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Relationship between Theory of Mind and Conflict Inhibitory Control in Japanese Children

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Abstract: Previous research has revealed that executive function (EF), particularly conflict inhibitory control (IC) and working memory (WM), contribute to the development of a *theory of mind* (ToM). Although most studies show that conflict IC, rather than WM, may influence ToM, Japanese studies indicate that WM, rather than conflict IC, might influence ToM. We propose that these inconsistent results could be attributed to using only one ToM task and an extended test session. Therefore, we re-examined the relationship between ToM and conflict IC in 50 3–5-year-old Japanese children using test batteries and shortening a test session. The results showed a significant correlation between the conflict IC and the ToM batteries after controlling for age and gender. This result is consistent with findings from other countries and contradicts those of previous Japanese studies. Our findings suggest that Japanese children may use conflict IC to perform ToM tasks as seen in other countries.

Key words: Theory of mind, executive function, working memory, conflict inhibitory control

Introduction

Theory of mind (ToM) is the ability to impute mental states to oneself and others (Premack & Woodruff, 1978) and is usually assessed using a false belief task in preschool. The false belief task requires children to predict and explain a protagonist's behavior by inferring their false beliefs (Devine & Hughes, 2014). Although three-year-old children cannot pass the false belief task, they can gradually pass these tasks after turning four years old (Perner, 1991). Researchers have regarded the transition from failing the false belief task to passing it as acquiring the concept of belief and mental representation (Gopnik & Wellman, 1994).

However, recent studies have shown that children can pass these tasks by using the concept of belief and mental representation and by using other supporting components. According to Wang et al. (2016), both internal (language) and external factors (culture, pedagogical experience) might contribute to individual differences in ToM during early childhood. Studies have particularly examined the relationship between ToM and executive function (Devine & Hughes, 2014). *Executive function* (EF) is a cognitive self-regulatory process for monitoring and controlling thoughts and actions (Carlson, 2005).

The relationship between ToM and EF has been interpreted using the *expression hypothesis* and the *emergence hypothesis* (Moses, 2001). In the expression hypothesis, the child has already acquired ToM, but EF is not sufficiently developed to pass ToM tasks. On the other hand, in the emergence hypothesis, EF is essential for children to acquire ToM.

Previous studies have primarily examined two subcategories of EF related to ToM: inhibitory control and working memory. *Inhibitory control* (IC) is the ability to inhibit responses and information about irrelevant stimuli while pursuing a goal (Carlson & Moses, 2001; Rothbart & Posner, 1985). Inhibitory control is divided into *conflict IC* and *delay IC* (Carlson & Moses, 2001). Conflict IC is the ability to withhold a dominant response while providing a novel and incompatible response, and delay IC is the ability to delay an impulsive response

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when a task calls for it (Carlson & Moses, 2001). *Working memory* (WM) is the ability to hold information temporarily in mind and process it (Baddeley, 1986). Based on these theories, researchers have found a robust relationship between ToM and conflict IC in many countries (Chasiotis et al., 2006; Oh & Lewis, 2008; Sabbagh et al., 2006). For example, conflict IC significantly predicted performance on the false belief task; however, WM was not predicted (Carlson et al., 2002). In other words, to pass the theory of mind task, it is more important to suppress the information about where the object is currently located and answer the correct position (conflict IC) than to retain the information about the position of the object (WM).

In contrast, in Japan, conflict IC did not significantly associate with performance on the false belief task (Ogawa & Koyasu, 2008; Ogawa & Koyasu, 2010). There are several reasons for the weak relationship between ToM and conflict IC in Japan (Ogawa & Koyasu, 2008). First, children's strategies to complete the false belief task could influence the weak relationship. For example, Western children could often pass the false belief task based on another's mental state (e.g., "the protagonist does not know the object has been moved"). In contrast, Japanese children attribute human action to behavioral and situational cues (e.g., "the protagonist looks in the place where they put the object away") (Naito & Koyama, 2006; Ogawa & Koyasu, 2010). Second, this relationship may have been influenced by the procedure and analysis. For example, Perner et al. (2002) indicated that longer test sessions tended to produce a weaker correlation between ToM and EF as it may have reduced motivation to complete the experiments successfully.

Furthermore, a single ToM task may influence the relationship with EF. For example, Ogawa and Koyasu (2008, 2010) used only the location false belief task in the analysis. However, Devine and Hughes (2014) showed that both the ToM and EF test batteries significantly increased the relationship's effect size. However, single ToM and EF tasks had limited variance and reduced associations.

Therefore, we made three changes based on the study by Ogawa and Koyasu (2008, 2010). First, multiple ToM and EF tasks were applied. We used the deceptive pointing task (Carlson et al., 1998) and the location false belief task. There are two reasons for using the deceptive pointing task. First, deception might enhance the passing rate of the ToM task because it may be a potential index of false belief understanding at an early stage (Carlson et al., 1998). To support this possibility, Wellman et al. (2001) revealed that children could pass a ToM task with the motivation of deception. Although Wellman et al. (2001) and Naito and Koyama (2006) revealed that Japanese children lag behind children from other countries in the false belief task, the deceptive pointing task may allow us to measure the earlier false belief understanding of Japanese children. Second, the act of pointing requires a high degree of inhibitory control. In everyday life, children point their fingers where objects exist; however, this task requires them to point to where objects do not exist. A high conflict IC is required to suppress salient responses formed in daily life to correctly respond in the task (Carlson et al., 1998). Carlson and Moses (2001) found a strong relationship between deceptive pointing and conflict IC tasks to support this suggestion.

Like the theory of mind task, we conducted multiple tasks on conflict IC. Ogawa and Koyasu (2008, 2010) analyzed EF for each task to examine the relationship between ToM and EF. However, according to Devine and Hughes (2014), whether EF is measured in multiple tasks affects its association with ToM. Therefore, we conducted the day/night task as an additional conflict IC task while using only the backward word span task for the WM task. We also examined whether the association between ToM and EF differed when measured by one or multiple tasks. Finally, we divided the two ToM tasks, two conflict IC tasks, and one WM task into two sessions, reducing the time per session to approximately 10 minutes.

We tested two hypotheses: (1) the deceptive pointing task is significantly correlated with conflict IC tasks; and (2) although the ToM battery is significantly correlated with the conflict IC battery, a single ToM and conflict IC task are not correlated.

Methods

Participants

The participants included 50 three-to five-

year-old Japanese children (M = 4 years 9 months [4;9], range: 3;7–5;7, male = 25); 21 were 4 years old (M = 4;2, male = 11), and 29 were 5 years old (M = 5;2, male = 14). In Japan, April is the beginning of the school year. Therefore, four-year-olds of the same age may have different grades depending on their birth month. Since Ogawa and Koyasu (2008, 2010) used a paradigm similar to that of this study and used a similar grade classification, we used the above age classification to facilitate comparison with their study.

Procedure

Before the test sessions, we explained the purpose of the experiment and its methods to the preschool principal and teachers and obtained their consent to conduct the study. In addition, we explained that the participants were free to refuse or end their participation at any time. Finally, we ensured no mental distress during the test sessions.

The children were tested over two sessions of 10–15 minutes each. Each session consisted of two ToM tasks (location false belief and deceptive pointing tasks), two conflict IC tasks (red/blue and day/night tasks), and one WM task (backward word span task). The first session comprised one ToM and one conflict IC task, and the second consisted of one WM task, one ToM task, and one conflict IC task. The order of the tasks was counterbalanced. These procedures were performed after obtaining approval from the Ethical Review Committee of the university to which the authors belong.

Measures

Location false belief task

We followed the procedure used by Ogawa and Koyasu (2008, 2010), using two puppets (a giraffe and an elephant), two boxes (pink and green), and a toy block. First, participants were told that the elephant placed the block in the pink box and left, after which the giraffe placed it in the green box. Finally, the elephant returns. Then, we asked the participants three questions: (1) "Where does the elephant think the block is?" (2) "Where is the block now?" and (3) "Where was the block when the elephant left?" Children passed if they answered all three questions correctly and received a score of 0 (*not passing*) or 1 (*passing*).

Deceptive pointing task

We followed the procedure described by Carlson et al. (1998), using two puppets (a horse and a giraffe), two boxes (pink and green), and a toy block. Although two experimenters participated in this task in the studies conducted by Carlson and colleagues (Carlson & Moses, 2001; Carlson et al., 1998), we used two puppets instead of two experimenters in the current study. In the story, the horse and the giraffe play together with the toy block. The horse then placed the block in a green box and left. The giraffe moved the block from the green box to the pink box to surprise the horse and then encouraged the children to surprise the horse by pointing so the horse would not find the block. If the children pointed to the green box, they were considered to have passed the task and received a score of 0 (*not passing*) or 1 (*passing*).

Red/blue task

This task was similar to the black/white task (Simpson & Riggs, 2005) and followed the procedure of Ogawa and Koyasu (2008, 2010). The materials included a red and a blue card. Children were instructed to point to the red card when the experimenter said "blue," and to the blue card when the experimenter said "red." Ten test trials were conducted (five for each color), and scores ranged from 0 to 10, reflecting the number of correct responses.

Day/night task

Following the task procedure of Gerstadt et al. (1994), we used two cards, one depicting the sun and the other the moon. Children were instructed to point to the sun card when the experimenter said "night" and to the moon card when the experimenter said "day." Ten test trials were conducted (five for each card), and the scores ranged from 0 to 10, corresponding to the number of correct responses.

Backward word span task

We followed the procedure described by Ogawa and Koyasu (2008, 2010). The children were instructed to repeat a list of two words in reverse order. After a practice trial, they completed the test trials in which the list size was increased by one word whenever the child correctly completed one of the two trials until it included five words. Children received scores ranging from 1 to 5, corresponding to the list size they correctly completed. Children who failed the two-word list received a score of 1.

Table 1 Number and Percentage of Children who Passed the Theory of Mind (ToM) Tasks

Theory of mind task	4-year-olds (n = 21)	5-year-olds (n = 29)	Total (n = 50)	Age differences (Pearson χ^2)
Location false belief	3 (14.3)	14 (48.3)	17 (34.0)	6.27 **
Deceptive pointing	2 (9.5)	20 (69.0)	22 (44.0)	17.47 **

Note. The numbers in parentheses indicate the percentages of children who passed the ToM task.
$^{**}p < .01$

Results

Table 1 shows the percentage of children who passed the two ToM belief tasks; 5-year-olds significantly outperformed 4-year-olds in both tasks. Table 2 shows the means and standard deviations of the three EF tasks; 5-year-olds significantly outperformed 4-year-olds in all three tasks.

Table 3 shows the raw and partial correlations between performance on the two ToM tasks and three EF tasks. After controlling for age and sex, the deceptive pointing task significantly correlated with the conflict IC battery. Moreover, the ToM battery was correlated with the red/blue task and conflict IC battery after controlling for age and sex. However, the backward word span task was not significantly correlated with either of the ToM tasks.

Finally, we performed a stepwise multiple linear regression analysis between ToM and EF. We entered age, sex, red/blue task, day/night task, and backward word span task as predictors of the ToM battery. The red/blue task was a significant predictor ($\beta = .60$, $t\,(48) = 5.23$, $p < .01$).

Discussion

The primary purpose of our study was to examine the relationship between ToM and conflict IC by introducing a deceptive pointing task as a ToM task, using shorter test sessions, and analyzing the correlation between ToM and conflict IC batteries. In this process, we tested two hypotheses: (1) the deceptive pointing task is significantly correlated with conflict IC tasks; and (2) the ToM battery is significantly correlated with the conflict IC battery, but a single ToM and conflict IC task are not significantly, or weakly, correlated.

Our findings show a significant correlation between the deceptive pointing task and the conflict IC battery. This result supports the first hypothesis and is consistent with the findings of previous studies (Carlson & Moses, 2001; Carlson et al., 1998). This finding is also consistent with Carlson's view that pointing requires children to engage in conflict IC (Carlson et al., 1998). However, whether the deceptive pointing task can measure early false-belief understanding is questionable. We found that the Deceptive Pointing Task was associated with Conflict IC to the same degree as the Positional False Belief Task. It will be necessary to examine further how the deceptive pointing task relates to ToM and EF because some researchers pointed out that deception does not require false beliefs (e.g., Jakubowska & Białecka-Pikul, 2020).

In the present study, we performed two ToM tasks that differed in how they responded and examined their relationship with EF. We found the association between conflict IC and the deceptive pointing task, which is considered to have a high load of conflict IC on children when responding, and we did not find the association between the false

Table 2 Means and Standard Deviations of Executive Function Task Performance

Executive function task	4-year-olds (n = 21)	5-year-olds (n = 29)	Age difference (t-test)
Red/Blue	2.48 (3.22)	8.55 (2.79)	7.13 **
Day/Night	6.10 (3.78)	7.93 (3.23)	1.85
Backward word span	1.95 (0.81)	2.62 (0.90)	2.70 *

Note. The numbers in parentheses indicate the standard deviations.
$^{**}p < .01$, $^{*}p < .05$,

Table 3 Raw and Partial Correlations Between Theory of Mind and Executive Function Measures

	1	2	3	4	5	6	7
1. Location false belief	—	.47 **	.85 **	.45 **	.14	.38 **	.20
2. Deceptive pointing	*.34 **	—	.86 **	.61 **	.32 *	.58 **	.20
3. ToM battery	*.84 **	*.80 **	—	.62 **	.27	.56 **	.23
4. Red/Blue	*.28*	*.25*	*.32 **	—	.22	.83 **	.24
5. Day/Night	*.04*	*.19*	*.14*	*.05*	—	.75 **	.08
6. Conflict IC battery	*.20*	*.30 **	*.30 **	*.63 **	*.81 **	—	.23
7. Backward word span	*.11*	*.04*	*.09*	*.04*	*-.04*	*-.01*	—

Note. Partial correlations controlling for chronological age and sex are shown below the diagonal. ToM battery = location false belief task + deceptive pointing. Conflict IC battery = red/blue + day/night.
$N = 50$, $^{**}p < .01$, $^{*}p < .05$,

belief task and conflict IC. These results may support the expression hypothesis in Japanese children. More specifically, Japanese children may place a more significant load on conflict IC while answering the task than during processing the task information or inferring mental state. However, to examine the validity of either the expression or emergence hypothesis, future research should examine multiple ToM tasks with different methods of expression in a longitudinal study.

Moreover, the ToM battery was significantly correlated with the conflicting IC battery. This result supports our second hypothesis and is consistent with findings from other countries (Sabbagh et al., 2006; Chasiotis et al., 2006). However, it contradicts the findings of Japanese studies (Ogawa & Koyasu, 2008; 2010). There are two possible explanations for the significant correlation between ToM and conflict IC in our study: the first relates to the battery score (Devine & Hughes, 2014); the second to the shorter test session duration (Perner et al., 2002). However, to ensure the impact of battery scores and reduced session duration on the results, it would be necessary to set up several groups with different numbers of tasks and session durations and compare their results.

Interestingly, the day/night task was not significantly correlated with ToM tasks in the present study. Simpson and Riggs (2005) indicated that the accuracy and reaction time for the day/night task were as good as those for the black/white task (similar to the red/blue task). However, our findings suggest less similarity between the two tasks among Japanese children. Furthermore, the backward word span task was not significantly correlated with either of the ToM tasks contradicting Japanese studies (Ogawa & Koyasu, 2008; 2010). Previous studies found WM to be significantly correlated with conflict IC in Western countries (Carlson et al., 2002), while backward word span tasks were not correlated with conflict IC tasks in earlier Japanese studies (Ogawa & Koyasu, 2008; 2010) or the present study.

In the present study, although some details differ from the findings in other countries, as described above, we improved the methods of previous studies in Japan and revealed the relationship between ToM and conflict IC. In addition, a recent study found an association between ToM and EF in Japan (Fujita et al., 2022). However, Fujita et al. (2022) used a ToM task that was very different from the false belief task used by Ogawa and Koyasu (2008, 2010). It is unclear whether the obtained results reflect differences in the tasks or the development of ToM. Therefore, it may be essential to conduct a task with a paradigm similar to the false belief task but with a different load on EF, as in the present study, to determine whether the expression or emergence hypothesis is more plausible in Japanese children.

The present study has three main limitations. First, we did not measure verbal ability, which influences the relationship between ToM and EF. However, the raw correlation between ToM and IC in the present study ($r = .56$) was almost equal to the correlations found in Chinese ($r = .59$) and American

(r = .63) samples (Sabbagh et al., 2006), and we controlled for chronological age, which is strongly related to verbal ability. Second, the WM task battery, similar to ToM and conflict IC batteries, should be used in future studies. Third, Japanese researchers rarely investigate the relationship between external factors and ToM, and previous studies have shown that children's ToM develops not only through EF but also through social interaction (Benson et al., 2013; Sabbagh et al., 2006). Future studies should consider external factors such as family context (e.g., number of siblings) and pedagogical experience (e.g., period of attendance at preschool).

References

Baddeley, A. D. (1986). *Working memory*. Clarendon Press.

Benson, J. E., Sabbagh, M. A., Carlson, S. M., & Zelazo, P. D. (2013). Individual differences in executive functioning predict preschoolers' improvement from theory-of-mind training. *Developmental Psychology*, **49**, 1615-1627.

Carlson, S. M. (2005). Developmentally sensitive measures of executive function in preschool children. *Developmental Neuropsychology*, **28**, 595-616.

Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development*, **72**, 1032-1053.

Carlson, S. M., Moses, L. J., & Breton, C. (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development*, **11**, 73-92.

Carlson, S. M., Moses, L. J., & Hix, H. R. (1998). The role of inhibitory processes in young children's difficulties with deception and false belief. *Child Development*, **69**, 672-691.

Chasiotis, A., Kiessling, F., Hofer, J., & Campos, D. (2006). Theory of mind and inhibitory control in three cultures: Conflict inhibition predicts false belief understanding in Germany, Costa Rica and Cameroon. *International Journal of Behavioral Development*, **30**, 249-260.

Devine, R. T., & Hughes, C. (2014). Relations between false belief understanding and executive function in early childhood: A meta-analysis. *Child Development*, **85**, 1777-1794.

Fujita, N., Devine, R. T., & Hughes, C. (2022). Theory of mind and executive function in early childhood: A cross-cultural investigation. *Cognitive Development*, **61**, 101150.

Gerstadt, C. L., Hong, Y. J., & Diamond, A. (1994). The relationship between cognition and action: Performance of children 3½-7 years old on a Stroop-like day-night test. *Cognition*, **53**, 129-153.

Gopnik, A., & Wellman, H. M. (1994). The theory. In L. Hirschfeld & S. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 257-293). Cambridge University Press.

Jakubowska, J., & Białecka-Pikul, M. (2020). A new model of the development of deception: Disentangling the role of false-belief understanding in deceptive ability. *Social Development*, **29**, 21-40.

Moses, L. J. (2001). Executive accounts of theory-of-mind development. *Child Development*, **72**, 688-690.

Naito, M., & Koyama, K. (2006). The development of false belief understanding in Japanese children: Delay and difference? *International Journal of Behavioral Development*, **30**, 290-304.

Ogawa, A., & Koyasu, M. (2008). Youji ni okeru "kokoro no riron" to jikkou kinou no kanrensei: wa-kingu memori to kattou yokusei wo chushin ni [The relation between components of executive function and Theory of mind in young children]. *The Japanese Journal of Developmental Psychology*, **19**, 171-182.

Ogawa, A., & Koyasu, M. (2010). Youjiki ni okeru tasha no goshinnen ni motozuku koudou heno riyuuzuke to jikkou kinou no kanrensei [The relationship between the level of explanation of another's false action and executive function in young children]. *The Japanese Journal of Developmental Psychology*, **21**, 232-243.

Oh, S., & Lewis, C. (2008). Korean preschoolers' advanced inhibitory control and its relation to other executive skills and mental state understanding. *Child Development*, **79**, 80-99.

Perner, J. (1991). *Understanding the representational mind*. MIT Press.

Perner, J., Lang, B., & Kloo, D. (2002). Theory of mind and self-control: More than a common problem of inhibition. *Child Development*, **73**, 752-767.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *The Behavioral and Brain Sciences,* **1**, 515-526.

Rothbart, M. K., & Posner, M. I. (1985). Temperament and the development of self-regulation. In L. Hartlage & C. F. Telzrow (Eds.), *The neuropsychology of individual differences: A developmental perspective* (pp. 93-123). Plenum.

Sabbagh, M. A., Xu, F., Carlson, S. M., Moses, L. J., & Lee, K. (2006). The development of executive functioning and theory of mind. A comparison of Chinese and U.S. preschoolers. *Psychological Science*, **17**, 74-81.

Simpson, A., & Riggs, K. J. (2005). Inhibitory and working memory demands of the day–night task in children. *British Journal of Developmental Psychology*, **23**, 471-486.

Wang, Z., Devine, R. T., Wong K. K., & Hughes, C. (2016). Theory of mind and executive function during middle childhood across cultures. *Journal of experimental child psychology*, **149**, 6-22.

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development*, **72**, 655-684.