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Preschool social-emotional competencies predict school adjustment in Grade 1

Keito Nakamichi [a], Naoko Nakamichi[b] and Jun Nakazawa[c]

[a]Faculty of Education, Chiba University, Chiba, Japan; [b]Department of Sports Wellness Sciences, Japan Women's College of Physical Education, Tokyo, Japan; [c]Uekusa Gakuen University, Chiba, Japan

ABSTRACT

We investigated whether preschoolers' social-emotional competencies predict their peer relationships and academic achievements during grade one. Measures of cool and hot executive functions, theory of mind, social-problem-solving, and peer acceptance were administered to a sample of 48 preschoolers ($M = 77.91$ months). Academic achievement and peer acceptance were assessed at the end of Grade 1. A path analysis revealed that cool and hot executive functioning during preschool had a direct impact on academic achievement in elementary school and an indirect effect on peer acceptance via the theory of mind and social-problem-solving, respectively. Further, peer acceptance in preschool had a positive direct effect on peer acceptance during grade one. These findings indicate the vital role of social-emotional competencies on peer relationships and academic achievement. Future study should include additional measures to examine the effect of preschooler's cool and hot executive functions on later school adjustment.

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Executive function; theory of mind; social problem-solving; peer relationship; academic achievement

Children need to develop various competencies throughout early childhood for their later academic and social success. Acquiring the basic competencies that enable adjustment to school is known as 'school readiness' (Hair, Halle, Terry-Humen, Lavelle, & Calkins, 2006). School readiness includes physical well-being and motor development, social and emotional development, approaches to learning and cognition and general knowledge (Kagan, Moore, & Bredekamp, 1995). Especially, educational policies have increasingly emphasized the importance of social-emotional development (Organization for Economic Cooperation and Development, 2015). This is because, as will be described in detail, children who have acquired masterful social-emotional competencies during early childhood seem to be academically and socially successful in elementary school.

Denham, Bassett, Zinsser, and Wyatt (2014) proposed that the core components of social-emotional competencies include self-regulation, social awareness, social problem-solving, and relationship/social skills. Self-regulation is the ability to control one's emotions, attention, and behaviors, including executive functions (EFs). Social awareness includes theory of mind (ToM), emotional understanding, and emotional knowledge. Social problem-solving includes analyzing situations, goal setting, and producing social strategies. Relationship/social skills refer to joining-in to play with others, starting and maintaining conversations, and cooperating with others. As follows, we will review each component of social-emotional competencies, and the relationships between these components and school adjustment.

CONTACT Keito Nakamichi nakamichi@chiba-u.jp Faculty of Education, Chiba University, 1-33 Yayoicho, Inage-ku, Chiba 263-8522, Japan

School adjustments and EF as a foundation for self-regulation

EF is the vital factor of self-regulation. EF is a top-down, neurocognitive process involved in the goal-oriented control of awareness, thoughts, action, and emotions (Miyake et al., 2000). Zelazo and his colleagues (Zelazo & Carlson, 2012; Zelazo & Müller, 2002) hypothesized that EFs have aspects that are 'cool' and 'hot' (i.e. cool-EF and hot-EF). Cool-EF tasks require children to engage in cognitive problem solving (e.g. inhibition, working memory, and cognitive flexibility) in situations that lack a significant affective or motivational component. In hot-EF tasks, children are asked to delay gratification or decide in a situation that arouses strong motivations or emotions (e.g. children are rewarded for correct responses). Many studies have indicated that cool-EF during preschool not only relates to concurrent adjustment, but also strongly predicts later school adjustment. For example, individual differences in cool-EF before entering elementary school predicted later abilities in arithmetic (Bull, Espy, & Wiebe, 2008; Clark, Pritchard, & Woodward, 2010), literacy (De Franchis, Usai, Viterbori, & Traverso, 2017), or both (Blair & Razza, 2007; Monette, Bigras, & Guay, 2011).

Compared to cool-EF, there are fewer studies that have examined children's hot-EF. Especially, little is known about the impact of preschoolers' hot-EF on adjustment to elementary school. Cross-sectional studies by Willoughby, Kupersmidt, Voegler-Lee, and Bryant (2011) found a significant correlation between hot-EF and inattentive-overactive behaviors in preschool-aged children. However, Hongwanishkul, Happaney, Lee, and Zelazo (2005) did not find such a relationship. Furthermore, Kim, Nordling, Yoon, Boldt, and Kochanska (2013) examined the longitudinal relationship between cool/hot-EF performance in children aged 38 and 52 months and teachers' ratings of academic achievement and problem behavior when they were 67-, 80-, and 100-months-old. The results revealed that cool-EF predicted later academic achievement, while hot-EF predicted later problem behaviors.

School adjustments and ToM as a social awareness

There is a large body of empirical evidence that preschoolers' social awareness, such as emotional understanding and ToM, is related to positive peer relationships. For example, the ability to read others' emotional gestures (Nowicki & Duke, 1992) and the ability to infer other people's emotions from the situation (Denham, McKinley, Couchoud, & Holt, 1990) are related to peer acceptance. A meta-analysis by Slaughter, Imuta, Peterson, and Henry (2015) found that children who scored high on ToM tasks were popular among their peers. Several longitudinal studies (e.g. Fink, Begger, Hunt, & Rosnay, 2014) have also shown that performance on ToM tasks predicts future peer relationship. Furthermore, a three-year longitudinal study (Caputi, Lecce, Pagnin, & Banerjee, 2012) showed that the performance on ToM tasks at 5-years-old indirectly influenced peer acceptance at 7-years-old via pro-social behavior at 6-years-old. As shown here, social awareness during preschool seems to be a direct or indirect predictor of later social adjustment.

School adjustments, social problem-solving and social skills

Young children's social problem-solving and social skills are related to their social adjustment. In a pioneering study, Feldman and Dodge (1987) showed that young children who did not attribute hostility to another party and did not form an aggressive strategy were liked better by peers. Furthermore, Mayeux and Cillessen (2003) reported that kindergarten children and first-grade students with high peer popularity produced proactive and pro-social strategies. A longitudinal study by Rubin and Daniels-Beirness (1983) showed that children who could product many social strategies were more popular among peers in grade one. These results showed that preschoolers' social problem-solving predicted positive peer relationships at the same time and after starting elementary school.

Relationships among these competencies

We must not forget that these social-emotional competencies during early childhood could be intercorrelated with each other. For example, several studies have examined the relationship between EF and ToM. A meta-analysis by Devine and Hughes (2014), using 102 studies within the past 20 years, showed that there was a moderate correlation between EF and false-belief understanding in 3- to 6-year-olds, and that although EF predicted later false belief understanding, the converse relationship was not significant.

Social problem-solving is theoretically related to ToM and EF. For example, social problem-solving includes a series of steps to understand the other person's intentions (i.e. interpretation of cues) (Crick & Dodge, 1994), and processes of perceiving and regulating emotions (Lemerise & Arsenio, 2000). Furthermore, it is presumed that the development of this process is impacted by cognitive attention and processing speed abilities (Crick & Dodge, 1994). In fact, Mazza et al. (2017) reported that the correlation between the steps of interpretation of cues and the steps of producing responses in 5–13-year-olds was mediated by ToM. On the other hand, Woffe, Vannatta, Nelin, and Yeates (2015) showed that young children's social problem-solving was related to cool-EF, but not ToM.

The purpose of the present study

As mentioned above, previous studies have indicated two findings. First, preschoolers' social-emotional competencies are predictors of school adjustment after enrollment in elementary school. Second, these competencies are intercorrelated and interconnected. Consequently, it seems probable that some competencies are more fundamental than other competencies. In fact, Denham et al. (2014) showed that cool/hot EFs, which are basic competencies during preschool, can indirectly predict pre-academic skills (literacy and numeracy) and classroom adjustment (actions and attitude related to learning in a class) in kindergarten, via social awareness and social problem-solving. However, it is unknown how social-emotional competencies interact and predict future peer acceptance and academic achievement.

Peer acceptance during early childhood is a key aspect of school adjustment. Positive peer relationships during childhood are related to the formation of positive self-concept and school adjustment (Vandell & Hembree, 1994). Poor peer relationships are related to externalizing/internalizing problem, long-term truancy, and poor academic performance (see Asher & Coie, 1990; Kupersmidt & Dodge, 2004 for review). By studying the effects of these social-emotional competencies during preschool on later peer acceptance and academic success, we can gain a better understanding of effective interventions that enable us to reduce the risk of social maladjustment and academic underachievement. This study extends previous research about young children's social-emotional competencies by addressing these issues.

In sum, we explored whether cool/hot EFs, ToM, and social problem-solving during preschool predict peer acceptance and academic adjustment in grade one, based on Denham et al.'s (2014) model. A cool/hot EF task, ToM battery, and social information-processing task were conducted with children in the final year of preschool. Thereafter, their peer status and academic scores were measured a year later in the winter of grade one. We predicted the following results: as Denham et al. (2014) discussed, cool/hot EFs are the most fundamental aspect of social-emotional competencies during preschool. Cool EF would predict peer acceptance via ToM, as mentioned earlier (Devine & Hughes, 2014; Slaughter et al., 2015). In addition, based on previous studies (Bull et al., 2008; Blair & Razza, 2007; Clark et al., 2010; De Franchis et al., 2017; Kim et al., 2013; Monette et al., 2011), cool EF during preschool would have a direct effect on academic achievement in grade one. On the other hand, based on the theoretical assumptions by Lemerise and Arsenio (2000), hot EF would predict peer acceptance via social problem-solving.

Methods

Participants

Participants were forty-eight Japanese preschoolers[1] (23 boys and 25 girls; $M = 77.91$ months, $SD = 3.37$ months; range = 71–83 months). All participants were native Japanese speakers from middle-class, urban neighborhoods in Tokyo, Japan. The participants were all enrolled in the same elementary school and participated in follow-up in research conducted one year later when they were in grade one ($M = 89.08$ months, $SD = 3.35$ months; range = 83–94 months).

Ethics committee approval for this research was obtained from the corresponding author's university, written consent was obtained from managers and guardians at each relevant site, and verbal consent was obtained by the children themselves.

Procedure and measures

In the first part of the study (preschool period: Time 1), children participated in a cool-EF battery, hot-EF battery, ToM battery, social problem-solving task, and socio-metric test via an individual interview. The tasks were divided into three sets: Set A (two Stroop-like tests), Set B (socio-metric test, forbidden toy task, and children's gambling task), and Set C ('Simon-says' task, social problem-solving task, backward digit span (BDS) task, and ToM task). The presentation order of the tasks within each set was fixed. The order that the participating child took each set was random. The interval between each session averaged 12.3 days (range = 1–41 days).

In the second part of the study (when the children were in grade one: Time 2), the participants in each group took a socio-metric test on paper, and a test of academic performance – the criterion reference test (CRT-II) – comprising Japanese and math tests as a measure of academic achievement. The socio-metric test and CRT-II were conducted on another day in the same month.

Cool-EF battery: Time 1

The cool-EF battery included four tasks: black-white task (Simpson & Riggs, 2005), shine-rain task (Nakamichi, 2017), 'Simon-says' task (Strommen, 1973), and BDS task.

Black-white task. The experimenter asked the participant to say 'black' when the white card was presented and 'white' when the black card was presented, as quickly as possible. Participants performed the practice trials (two black and white cards each), followed by the test trials. In the test trials, the participant was instructed to respond as quickly and many cards as possible within 30 s (maximum = 30). For the black-white Stroop task, the number of correctly responded card (i.e. saying the opposite color from card drawn) was calculated.

Shine-rain task. The experimenter asked the participant to say 'rainy' when the sun card (with a picture of a sun) was presented and 'sunny' when the rain card (with a picture of a shower cloud) was presented. After the instructions, participants performed the practice trials (two sun and rain cards each) and test trials (30 s, maximum = 30 cards) following the same procedures as in the black-white Stroop task. For the shine-rain Stroop task, the number of correctly responded card in 30 s (i.e. saying the opposite weather from card drawn) was calculated.

'Simon-says' task. First, the children practiced ten actions (e.g. 'touch your feet') that were included in the task. Then, the experimenter explained the task rules in the following manner: 'When I (the experimenter) command the action with "Simon says," do the action; however,

when I do not say "Simon says," you cannot do the action.' After practicing a few times, the children completed the two sets of ten movements. Five trials for each set were 'with-Simon-says' trials, while the remaining five trials were 'non-Simon-says' trials. The score is the total number of times children correctly inhibited an action during the 'not-Simon-says' trials (maximum = 10).

BDS task. The experimenter said a list of single-digit numbers, and then required the participant to repeat the number sequence in reverse order. The sequence ranged from two to nine digits, with each trial being conducted twice. The experimenter began with two digits number and increased the number of digits until children failed twice on the same number of digits. The score is the maximum number of digits the children could recite in reverse.

Hot-EF battery: Time 1

The hot-EF battery included the Forbidden Toy Task (Lewis, Stanger, & Sullivan, 1989) and the Children's Gambling Task (Garon & Moore, 2004).

Forbidden toy task. The experimenter introduced children to an attractive toy of a dog robot (Zoomer®, Takara Tomy, 2014), which speaks and moves when given a verbal command or touched. After briefly demonstrating how to play with the toy, the experimenter explained to the children that she had to leave the room for a few minutes; however, the children should not touch the toy while she was gone. Children were left alone in the room for five minutes, and their behaviors were recorded using two hard-disc-drive video recorders. The latent period until each child touches the toy was used as the measurement (maximum = 300 s).

Children's gambling task. The experimenter placed four decks of cards in front of the children and presented them in a random order. Of the four decks, two were the 'advantageous' decks, while the remaining two were 'disadvantageous' decks. In the advantageous decks, each card had one bear and one or two tigers. Each card from the disadvantageous decks had two bears and some tigers (range = 6–13 tigers). The experimenter explained that the children would be rewarded with the same number of marbles as the number of bears drawn on a card. The experimenter also explained that the same number of marbles as the number of tigers drawn on a card would be taken away. After confirming that the children understood the rules of the game, the experimenter asked the children to draw 40 cards one-by-one from the four decks to try and get as many marbles as possible. If the children kept drawing from the 'advantageous' decks, their marbles gradually increased. The children's card selection was recorded on a scoring sheet. The score is the proportion of 'disadvantageous' selections per the last 20 trials minus the proportion of 'advantageous' selections per the last 20 trials (range = −1 to 1).

ToM battery: Time 1

The ToM battery included six tasks: the diverse desires task, diverse belief's task, knowledge-access task, false belief task, hidden emotion task, and sarcasm task. The first five tasks were conducted in accordance with instructions by Peterson, Wellman, and Liu (2005). The sarcasm task was conducted in accordance with the instruction of Peterson, Wellman, and Slaughter (2012). All tasks were conducted using pictures and toys to aid the children's understanding of the story. In all tasks, a score of one point was given when the children could correctly answer both the control question(s) and the test question(s). The ToM score is the total score of each task (range = 0–6). The content of each task was as follows:

Diverse desires. The children were asked if they understood the desire of another person that differs to their own (e.g. children want to eat a cookie; however, the doll wants to eat a carrot).

Diverse beliefs. The children were asked if they understood the belief of another person that differs from their own (e.g. children believe that the cat is hiding in the kitchen; however, the doll believes that the cat is hiding in the bathroom).

Knowledge access. Understanding the relationship between seeing and knowing (e.g. children saw and knew the fact that the toy refrigerator contained a toy dog; however, others who did not see this do not know this).

False belief. Understanding the false beliefs of others was investigated (e.g. a toy pig is in a box of Band-Aids; however, other people believe that Band-Aids are in the box).

Hidden emotion. The participants' understanding of other people's hidden emotions was investigated (e.g. although a boy who was said mean things to by his friend is still smiling, he is sad).

Sarcasm. The participants' understanding of sarcasm was investigated (e.g. a girl says, 'It's a lovely day for a picnic' on a rainy day).

Social problem-solving task: Time 1

The experimenter showed the participants two video clips about interpersonal conflict. In the first video clip (balloon setting), two girls are inflating a balloon. A balloon leaves the hand of one of the girls while the wind blows onto the other girl's face. In the other video clip (playing card setting), the two girls are playing with cards; then, a boy comes in and asks, 'Let me in'; however, the girls do not respond. The children were instructed to watch the videos from the target character's perspective (the girl whose face was blown by the wind in the balloon setting, and the boy in the playing card setting). After each video clip was presented, the experimenter asked the interpretation question, 'What happened?' and the strategy question, 'If you were that child, what do you think you would do?' In both settings, the children's responses were categorized in the following manner. The scores for the interpretation and strategy questions in two settings were summed to calculate social problem-solving score (range = −4 to 4).

Interpretation question. The children's reactions were categorized as either 'negative' (−1 point), 'positive' (1 point), 'neutral' (0 points), or 'other/no answer' (0 points). 'Negative' meant mentioning the other person's negative emotions and intentions (e.g. she wanted to say something bad, she ignored). 'Positive' meant mentioning the other person's positive emotions and intentions (there were no children who gave a positive interpretation). 'Neutral' meant simply explaining the situation (e.g. the air went out of the balloon, she did not say anything). 'Others/no answer' meant mentioning something that did not occur in the video or not offering an interpretation.

Strategy question. The children's reactions were categorized as one of 'aggressive' (−1 point), 'efficient' (1 point), 'inefficient' (0 point), or 'other/no answer' (0 points). 'Aggressive' meant mentioning physical aggression (e.g. hitting), expressing aggressive emotion (e.g. becoming angry), and using an aggressive verbal strategy (e.g. saying that the other person is stupid). 'Efficient' meant mentioning a verbal strategy that is not aggressive (e.g. saying, 'watch out,' or saying, 'let me in' once again) or a pro-social behavior (e.g. going to pick up the balloon). 'Inefficient' meant a passive strategy (e.g. staying quiet), evasive strategy (e.g. go somewhere else), or relying on other people (e.g. asking the teacher). 'Other/no answer' meant expressing the negative feelings of myself (e.g. 'I do not like it') or being unable to come up with a strategy.

Assessment of peer acceptance: Time 1 and Time 2

The socio-metric peer nomination was used to assess the acceptance by peers. At baseline (pre-school-age: Time 1), as the experimenter presented a participant with pictures of all children from the class, they asked for the names of three friends the participant always plays with (maximum = 3). At follow-up (grade one: Time 2), the same question was asked in a group using a survey sheet. The score of peer acceptance is the number of times each child was nominated by peer at each time.

Assessment of academic achievements: Time 2

At follow-up (grade one: Time 2), the participants were administered language (Japanese) and math subtests from the CRT-II (Tatsuno & Kitao, 2012), which is a valid, reliable, and standardized academic assessment test that is commonly used in Japan. The language subtest included reading/writing word and sentence comprehension. The math subtest included calculations, quantitative concepts, and arithmetic word problems. The CRT-II scores for subtests of Japanese and math were used as the academic achievement scores (each test's maximum = 100).

Statistical analysis

Descriptive analyses, principal-component analysis of EF measures, zero-order (Pearson) correlations among measures, and *t*-tests in which each measure was treated as dependent variable and sex was treated as independent variable were performed. These analyses were conducted using IBM SPSS for Windows, Version 23.

The structural equation modeling (SEM) using Amos software (Version 23) was used to examine the longitudinal model that school adjustments (peer acceptance and academic achievements) at Grad 1 be explained by preschool social-emotional competencies (cool/hot EFs, ToM, and social problem-solving). The fit of model to the data was evaluated by Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), and Root Mean Square Error Approximation (RMSEA).

Results

Descriptive statistics of each measure at Time 1 and Time 2

Table 1 shows the mean scores and standard deviations at preschool age (Time 1). We subjected the six EF measures to a principal-component analysis with an orthogonal rotation. This analysis yielded two-factors (accounting for 60.90% of the variance). The loadings of measures are displayed in Table 2. Each factor contained measures that corresponded to the theoretical grouping of tasks described earlier. The first factor contained four measures (i.e. black-white, shine-rain, Simon says, and BDS), $\alpha = .75$, average item-total $r\ (48) = .43$, and was labeled as a cool-EF scale. The second factor contained two measures (i.e. Gambling and forbidden toy), $\alpha = .63$, average item-total $r\ (48) = .37$, and was labeled as a hot-EF scale. Consequently, using the standardized (z) scores of each task, cool-EF and hot-EF composite scores were calculated for each participant.

To investigate sex difference at Time 1, a *t*-test was performed for each measure. Results showed that there were no sex differences, except for ToM score, $t(46) = 2.47$, $p = .02$, $d = 0.73$, and hot-EF score, $t(46) = 2.16$, $p = .04$, $d = 0.64$. For these two scores, girls' scores (ToM, $M = 3.87$, $SD = 0.92$; hot-EF, $M = 0.50$, $SD = 1.21$) were higher than boys' scores (ToM, $M = 3.08$, $SD = 1.26$; hot-EF, $M = -0.46$, $SD = 1.79$).

In grade one (Time 2), the mean score of peer acceptance was 2.90 ($SD = 1.87$, range = 0–7). The mean score of language subtest was 88.23 ($SD = 9.16$, range = 63–100), and the mean score of math subtest was 89.0 ($SD = 11.34$, range = 50–100). The scores for language and mathematics were significantly and positively correlated ($r = .66$, $p < .001$). Consequently, an academic achievement score was

Table 1. Mean performance on each measure at Time 1.

	Black-white	Shine-rain	Simon says	BDS	Forbidden toy	Gambling	ToM	SPS	Peer acceptance
Total	15.69	16.13	6.65	2.71	242.73	−0.09	3.46	−0.83	2.90
($N = 48$)	(2.50)	(2.72)	(3.68)	(1.38)	(122.19)	(0.29)	(1.17)	(0.94)	(1.65)

Note: Standard deviations are shown in parentheses. BDS = Backward Digit Span; ToM = Theory of Mind; SPS = Social problem-solving.

computed by summing these two scores ($M = 177.31$, $SD = 18.75$, range = 133–200). For peer acceptance and academic achievement scores at Time 2, the sex differences of these scores were not significant.

Correlations between variables at Time 1 and Time 2

To investigate the relationships among each score at Time 1 and Time 2, Pearson's correlation analyses were performed (Table 3). At Time 1, cool-EF was significantly and positively related to ToM and peer acceptance. At Time 1, hot-EF was significantly and positively related to social problem-solving. Moreover, at Time 1, ToM and social problem-solving were significantly and positively correlated with peer acceptance. At Time 2, peer acceptance was not significantly correlated with academic achievement. Peer acceptance at Time 1 was significantly and positively related to peer acceptance at Time 2. Cool-EF and ToM at Time 1 were significantly and positively related to academic achievement at Time 2.

The effects of social-emotional competencies at preschool-age school adjustment in grade one

SEM was conducted to examine whether Time 1's variables influenced the peer nomination and academic achievement at Time 2. Based on the Denham et al. (2014), we presumed the model that basic ability (i.e. cool-EF and hot-EF) supports applied ability (i.e. ToM and social problem-solving) during preschool-age, and these abilities at preschool-age influence on peer relationships in concurrent and later adjustment (i.e. peer acceptance and academic achievement).

Figure 1 depicts the final structural model, with non-significant hypothesized paths deleted. Model fit was sufficient, GFI = .924, AGIF = .848, CFI = .996, RMSEA = .017. Path coefficients in the model can be interpreted as standardized beta weights, each estimated after all other paths' effects have been controlled. At Time 1, cool-EF and hot-EF had positive effects on ToM and social problem-solving, and these applied abilities had positive effects on peer acceptance. Peer acceptance at Time 1 significantly predicted peer acceptance at Time 2. Moreover, cool-EF and hot-EF at Time 1 directly predicted academic achievement at Time 2.

Discussion

Using a longitudinal design, we examined how social-emotional competencies (i.e. EF, ToM, and social problem-solving) during preschool impact academic achievement and social adjustment in

Table 2. Loadings of EF measures on factors in a principal-component analysis.

	Factor 1	Factor 2
Black-white	**.861**	−.039
Simon says	**.860**	.138
Shine-rain	**.797**	.072
BDS	**.480**	−.240
Gambling	.059	**.856**
Forbidden toy	−.045	**.698**

BDS = Backward Digit Span.

Table 3. Pearson's correlations between Time 1 measures and Time 2 measures.

	Time 1						Time 2	
	1	2	3	4	5	6	7	8
1. Age (months)	1.00	.09	.11	.10	.28	.28	−.01	.14
2. Cool-EF		1.00	.01	.39**	.07	.30*	.17	.58**
3. Hot-EF			1.00	.15	.31*	−.09	−.05	.24
4. ToM				1.00	.23	.42**	.04	.32*
5. Social problem-Solving					1.00	.31*	.03	-.06
6. Peer acceptance						1.00	.40**	.12
7. Peer acceptance							1.00	−.02
8. Academic achievement								1.00

grade one. This study presented four key findings: first, analyses related to the EF-task showed that children's EF can be separated into 'cool' and 'hot' components. As mentioned previously, Zelazo and colleagues (Zelazo & Carlson, 2012; Zelazo & Müller, 2002) hypothesized that EF has the 'cool' cognitive component and 'hot' emotional component. Many studies among young children showed that hot-EF tasks and cool-EF tasks contribute to varied factors respectively (e.g. Denham et al., 2014; Kim et al., 2013; Willoughby et al., 2011). However, a few other studies (Allan & Lonigan, 2011; Sulik et al., 2010) found that hot-EF tasks and cool-EF tasks during preschool contribute to a single factor. Contrary to these findings, Zelazo and Carlson (2012) suggested that the dissociation of cool-EF and hot-EF emerged at around six years of age. The average age of the participants in this study was 77.91 months, with most of them being over six-years-old. The results of this study provide further evidence in support of Zelazo and Carlson's (2012) assertions regarding the development of cool-EF and hot-EF.

Second, the SEM revealed that the two aspects of cool-EF and hot-EF during preschool significantly predicted academic achievement in grade one. Most prior research showed a longitudinal relationship between cool-EF during preschool and later academic achievement (Blair & Razza, 2007; Bull et al., 2008; Clark et al., 2010; De Franchis et al., 2017; Monette et al., 2011). However, it was less known that hot-EF during preschool impacts academic achievement after enrollment in elementary school. For example, Kim et al. (2013) examined the correlation between EF during preschool and academic achievement after starting school, but did not find a correlation between hot-EF and later academic achievement, unlike this study. This discrepancy may be explained in part by the

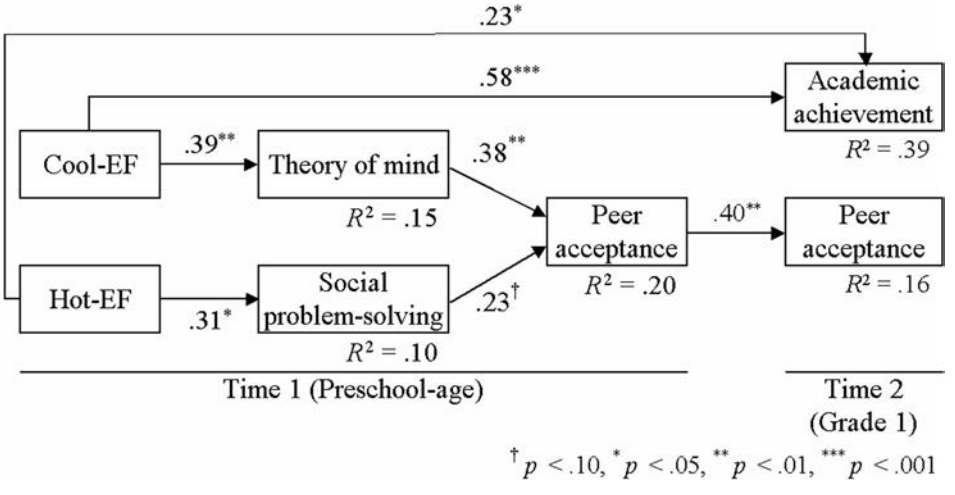

Figure 1. Path diagram with standardized parameter estimates of the effects of social-emotional competencies (cool and hot executive functioning, theory of mind, and social problem-solving) on peer acceptence at Time 1 and Time 2 and academic achievement at Time 2.

difference in how academic achievement was measured. In this study, academic achievement was measured using a standardized written test. On the other hand, Kim et al. (2013) used teachers' reporting of the children's academic performance. The evaluation of children's academic performance by the teachers may be partly influenced by subjective bias. We thus employed a more valid measure of children's academic competencies than Kim et al. (2013) did. Furthermore, as indicated in research on test anxiety (e.g. Sarason, 1984), academic tests in elementary school generate emotions such as anxiety and nervousness among children to some extent. Hot-EF works when strong emotions are triggered (Zelazo & Carlson, 2012; Zelazo & Müller, 2002). In this study, academic achievement was measured purely in a setting that requires hot-EF; therefore, contrary to Kim et al. (2013), the current study may have discovered the correlation between the two factors.

Third, SEM indicated that cool-EF predicts ToM while hot-EF predicts social problem-solving, and that both ToM and social problem-solving predict peer acceptance during preschool. Denham et al. (2014) argued that even among the sub-components of social-emotional competencies, EF as self-regulation is the most fundamental factor. This study's findings provide further empirical support for this assertion. Furthermore, Denham et al. (2014) did not examine the impact of social-emotional competencies on acceptance by peers. This study's results expanded on Denham et al.'s (2014) findings by demonstrating that social-emotional competencies play a key role in peer relationships and academic skills.

Concerning the path from cool-EF to peer relations, correlation analyses showed a positive correlation between cool-EF and peer acceptance. However, the SEM did not show a direct effect of cool-EF on peer acceptance. Furthermore, previous studies suggested that ToM is underpinned by cool-EF (Devine & Hughes, 2014) and predicts peer popularity (Caputi et al., 2012; Fink et al., 2014; Slaughter et al., 2015). Based on the present study, as well as previous studies, it seems reasonable to conclude that cool-EF indirectly, and not directly, affects peer acceptance via ToM.

On the other hand, hot-EF had an indirect effect on peer acceptance via social problem-solving. Previous research (e.g. Feldman & Dodge, 1987; Rubin & Daniels-Beirness, 1983) has shown the correlation between social problem-solving ability and peer relations. Although the correlation between EF and social problem-solving has been presumed theoretically (Crick & Dodge, 1994), its correlation has not been examined sufficiently. When EF was divided into cool and hot aspects, the relationships between these two aspects of EF and social problem-solving remained unclear. Interpersonal conflict situations tend to elicit emotions, as hypothesized by Lemerise and Arsenio (2000). For this reason, hot-EF, which is involved with emotions (Zelazo & Carlson, 2012; Zelazo & Müller, 2002), would play an effective role in social problem solving, rather than cool-EF.

Fourth, ToM and social problem-solving in preschool impacted peer acceptance in grade one indirectly, and not directly, by mediating the peer relationship during the concurrent period. As mentioned earlier, social problem-solving abilities predict concurrent peer relationships. In addition to this, peer relationships are vital in fostering future social-emotional competencies. For example, rejection by peers when preschool-aged diminishes the opportunity to develop the ability of social problem-solving, resulting in poorer social problem-solving when elementary school-aged (Dodge et al., 2003). Moreover, Nelson (2007) proposed that conversations about mental states with others are a significant learning context for the development of ToM. Based on these studies, the longitudinal relationships in peer acceptance between preschool and grade one was due to the development of ToM and social problem-solving abilities, which were affected by positive or negative peer relationships. Future studies that use a panel study design are needed, such as measuring peer acceptance, ToM, and social problem-solving at diverse times, to examine the cyclical relationship between peer relationships, ToM, and social problem-solving ability.

Although these findings are beneficial, this study has several limitations that must be noted. First, this study had a small sample size. In addition, the participants were from middle-class households; therefore, future studies should attempt to include a larger sample with a diverse range of household income and education history. Another limitation concerns measurement issues. This study's cool-EF battery included measures of inhibitory control and working memory. On the other hand, the hot-EF

battery included measures that are not necessarily limited to inhibitory control and working memory. A battery designed for measuring the three sub-factors of EF (i.e. inhibitory control, working memory, and shifting) or the general EF ability will be beneficial in future projects.

Despite these limitations, the results of this study provide useful suggestions for future research and education practice. First, this study indicated that preschoolers' social-emotional competencies predict the quality of peer relationships in addition to academic achievement one year later. Peer relationships during preschool are a key factor in school adjustment, the formation of a positive self-image, and the amount of externalizing/internalizing problems (Asher & Coie, 1990; Kupersmidt & Dodge, 2004; Vandell & Hembree, 1994). Furthermore, peer relationships during childhood have a long-lasting impact on social adjustment. For example, positive peer relationships and popularity when children are aged 5–8 years predicts the quality of friendships when aged 19–23 years (Lansford, Yu, Pettit, Bates, & Dodge, 2014). This study and previous results imply that social-emotional competencies during preschool are significantly related to adjustment in school and adult life.

Second, the current results not only reveal that both cool-EF and hot-EF during preschool can directly predict academic achievement in grade one, but that they also indirectly predict the quality of peer relationships via different pathways. The existence of these distinct routes suggests that children's academic and social adjustment can be supported by educators using various approaches. For example, to promote the development of EF, Diamond and Lee (2011) suggested that 'Tools of the Mind' and a Montessori education approach are relatively effective. Furthermore, to support the development of ToM, Nelson (2007) proposed that conversations about one's mental state are key for developing ToM. Moreover, to support social problem solving, various intervention methods, such as the Fast Track Program (e.g. Conduct Problems Prevention Research Group, 2004) have been developed (Merrill, Smith, Cumming, & Daunic, 2017). To support children's academic and social adjustment, it is crucial for educators to use varied approaches.

Third, this study was the first to examine the effect of Japanese children's social-emotional competencies on later school adjustment. Prior studies cited earlier were all conducted in Europe and the United States. However, the development of sub-factors of social-emotional competencies is not necessarily the same in all cultures or countries. For example, the ToM pass rate at 44-months-old in the US and the UK is 50%; in comparison, Australia has a higher rate (69%), while Japan has a lower rate (40%) (Wellman, Cross, & Watson, 2001). Despite the cultural differences in the development of these sub-factors, the results of this research among Japanese children were consistent with the findings in Europe and the United States. This suggests that the developmental process that social-emotional competencies affect later adjustment is at least similar between Japan and the West.

In summary, this study presented novel evidence that the two aspects of self-regulation during preschool (i.e. cool-EF and hot-EF) have a direct effect on later academic achievement, and an indirect effect on peer relationships. Furthermore, ToM and social problem-solving ability based on self-regulation directly predicted peer relationships during preschool, and this peer relation predicted peer relationships after entering elementary school. These results indicate that the components of social-emotional competencies interact with one another during preschool, and, consequently, these components impact the formation of positive peer relationships and academic achievement following school enrollment.

Note

1. Japanese kindergarten is not attached to elementary school, and it is not the lower class of first grade of elementary school. In Japanese compulsory education, 6 years old children start to learn academic skills (reading, writing and math) at first grade of elementary school. Children under 5 years of age spend play activities at kindergarten (Yochien) or day nursery (Hoikuen) (Tobin, Hsueh, & Karasawa, 2011). Japanese government formalizes play as main activities in early childhood education (Ministry of Education, Culture, Sports, Science and Technology, 2017).

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Notes on contributors

Keito Nakamichi is an assistant professor of developmental psychology in Faculty of Education, Chiba University. His research interests include cognitive development (reasoning, self-regulation, and executive function) and social development in childhood. He also earned his Ph.D. in Education from Tokyo Gakugei University in Tokyo, Japan.

Naoko Nakamichi is an assistant professor of developmental psychology in Department of Sports Wellness Sciences, Japan Women's College of Physical Education. Her research interests include social cognition (theory of mind and testimony) and pretend play in childhood. She also earned his Ph.D. in Education from Tokyo Gakugei University in Tokyo, Japan.

Jun Nakazawa is the president of the Uekusa Gakuen University. His research interests include social development in childhood. He also earned his Ph.D. in Psychology from Hiroshima University in Hiroshima, Japan.

ORCID

Keito Nakamichi http://orcid.org/0000-0003-4786-0529

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