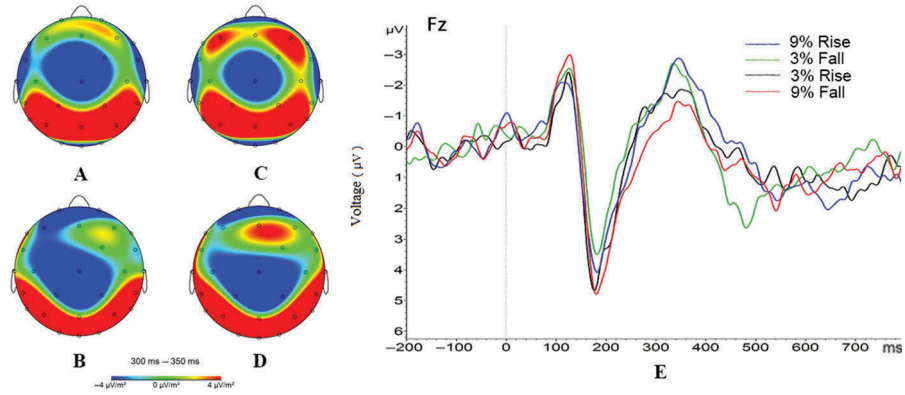

Figure 3. Grand-average event-related potential wave forms recorded at Fz and showing the distribution of observed FRNs. The graphs of A B C D show topographical maps of four different situations of others' stock performance: An increase of 3%, a decrease of 3%, an increase of 9%, and a decrease of 9%, respectively. The graph of E shows the different waves among these four situations. FRN was measured using a peak-detecting program approximately 320–360 ms after the onset of feedback.

Five Personality (r = –.453, p = .045) scale, marginally correlated with their scores on the Emotional Stability of the Big Five Personality (r = −.420, p = .065), but not significantly correlated with perspective-taking of the IRI, r = −.347, p = .134. These results indicate that individuals scoring higher on agreeableness displayed greater FRN, suggesting a lower level of *schadenfreude*.

DISCUSSION

In this study, we examined the neural activity of participants as they observed others' gains and losses at small and high stakes. At small levels of changes in stock prices, participants showed a trend toward more negative FRN when observing others' losses than when observing others' gains, although not to a statistically significant level. This finding replicates results from previous neuroeconomic laboratory studies that have identified sympathy or indifference processes in participants when the participants were observing others' losses (Fukushima & Hiraki, 2006). More notably, we observed that at high levels of change in stock prices, participants demonstrated significantly less negative FRN toward others' losses than toward others' gains, reflecting *schadenfreude* toward others' losses. Moreover, individuals' agreeableness influenced responses to others' outcomes in a feedback setting, indicating that kind-hearted people are more likely to perceive others' financial problems as unexpected negative events. This finding supports previous research that FRN is influenced by individuals' characters. For example, Li and colleagues (2010) asked participants to perform a gambling task individually in a high-responsibility and a low-responsibility scenario, and they observed that FRN was sensitive to the self-reported responsibility level. Similarly, Fukushima and Hiraki (2009) observed that self-reported measures of empathy were positively associated with the magnitude of the observational FRN.

Our findings are consistent with previous research by proposing the perspective of social distance. Previous studies have observed that FRN differences are displayed only when observing the outcomes of decisions made by humans but not those by computers (Fukushima & Hiraki, 2009). Using our perspective of social distance, the psychological distance between the self and inanimate computers is greater than the distance between the self and living human beings, which explains why FRN differences are displayed only when observing the outcomes of decisions made by humans.

To the best of our knowledge, our finding is a first in showing that FRN is less negative toward the feedback of others' losses than toward others' gains in the context of finances, indicating non-sympathetic negative reactions toward others' misfortunes in the stock market. The stock market is so large that there are too many investors from all over the world for investors to compete with one another, and even a few percentage points of change in stock prices indicates huge gains or losses. In this circumstance, the quantity effect and the distance effect would occur, leading investors to feel negative emotions toward others' losses.

One limitation to this study is that we did not measure perceived social distance. In addition, there could be some other explanations for our findings.

Future research may further identify which is the most dominant mechanism underlying the negative reactions toward others' failures in a financial context.

First, unlike the more complex motivations (e.g., fun and the need for interpersonal contact) involved in gambling or the economic games upon which previous studies have been based, financial investment instills in participants relatively pure motivations of resource competition (Fukushima & Hiraki, 2009), which prevents people from showing sympathy. Similar findings were reported by another study (Marco-Pallarés, Krämer, Strehl, Schröder, & Münte, 2010). Three different groups of "observers" were studied. The first (neutral) group simply observed the performer's action, which had no consequences for the observers. In the parallel group, wins/losses of the performer were paralleled by similar wins and losses by the observer. In the reverse group, wins of the performer led to a loss for the observer and vice versa. ERPs of the performers showed that the FRN occurred for wins of the performer, which translated to losses for the observer. To some extent, financial markets are a zero-sum game; therefore, we show *schadenfreude* toward others' losses.

Second, previous researchers have argued that individuals gain utility not only from monetary gains but also from fairness (Ochs & Roth, 1989). With smaller stakes, fairness may outweigh monetary gains, but with higher stakes, such monetary gains may outweigh the utility of fairness. We parallel our current findings with such notions by arguing that as resource competition dictates (Armstrong & McGehee, 1976), resources are limited so that others' gains will, to an extent, reduce the pool of available resources. With smaller stakes, individuals' utility in socially desirable responses toward others may outweigh the utility of competition for resources. Conversely, when the stakes are high, individuals experience more utility in competition and thus may exhibit more self-serving responses. In such circumstances, it would be interesting to examine participants' responses to others' feedback outcomes when the responses belong to those with whom they are familiar, which arguably increases the utility of social desirability.

Third, the paradigm employed in the current study differs from the economic games used in previous research that presented observers with others' actions and the results of such actions (Fukushima & Hiraki, 2009; Yu & Zhou, 2006). We argue that such paradigms elicit observers' observational learning whereby they form an action-outcome expectation (Bandura, 1977). As such, previous studies observed that FRN toward others' outcomes mimics FRN toward ones' own outcomes. In contrast, in the present study, we asked participants to observe outcomes of others' stock prices without providing information regarding the actions that caused such outcomes, thereby reducing the cues for social learning and resulting in patterns different from previous findings.

Fourth, former studies (Holroyd, Larsen, & Cohen, 2004) have observed that monetary loss may not necessarily lead to more negative FRN, depending on the value of eliciting outcomes relative to the range of outcomes possible. Consistent with the findings of that study, our results demonstrate that the relationship of FRN to gains and losses is more complicated, depending on which is expected and which is unexpected. For example, in an economic recession, most people consider large drops in stock prices unsurprising.

We believe that the present findings have implications for theory and future work. Previous studies have labeled FRN a component of brain response elicited in response to negative, unexpected outcomes. Although this likely occurs for ones' own feedback outcomes, i.e., more negative FRN toward own losses, we suggest that there is a fallible assumption being made because negativity may not always go hand-in-hand with unexpectedness. For example, in our study, we observed that others' large losses attracted minimal FRN from observers. Because losses are intrinsically negative, it appears that the responses to such outcomes indicate observers' expectations of such losses and suggest that existing beliefs regarding FRN may not be generalizable in complex financial situations. In a wider context, we argue that at certain times, environmental cues such as economic crises may shift expectations from expectancy of gains to expectancy of losses. As such, observing large drops in others' stock prices may be expected (leading to less negative FRN) whereas observing large increases in others' stock prices may instead be unexpected. Our findings and others' findings suggest that FRN is moderated by social interaction factors and predicts subjective feelings of the pleasantness or unpleasantness of an outcome rather than the win/loss of an outcome (Rigoni, Polezzi, Rumiati, Guarino, & Sartori, 2010). Based on these findings, we suggest that more precision be directed toward a more definitive description of this brain component.

Although we believe that the current study is a first step toward uncovering the 'dark side' of social processes in neuroeconomic investigations, our study is not without limitations. First, in recent years, economic game experiments have been widely utilized to investigate mechanisms of human economic behavior such as fairness and equality (Burnham, 2007;

Koenigs & Tranel, 2007). The current research contributes to our understanding of brain responses to financial outcomes although the brain mechanism of financial decision-making remains unknown. Second, the participants in the current research were all students and thus may be inexperienced in financial markets. Future research should examine the current findings among actual stockholders or fund managers to increase external validity.

The present study contributes to the literature on social neurofinance. Moreover, we suggest that the notion of FRN as a reflector of negative surprise should be applied to research on social emotions because social emotions play important roles in determining expectancy. We call for more research into this specific area of finance in future neuroeconomic investigations.

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