EMERGENCE OF THE UNDERSTANDING OF THE OTHER'S INTENTION: RE-ENACTMENT OF INTENDED ACTS FROM "FAILED-ATTEMPTS" IN 12- TO 24-MONTH OLDS

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Two studies were conducted to examine developmental emergence of the infants' ability to respond to the other's intention that cannot be observed from the surface of the act, adapting the behavioral re-enactment procedure developed by Meltzoff (1995). In Study 1, as a part of the questionnaire, we asked 156 caretakers to test their infants with the modified and simplified version of a re-enactment procedure. In Study 2, on the basis of the finding of Study 1, we directly tested 33 infants younger than ones tested in Meltzoff (1995) and confirmed that 15-17month olds could respond to the other's intention. The agreement of results between these different procedures suggested validity of the procedure used in Study 1. This procedure might work as a serviceable tool for the preparative study, which opens the possibility to use it as a part of test batteries for assessing infants' development in broad age.

Key words: intention, infancy, behavioral re-enactment

Imitation has been one of the most important topics in developmental psychology over the last quarter century. Especially since Meltzoff and Moore (1977) reported facial imitation in neonates, many empirical studies gradually clarified our views about young children's cognitive developmental mechanism of imitation.

Studies of imitation are important not only as themselves but also as an observable measure to investigate some aspects of the early development. Intention is one of the important topics that could be investigated through imitation. Doing the same acts as others in the same way has two interpretations with respect to understanding intentions: one is that the infant does so, as the adult does, on the basis of understanding of the

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model's intention and purpose of the act, which is called imitation. The other is that the infant copies the model's act only at the behavioral level, without understanding of the intention, which is called mimicry (Tomasello, 1999). To see understanding others' intention through doing the same acts as others, these two possibilities should be divided methodologically.

In the recent survey on this topic, Meltzoff (1995) has taken some important steps in this direction. He developed a technique called the "behavioral re-enactment" procedure, separating the two possible interpretations above. In this procedure, the response of the infant subject was observed after the exposure of one of the two demonstration conditions: in one condition, the infant subject saw the experimenter perform a specific target act with the object (D/Target condition). In the other condition, the experimenter demonstrated only the intention of performing target acts but not the final state (D/Intention condition). For example, the experimenter tried to pull the ends of a dumbbell outward three times but slipped off the end, so that all infants saw was the experimenter's attempts in vain. The results were that the D/Target and D/Intention conditions were not significantly different from each other. This led the conclusion that 18-month olds could understand and re-enact what the experimenter intended to do, even if the adult did not successfully reach his goal.

Taking the same procedure, Bellagamba and Tomasello (1999) reported that they succeeded in replicating the Meltzoff's results in 18-month olds but found no positive evidence in 12-month olds. It led to the conclusion that D/Intention condition was an effective model for 18-month olds, but not for 12-month olds. This might suggest that there should be a period before 18 months where infants just copy the model's act without understanding of its intention. At somewhere between 12 and 18 months, infants might re-enact the model's act on the basis of the understanding of its intention.

On the other hand, Huang, Heyes, and Charman (2002) questioned whether the results of Meltzoff (1995) and Bellagamba and Tomasello (1999) really reflected understanding others' intention. They claimed that nonimitative social learning such as emulation learning and stimulus enhancement might induce infants to re-enact target acts. They also noted that affordances of the objects might also play a role in determining infants' performances. To minimize these potential artifacts, selection of the target acts should be important.

Based on the findings of these previous studies, two major goals of the present study were as follow: (a) clarifying when between 12 and 18 months the infant "finds" other's intention through the acts; (b) examining the infant's reaction (imitation) with excluding the influence of previous experience or affordance, that is, with using novel acts for the infant as models.

STUDY 1

Previous studies have shown that 18-month olds could "read" the model's intention through his/her act while 12-month olds could not. However, developmental changes between these ages have not been examined successively. Investigating where between

Fig. 1. A schematic photograph of the caretaker's demonstration in the D/Intention condition, which was reproduced in the laboratory, not at home. The final state of the act is presented here: the caretaker did not touch the rice bowl.

12 and 18 months of age infants come to understand others' intention should be important in order to clarify how such ability co-relates to other cognitive skills.

Study 1 asked volunteer mothers to test their infants at their own home and report the results, following the manual for the testing procedure. To examine detailed developmental change, a considerable amount of data should be required. The procedure taken in the Study 1 made us it possible to collect them.

Method

Participants: Participants were 156 pairs of a baby and his/her caretaker. The age of infants ranged from 12 to 24 months. We included 19- to 24-month olds in addition to 12- to 18-month olds in the subject group, in order to follow up the results obtained in 18-month olds. They divided into four different age groups depending on the infant's age; 12- to 14-month olds ($n=29$), 15- to 17-month olds ($n=40$), 18- to 20-month olds ($n=37$), and 21- to 24-month olds ($n=50$). The caretakers were recruited as volunteers from several nursery schools and play centers for infants and young children in Fukuoka, Japan.

Test materials: The test materials were a rice bowl for D/Intention condition and a small box for D/Target condition, both of which can be available in each home.

Procedure: Each caretaker (mother) was handed out an instruction, which described two experimental conditions; D/Intention and D/Target conditions. For both conditions, the target act was leaning and touching the foreheads towards the objects (Figs. 1 & 2), which is a modification of the procedure developed by Meltzoff (1988) to assess infants' imitation of novel acts. This head-touch act should not be induced by the physical properties of these objects, since the previous study observed virtually no such spontaneous acts by infants when they were presented similar objects (Meltzoff, 1988). All caretakers were instructed to examine D/Intention condition before D/Target condition, in order not to provide infants a chance to know the final state.

The caretaker conducted the experiments when her infant was in relaxed and comfortable atmosphere. During the experiment, she had to keep infant's attention with saying nothing about imitation or the particular target act, though she was allowed to communicate with the infant verbally. The infant was seated facing the caretaker across the table. The caretaker successively repeated one of the two demonstrations on each object three times and directly placed it on the table in front of the infant. The demonstration in each condition was as follows: in D/Intention condition, the caretaker put in front of her a rice bowl upside-down on the table. Then she leaned her body and tried to touch their foreheads on the bowl, but failed to do so because it was a bit away. In D/Target condition, a small box was put in front of caretakers. They leaned their bodies and successfully touched their foreheads on the box.

Fig. 2. A schematic photograph of the caretaker's demonstration in the D/Target condition, which was reproduced in the laboratory, not at home. The final state of the act is presented here: the caretaker did touch the box.

Scoring: In both conditions, after demonstrating the act, the caretakers observed their infant's response and reported what the infant did in 20 seconds after the infant touched the object. Based on the caretaker's report, the first author classified each subject's response on the basis of whether the infant showed the target act, which is defined as touching his / her foreheads to the objects.

Results and Discussion

The percentage occurrences of the target act for each age group was shown in Fig. 3. The scored percentages for D/Target and D/Intention condition were 10.34% and 13.79% for 12- to 14-month olds, 52.5% and 50% for 15- to 17-month olds, 54.05% and 62.16% for 18- to 20-month olds, and 58% and 58% for 21- to 24-month olds.

A two-way analysis of variance (ANOVA) was conducted after arcsine transformation of these percentages, with age (12 to 14 months, 15 to 17 months, 18 to 20 months, and 21 to 24 months) and experimental condition (D/Target and D/Intention) as independent variables. There was no main effect of experimental condition across ages, but ages yielded a main effect. Across conditions, 12- to 14-month olds produced significantly less target acts than the others, $F(3, 148)=54.95, p<.01$. This result showed that 15-month olds imitate target acts even if the target act was unaccomplished and novel. There was no significant difference between D/Target and D/Intention conditions, irrespective of the age group, whereas Bellagamba and Tomasello (1999) found difference in 12-month olds who were included in the youngest age group tested in the present study.

The procedure used in Study 1 made possible to collect enough data for discussion with relative ease. However, we must consider the possibility that the mothers might overestimate their babies' response. Moreover, the experimenter was almost unfamiliar for the subject infants in the previous studies, even though he/she interacted with the infant before the experiment, which makes clear contrast to the Study 1 where mothers played a role of the experimenter. To examine the possibility that these factors might affect the results obtained in Study 1, replication of the results in laboratory-based experiment should be necessary, especially for around 15-month olds.

Fig. 3. The percentages of performing target acts with each age group and condition.

STUDY 2

Study 2 tested infants around 15 months following the laboratory-based behavioral re-enactment procedure of Meltzoff (1995).

Method

Participants: Participants were 32 infants: fourteen 12- to 14-month olds (6 boys and 8 girls; $M=13.4$ months, $SD=.8$) and eighteen 15- to 17-month olds (8 boys and 10 girls; $M=17.1$ months, $SD=.7$). Three additional infants were eliminated from the analysis; one infant for procedural error, and two for not being able to complete the test session. The children were recruited from the volunteer panel in Kyoto University in Kyoto, Japan, or from the nursery schools and play centers for infants and young children in Fukuoka, Japan. Thirty children were Japanese, 1 was Nepal-Japanese, and 1 was Canadian-Japanese.

Test materials: The test materials were designed to be replicas of the five objects used in Meltzoff (1995)'s study (see Meltzoff, 1995, for diagrams). The list of object sets and the corresponding target act for each set were as follow; (a) a dumbbell-shaped toy that could come apart into two pieces and take together again, (b) a black box with buzzer which could be activated by a wooden stick, (c) a black and yellow loop that could be draped over a horizontally prong, (d) 20 cm loop of white beads that could be put into a yellow cylinder, and (e) a square with a hole in the middle that could be placed over a vertically prong.

Procedure: The experiment was conducted in a quiet room in the play centers ($n=12$), in a quiet room in the nursery schools ($n=6$), or in the laboratory of the university ($n=14$). Two video cameras recorded the infant's reaction including manipulations of the objects, as well as whole interaction between the infant and the experimenter.

The infants at each age group were randomly assigned to one of three independent conditions; D/Target, D/Intention, and Baseline condition.

During the session, the infant was seated facing the experimenter across a table. The caretaker(s) sat behind or next to the infant. The session started with a warming-up period. In this period, the infant played with the female experimenter and two stuffed toys. The experiment proceeded to the test session when the infant seemed to be comfortable enough and ready to participate in the test session actively.

In each test trial, the experimenter placed one of the five object sets in front of the infant. The order of the object tested was counterbalanced both within and between the conditions. The experimenter successively repeated demonstrations corresponding to each object three times. The infant was not allowed to touch the object during the demonstration. After the demonstration, the infant was allowed to manipulate the object. During the experiment, the experimenter kept infant's attention with saying nothing about imitation or the particular target act, though she communicated with the infant verbally. The demonstration in each

Fig. 4. The mean number (SE) of target acts with each age group and condition.

condition was as follows: in D/Target condition, the experimenter demonstrated the target acts (the target act for each object was identical to Meltzoff (1995)). In D/Intention condition, she demonstrated the failed attempts of the target acts. In Baseline condition, she did not manipulate the object but only showed it for 20 seconds, almost as long as the duration required for one trial of D/Intention or D/Target condition.

Analysis: For each condition, 20 seconds after the infant touched the object were observed through the video records.

The criterion to judge infant's response, whether he/she performed the target acts or not, was identical to Meltzoff (1995). The infant was assigned score, ranged from 0 to 5, according to how many of the five target acts he/she reproduced, which was used for later statistical analysis. Seventy-five percent of the data was scored by the first author and another 25% of the data was scored by two independent scorers including the first author to assess the scoring agreement. The agreement was excellent enough; there was only 1 disagreement across the 40 trials.

We also performed frame-by-frame analysis (30 frames for 1 second) of the video record to assess latency to produce the target act.

Results and Discussion

Fig. 4 showed the mean number of target acts for each condition for each age group. The main analysis was a 2×3 ANOVA, with age group (12- to 14-month olds and 15- to 17-month olds) and experimental condition (D/Target, D/Intention, and Baseline). Both independent variables yielded significant effects. Across conditions, 15- to 17-month olds produced more target acts than 12- to 14-month olds, $F(1, 26)=4.77$, $p<.05$. Across the age groups, the target acts of Baseline condition were significantly less than those of D/Target and D/Intention condition ($p<.0001$ and $p<.05$, respectively, Tukey HSD tests). The number of target acts was not different from each other between D/Target and D/Intention conditions. The results for the 15- to 17-month group precisely replicated those of Meltzoff (1995). The D/Target and D/Intention condition did not differ from each other, but were different from Baseline condition ($p<.01$, Tukey HSD tests). On the other hand, the results of the 12- to 14-month group showed different tendency; there was no significant difference in performance among conditions. This was in contrast to that of Bellagamba and Tomasello (1999) where significant difference found between D/Target and D/Intention conditions.

The mean latencies to produce the target acts in the 20-s response period were as follow; in 12- to 14-month group, 8.40s ($SD=7.38s$) for D/Target condition whereas 6.68s ($SD=3.30s$) for D/Intention condition, and, in 15- to 17-month group, 5.40s ($SD=3.77s$) for D/Target condition whereas 7.86s ($SD=5.62s$) for D/Intention. These latencies were not significantly different from one another.

The present results showed that 15-month olds imitate target acts even if the target act was unaccomplished. On the other hand, before 14 months, infants might not respond on the basis of the understanding of the other's intention in action. Though the infant younger than 14 months should utilize some behavioral cues like eye directions or facial expressions (e.g., Brooks & Meltzoff, 2002; Sorce, Emde, Campos, & Klinnert, 2000) which are considered as windows of the other's intention, such information might not be sufficient to respond inferring the other's intention in action from the failed attempts.

GENERAL DISCUSSION

Two studies were conducted to examine developmental emergence of the infants' ability to understand of the other's intention, using the behavioral re-enactment procedure. In Study 1, by asking volunteer caretakers to perform a series of experiment at their own home, we found that 15- to 17-month olds, not younger participants, succeeded in completing the target act even in the D/Intention condition, despite that the test objects have no affordance to induce the infants to do the act. This suggested the possibility that the infants at this age could read the demonstrator's intention. However, we have to consider the possibility that the mothers might overestimate their babies' response, when examining the results of Study 1. In addition, the experimenter was usually unfamiliar for the subject infants in the previous studies, while in the Study 1 the mothers, who are undoubtedly familiar to the infant, played a role of the experimenter. To examine the possibility that these factors might affect the results obtained in Study 1, Study 2 directly tested infants following the laboratory-based behavioral re-enactment procedure, which reconfirmed the result of Study 1. This suggested that the effect of overestimation by mothers is not so critical in the procedure of Study 1. The combination of such "caretaker as experimenter (CAE)" procedure and laboratory-based experiment should be fruitful which could be expanded to other topics in developmental psychology.

As for 12- to 14-month olds, the result of the present study looks different from that of Bellagamba and Tomasello (1999). The possible factor to explain this difference might be the participants' age. In the present study, 13- or 14-month olds, not only 12-month olds, were included in the first age group. There might be a period between 12 and 14 months where only D/Target demonstration is effective but D/Intention is not. More detailed investigation might clarify whether there is a developmental period where infants show only mimicry but not imitation, which have critical implication to the studies of intention and imitation. Our study suggested that 15-month olds could understand others' intention in action. At around 15 months, Ohgami (2002) reported based on his longitudinal questionnaire research that infants become sympathetic and come to react

appropriately to others' pain. The infant at this age might understand others' innate state including intention.

Taken together, we had good agreement of results across two methods of study; the CAE procedure in Study 1 and the laboratory-based experiment in Study 2. Both studies concur that 15- to 17-month olds could respond to the other's intention. The agreement of results between the procedures suggested validity of the procedure adopted in Study 1, at least as a strategic preparative study. Just as language research has greatly benefited from the development of maternal questionnaires (e.g., the MacArthur scale developed by Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly (1993)), this type of procedure could compensate some of the difficulties of the laboratory research and play a helpful role in understanding an aspect of infant development.

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