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Outcome evaluations in group decision-making using authority rule: An electrophysiological study

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ABSTRACT

The present study aimed to investigate whether coincidence of opinion affects the evaluative processing of outcomes in group decision-making under authority rule. For this purpose, we examined the effects of the opinion coincidence on feedback-related negativity (FRN), an event-related brain potential (ERP) reflecting the evaluative processing of outcomes. Six three-person groups performed a group decision-making task in which one member acting as a leader (leader blocks) made a group decision to choose one of two cards after he/she observed opinions of the other members acting as followers (follower blocks), and monetary gain or loss was contingent on the group decision. To examine the effect of the opinion coincidence, each trial of each individual was classified into one of three trial types: unanimous, majority, or minority trials. As a result, the amplitude of FRN was smaller for unanimous trials than for majority trials in the leader blocks. In addition, the amplitude of FRN was larger for majority trials compared to minority trials in the follower blocks. These results suggest that the coincidence of opinion in group decision-making affects the evaluative processing of outcomes, and this occurs even when roles and responsibilities over outcomes is explicitly clarified under the authority rule.

1. Introduction

Humans are social animals and live in highly sophisticated societies. As such, many important decisions are made not by individuals alone, but by groups of individuals collectively (i.e., group decision-making). Although members in a group may have different or conflicting opinions, once the group implements a group decision, group members receive an identical "good" or "bad" outcome associated with the group decision. Traditionally, previous studies on group decision-making focused on the group decision-making process (i.e., how individual opinions interact and reach group decisions, e.g., Stasser and Davis, 1981). However, little attention has been paid to the evaluative processing of outcomes in group decision-making.

Human electrophysiological studies have identified an event-related brain potential (ERP) that is involved in the evaluative processing of action outcomes. These studies have reported that a fronto-central negative deflection around 200–300 ms after the onset of action outcomes can be extracted by comparing ERPs elicited by negative outcomes (e.g., a monetary loss) to those elicited by positive outcomes (e.g., a monetary gain) (e.g., Gehring and Willoughby, 2002; Holroyd and Coles, 2002; Miltner et al., 1997). This negative deflection is called feedback-related negativity (FRN) (for a review, see Ullsperger et al., 2014) and considered to be involved in rapidly evaluating the motivational value of outcomes (e.g., Gehring and Willoughby, 2002; Masaki et al., 2006).

Recent studies have investigated the evaluative processing of outcomes when an individual acts as part of a group. Li et al. (2010) reported that, in a dice-tossing task, the amplitude of FRN elicited by monetary outcomes was reduced when participants tossed one die while other players tossed the other two dice, compared to when the participants tossed all the dice. Similarly, Kimura and Katayama (2016) demonstrated that the amplitude of FRN elicited by monetary outcomes was smaller when an individual choice in a gambling task coincided with the choices of group members, relative to when an individual choice did not coincide with them. These results have been interpreted in terms of the diffusion of personal responsibility (e.g., Latané, 1981; Latané and Darley, 1968). That is, acting a part of a group or the coincidence of choice made individuals feel less responsible for the outcome, which reduces the motivational value of the outcome, resulting in the reduction of FRN amplitude. From this perspective, it has been

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suggested that FRN amplitude is associated with the degree of the personal responsibility over action outcomes in social contexts (e.g., Boksem et al., 2011; Boksem et al., 2012).

To date, few studies have examined the evaluative processing of outcomes in group decision-making. Kimura and Katayama (2013) reported that the coincidence of opinion modulated FRN in group decision-making under majority rule. In their study, a three-person group was asked to individually choose one of two cards and the card which had a majority was chosen as the group decision. Subsequently, monetary gain or loss was contingent on the group decision. To examine the effects of the opinion coincidence, each trial for each individual was classified into unanimous, majority, or minority trials; namely, the participant's opinion was part of a unanimous choice, that was in the majority, or that was in the minority of the group. As a result, FRN amplitudes for the majority trials were larger than that for the minority trials. Further, FRN amplitude for the unanimous trials was intermediate between them. The authors concluded that the coincidence of opinion can modulate personal responsibility over outcomes under majority rule, which influences the motivational value of outcomes. These findings suggest that coincidence of opinion plays a crucial role in modulating the evaluative processing of outcomes in group decision-making.

Although majority rule is a popular group decision-making strategy, it is also common to use the authority rule (Schwartz, 1994). The authority rule is a situation in which a specific group member (i.e., a leader) has the authority to make the ultimate decision for a group, whereas other members (i.e., followers) can give opinions but have no authority in making the ultimate decision. This implies that, unlike the majority rule, the responsibility over outcomes under authority rule is explicitly clarified; a leader, but not followers, is responsible for outcomes in group decision-making. In spite of the different roles, group members receive identical outcomes as a result of the group decision (i.e., a decision of a leader). No study has examined whether the coincidence of opinion affects the evaluative processing of outcomes even when the responsibility over the outcomes is explicitly clarified in group decision-making. Given the importance of the opinion coincidence for the modulation of the evaluative processing of outcomes in group decision-making (Kimura and Katayama, 2013), it is possible that the coincidence of opinion affects the evaluative processing of outcomes under the authority rule. In contrast, considering that clarifying roles and individual contributions to the collective group performance diminishes the diffusion of personal responsibility (e.g., Williams et al., 1981), it is also possible that clarifying roles and responsibilities under authority rule can diminish the effects of the opinion coincidence on personal responsibility and the evaluative processing of outcomes.

The purpose of the present study was to answer this question by assessing FRN. To accomplish this purpose, we developed a group decision-making task in which a three-person group makes a group decision based on authority rule. In this task, the leader makes a group decision to choose one of two cards after he/she observed the decisions of followers, and monetary gain or loss is contingent upon the group decision (i.e., a choice of the leader). Thus, participants performed the task under two types of experimental blocks: leader and follower blocks. Further, in line with the previous study (Kimura and Katayama, 2013, 2016), we classified each trial for each individual into one of three trial types: unanimous, majority, or minority trials. If the coincidence of opinion affects the evaluative processing of outcomes in group decision-making under authority rule, then FRN in the leader and/or follower blocks would differ among trial types. In contrast, if coincidence of opinion has no influence on the evaluative processing of outcomes in group decision-making under authority rule, then FRN in the leader and/or follower blocks would not differ among trial types.

2. Methods

2.1. Participants

Eighteen (12 women, 6 men; age range = 18–26 years, M = 20.7 years) adults participated in the present study. They were randomly assigned to six gender-matched three-person groups. All participants were right handed, had normal or corrected to normal vision, and did not have any history of neurological or mental diseases. All participants provided written informed consent according to protocols approved by the Kwansei Gakuin University (KGU) Research Ethics Review Board under the KGU Regulations for Research with Human Participants. Participants were paid 1000 Japanese yen (approximately US $9) and a bonus based on their performance.

2.2. Stimuli and procedure

Participants performed the group decision-making task in a three-person group. In this task, the group was asked to choose one of two cards and received visual feedback indicating a monetary gain or loss in each trial. The presentation of visual stimuli and the recording of the participants' responses were controlled using Presentation software (Neurobehavioral Systems). All visual stimuli were presented via a projector (Sight3D, Solidray) onto the center of a screen (2.4 m × 1.8 m, Kikuchi Science Laboratory) located approximately 2 m in front of the participants.

Fig. 1 illustrates a scheme of the group decision-making task. Participants performed the task as either a leader or a follower. Each trial began with names of the three participants displayed on the left side of the screen and two white cards (approximately 25 cm × 46 cm) with a thin black border. The name of the leader was surrounded by red square. After 500–1500 ms, the fixation cross turned red, asking followers to guess which card indicated monetary gain and to choose the left or right card by pressing a left/right button with their left/right thumb. Once they chose a card, two cards disappeared and only a black fixation cross remained for 500–1500 ms. Then, two black circles (approximately 8 cm), which indicated choices of the followers, were displayed on the card adjacent to their names. After 1000 ms, the fixation cross turned red, prompting the leader to make an ultimate decision by pressing a left/right button with the left/right thumb. The choice of the leader was followed by the presentation of a black circle superimposed on the card adjacent to his/her name, and the card chosen by the leader was highlighted by a thickening of the black outline of the card. After 2000 ms, the color of the chosen card turned red or blue, and the word "+ 30" or "-30" was shown above the card for 1000 ms, indicating the monetary gain or loss associated with the group decision. The probability of monetary gain for left/right card was 50% in each trial, and thus gains and losses did not occur with equal frequency in the present study. Assignment of colors signifying monetary gain or loss was counterbalanced across groups. An inter-trial-interval of 500–1500 ms during which only a black fixation cross was presented on the screen separated each trial.

Three participants, who were strangers, were individually invited to the laboratory and the experimenter briefly introduced the three participants to each other. After a brief description of the experiment, participants were asked to sit next to each other in front of the screen on chairs placed 1 m apart. Then, electrodes were attached. Fig. 2 shows the experimental setting of the present study. The experimenter informed participants that the sum of the accumulated amount of monetary outcomes would be divided equally and paid to each participant at the end of the experiment. The experimenter also instructed participants not to communicate with each other during the experimental task. Following detailed task instructions, each participant performed a practice block of 10 trials as a leader (i.e., two practice blocks as a follower). After the practice blocks, participants performed 12 blocks of 30 trials (360 total trials). The 12 blocks included four