# How children understand other's belief before they develop attentional flexibility?

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## Abstract

*Recent studies had shown that there is developmental link between theory of mind and self-control ability. According to those studies, 3-year-old children who were not supposed to have theory of mind did not develop attentional flexibility, one of the main functions of self-control ability. In this study, we investigated how 3-year-old children understand other's belief before they develop attentional flexibility. In the Experiment1, preschoolers were given a card sorting task. Prior to starting the task, they were shown that the demonstrator sorts the cards incorrectly. There were two conditions, false belief condition and correct belief condition, according to the demonstrator's belief. Children needed attentional flexibility to solve this task correctly. In the Experiment 2, the procedure was identical except that the demonstrator sorted the cards correctly. The results showed that there was significant difference of performance between conditions in 3-year-old children, and that other's belief affected the performance of children in the task which needed attentional flexibility. This suggested that even 3-year-old children, whose attentional flexibility was immature, could discriminate the other's belief implicitly. We discussed the relationship between theory of mind and self-control ability from our results and proposed the new theory.*

## 1. Introduction

### 1.1. Self-control ability

The ability to control attention and behaviour becomes more efficient during preschool years [1, 2]. One task frequently used to examine children's self-control is the dimensional change card sorting task (DCCS) [3]. In this task, children were given two target cards (e.g., red rabbits and blue boats) and sorting cards (red boats and blue rabbits), featuring two dimensions, and matched one target on one dimension and the other target on the other dimension. The task had two phases. In the first phase, the children were told a rule of the game which specifies how to sort the test cards according to a particular dimension, e.g. shape dimension. The experimenter said to children "Let's start a game. This game is the shape game. In this game, all the rabbits go here (pointing to a blue rabbit target) and all boats go there (pointing to a red boat target)." When the children finished five trials, the rule was changed to the color rules. The experimenter said to children "Now we are playing another game. We are playing the color game. In this game, all the red cards go here (pointing to a red boat target) and all blue cards go there (pointing to a blue rabbit target)" The children were given five trials without feedback. In this task, three-year-old children could sort the cards according to first dimension, but they could not inhibit the preceding response and showed perseverance with the old dimension when they were requested to sort according to the new dimension. On the other hand, most of the 4- and 5-year-old children could switch between the rules and sort the cards correctly

Gerstadt, Hong and Diamond [4] had observed similar difficulty in preschoolers using a Stroop-like task. In their study, children were required to keep to rules set by the experimenter and resist the temptation to say what the stimuli really represented. When presented with black/moon cards, the correct response was "day", and when presented with white/sun cards, the correct response was "night". Children between 3 and 4 years of age showed difficulty performing this task, saying "night" when they saw the black/moon cards and "day" when they saw the white/day cards. On the other hand, 5-6-year- old children age were able to respond correctly..

One of the theories used to explain young children's difficulty in this kind of task is attentional inflexibility theory. Moriguchi and Itakura [5] postulated that children should develop the ability to inhibit attention to irrelevant information and behavior. Younger children's perseveration is caused by a failure to inhibit attention to old rules. The tasks used included two alternatives (e.g., shape rule and color rule). One of two alternatives was salient for children for various reasons (e.g. familiarity, reinforcement by feedback, more attractive object) and in the tasks children needed to suppress their attention to the salient alternative in order to use another alternative. Five-year-old children were able to inhibit their attention to the

salient alternatives and switch their attention to less salient ones and thus control their choices, but 3-year-old children could not; the latter perseverated to the salient alternative.

## 1.2. Theory of Mind

Theory of mind is one of the most important topics in developmental science. Young children show difficulty understanding that people have the mental state such as belief and knowledge, but as they get older they acknowledge the representational quality of mental states [6]. Most popular task to measure theory of mind is the false belief task. Two puppets (Bert and Ernie) played with a ball bliefly and then Bert put the ball in a blue container and left. Ernie retrieved the ball, played briefly with it and then put it away in a red container and left. Finally, Bert returned , wanting to play with the ball, and children were asked the False belief question ("Where does Bert think the ball is?") followed by the reality question.

Wellman, Cross and Watson [7] presented a meta-analysis of these kind of tasks and showed that children who were 3 years 5 months or younger performed below chance and made the error in the false belief question. Children who were 4 year or older performed above chance and could recognize that people held the false belief.

## 1.3. Self-Control Ability and Theory of Mind

Recent studies suggest that the development of self-control is related to the development of theory of mind. Perner and Lang [8] reviewed studies of the relationship between self-control and theory of mind, and concluded that self-control tasks (e.g. DCCS) and theory of mind tasks (e.g. false belief task) have something in common. For example, although typically developed children showed a four-year shift in both tasks, difficulties are encountered by many atypically developed children (e.g. autism) on both tasks. Many studies have shown a strong correlation between theory of mind tasks and self-control tasks in preschoolers [9,10]. Perner, Lang and Kloo [10, Experiment1] gave preschoolers two versions of a false belief task to assess theory of mind, and the Dimensional Change Card Sorting task (DCCS) as a self-control task. They found a significant positive correlation between two of false belief tasks and the card sorting task.

Self-control ability consisted of several functions such as planning, attentional flexibility, inhibitory control , error detection and correction, and so on [11,12]. Moriguchi and Itakura [5] suggested that one function of self-control ability might be related to the development of theory of mind. They used the card sorting tasks which had the correlation with theory of mind tasks and showed the possibility that the development of attentional flexibility was related to the development of theory of mind.

In their study, they modified the DCCS and gave the children three phases. The first phase was the same as DCCS. In the second phase, the children practiced directing their attention to the new dimension and then in the third phase they were asked to sort the cards according to the new dimension. Compared with the standard DCCS, the children's performance did not improve. This result suggested that the children could not switch their attention to the new dimension in the presence of conflicting cues, which were cues related to old rules. Therefore, in the subsequent experiment, there were two phases and they removed the old dimension from the targets in the second phase. Thus the children did not face conflicting situations in this phase. In this experiment, the children were able to direct their attention to the new dimension easily. This result suggested that the 3-year-old children have difficulty switching attention when faced with conflicting situations, and that 3-year-old children lacked the attentional flexibility.

From this result and the fact that there is the positive correlation between theory of mind tasks and DCCS, the development of attentional flexibility might be related to the development of theory of mind

## 1.4. Purpose of the present study

Earlier studies suggested that the development of theory of mind was related to the development of the attentional flexibility, but it is not still clear that how children might understand other people's mental states before they develop attentional flexibility. Some studies suggested that children who were 3 year or younger had the implicit understanding of theory of mind [13], but there were no studies about their implicit understanding with respect to the attentional flexibility. In the present study, using the new paradigm, we investigated how 3-year-old children could understand the other's belief when their attentional flexibility was immature. In a card sorting task requiring attentional flexibility, children watched another person performing the task after being told the rule, but the demonstrator sorted the cards according to the wrong rule. After the demonstrator's performance, children were required to sort the cards according to the rule experimenter had announced first. There were two conditions; in each condition the demonstrator showed the same sorting behaviour, but the demonstrator's belief was different. In one condition she (the demonstrator) believed that her sorting was correct, whereas in the other condition she noticed that her sorting was wrong. To perform the task correctly, children needed to keep the correct rule in memory and inhibit attention to the wrong rule regard-

less of the demonstration, that is, children needed the attentional flexibility.

If 3-year-old children might understand and discriminate other's belief before they develop attentional flexibility, there was the difference of the performance between conditions.

## 2. Experiment 1

### 2.1 Method

***Participants***

Thirty-four 3-year-old children (*M* = 42.8 months, range = 37 months to 46 months, 19 boys and 15 girls), thirty-six 4-year-old children (*M* = 54.0 months, range 48 months to 59 months, 18 boys and 18 girls) and thirty-eight 5-year-old children (*M* = 67.8 months, range 61 months to 71 months, 19 boys and 19 girls) were recruited from nursery schools in Kyoto as participants. Half of 3 and 4 year old children and 18 5-year-old children were distributed the correct belief condition, and the rest of children were distributed the false belief condition. Most children came from middle-class back grounds and had developed normally.

***Materials***

Laminated cards (12 cm × 8 cm) were used as stimulus. There were two target cards （a yellow house and a blue cup）to be matched. There were 6 sorting cards (3 blue houses and 3 yellow cups). The trays (13 cm ×13 cm) on which the children put the cards were transparent and were placed near the targets.

***Procedure***

Each child was tested individually for 5 - 10 minutes. The participant was seated at a table. There were two conditions: a correct belief condition, and a false belief condition. In both conditions two experimenters were present. Experimenter A sat at a table across from the child and Experimenter B sat next to the child. The experimenters spoke briefly with the child, and once the child appeared relaxed, the experiment began. Each condition had three phases: pretest phase, observation phase and sorting phase.

In the correct belief condition, Experimenter B was instructed to sort the cards according to the wrong dimension, to maintain a neutral facial expression, and not to express any cues that the child might identify. In the pretest phase, Experimenter A presented the child with the cards and asked the child to name the pictures ("What is this picture?"). Children were asked to label the objects according to the two dimensions (e.g. "yellow" "cup"). If they answered correctly, Experimenter A announced the rule of the game, the shape rule ("In this game, all the cups go in this tray, and all the houses go in this tray). Earlier studies [5] showed that the order of dimension did not affect children's performance, so in the present study we used the shape rule only. We then asked the child knowledge questions to make sure that the rule was understood. Experimenter A asked "Where does this (yellow cup or blue house) card go?" The child was asked to answer two questions by pointing.

After confirmation that the child could answer knowledge questions correctly, Experimenter A said, "Now she (Experimenter B) will sort the cards, so please wait and see her," and she started to sort the cards. Although experimenter B was instructed to sort the cards according to the same dimension as the child, she failed to do this; instead she sorted the cards according to color dimension. On every one of three or four trials Experimenter A asked Experimenter B "Is this sorting right?" Experimenter B noticed her mistake and said "Oh, I am mistaken." This was the observation phase.

After the observation phase, Experimenter B said "I want to go to the toilet" and went out of the room and then Experimenter A asked the child whether Experimenter B's performance was correct or not. If the child did not answer correctly, Experimenter A stated that Experimenter B had sorted the cards incorrectly. The child was then told: "Please sort the cards according to the rule I told you first." The child was given five sorting trials, with no feedback about the cards were sorted correctly.

The false belief condition was identical except that Experimenter B had a false belief in the observation phase. In the observation phase, the child watched while Experimenter B sorted the cards according to the color (wrong) dimension. On each trial, Experimenter A asked" Is this sorting right?" Experimenter B pretended not to notice her mistakes and she confidently nodded "Yes." (See Fig. 1)

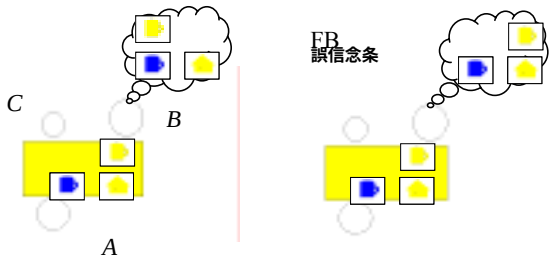


Figure 1. The observation phase in the correct belief condition and false belief condition.
*A* = Experimenter A, *B* = Experimenter B, *C* = Child, CB = correct belief condition, FB = false belief condition

### 2.2 Result

The result was shown in Fig. 2. Three 3-year-old children (from the correct belief condition) were excluded from the analysis because they did not answer the pre-

test phase knowledge questions correctly. Children were thus classified as passing or failing according to whether they sorted at least four out of five cards correctly. This classification followed an earlier study [3].

No significant effect of gender was found, so all data were collapsed across this variable. There was no significant developmental change in the correct belief condition, but the performance of children in the false belief condition improved with age ($\chi^2(1, N = 55) = 90760$ $p = .008$).

The difference between the correct belief condition and the false belief condition fell short of significance ($\chi^2(1, N = 105) = 2.909$ $p = .088$)

Interestingly, 3-year-olds performed nearly significantly worse in the false belief condition than in the correct belief condition ($\chi^2(1, N = 31) = 3.0770$ $p = .052$), but 4- and 5-year-olds' in these conditions did not vary.

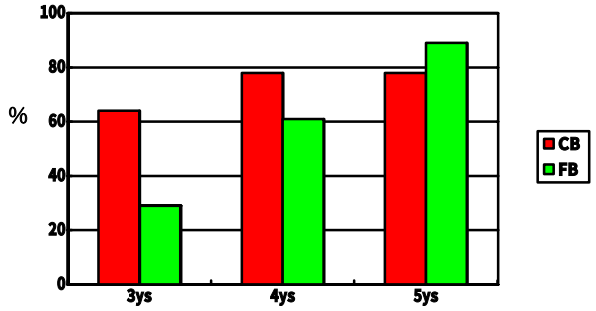


Figure 2. Percentage of children who passed the task in each age. CB = Correct Belief, FB = False Belief

## 2.3 Discussion

We found no significant difference between children's performance in the false belief and the correct belief conditions; however, 3-year-old children in the false belief condition were more likely to be affected by the demonstration than in the correct belief condition. In the observation phase of both conditions, children observed Experimenter B's demonstration as she mistakenly sorted cards according to color. This was inconsistent with the children's knowledge because in the pretest phase they were asked to sort the cards according to shape. In each condition, the experimenter's behavior was the same, but the effect on children's sorting was different. In the correct belief condition, most of the children including 3-year-olds sorted cards correctly in the sorting phase. In contrast, younger children in the false belief condition were inclined to imitate Experimenter B, probably due to being influenced by Experimenter B's mental state. In the correct belief condition Experimenter B noticed her mistakes, possibly reinforcing the children's confidence in the rule for this task. They paid attention to the shape-rule. However, in the false belief condition Experimenter B "believed" that her performance was correct, which might have led children to doubt their knowledge (the rule of the game) and instead think that the rule Experimenter B used was correct. Even if Experimenter A stated that Experimenter B was wrong at the start of the sorting phase, children perseverated with the color dimension. For these children, the correct rule was the color rule, so most 3-year-old children in the false belief condition sorted the cards according to color. This result suggested that 3-year-old children's attentional flexibility was immature, and that children's performance on the task which required attentional flexibility was affected by the demonstrator's mental state. This meant that 3-year-old children, who were not supposed to have theory of mind, could discriminate other's belief implicitly before they developed attentional flexibility.

We also found a developmental change in responding in the self-control task, especially in the false belief condition. Although younger children were influenced by the demonstration, most 5-year-olds were not. This developmental change would reflect the development of self-control ability. Five-year-old children with developed self-control ability could inhibit experimenter B's rule and control their behavior and attention, but children at age of 3 years could not.

In the Experiment 2, we investigated further whether 3-year-old children discriminate other's belief. Were children affected the demonstrator's belief when the experimenters did not use and refer the wrong rule? In this experiment, there were three phases as Experiment 1, but in the observation phase, the demonstrator sorted cards correctly, so children did not have to inhibit the wrong rule. They were instructed the rule of the game, shown the correct demonstration and asked to sort the cards according to the correct rule. There were also two conditions as Experiment 1; in misunderstanding condition, children were shown the correct behavior with the false belief, and in control condition, children were shown the correct behavior with the correct belief. If 3-year-old children could discriminate the belief implicitly, there was the difference of the performance between conditions even if they were shown the correct demonstrations.

# 3. Experiment 2

## 3.1 Method

***Participants***

Thirty 3-year-old children ($M$ = 42.5 months, range = 38 months to 48 months, 18 boys and 12 girls), twenty 4-year-old children ($M$ = 55.6 months, range 48 months to 60 months, 10 boys and 10 girls) were recruited from nursery schools in Kyoto as participants. Thirteen 3-year-old children and half of 4 year-old children were

distributed the misunderstanding condition, and the rest of children were distributed the control condition. Most children came from middle-class back grounds and had developed normally.

***Materials and Procedure***

Material was the same as that of Experiment1. Each child was tested individually for 5 - 10 minutes. There were two conditions: a misunderstanding condition, and a correct condition. The experimental situation was the almost same as that of Experiment1. There were two experimenters and one participant.

In the misunderstanding condition, Experimenter A presented the child with the cards and asked the child to name the pictures. Children were asked to label the objects according to the two dimensions. When they answered correctly, Experimenter A announced the rule of the game, the shape rule. We then asked the child knowledge questions to make sure that the rule was understood. Experimenter A asked "Where does this card go?" The child was asked to answer two questions by pointing.

Experimenter A said, "Now she (Experimenter B) will sort the cards, so please wait and see her," and she started to sort the cards. She could sort the cards correctly. On every one of three or four trials Experimenter A asked Experimenter B "Is this sorting right?" Experimenter B misunderstood the rule of the game and said "Oh, I am mistaken." This was the observation phase.

After the observation phase, Experimenter B said "I want to go to the toilet" and went out of the room and then Experimenter A asked the child whether Experimenter B's performance was correct or not. If they could not answer correctly, Experimenter A told the child "Her performance was correct." The child was then told: "Please sort the cards according to the rule I told you first." The child was given five sorting trials, with no feedback about the cards were sorted correctly.

The control condition was identical except that Experimenter B had a correct rule in the observation phase. In this condition, she didn't misunderstand the rule of the game.

## 3.2 Result

The result was shown Fig. 3. Five 3-year-old children (two from misunderstanding condition and three from the correct belief condition) were excluded from the analysis because they did not answer the pretest phase knowledge questions correctly. No significant effect of gender was found, so all data were collapsed across this variable. There was no significant developmental change in both condition, but 3-year-old children in the control condition were more likely to perform the task correctly than those in the misunderstanding condition ($\chi^2$ (1, $N$ = 34) = 5.885 $p$ = .015).

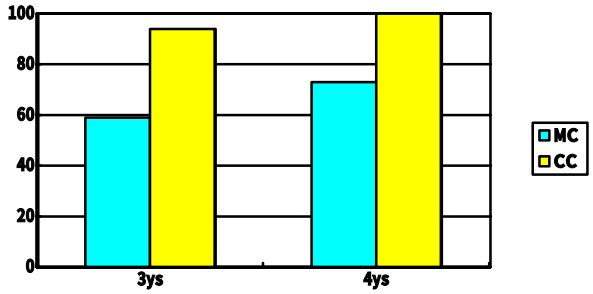


Figure 3. Percentage of children who passed the task in each age. MC = Misunderstanding Condition, CC = Control Condition

## 3.3 Discussion

In this experiment, we could find the significant difference of the performance in 3-year-old children between misunderstanding condition and control condition. In both conditions, children were shown the correct performance in the observation phase, so this difference would caused by the demonstrator's belief. In the control condition, children showed no difficulty to the task because the rule given on the pretest phase, the rule shown on the observation phase and the rule the demonstrator had in mind were the same. On the other hand, more than half children sorted cards incorrectly in the misunderstanding condition in which the demonstrator used correct rule with false belief. This result supported the view 3-year-old children could discriminate the other's mind implicitly.

Most interesting point in this experiment was that children in the misunderstanding condition used the color rule although no one showed, used, and even referred it. On the pretest phase, the experimenter confirmed the rule and children could answer by pointing, and on the observation phase, children were shown the correct demonstration and the experimenter B said "I am mistaken" only. In addition, Experimenter A said "Her performance was correct"

This might be because 3-year-old children know that there were two rules in this task and they could switch the rule and perhaps they speculated the rule the experimenter had in mind. However, once they focused on the color rule, they could not switch back to the shape rule even if experimenter said "The demonstrator's performance was correct". This suggested that 3-year-old children's attentional flexibility was immature although they might speculate other's mental state.

## 5. General Discussion

In the present study, we investigated whether 3-year-old children, who were not supposed to have theory of

mind and mature attentional flexibility, could understand and discriminate other's belief implicitly. In the Experiment 1, children needed to keep the rule the experimenter instructed on the pretest phase. They were shown other's wrong performance with different beliefs. Children were shown the same behaviour, but children in the false belief condition where the demonstrator had the false belief were more likely to imitate the demonstrator's wrong action than those in the correct belief condition where the demonstrator had the correct belief.

In the Experiment 2, we investigated whether 3-year-old children were affected by other's belief even when children were not shown the wrong rule. Children were shown the correct performance in each condition, but children who were exposed the false belief were more likely used to the wrong rule than children who were exposed the correct belief. These results suggested that 3-year-old children would discriminate other's belief implicitly before they developed attentional flexibility.

Does this study support the notion that there is the relationship between theory of mind and self control ability ? As described above, earlier studies showed a positive correlation between self-control and theory of mind [9]. However as Perner and Lang [8] point out, several hypotheses exist concerning this relationship. For example, Russell [14] emphasized that self-control ability is necessary for developing theory of mind. He suggested that monitoring of action and the ability to act at will is needed to develop self-awareness, and that this self-awareness is necessary for acquiring a mental concept. On the other hand, Perner [15] suggested that children need to acquire the meta-representation before they can perform self-control tasks successfully. According to Perner, children develop meta-representation when they develop theory of mind; therefore, developing theory of mind leads the development of self-control ability.

The present study suggests that children who have immature attentional flexibility might have implicit understanding of theory of mind. From this result, we would support the notion that self-control ability is necessary for developing theory of mind. We proposed that the development of attentional flexibility was needed when implicit understanding theory of mind becomes explicit. When children's attentional flexibility is immature, they can not pass the tasks which measures self-control ability (e.g. DCCS) and theory of mind tasks (e.g. false belief task), but they can discriminate other's belief implicitly. When they develop the attentional flexibility and they can pass the tasks which measures self-control ability, they come to understand other's belief explicitly and pass the theory of mind tasks. In the further research, we would investigate the causal relationship between the development of attentional flexibility and the development of theory of mind.

## 6. Acknowlegement

This research reported here was supported in part by Basic Research 21 for Breakthroughs in Info-Communications and a grant from JSPS (No: 13610087) to Shoji Itakura.

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