Mem.Fac.Educ.Kumamoto.Univ.
The.Humanities, No.61, 163－172, 2012

The Development of Teaching Ability as Executive Function in Preschool Children : Toward Linking Teaching Strategies with Theory of Mind

Yutaka FUJITA[1]*, Kanako SUMI[2]

(Received October 1, 2012)

The purposes of this study were to examine how preschool teacher's teaching skills or strategies are adapted flexibly to monitor and support learner's changing processes of understanding. We had also very interest in how the preschooler's teaching strategies related with ToM or the mental understanding of others. Fifty two 6.5-, 5.5-,4.5-year-old children participated in the peer teaching with the board game adapted from Strauss, et al. (2002) & Davis-Unger & Carlson (2008). Main analysis was focused on the 6.5-and 5.5-year-old's teaching strategies concerned with ToM (location false belief & knowledge change). A series of analyses revealed that there was a beginning of relation between preschool children's teaching strategies and ToM especially functioning of location false belief. These results were discussed from the Tomasello's (1998) argument that the process of collaborating involves socio-cognitive bases of second-order mental states integrating partner's participation through collaborative and intersubjective relationships.

Key words : teaching strategy; executive function; theory-of-mind; preschool children; development

Early behavioral development is associated with a variety of cognitive advancement such as executive function (EF), theory of mind (ToM) and verbal ability. Each advancement has been focused on individual abilities such as perception, memory, self-control, representation, reasoning, belief, social understanding and communication. In recent years, however, there have increased empirical and theoretical approach to link between social interaction and individual cognitive processes. Several integrative attempts have been applied to explain how early children's cognitive skills could be acquired through social interaction to sustain everyday behavior (Carlson, 2009; Lewis and Carpendale, 2009)

We briefly define each cognitive abilities mentioned above. First, the concept of executive function (EF) involves the set of processes governing goal-directed acts and flexible, adaptive responses to the changes in the environment. Lewis and Carpendale (2009) pointed out typical components and made definition of the control skills of human behaviour: "*working memory*" that is capacity not only to hold information in mind but to be able to report it in a way that is not simply rote repetition; "*attentional flexibility*" capable of changing from one way of solving a problem to another complementary means; " *inhibitory control*" that is propensity to suppress prepotent responses; "*planning*" taken to superordinate executive skills when confronting with complicated tasks. These components are coordinated to work as a control mechanism in adaptive behavior through everyday life. Second, theory-of-mind (ToM) has at least two different research route (Astington & Baird, 2005), one from Wellman's (1985) reference to the child's conception of human cognition, and the other from Premack and Woodruff's (1978) investigation of primate cognition, both of which were taken up and applied to children's communicative abilities and false belief understanding(Bretherton, et al., 1982; Wimmer & Perner, 1983). In this study, we define theory-of-mind as cognitive structure leading to certain abilities such as attribution of mental states (desires, beliefs, and intentions) to others in order to explain or predict other's behavior (Wimmer & Perner, 1983). Finally, language with very broad concept and its multifaceted nature has been analyzed from the functional and the structural views. Astington & Baird (2005) categorized the human language in terms of functional (representation/communication) and structural (syntax / semantics) aspects. The present study focuses on the former aspect, making difference between intra-individual representation system and inter-individual communication system.

[1]Kumamoto University
[2]Akita Higashi Elementary School
*Correspoding author. E-mail address : fujita@gpo.kumamoto-u.ac.jp
Note : This research was supported by JSPS Grant in-Aid for Scientific Reseach(C) No.22530708

How can these cognitive abilities be explained in each course of development? Next, we explore cognitive development from the sociocultural view points. As for EF, Lewis and Carpendale (2009) pointed out the role of social processes in executive attention and control skill based on the view from Vygotsky and Luria. For Vygotsky(1978), it is very important that language and related symbol system learned through social interaction are central to the process of children's self-control through growth of higher cognitive processes. And Luria (1961) had major influence on the contemporary research of EF focussing from the view points of the role of language and social process in executive function, that contributed more refinement of conception, measurement, and remediation. On the other hand, as far as ToM is concerned with cultural learning studies, we can realize that human learning is based on how we have acquired the conception of person or mind (intentions and beliefs) changing from infant to adulthood. Tomasello, et al.(1993) characterized cultural learning as learning not "from" another, but "through" another. This "through" means that our learning are mediated by taking role or perspective of the other, by attributing or simulating mental states of the other, or by engaging in joint attention with the other, etc. Tomasello and coleagues modeled three types of cultural learning, based on socio-cognitive development: "Imitative learning" requires children to engage in understanding demonstrator's intentions toward things; in "instructed learning" it is necessary that children understand instructor as a mental agent having their own thoughts or beliefs; "collaborative learning" comes from reflective thoughts and beliefs between learners (Tomasello, et al. 1993).

The recent studies have gradually been designed to explore in detail the cooperative or collaborative learning and teaching abilities of young preschool children (Cooper, 1980; Brownell & Carriger, 1990; Koester & Bueche, 1980; Ashley & Tomasello, 1998). Ashley & Tomasello (1998) state that cooperation involves two or more children coordinating behavior in which they must cooperate in order to solve an external problem which expects them to cooperate to use task-specific skills for solving problem. And collaborative learning, as seems to share common characteristics of symmetrical relations as cooperative one, is conceptualized deeply from socio-cognitive bases as thinking by second-order mental states integrating "partner's act toward me" and "mine toward the partner" recursively at the same time (intersubjectivity), and synthesizing into a single overarching cognitive representation between partners (Tomasello, et al. 1993). Symmetrical or cooperative relation or equality of power are important for understanding the concept of Piaget's (1932) peer interaction or peer learning. However, in problem-solving context one child is sometimes more knowledgeable or skillful than another and so does something to assist her(Ashley & Tomasello, 1998). That is why teaching ability is important and worth investigation in the domain of cognitive development in preschool children.

Another recent studies have promoted to investigate the developmental link between teaching ability and knowlege or belief in preschool children (Ziv & Frye, 2004; Ziv, Solomon & Frye, 2008; Strauss, Ziv & Stein, 2002). Strauss, et al.(2002) pointed out that unlike teaching, learning, its mirror image, has been a major focus of research in cognitive development, and little is known about children's construction of the concept of teaching, as well as of the actual process of it. Their original argument is the definition of "teaching as natural cognition". Strauss and colleagues summarized the its characteristics from following seven points of views. (1) Human beings are the only species that teach by using a theory of mind. (2)Teaching is ubiquitous among human beings. (3) Teaching is an extraordinarily complex enterprise that has much to do with mind-, emotions-, and motivation-reading. (4) Much of teaching is invisible to the eye. While visible part is the external act of teaching, invisible parts are the teacher's intention, inferences and the mental processes that lead to these inferences. (5) Teaching may be a specialized kind of social interaction such as conversation, argument, and collaboration. (6) Teaching is unschooled cognition, that is universal among human beings, learned without formal or informal teaching. (7) If very young children engage in teaching and they have not been taught to teach, teaching is a natural cognition (Strauss, et al., 2002).

After Miller's(2000) argumentation for broadening the application of theory-of-mind (false beliefs about the location, identity, or contents of physical objects) to include the understanding of any difference in knowledge, the aspect of theory-of-mind could have become construed as a more general understanding of knowledge difference (Ziv & Frye, 2004). Ziv & Frye(2004) investigated the relation between theory of mind and concept of teaching in preschool children, with stories composed of three kinds of knowledge difference (understanding difference itself, teacher's belief about the difference, teacher's belief about own knowledge). They clarified that the 3- and 4-year-olds understood teaching stories with clear knowledge differences and could correctly use that information to specify the teacher and learner. The 5- and 6-year-olds, who performed well on a standard theory-of-mind task, further understood that it was teacher's belief about the knowledge

difference that would actually govern teaching. Ziv, Solomon & Frye (2008) focused on the role of intention and examined whether children consider intention versus outcome to understand what teaching is, and how theory of mind may be relevant to concept of teaching. They found age related change in the understanding of teaching with distinction of embedded instructional intent. Davis-Unger & Carlson (2008) adapted a task in which children of 3.5-, 4.5-, 5,5- years of age first learned how to play a simple board game having eight rules(player can move in only one direction, if the flower color on the block and on the stop match, you can remove it to your stem, etc.) actually, and then were asked to teach a confederate who doesn't know how to play it. And they investigated the children's teaching skill and the relation between teaching skill and ToM understanding(standard false belief and knowledge change understanding), and results showed that children's teaching skill improved with age, and significantly correlated with ToM performance.

Carlson (2009) proposed that Davis-Unger and Carlson's (2008) task has numerous EF skills recruited: goal-directedness, planning, working memory, inhibition of the impulse to "just let me do it for you", continuous monitoring of the learner's progress, flexible attempts to correct errors. Following Carlson's (2009) proposition of teaching skills as elemental EF, we have designed to conduct actual teaching-learning interaction between preschoolers. We have interest in three main problems about preschool children's teaching: (1) What is the EF component concerned with the teaching strategies preschool children have? (2)How are the teaching strategies realized through actual peer teaching-learning processes in preschoolers? (3) How are the preschooler's strategies flexible to adapt the moment by moment change of learner's progresses or age related characteristics? (4)How are the preschool children's teaching strategies related with ToM or mental understanding toward others? The current study was designed to investigate these problems with experimental method.

METHOD

Participants

Thirty-nine children from nursery school located at Koshi city in Kurmamoto Prefecture participated in this study. They were all typically developing and recruited from 3 age classes. Twenty one 6.5-year-olds(M=6:02), eighteen 5.5-year-olds(M=5:05), and thirteen 4.5-year-olds(M=4:01,) were involved. As for 6.5-and 5.5-year-old children, two thirds of them participated as taking the role of teachers. Rest of them, that is seven 6.5-year-olds, six 5.5-year-olds, and all of 4.5-year-olds took part in as the instructed learner (the same age, or the younger) in peer teaching task.

Experimental Design

This study was executed by 2 (ToM location false belief: high, low) x 2 (ToM knowledge change understanding: hight, low) x 2 (age of learner: same, younger) x 3 (session: instruction,gamel,game2) mixed factorial design with three betweeen factors of ToMs and age of learner and one within factor of session.

Procedure

This study was executed by individual experimental method through three phases. At first phase, after children were introduced to one experimenter (second author), they were asked to reply two kinds of ToM tasks (location false belief task and knowledge change task). ToM tasks performance were applied to make eight experimental groups varied to 2 (location false belief understanding: hight vs. low) x 2 (knowledge change understanding: high vs. low) x 2(age of learner: same, younger) by between factorial combination. It totally lasted about 20 to 30 minutes. In second phase, each of them was introduced to teaching task by Davis-Unger & Carlson (2008) adapted from Strauss et al.(2002). Based on the performance in the first phase, 5.5 year-olds and 6.5 year-olds were required to take the role of teacher of the game, and were shown to learn how to play a set of game (truck & flower game) made of familiar materials to them. After experimenter explained the way to play with eight rules to follow, both child and experimenter enjoyed another trial of game during which experimenter promoted child's learning by doing the rules through verbal instructions and demonstrations. Check test followed after the game was over, and whole game session took 20 to 30 minutes in total. Final phase was designed as peer teaching session in which 5.5 and 6.5 year-old children as teacher took a confirmation test of the rule (same as check test in second phase), they were required to teach to the same age or the younger age children how to play with the board

game. They were given ten minutes to play, and teaching child was instructed to teach how to play by explaining verbally and doing together. There were a few days interval between each phase.

Measures

Teaching task

The board game task "truck & flower task" we call here, was originally used by Strauss, et al. (2002) and Davis-Unger & Carlson (2008).The current study adapted it, because it looked very familiar and seemed interesting and challenging for young children to play. The game material was composed of the paper board (44cm length x 30 cm hight), which is attached with two stems set opposite angle for each player to hold three different colored flowers, and athletic field like road to drive the truck, a miniature toy on the market. The die that truck carry in each step was hand made for children to manipulate easily. In each surface of the die was marked 6 kinds of symbols: a blue, pink, and yellow flower, a happy face, a sad face, and a wild flower. Along the inside of the road, six flowers (3 colors x 2 each) were interspersed with magnet. In this study, six toy truck marks were attached on the road next to the six flowers which was a sign that a child easily understand the point of car stop. The goal of the game was to obtain all three colors of flowers for one's own stem by waiting the turn of driving the truck to next stop and dumping a die from the truck, following eight game rules described below (Table 1).

In learning task phase (phase 2), the experimenter taught child how to play the game with verbal and physical explanation so that he/she could take a role of teacher in next phase. A game was executed for several minutes after rule explanation was over so that child could certify their understanding, then comprehension of rule test was presented that a child responded verbally. At this point, if child replied wrong answer to question, the experimenter corrected them. Finally, the experimenter explained the child that next phase he/she will take a role of teacher and be required to teach how to play with the game.

In teaching task phase (phase 3), the child as a teacher was paired with a peer learner (same aged or younger aged) and taught how to play with the board game. They were given about ten minutes to play and understand, during which peer teaching and learning was video recorded through whole processes. Based on the video recorded data we coded child's teaching strategies as following EF measures to analyze: task rule specificity, second-order perspective taking, distribution of responsibility, and instructional style (Table 2).

Table 1 Eight rules of board game check list (in Davis-Unger & Carlson, 2008)

RC1: "Which way do you move the truck? Do you have to follow the arrows or can you go backwards?"
RC2: "If the color of the flower on the block and the color of the flower you have stopped next to are the same, like this, can you take the flower or do you have to leave it?"
RC3: "If the color of the flower on the block and the color of the flower you have stopped next to are different, like this, can you take the flower or do you have to leave it?"
RC4: "What if they are the same but you already have that color flower on your stem? Can you take the flower or do you have to leave it?"
RC5: "What happens if you get a wild flower on your turn? Can you make it match the flower you are stopped next to and take the flower?"
RC6: "What happens if you get a happy face on your turn? Do you lose your turn or get another turn?"
RC7: "What happens if you get a sad face on your turn? Do you lose your turn or get another turn?"
RC8: "If you are the first one to fill your stem with flowers, are you the winner?"

Table 2 Categories to classify children's teaching strategies and definition with scoring in teaching board game task

Category	*Definition*
Task rule specificity	*how accurately children explained verbaly eight kinds of task rules in each act of teaching*
sufficient explanation	identify the play act of the game with verbal explanation
partial explantaion	partial lack of explanation, either indetifying or explanation
lack of explanation	no explanation both of identification & explanation
Second order perspective taking	*how attentively and reflectively children give explanation from the view point of the learner in each act of teaching*
sufficient taking	attentive watching of the learner's task participation and sharing task situation with the learner via thoughtful explanation with linguistic explanation and demonstration
partial taking	partial lack of either attentive watching or thoughtful explanation
lack of taking	no attention and explanation
Distribution of responsibility	*in what degree children inhibit impulsive intervention or directive teaching in order to promote learner's responsibility toward learning process*
responsibility on the learner	learner centered teaching by taking scaffolding adapted to the learner's understanding
responsibility on the teacher	domestic and directive teaching by the teacher
no responsibility shared	none of them taking responsibility to the task
Teaching style	*how well balanced teaching is executed between verbalization and demonstration*
well balanced teaching style	explanation through verbalization and demonstration very easy to understand
verbal teaching style	explanation only through verbalization

Theory-of-Mind Tasks (location false belief & knowledge change)

Location false belief task and knowledge change task were chosen to measure children's understanding of other's mental states. In location false belief task, the task scenario was same as in Wimmer & Perner(1983). Two puppets (a bear named"Gonta" and a hare named "Mimi") were friends. One day Gonta was back home with cake presented. And he soon put the cake into the cupboard, and went out to play more. In a meantime, his girl friend Mimi came to Gonta's home to play with him. Mimi found cake in the cupboard, and removed it into refrigerator before going out. When Gonta returned, children were asked the false belief question ("Where do you think Gonta will look for a cake?") and Control question (Memory: "Where was the cake first?"; Reality: "Where is the cake really?") And further question of perceptual access was added ("Did Gonta look actually at the cake removed from cupboard to refrigerator?"). In each question (belief, control, perceptual access), success or failure of the answer was scored 1 or 0 in total 3 points.

As for Knowledge change task, children were asked about their understanding of the familiar and unfamiliar color. Each child was handed out a sheet of paper on which boy's or girl's figure printed, and was handed a crayon and asked to draw the half (shirt) of the figure with a familiar color of crayon (red or blue), then to draw the rest of figure with an unfamiliar color (bright golden yellow, "yamabuki-iro" in Japanese) . After color drawing was over each child were give five series of question about knowlege of the color as follows: (1)"Do you know the color bright-golden-yellow?", (2) "When did you learn the name of the color bright-golden-yellow?", (3)"Did you know the color bright-golden-yellow yesterday?", (4)"Did you know the color bright-golden-yellow when you were baby?",(5)"How did you learn the color for bright-golden-yellow ?".If the child's answer was obscure about understanding in question (2), probing question (3) and (4) were ready for asking. Same series of questions were ready for the name of familiar color. After a series of questions

were asked in a familiar and an unfamiliar crayon condition, final question "Which color have you known longer, red or bright golden yellow?" was asked. In the current study, if question (2),(5) in a familiar/unfamiliar condition was passed successfully scored .5 in total(.5x4=) 2 point, and final question scored 1 was added if succeeded, in total 3 points measure was made for analysis.

RESULTS

All of the teaching sessions were double-coded (N of sessions were25). Percent agreement of coding was used to calculate reliability of teaching strategies. Average agreement was 95.1% ranging from 87% to 100%. The results for the relation between ToM and Teaching strategies will be described in term of five relational measures: rule specificity, second-order perspective taking, distribution of responsibility, teaching style, effects of learner's age (same or young) in pair.

1. Experimental Group Classification and It's Relation to Explanations of Each Task Rules

After two kinds of ToM tasks (location false belief task & knowledge change task) were completed, 5.5- and 6.5-year-old children's ToM score was calculated in each task with maximum scale of 3 points. 2(scores of location false belief: high, low) x 2 (knowledge change understanding: high, low) groups were formed based on mean scores (location false belief: M= 2.23 ; knowledge change: M=2.15) in each task. Then, mean number, standard deviation (SD), and percentage were calculated in each task rule (RC1 to RC8). Based on the mean scores, we conducted three way factorial mixed type analysis of variance (ANOVA) with location false belief (2) and knowledge change (2) as between-group factors and type of task rule (8) as repeated within-group factor. Main effects were found for type of task rule as significant ($F(7,154)=14.82$, $p<.0001$), and false belief was marginally significant ($F(1,22)=2.98$, $p<.10$). Post hoc multiple comparison tests revealed that RC6 rule (M=3.27) was highly explained than the rest of other rules. As for location false belief, the higher groups tended to increase number of task rules explanations than the lower ones.

2. Relation between ToM and Task Rule Specificity

Every teacher's talk in teaching the board game session was classified in terms of three categories of task rule specificity (sufficient, partial, lack of explanation), and based on every teaching child's score three way factorial mixed type analysis of variance (ANOVA) was conducted with the type of location false belief(2) and knowledge change(2) as between-group factors, and degree of task rule specificity(3) as repeated within-group factor. Main effects were only found for explained rule specificity as significant ($F(2,44)=42.17$, $p<.001$). Post hoc multiple comparison tests revealed that there exists significant difference between every rule specificity: sufficient explanation (M=5.52) < partial explanation(M=18.72) < lack of explanation(M=29.76). This main effect of task rule specificity seemed qualified by two types of two-way interaction: location false belief-by-rule specificity ($F(2,44)=2.53$, $p<.10$), and changing knowledge-by-rule specificity($F(2,44)=2.66$, $p<.10$). Each interaction was marginal difference: Former interaction suggests that higher false-belief group tend to produce sufficient explanation(Figure1) and latter interaction suggests that higher knowledge difference group tended to make partial (insufficient) or lack of specificity of explanations (Figure2).

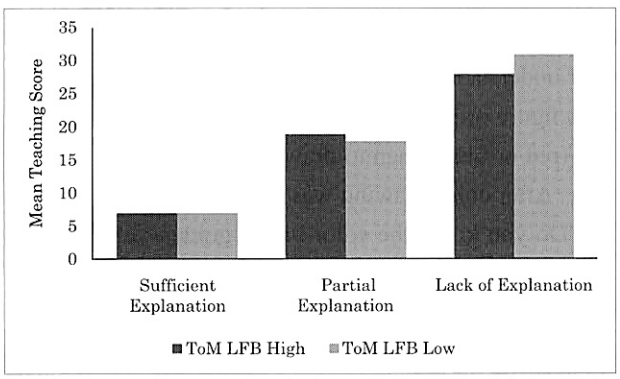

Figure1 Mean teaching scores in task rule specificity (LFB x Rule Specificity)

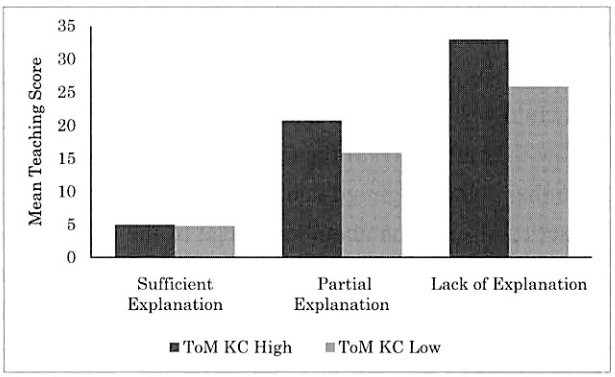

Figure2 Mean teaching scores in task rule specificity (ToM x Rule Specificity)

3. Relation between ToM and Second-order Perspective Taking

Every teacher's talk in teaching session was classified in terms of three categories of second-order perspective taking (sufficient, insufficient, lack of perspective taking), and based on every teaching child's score three way factorial mixed type analysis of variance (ANOVA) was conducted with the type of location false belief(2) and knowledge change(2) as between-group factors, and degree of perspective taking(3) as repeated within-group factor. Main effects were only found for degree of perspective taking as significant ($F(2,44)=36.86$, $p<.001$). Post hoc multiple comparison tests revealed that there exists significant difference between every perspective taking: sufficient taking($M=4.85$) < partial taking($M=19.12$) < lack of taking($M=28.15$). This main effect of task rule specificity seemed qualified by two types of two-way interaction: false belief-by-rule specificity ($F(2,44)=2.53$, $p<.10$), and changing knowledge-by-rule specificity($F(2,44)=2.66$, $p<.10$). It means tendency that higher groups of false-belief seem to give explanation very easy to understand for the learner at marginal difference level (Figure 3).

4. Relation between ToM and Distribution of Responsibility

Every teacher's talk in teaching session was classified in terms of three categories of responsibility (learner centered, teacher domestic, no shared), and based on every teaching child's score three way factorial mixed type analysis of variance (ANOVA) was conducted with the type of location false belief (2) and knowledge change(2) as between-group factors, and degree of sharing responsibility(3) as repeated within-group factor. Main effects were only found for degree of sharing responsibility as significant ($F(2,44)=9.37$, $p<.001$). Post hoc multiple comparison tests revealed that there exists significant difference between every perspective taking: no sharing ($M=1.38$) < learner centered($M=1.56$) < teacher domestic($M=3.79$). This main effect of perspective taking seemed qualified by two type of two-way and three-way interactions: Former two-way, false belief-by-responsibility interaction remained marginal difference ($F(2,44)=3.10$, $p<.10$). It means that higher groups of false-belief tend to give learner centered explanation than the lower groups (Figure 4).: Another three-way, false belief-by-knowledge change-by-responsibility interaction was significant ($F(2,44)=4.16$, $p<.05$). It was suggested that higher false-belief plus higher knowledge difference group children gives learner centered explanation (Figure 5-1), and that lower false-belief plus higher knowledge group children make teacher domestic or no sharing participation (Figure 5-2).

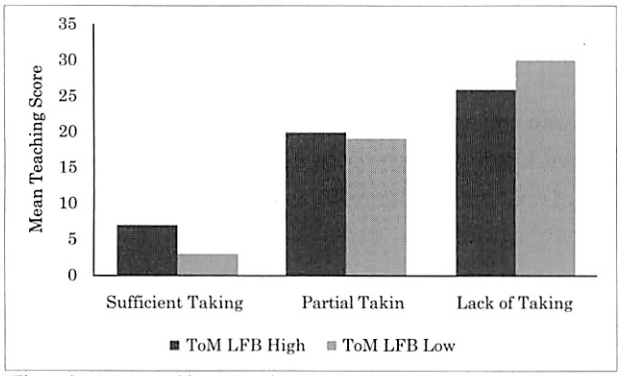

Figure 3 Mean teaching scores in second-order perspective taking (ToM x Perspective Taking)

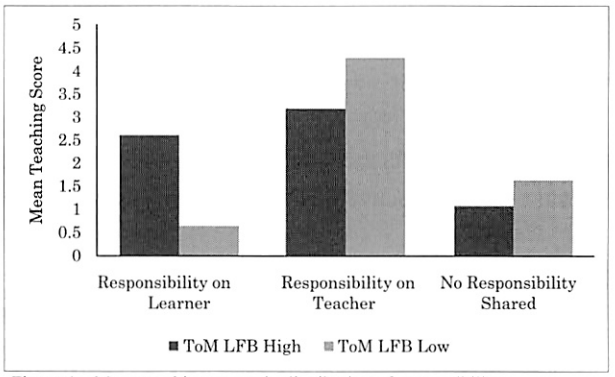

Figure 4 Mean teaching scores in distribution of responsibility (ToM x Response Distribution)

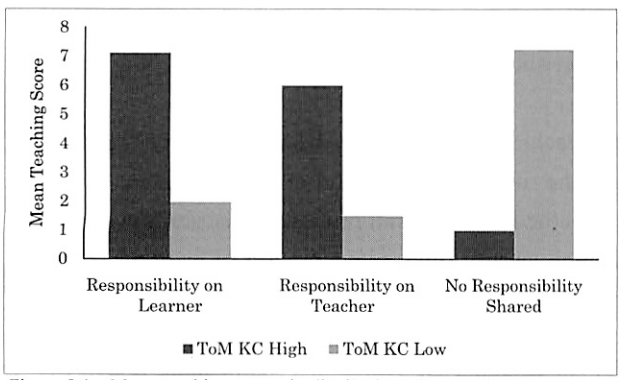

Figure 5-1 Mean teaching scores in distribution of responsibility (KC x Distribution of Responsibility in ToM LFB H Group)

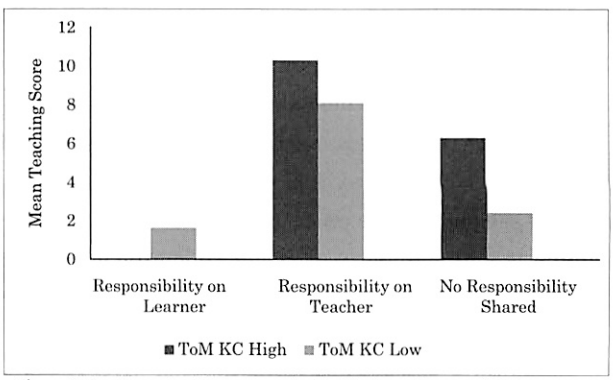

Figure 5-2 Mean teaching scores in distribution of responsibility (KC x Distribution of Responsibility in ToM LFB L Group)

5. Relation between ToM and Teaching Style

Every teacher's talk in teaching session was classified in terms of three categories of teaching styles (well balanced style, inclined style, no emergence of teaching), and based on every teaching child's score four way factorial mixed type analysis of variance (ANOVA) was conducted with the type of location false belief(2) and knowledge change(2) as between-group factors and teaching style(2) and game situation(5) as repeated within-group factor. Main effects were found for teaching style and for game situation as significant: the former result ($F(1,22)=9.58$, $p<.01$) suggested their teaching style inclined to verbalization($M=14.42$) than to verbal and demonstration($M=8.88$). In the latter main effect of game situations, post hoc multiple comparison tests revealed that there exists significant difference as follows : different color($M=7.85$) > same color($M=5.31$) = sad face($M=4.15$) = wild flowers($M=3.81$) > happy face($M=2.19$).These main effects of teaching style and game situation seemed qualified by two types of two-way interactions: false belief-by-teaching style ($F(1,22)=4.23$, $p<.10$), and teaching style-by-game situation ($F(4,88)=7.04$, $p<.001$).The former result means at marginally different level that higher groups of false-belief tend to give well balanced explanation verbally and physically, while lower group inclined to verbal dominant explanation(Figure 6). The latter result by post hoc comparison test shows no difference between verbal and physical explanation except different color situation (Figure 7).

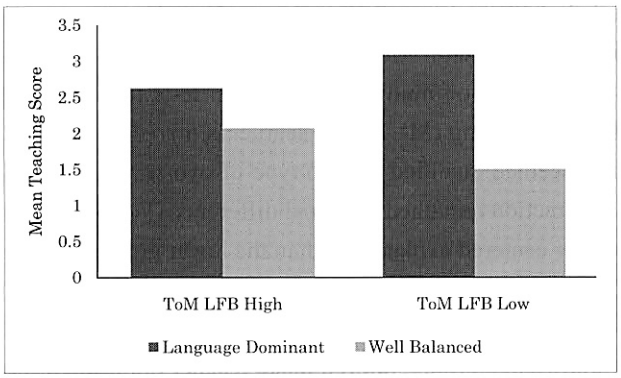

Figure 6 Mean teaching scores in teaching style (ToM x Teaching Style)

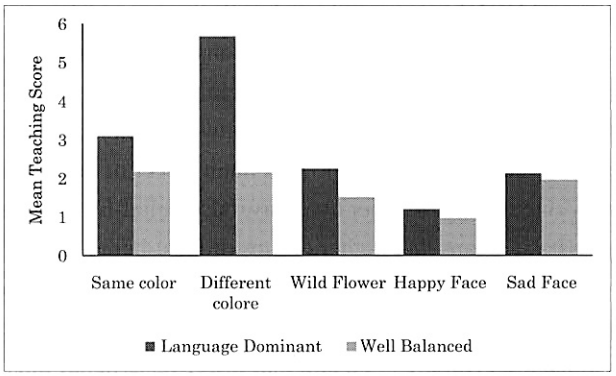

Figure 7 Mean teaching scores in teaching style (ToM x Teaching Style)

6. Effects of learner's age difference

Same kinds of ANOVA were repeated, except changing main between factors from false-belief and knowledge change to learner's age difference, and significant results were gotten in two kinds of teaching strategies: task rule specificity, second-order perspective taking. However, any result from a series of analysis did not reach to the significant difference.

DISCUSSION

Following Carlson's (2009) proposition we have designed to investigate preschool children's teaching abilities, focusing on what is the characteristics of teaching strategies concerned with the board game by Strauss, et al.(2002) and Davis-Unger & Carlson (2008), and how preschool children's teaching skills or strategies are adapted flexibly to monitor learner's changing processes of understanding or age related characteristics. How are the preschooler's teaching strategies related with ToM or the mental understanding of others?

In a series of analyses, we could identify preschool children's teaching strategies after having observed their way of teaching interaction: "task rule specificity" to identify and explain the rule to play, "second-order perspective taking" to monitor and support the process of learner's learning processes from the learner's point of views, "distribution of responsibility" to inhibit impulsive teacher's domestic instruction and support learner's own active process of learning, "teaching style" to coordinate verbal and physical explanation flexibly in harmony with learner's process of learning. They were all observed strategies by preschool children.

Based on a series of analysis of each categorized scores about teaching strategies, we could have the image of

developing characteristics about beginning of peer teaching in preschool aged children. In the strategies analyzed in the current study, ToM especially location false belief than knowledge change tended to have developmental relationship with "task rule specificity", "second-order perspective taking", "distribution of responsibility", and "teaching strategy". In these analysis, however, preschooler's actual and ideal use of each strategies remained very low proportion, that would lead to whole characteristics of preschool children's difficulty to adapt to learner's process of learning. It was very necessary to take a second-order perspectives from teacher to learner and at the same time from learner to teacher, and support learner centered learning processes with inhibition to have impulsive desire to control other task learning or solving processes.

As in Davis-Unger & Carlson's(2008) way of experimental control, confederate adult learner's participation would have clear effect to investigate how younger children have natural cognitive abilities of teaching. However, through contextualizing "natural" teaching-learning situation, there come to exist such situation as we have examined in this study in which children are interacting naturally. Tomasello (1998) argued the process of collaborating involves socio-cognitive bases of second-order mental states integrating "partner's act toward me" and "mine toward the partner" recursively at the same time (intersubjectivity), and synthesizing into a single overarching cognitive representation between partners. Through contextualizing Tomasello's argument in our experimental design, we can identify what is the really developmental and natural problem we must search for. Through comparison of designing characteristics that may surround control socio-cognitive relation between child-adult or peer, we will be able to get some clue to drive the research to understand more deeply developmental factors promoting peer teaching abilities during preschool age of children .

REFERENCES

Ashley, J., & Tomasello, M. (1998). Cooperative problem-solving and teaching preschoolers. *Social Development*, 7, 143-163.

Astington, J. W., & Baird, J. A. (Eds.). (2005). *Why language matters for theory of mind*. New York : Oxford University Press.

Bretherton, I., & Beeghly, M. (1982). Talking about internal states : the acquisition of an explicit theory of mind. *Developmental Psychology*, 18, 906-921.

Brownell, C. A., & Carriger, M. S. (1990). Changes in cooperation and self-other differentia- tionduring the second year. *Child Development*, 61, 1164-1174.

Carlson, S. M. (2009). Social origins of executive function development. In C. Lewis & J. I. M. Carpendale (Eds.), *Social interaction and the development of executive function. New Directions in Child and Adolescent Development*, 123, 87-97.

Cooper, C. R. (1980). Development of collaborative problem solving among preschool children. *Developmental Psychology*, 16 (5), 433-440.

Davis-Unger, A. C., & Carlson, S. M. (2008b). Development of teaching ability in preschool children and relations to theory of mind. *Journal of Cognition and Development*, 9, 26-45.

Hogrefe, G. J.,Wimmer, H.,&Perner, J. (1986). Ignorance versus false belief : A developmental lag in attribution of epistemic states. *Child Development*, 57, 567-582.

Koester, L. S., & Bueche, N. A. (1980). Preschoolers as teachers : Where children are seen but not heard. *Child Study Journal*, 10 (2), 107-118.

Lewis, C., & Carpendale, J. I. M. (2009). Introduction : Links between social interaction and executive function. In C. Lewis & J. I. M. Carpendale (Eds.), *Social interaction and the development of executive function. New Directions in Child and Adolescent Development*, 123, 1-15.

Luria, A. R. (1961). *The role of speech in the regulation of normal and abnormal behavior*. Oxford : Pergamon.

Miller, S. A. (2000). Children's understanding of preexisting differences in knowledge and belief. *Developmental Review*, 20, 227-282

Perner, J., & Wimmer, H. (1985). "John thinks that Mary thinks that..." Attribution of second-order beliefs by 5- to 10-year-old children. *Journal of Experimental Child Psychology*, 39, 437-471.

Piaget, J. (1932). *The Moral Judgement of the Child. London* : Routledge & Keegan Paul.

Premack, D. & Woodruff, G. (1978). Does the chimpanzee have a theory of mind ? *Behavioral and Brain Sciences*, 4, 515-526.

Strauss, S. (2002). Teaching as a natural cognition : Going from basic science to teacher education. In D. Pillemer & S.White (Eds.), *Developmental psychology and the social changes of our time*. New York : Cambridge University Press.

Strauss, S., Ziv, M.,&Stein, A. (2002). Teaching as a natural cognition and its relation to preschoolers' developing theory of mind. *Cognitive Development*, 17, 1473-1487.

Tomasello, M., Kruger, A. C., & Ratner, H. (1993). Cultural learning. *Behavioral and Brain Sciences*, 16, 495-511.

Vygotsky, L. S. (1978). *Mind in society : The development of higher psychological processes*. Cambridge, MA : Harvard University Press.

Wellman, H.M. (1985). The child's theory of mind : The development of conceptions of cognition. In S.R. Yussen (Ed.), *The growth of reflection in children*. Pp.169-206. San Diego, CA : Academic Press.

Wellman, H., & Bartsch, K. (1988). Young children's reasoning about beliefs. *Cognition*, 30, 239-277.

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

Wimmer, H., &Perner, J. (1983). Beliefs about beliefs : Representations and constraining function of wrong beliefs in young children's understanding of deception. *Cognition*, 13, 103-128.

Ziv, M., & Frye, D. (2004). Children's understanding of teaching : The role of knowledge and belief. *Cognitive Development*, 19, 457 -477.

Ziv, M., Solomon, A., & Douglas Frye (2008) Young children's recognition of the intentionality of teaching. *Child Development*, 79, 1237-1256.