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Author(s)	Itagaki, Shun; Katayama, Jun'ichi
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Feedback-related negativity reflects the evaluation based on the one's own criteria

Shun Itagaki[1] and **Jun'ichi Katayama**[2]
([1]The University of Tokyo, [2]Hokkaido University, Japan)
itagaki@ardbeg.c.u-tokyo.ac.jp

Introduction

● **Feedback-related negativity (FRN)**
- An event-related brain potential (ERP) component, reflecting the evaluation of whether the outcome is good or bad.

● **Involvement with *"Mirror"* Error Monitoring System??**
- Elicitation of the FRN in observation of other's error responses or monetary losses (Miltner et al., 2004., van Schie et al., 2004., Yu & Zhou, 2006).
- These studies were conducted in the situation where other's outcome had no relation to the participant's reward.

● **Purpose**
- To investigate the evaluation process of outcomes induced by self and others, using ERP.
- To investigate how the evaluation process is modulated in the situation where the outcomes affect each other.

Exp.1: The relationship between self and others was *corporative.*
Exp.2: The relationship between self and others was *antagonistic.*

Methods

● **Task & Procedure (common in Exp.1 & 2)**
- Alternative gambling game by participant and virtual others.
- Each trial had the bet of 100 Japanese yen (100 yen ≒ 0.83 US $).
- In participant turns: *Gain of 100 yen* or *Loss of 100 yen*

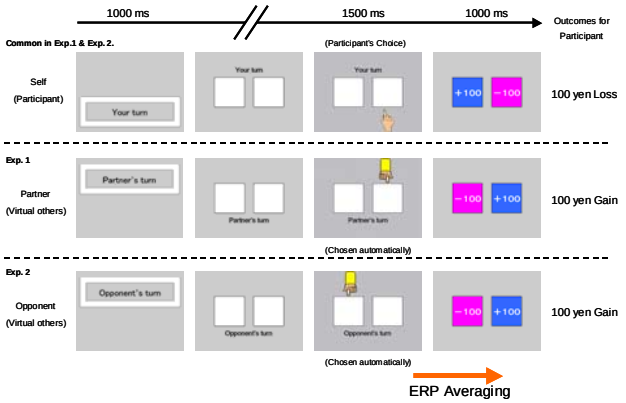

Fig. 1. Schematic diagram of alternative gambling task. Top panel shows the participant's turn (common in exp.1 and exp.2), middle panel shows the partner's turn (exp.1), and bottom panel shows the opponent's turn (exp.2).

- 8 blocks of 40 trials, in which each player chose a card 20 times per block.
- Order of both players was randomized.
- Probability of "Gain" card choice was randomized with replacement.
- Participants had 1,000 yen at the beginning of task.

● **Participants, Task, & Procedure (Exp.1)**
- Participants: 12 young adults (male:6, female: 6)
  Partner's gains ⇒ Participant's gains.
  Partner's losses ⇒ Participant's losses.

● **Participants, Task, & Procedure (Exp.2)**
- Participants: 13 young adults (male:7, female: 6)
  Opponent's gains ⇒ Participant's losses.
  Opponent's losses ⇒ Participant's gains.

● **EEG Recording & Analysis (common in Exp.1 & 2)**
- Electrodes: 30 scalp electrodes referenced to the nose tip.
- Band pass filter: 0.05–100 Hz, A/D: 500 Hz.
- Re-reference: Averaged earlobes
- Off-line filter: Zero-phase 12 Hz low-pass filter (12 dB/oct).
- FRN: Mean amplitudes within 200–300 ms from feedback stimuli.

Results

Exp. 1

● **Probability of "Gain"**
Self: 41~55 % (*M* = 48 %)
Partner: 43~57 % (*M* = 49 %)

● **Monetary outcomes**
-2,200 ~ 2,600 yen
(*M* = 167 yen, *SD* = 1,675 yen)

Exp. 2

Self: 45~56 % (*M* = 49 %)
Opponent: 44~57 % (*M* = 50 %)

-2,000 ~ 3,600 yen
(*M* = 523 yen, *SD* = 1,542 yen)

● **Grand averaged ERPs**

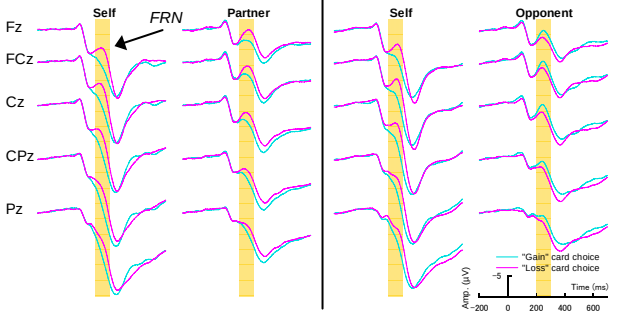

Fig. 2. Grand averaged ERPs in response to feedback stimuli from five midline electrodes in exp. 1 (left) and exp. 2 (right).

● **Topography of participant's loss – gain difference waves**

Fig. 3. Scalp topography of difference wave for both players obtained by subtracting ERPs to the monetary gains from those to losses for participants in exp.1 (left) and exp.2 (right).(*i.e.,* [Loss – Gain] for Self, [Loss - Gain] for Partner in exp.1, and [Gain – Loss] for Opponent in exp.2).

Discussion

● **Elicitation of the FRN in response to (1) Losses of Self (Exp.1 & 2), (2) Losses of Partner (Exp.1), & (3) Gains of Opponent (Exp.2).**
⇒ The FRN was sensitive to one's own monetary losses.
⇒ The outcomes induced by others were regarded as good or bad things for one's own evaluative criteria.
⇒ The FRN reflects self-relevant outcome monitoring rather than "mirror" system.

● **Smaller FRN induced by others (partner & opponent) than participant's own, in spite of the same bets.**
⇒ Although the evaluation process was activated without participant's own choice actions, discrimination between self and others affects the evaluation process.

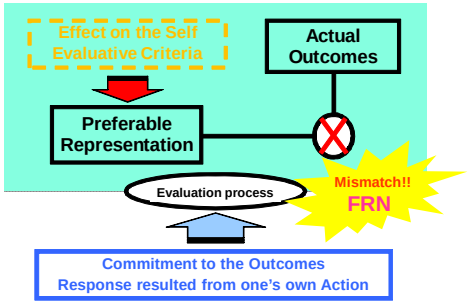

Fig. 4. Schematic representation of generation of the FRN.

Conclusion

- The self-relevant criteria determine the evaluation of outcomes induced by others.
- The commitment to the outcomes by the response enhances the evaluative process.