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HOW DOES EXECUTIVE FUNCTION CONTRIBUTE TO SOURCE MONITORING IN YOUNG CHILDREN?

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In the present study, children in the age group of 3–5 years had to perform a source-monitoring task, a cognitive shifting task and an inhibitory control task, and the correlations between the tasks were examined. In the source-monitoring task, children were asked to discriminate objects they acted on (internal source) from objects an experimenter acted on (external source). They were also administered the Dimensional Change Card Sort (DCCS) task as a cognitive shifting and Black/White task as an inhibitory control task. We found that there was a significant correlation between the measure on the external source and the performances in the DCCS task. The results indicated that cognitive shifting may play an important role in source monitoring where children have to discriminate internal sources from external sources.

Key words: source monitoring, executive function, inhibitory control, preschool children

Episodic memory refers to the explicit memory of unique concrete personal experiences dated in the individual's past (Tulving, 1983). Episodic memory includes access to details about where, when, and with whom the experience took place. Recent research on the development of episodic memory focuses on when and how children develop the ability to specify the contextual information related to a memory, which is often referred to as source monitoring (Johnson, Hashtroudi, & Lindsay, 1993).

Empirical studies have demonstrated that source monitoring shows a marked development during preschool years. Foley and colleagues reported that children develop the ability to discriminate between internal and external sources of information. Foley, Johnson, and Raye (1983) showed that six-year-old children discriminated what they said from seeing what others said. Foley and Johnson (1985) reported that children discriminated what they did from observing what the other person did. Further, Naito (2003) showed that four-year-old children displayed difficulty in judging when they acquired new knowledge (e.g., the color that mixes red and green) after an experimenter informed them about the knowledge, but six-year-old children had significantly better performances in the task. Furthermore, children displayed marked development in their ability to discriminate between external sources of information (e.g., "which person said

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it," Lindsay, Johnson, & Kwon, 1991) and internal sources (e.g., "what is imagined," Foley et al., 1983) at the preschool age. Taken together, these studies have shown that preschool children develop the ability to efficiently identify the various kinds of contextual information related to a memory.

Recently, there has been a growing body of interest in the individual differences in the source-monitoring ability. It has been proposed that executive functioning is strongly related to source monitoring. Executive function is a higher-order cognitive control process that enables us to execute and monitor appropriate and relevant actions as well as to inhibit irrelevant and inappropriate actions for the attainment of a specific goal (Zelazo, Carter, Reznick, & Frye, 1997). Recent studies suggested that the executive function is not unitary; instead, it consists of several components such as inhibitory control, cognitive shifting, and working memory (Garon, Bryson, & Smith, 2008). Theoretically, source monitoring requires cognitive control processes in which one must represent the goal (i.e., selecting the correct source) and the best strategies for achieving the goal, and inhibit suboptimal processes that will interfere with goal attainment (i.e., selecting the incorrect source) (Johnson et al., 1993). Indeed, there are empirical studies that examine whether executive function is correlated with source monitoring in the older population (Craik, Morris, Morris, & Loewen, 1990) and in children (Drummey & Newcombe, 2002; Melinder, Endestad, & Magnussen, 2006; Ruffman, Rustin, Garnham, & Parkin, 2001).

In developmental studies, Ruffman et al. (2001) reported that school-aged children's inhibitory control and working memory were correlated with a source-monitoring task in which children had to discriminate between external sources of information. In this study, six- , eight- , and ten-year-old children were given a videotape about a dog, followed by an audiotape that included eight old events that were shown in the video and eight new events that had not occurred in the video. Then, the children were asked to discriminate between the sources of the events. They were also assigned a Stroop task as an index of inhibitory skills, and a digit span task as an index of working memory. The results revealed that the performances of the Stroop task and the working memory task were significantly correlated with the source-monitoring task even after controlling for age and verbal ability.

On the other hand, it is still unclear whether young children's executive skills are correlated with source monitoring. Drummey and Newcombe (2002) reported that external source-monitoring errors in preschool children are partly due to poor executive skills. The researchers argued that the errors of source monitoring in young children may be divided into two types, as follows: extraexperimental errors and intraexperimental errors. Extraexperimental errors occur when children do not remember that some knowledge was learned in the experimental situation and incorrectly attribute the events to a source like television. On the other hand, intraexperimental errors occur when children remember that some knowledge was learned in the experimental situation, but fail to remember who imparted the information. In the study, children were given ten facts by one of the two sources, namely, the experimenter or puppet. After a one-week delay, children were given questions on the facts and source questions. The results showed that four-year-old children committed more extraexperimental errors than intraexperimental errors. They tended to attribute the source of the knowledge to a teacher or parent. On the other hand, six- and eight-year-old children made more intraexperimental errors. In addition, the incidence of extraexperimental errors was negatively correlated with performance on the modified version of the Wisconsin Card Sorting Test in some of the four-year-old children, although Drummey and Newcombe failed to detect a significant negative correlation between the measures in the whole sample.

Melinder et al. (2006) examined whether three- to six-year-old children's executive skills predicted their performances on an external source-monitoring task. In this task, children were shown some videos in which child actors/actresses were interacting each other. After watching the videos, children were given the source questions (e.g., "In which video did the boy take a toy from the girl?"). Melinder et al. found that children demonstrated age-related improvement on the performances in the source-monitoring task but did not find significant correlation between the measures on the source-monitoring task and the performances on the Day/Night Stroop task (Gerstadt, Hong, & Diamond, 1994).

On the other hand, there is some evidence that children's source monitoring may be correlated with their executive skills. Sluzenski, Newcombe, and Ottinger (2004) gave four-, six- and eight-year-old children a monitoring task where they had to discriminate what they did from what they imagined, and a categorical fluency task where children had to generate examples of a specified category (e.g., animals), as a measure for prefrontal function. The researchers found a significant correlation between the performances in the tasks.

In sum, previous studies on the developmental relationship between executive functioning and source monitoring have revealed the following: (1) in school-aged children, executive function is significantly correlated with external source monitoring and (2) in preschool children, executive function is partially correlated with source monitoring, but the results were mixed.

In our view, the mixed results may be due to the differences in tasks used. The studies that used external monitoring tasks (e.g., Melinder et al., 2006) failed to show the significant correlation between executive function and source monitoring. As described above, the external source-monitoring tasks require children to discriminate between external sources of information (e.g., an experimenter vs. a puppet). In the tasks, the saliency in the sources may not be very different. However, source monitoring requires executive process in which one must represent the goal and the best strategies for achieving the goal, and inhibit suboptimal processes that will interfere with goal attainment (see above). Specifically, when one source is more salient than the other source and the salient source will strongly interfere with the goal attainment, the executive process might be important. Given that, it is likely that the development of executive function may contribute to the development of source monitoring in case one source is more salient than the other source.

In which case is one source more salient than the other? There are several factors that may contribute to the differences of the saliency (e.g., familiarity, attractiveness), but we focused the case where two sources of information are qualitatively different. Some previous studies used source-monitoring tasks that required children to discriminate between two sources of information that were qualitatively same, while other studies gave children tasks where two sources of information were qualitatively different. External source-monitoring tasks are the typical examples of the former (e.g., Melinder et al., 2006). On the other hand, the latter included studies that examined whether children could differentiate the internal source of the information from the external source of the information. For example, Hill and Russell (2002) asked children to discriminate objects they acted on from objects an experimenter acted on. In such tasks, children sometimes mistake an experimenter's actions as their own. Indeed, Foley and Ratner (1998) reported "I did it" bias in a source monitoring task, where 4-year-old children tended to claim that they placed pieces on collages that were actually placed by an experimenter (see also, Foley, Ratner, & Passalacqua, 1993). This study clearly showed that the internal source (children) would be more salient than the external source (an experimenter). To perform the task correctly, children may have to represent the goal (i.e., choosing the correct, external source) and inhibit suboptimal processes that will interfere with goal attainment (i.e., choosing the incorrect, internal source).

Consistent with the view, Sluzenski et al. (2004) used the source monitoring task where one source is more salient than the other (what children did vs what children imagined), and found a significant correlation between source monitoring ability and the performances in the category fluency task, a measure of the prefrontal function. However, the category fluency task included several cognitive processes such as encoding, binding and retrieval of different stimuli (Sluzenski et al., 2004). The previous study failed to specify how prefrontal function contributed to the source monitoring. More specific measures of prefrontal function were needed.

Given the considerations, we hypothesized that the development of executive function may be more significantly correlated to the development of source monitoring in which children discriminate between internal and external sources of information. The present study tested this hypothesis.

In this study, children were administered a source-monitoring task that required them to discriminate the internal source of information from the external source of information, which was originated from Hill and Russell (2002). In this task, children were presented with a series of pairs of objects (e.g., a pig and a box) and asked to perform a designated action or watched the experimenter perform a designated action (e.g., "You put the pig on the box" or "Watch me, I'm putting the pig on the box"). After a while, children were presented with a series of pairs of objects that included the original pairs and new pairs, and asked whether the pairs were included in the original pairs (memory questions) and whether they or the experimenter acted on it (source monitoring questions). In this task, to identify the external source of information correctly, the children may have to inhibit irrelevant information (i.e., children may have acted on the objects) and represent the external sources of information (i.e., the experimenter acted on objects). In the sense, this task included the goal-directed nature. The performances on the measures and their relations to executive function were examined.

As described above, executive function consists of several components, such as cognitive shifting and inhibitory control. It has been repeatedly shown that both cognitive shifting and inhibitory control develop significantly during preschool years (Garon et al., 2008; Moriguchi & Itakura, 2008). Thus, the present study examined whether cognitive shifting and inhibitory control were significantly correlated with source monitoring in young children.

METHOD

Participants

A total of 70 preschool children (*M* = 54.7 months, *SD* = 9.0, range = 39 months to 71 months, 43 boys and 27 girls) participated in the experiment. Children consisted of 21 three-year-olds, 23 four-year-olds, 26 five-year-olds. The children were recruited from nursery schools in the suburban areas of China. Most participants belonged to middle-class backgrounds. Informed consent was obtained from all parents.

Procedure

A within-subjects design was used. All children participated in the experiment at their nursery schools. Children were tested individually for about 30 minutes. Because we were interested in consistency in individual differences across situations, tasks were administered in a fixed order (for a rationale, see Carlson & Moses, 2001). The order of the tasks were a source-monitoring test, the Dimensional Change Card Sort task (cognitive shifting task, Moriguchi & Itakura, 2008), and the Black/White test (inhibitory control task, Simpson & Riggs, 2005).

Measures

Source-Monitoring Task

We modified the procedure used by Hill and Russell (2002). There were two phases in the task, namely, an introduction phase and a test phase. In the introduction phase, children were presented with a series of pairs of objects on the table (e.g., a pig and a box) and asked to perform a designated action or watched the experimenter perform a designated action (e.g., "You put the pig on the box" or "Watch me, I'm putting the pig on the box"). These objects were then removed from the table and the next pairs of objects were presented. Thirty-six objects that were familiar to children were used and divided into 18 pairs (see Appendix). Each object was involved in only one action and the same combination of objects was maintained throughout the experiment (i.e., the box and the pig always went together). For each child, nine pairs of objects were acted upon by self and nine pairs of objects were acted upon by the experimenter. The order in which the individual (child/experimenter) had acted on those objects was fixed: child (c), c, c; experimenter (e), e, c, e, c, c, e, e, e, e, c, e, e, c, c.

The test phase began five minutes after the introduction phase. In the test phase, all 18 pairs of objects (hereafter, real pairs) were included, along with 9 additional pairings that had not been featured in the initial phase of the experiment (lure pairs). These lure pairs comprised of objects included in the first phase of the experiment but in new combinations; for example, in the introduction phase of the experiment, a coin was combined with a book, but during the test phase, a coin was combined with a candle as one of the lure pairings. In this phase, the children were administered test questions. The experimenter showed the child two objects. In the real parings, children were shown the objects while the experimenter was performing the same actions as in the introduction phase. In the lure parings, children were shown the objects while the experimenter put one object beside the other. Then, children were asked two questions, relating to the child's memory, as follows: (i) the correct pairings (question: "Here is the [pig] and the [box]. Were these two put together?") and (ii) the individual who had acted on those objects (child/experimenter) (question: "Can you remember if it was you or me who did something with these things?").

Question 1 was a memory question and was always asked first. Given the presence of the lure pairings in the memory test, the answer to this question should be "yes" for the real pairings and "no" for the lure pairings. However, it was possible for children to think that objects involved in the lure pairings had been seen together in the initial phase of the test. Thus, four possible answers to this question existed, a correct yes for real pairings and a correct no for lure pairings, and an incorrect yes for lure pairings (false positive) and an incorrect no for real pairings (false negative). When a false positive was made, Question 2 was asked without a child being corrected, while in the case of false negatives, children were not asked further questions (Hill & Russell, 2002). Question 2 concerned source memory in the sense that it asked which agent had carried out a particular action. No feedback was given for this question.

There are several measures in the source-monitoring test. For Question 1 (memory question), we calculated real A scores (0–9), real B scores (0–9), and lure scores (0–9). The real A scores were defined as the number of correct pair identifications in the pairs of objects that the children themselves had acted on (i.e., the objects were put together). The real B scores were defined as the number of correct pair identifications in the pairs of objects that the experimenter acted on. The lure scores were defined as the number of correct pair identifications in the lure parings (i.e., the objects were not put together). Then, following the previous study (Hill & Russell, 2002), we created composite real scores (0–18), which consisted of the real A scores and real B scores. We used both the composite real scores and lure scores in the analyses.

For Question 2 (source monitoring question), we calculated the self-performed monitoring scores (0–9) and other-performed scores (0–9). The self-performed monitoring scores and the other-performed monitoring scores were defined as the scores of recall of whether children or the experimenter had each performed an action with an object pairing (i.e., the experimenter acted on the pairs). Then, the self-performed monitoring scores and other-performed monitoring scores were respectively divided by the real A scores and real B scores, resulting in the internal source scores (0–1) and external source scores (0–1), respectively. For example, if a child identified the eight pairs of objects that the child acted on correctly (the real A scores are eight) and recalled that they acted on six pairs out of eight pairs (the self-performed monitoring scores are six), then the internal source scores are 0.75.

Executive Function

Cognitive Shifting Task

We used the DCCS task as a measure of cognitive shifting. Following the procedure by Moriguchi and Itakura (2008), the experimenter showed the children cards with a red cup and a blue star on them, a box with a picture of a red star on it, and a box with a picture of a blue cup on it. In the first phase, children were instructed to sort the cards according to one dimension (e.g., in the shape game, "This is a shape game. All the cups go here and all the stars go there"). Children were given six trials, and at the beginning of each trial, the experimenter informed the children about the rules of the game, randomly selected a sorting card and asked them to sort the cards ("Where does this go in the shape game?"). Children were given feedback on every trial ("Yes"/"No"). The experimenter withdrew the sorting card on each trial. When they had completed six trials, children were asked to stop playing the first game and told to switch to a new game ("Now we are going to switch and play a new game."). If children sorted the cards according to the shape dimension in the first phase, they were asked to sort cards according to the color dimension (e.g., "The new game is a color game. The color game is different from the shape game. In the color game, all the red ones go here and all the blue ones go there."). Children were then given six trials that were identical to those in the first phase except for the dimension (e.g., color). In the second phase, children were not told whether he/she sorted the cards correctly. Scoring was based on the number of trials in which the children could sort the cards according to the second dimension in the second phase (range, 0–6).

Inhibitory control task

We used the Black/White task as a measure of inhibitory control. Following the procedure by Simpson and Riggs (2005), the experimenter presented a child with a black card and a white card. The experimenter gave the children the instructions for the task ("Let's play the Black-White game! In this game, when you see this black card, I want you to say 'white'. And when you see this white card, I want you to say 'black'"). Children were administered practice trials until they performed correctly in two consecutive trials (one for a white card and the other for a black card). In the test phase, fourteen trials were administered in which seven black cards and seven white cards were presented according to a pseudorandom sequence. The cards were presented in the order black (b), white (w), b, w, w, b, b, w, b, w, w, b, w, b. If the child hesitated to answer, the experimenter prompted the child ("What do you say for this card?"). The experimenter never said the words "black" or "white" as a prompt. Scoring was based on the number of trials in which the children correctly responded to the cards according to the experimenter's instructions (range, 0–14).

Table 1. Descriptive Statistics of Source-Monitoring Tasks and Executive Function Tasks As a Function of Children's Age. *M(SD)*

Variable	3-year-olds	4-year-olds	5-year-olds
Source monitoring task			
Composite Real (0–18)	17.57 (1.20)	17.60 (0.50)	16.42 (4.12)
Real A (0–9)	8.86 (0.48)	8.83 (0.49)	8.38 (1.92)
Real B (0–9)	8.71 (0.78)	8.78 (0.52)	8.04 (2.29)
Lure (0–9)	4.10 (3.99)	6.26 (3.82)	6.15 (3.79)
Self-performed (0–9)	7.48 (1.81)	7.91 (1.86)	8.12 (2.12)
Other-performed (0–9)	7.71 (1.93)	7.96 (1.82)	7.65 (2.40)
Internal source (0–1)	.85 (.21)	.89 (.19)	.94 (.20)
External source (0–1)	.89 (.21)	.90 (.19)	.95 (.11)
Cognitive shifting			
DCCS (0–6)	4.81 (2.29)	5.87 (0.46)	5.65 (1.20)
Inhibitory control			
B/W (0–14)	10.19 (3.54)	11.35 (2.91)	12.65 (2.10)

RESULT

We first reported the results of the source-monitoring task and executive function tasks individually, followed by the analyses of the relations among measures. Descriptive results of the source-monitoring task are presented in Table 1 as a function of children's age.

First, we analyzed the results of Question 1 (i.e., memory question). We conducted a one-way ANOVA to examine the age-related changes in the composite real scores and lure scores; however, we found no significant main effect of age in the composite real scores ($F(2, 67) = 1.568, p > .21$) and the lure scores ($F(2, 67) = 2.200, p > .11$).

Next, we analyzed the results of Question 2 (i.e., monitoring question). One-way ANOVAs were conducted to assess the age-related changes in internal source scores and external source scores. We did not find significant age-related changes either in internal source scores ($F(2, 67) = 1.145, p > .32$) or in the external source scores ($F(2, 67) = 0.918, p > 40$). Then, we examined whether the data in each age group were different from what was to be expected by chance (0.5). One-sample *t*-tests were conducted to compare the mean monitoring accuracies to a score of 0.5. We found that children in each age group performed above chance in both internal source scores and external source scores (three-year-olds, $t(20) = 7.698$, $p < .001$; $t(20) = 8.644$, $p < .001$, four-year-olds, $t(22) = 9.765$, $p < .001$; $t(22) = 10.243$, $p < .001$, five-year-olds, $t(25) = 10.869$, $p < .001$; $t(25) = 21.192$, $p < .001$).

Next, we examined whether there were differences of performances between two

Table 2. Raw Correlations Between the Measures.

Variable	1	2	3	4	5	6	7
1. Composite Real		–.20	.40**	–.04	–.12	–.11	–.03
2. Lure			.08	.28*	.23	.37**	.17
3. Internal source				.14	.19	.02	.05
4. External source					.15	.38**	–.02
5. Age in month						.26*	.39**
6. DCCS							.09
7. B/W							

Note. N = 70, *p < .05 (two-tailed), **p < .01 (two-tailed).

sources of information. First, we examined whether the internal source scores were different from the external source scores using a paired *t*-test and did not find a significant difference between them ($t(69) = 0.761$ $p > .44$). Second, we conducted error analyses. Children's responses on the source monitoring questions were classified into three categories: "correct response", "source error", "no answer". Source error refers to the errors in which children answered "experimenter" on the internal source questions or answered "me" on the external source questions. We compared the percentage of the source errors in both source questions and found no significant differences of the errors between internal source questions and external source questions (Wilcoxon signed-rank test, $Z = –0.383$, $p > .70$). The lack of the difference between internal and external source scores may be due to that children performed quite well in both questions.

The results of the executive function are also depicted in Table 1. We conducted a one-way ANOVA to examine the age effects in each task and found significant age effects in both the DCCS task ($F(2, 67) = 3.152$, $p < .05$) and the Black/White task ($F(2, 67) = 4.347$, $p < .05$).

Correlations

All measures were standardized and the correlations between the measures were then examined.

Memory and Other Measures

First, we examined the correlations between the measures in Question 1 and other measures. We depicted the zero-order Pearson correlations between the variables in Table 2. The composite real scores were not significantly correlated with the children's age, DCCS scores, and Black/White scores ($r(70) = –.12$, $p > .32$, $r(70) = –.11$, $p > .35$, $r(70) = –.03$, $p > .80$, respectively). On the other hand, we found a significant correlation between the lure scores and the DCCS scores, ($r(70) = .37$, $p < .003$), but not between the lure scores and children's age and between the lure scores and the Black/White scores

($r(70) = .23, p > .05, r(70) = .17, p > .17$, respectively). The lure scores were significantly correlated with the DCCS scores even after the age effects were partialled out ($r(67) = .34$, $p < .01$).

Source Monitoring and Other Measures

Next, we examined the correlations between the measures in Question 2 (i.e., the internal source scores and the external source scores) and other measures. First, we depicted the zero-order Pearson correlations between the variables in Table 2. As shown in the table, the internal source scores were not significantly correlated with children's age, the DCCS scores, and the Black/White scores ($r(70) = .19$, $p > .11$, $r(70) = .02$, $p > .84$, $r(70) = .05$, $p > .69$). On the other hand, the external source scores were significantly correlated with the DCCS scores ($r(70) = .38$, $p < .002$), but not with children's age and the Black/White scores ($r(70) = .15$, $p > .20$, $r(70) = -.02$, $p > .84$). The significant correlation between the external source scores and the DCCS scores were observed even after the age effects were partialled out ($r(67) = .36, p < .003$).

Regression Analyses

To further assess the unique contributions of age and executive function to memory questions and source monitoring questions, we carried out hierarchical regression analyses.

Memory and other measures

A hierarchical regression analysis was conducted with children's composite real scores. We entered age at Step 1 and then entered the DCCS scores and the Black/White scores at Step 2 as predictors of the composite real scores. The overall model of the composite real scores were not significant ($R^2 = .04$, $F(3, 66) = 0.915, p > .43$).

Next, we conducted a hierarchical regression analysis with children's lure scores and found a significant model of the lure scores. The first model of the lure score was not significant ($R^2 = .04$, $F(1, 68) = 3.051$, $p > .08$), but the second model was significant ($R^2 = .16$, $F(3, 66) = 4.241$, $p < .01$). At Step 2, we found that the DCCS scores were significant predictors of the lure scores ($\beta = .34$, $t(69) = 2.917, p < .01$).

Monitoring and Other Measures

We conducted the same hierarchical regression analyses to examine how executive function contributes to measures in Question 2. First, the overall model of the internal source scores was not significant ($R^2 = .03$, $F(3, 66) = 0.762$, $p > .51$). Next, the first model of external source scores was not significant ($R^2 = .03$, $F(1, 68) = 1.732, p > .19$). Children's age was not a significant predictor ($\beta = .03$, $t(69) = 1.316, p > .19$). However, the second model was significant ($R^2 = .16$, $F(3, 66) = 4.173$, $p < .01$). At Step 2, we found that the DCCS scores were significant predictors of the external source scores ($\beta = .37$, $t(69) = 3.169, p < .003$) (Table 3).

Table 3. Hierarchical Regression Analysis for Variables Predicting External Source Scores.

	B	*SE B*	*β*
Step 1			
Age in months	.03	.03	.16
Step 2			
Age in months	.02	.03	.11
DCCS	.04	.01	.32*
Black/White	–.005	.007	–.09

Note. $R^2 = .03$ for Step 1; $\Delta R^2 = .13$ for Step 2 ($ps < .05$). *$p < .05$

DISCUSSION

The present study examined individual differences in the source monitoring and their relationship to age and executive function. There were three main findings. First, preschool children performed source-monitoring tasks quite well. Even three-year-old children could discriminate the internal source from the external source. Second, children's source-monitoring ability was, in part, significantly correlated with their cognitive shifting ability indexed by the DCCS task. Third, children's lure scores were significantly correlated with their cognitive shifting, but not with inhibitory control. We discussed each point in the following subsections.

Source-monitoring task

In the present study, we did not find age-related differences in the source-monitoring ability. Instead, even three-year-old children could correctly identify the actor of an object after they acted on it or after they watched an experimenter performing the objects. In fact, their performances in both internal source scores and external source scores were significantly above chance. The results might not be consistent with the previous results that three- and four-year-old children often face difficulty in source monitoring. For example, Drummey and Newcombe (2002) reported that the mean correct performances of four-year-old children in their source-monitoring task were only about 24%. They committed many extraexperimental errors (see Introduction). Moreover, Melinder et al. (2006) showed that three-year-old children's performances were significantly worse than older children when children were presented with videos and then given source questions. According to Naito (2003), four-year-olds failed to judge the source of new knowledge after an experimenter told them about the knowledge.

We pointed out some differences between our study and the previous studies. One important factor may be an interval between an event and question. In Drummey and Newcombe (2002), children were asked the source questions one week after the event. On the other hand, in the same task, when children were given the source questions immediately after the event, even the four-year-old children committed a few errors.

Children in the present study were asked to identify the source about five minutes after the event. The differences in intervals would have a significant impact on the performances in the source-monitoring questions. Second, included contextual information may vary between studies. In Naito's (2003) study, children had to remember *when* they acquired new knowledge. On the other hand, in the present study, children were given questions about *who* acted on the objects. It is likely that the differences in the contextual information may affect the performances in young children. Furthermore, children's identification of source may be affected by how the information is presented. Melinder et al. (2006) presented children with the information using videos, whereas Drummey and Newcombe (2002) and our study presented the information live. Currently, we do not know which factors may be crucial for the differences between our study and previous studies. Therefore, additional controlled studies were needed to assess the reasons for the mixed results in young children's source-monitoring ability.

Monitoring and Executive Function

We found a significant correlation between external source scores and performances on the DCCS task. The results indicate that children need to develop executive skills to correctly identify the objected the experimenter acted on. The results supported the proposal that source monitoring partially requires cognitive control processes (Johnson et al., 1993). Specifically, when the one source is more salient than the other source and the less salient source should be selected, the executive function may play a role. In our source monitoring task, there were two sources of information: internal source (children) and external source (the experimenter). Two sources of information are qualitatively different. Foley and Ratner (1998) reported "I did it" bias in a similar source monitoring task, which suggested that an internal source is more salient than an external source. Although the present study failed to detect the "I did it" bias probably due to that children performed quite well in the source monitoring task, the previous studies clearly showed that the internal source was more salient than the external source. Thus, on the external source questions, children needed to ignore the dominant internal source of information. In other words, the children may have to inhibit irrelevant information (i.e., children may have acted on the objects) and represent the external sources of information (i.e., the experimenter acted on objects) to perform the external source questions correctly. The cognitive process clearly needed executive function such as cognitive shifting. On the other hand, children did not need executive skills to answer the internal sources questions because the internal source was sufficiently salient. The explanation may be supported by the fact that the external scores, but not internal source scores, were significantly correlated with cognitive shifting.

It should be noted that cognitive shifting, but not inhibitory control, is significantly correlated with source monitoring. It is not surprising that we got the results because cognitive shifting and inhibitory control is conceptually separable (Garon et al., 2008). Specifically, according to Garon et al., the Stroop-like tasks such as the Day/Night task (the Black/White task is quite similar to the Day/Night task, Simpson & Riggs, 2005) are complex response inhibition tasks. Complex response inhibition refers to holding an arbitrary rule in mind, responding according to the rule, and inhibiting a dominant response. On the other hand, Garon et al suggest that in the DCCS task, children had to switch their attention as well as behavioral responses. That is, the Black/White task includes less attentional control process than the DCCS task. In the source monitoring task, children may represent the goal (i.e., choosing the correct source) and inhibit suboptimal processes that will interfere with goal attainment (i.e., choosing the incorrect source). In the cognitive process, cognitive (attentional) control, but not response control, was required. Thus, source monitoring task is significantly correlated with the DCCS task, but not the Black/White task.

The present results were inconsistent with the previous studies that reported a weak correlation between source monitoring and executive function. Most of the previous studies used the external source-monitoring tasks (e.g., an experimenter vs. a puppet) (Drummey & Newcombe, 2002; Melinder, et al., 2006). However, the saliency in the sources may not be very different, in which case executive skills were not necessarily required. On the other hand, in the present study, children were asked to discriminate between internal and external sources of information. Clearly, the internal source of information is more salient than the external source of information. Therefore, the performances in our source-monitoring task were significantly correlated with those in the cognitive shifting tasks.

Our results were consistent with the previous evidence that children's performances on the measure of the prefrontal function were significantly correlated with those of the source monitoring task where one source is more salient than the other (what children did vs. what children imagined) (Sluzenski et al. 2004). Our results extended the previous findings in an important way that more specific aspects of the prefrontal function were related with the source monitoring ability. The previous study used the category fluency task, and the task included several cognitive processes such as encoding, binding and retrieval of different stimuli (Sluzenski et al. 2004). Therefore, the study failed to specify how prefrontal function was correlated with the source monitoring. We showed that cognitive shifting, one of the important function of the prefrontal cortex (Moriguchi & Hiraki, 2009), may contribute to source monitoring.

One might argue that other factors may play an important role in the differences between the present study and the previous studies. As described above, there were some factors that affected the differences of performances in source-monitoring tasks (e.g., interval between an introduction phase and a test phase). Thus, we have to consider whether those factors may have a significant role in the correlational results. First, it is unlikely that the differences in the interval may affect the correlational results. Drummey and Newcombe (2002) gave children a one-week interval whereas the interval given by Melinder et al. (2006) is almost the same as that in the present study. However, both studies found a weak correlation between source monitoring and executive function. Second, the manner in which the information was presented (live or video) would not affect the results. Melinder et al. (2006) presented the information using the videos whereas Drummey and Newcombe (2002) gave the information live. Nevertheless, both studies showed a weak correlation between source monitoring and executive function.

Memory and Executive Function

Interestingly, we found a significant correlation between the lure scores and the performances on the DCCS task but not between the composite real scores and the performances on the DCCS task. We discussed the results in terms of suggestibility effect. Suggestibility often refers to the incorporation of incorrect post-event information into a memory report, which might result in inaccurate memories of an event (Scullin & Bonner, 2006). It has been suggested that children may need executive skills to resist the misleading suggestions. Indeed, Alexander et al. (2002) reported that preschool children's memory errors and suggestibility may be predicted by their executive function. Given this, it is likely that the same explanations could be applied for the current results that children's executive skills were significantly correlated with the lure scores. That is, children may resist misleading lure questions by means of executive skills.

In conclusion, the present study showed a significant correlation between executive function and source monitoring. The possible reason why we found the correlation, but some previous studies did not, is that children in the present study were given the source monitoring task where one source is more salient than the other, but children in the previous studies were given tasks in which the saliency in the sources may not be very different. Given these facts, we propose that executive function, such as cognitive shifting, may not always play an important role in source monitoring in young children. Instead, when faced with situations in which one source is more salient than the other source, executive function contributes to the source monitoring.

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