BEHAVIORAL EVIDENCE FOR REPRESENTATIONS OF THE OTHER'S ACTION DURING A JOINT TASK IN RATS

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1. Introduction

Shared intentionality is one of the essential basis for linguistic communication in humans (Tomasello, Carpenter, Call, Behne, & Moll, 2005). It refers to the motivation to share a psychological state and collaborate with others for shared goals and actions. Various cooperative behaviors have been reported in nonhuman species including rats (*Rattus norvegicus*). Nevertheless, it is unclear whether such behaviors are established based on each individual's coordination or independent contributions. Therefore, we used the Joint Simon task to examine whether the rats have representation for other's action to the shared goal.

The joint Simon task is based on the Simon task. In an auditory discrimination task in which correct response is a left lever to stimulus A, and a right lever to stimulus B for example, the response is faster and more accurate when the A is presented from the left than right side. This is because the stimulus and the response are incompatible in the latter condition (Simon effect). Generally, this effect disappears when the task is divided into left and right (half task) but reappear when this task is performed by two people (joint Simon task). This joint Simon task is used to examine the shared representation of the action of a partner during joint activity in humans (Sebanz, Knoblich, & Prinz, 2003).

A previous study demonstrated the joint Simon effect in common marmosets between familiar pairs (Miss & Burkart, 2018). However, the degree of representation sharing may differ according to familiarity between partners, as in humans. Therefore, we also compared the effects based on familiarity with the

partner; cagemate and non-cagemate pairs. Subjects were also assigned to mixed and single strain cagemate conditions to manipulate familiarity between strains.

2. Methods

The subjects were eight male rats (four Long-Evans and four Wistar strain), housed in pairs. We used an operant box that could be divided into two chambers using a wire-mesh wall. Rats were trained individually on a two-choice auditory discrimination task. All subjects learned to respond by pressing the left lever at 2 kHz, and the right lever at 4 kHz. Unlike in the training, the stimuli were presented from either the left or right in the tests. The subjects experienced the four task conditions; a single condition in which one individual performed a full Simon task, a control condition in which one individual performed a half task, a joint condition in which two individuals shared the left and right half tasks, and a paired control condition in which two individuals were in the operant box but only one performed the half task. The subjects were also tested for joint and paired control tasks both with a cagemate and a non-cagemate. The compatibility effect was used for the index of the Simon effect, calculated by subtracting the correct rate for incompatible from compatible trials. The effect of task condition and familiarity on the compatibility effect was examined by linear mixed models (LMMs).

3. Results and Discussion

The subjects showed larger compatibility effects in the single and joint conditions than in control or paired control conditions. Overall, the rats showed both Simon and joint Simon effects. The difference between the paired control and joint conditions indicates that this effect was caused by sharing the task, not merely due to existence of the partner. The effects were significantly larger in cagemate than in non-cagemate pairs. However, no significant differences were found based on whether the partner was of the same or different strain. Therefore, familiarity between partners only partially explain the differences in compatibility effects. In summary, action co-representation for partner in joint tasks was shown in rats, which is highly social species. Although cooperative tendency differed based on familiarity of the strain in the previous study, it is unclear whether social factors modulated the joint Simon effect in this study. Therefore, further studies focusing on individual differences in the effect, such as the frequency of paying attention to the partner, would be informative.

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