The effect of social observation on children's inhibitory control

Yusuke Moriguchi [a, b]
[a] Department of School Education, Joetsu University of Education
[b] Japan Science and Technology Agency, PRESTO/Sakigake

Author Note

Yusuke Moriguchi, Department of School Education, Joetsu University of Education.
Correspondence should be addressed to Yusuke Moriguchi, 1 Yamayashiki-machi, Joetsu 943-8512, Japan. E-mail: moriguchi@juen.ac.jp

Abstract

This study examined the effects of social observation on young children’s performance during an inhibitory control task. In Experiment 1, children were randomly assigned to either a neutral, facilitation, or interference condition. In the neutral condition, children were presented with a standard black/white task. In the facilitation and interference conditions, children were asked to observe the task performance of another, who gave either correct (facilitation) or incorrect (interference) responses, and then complete the task themselves. The results revealed that the performance of children in the interference condition was worse than in the other two conditions, but the difference between the two other conditions was not significant. The results of Experiment 2 showed that social observation did not facilitate inhibitory control in children. These results suggest that social observation interferes with but does not facilitate inhibitory control in children. Therefore, social observation may interfere with certain aspects of executive function.

Keywords: executive function, inhibitory control, social learning, preschool children.

The effect of social observation on children's inhibitory control

There has been a growing interest in the fields of developmental psychology and developmental cognitive neuroscience regarding the development of executive function during early childhood. Executive function comprises complex cognitive functions that are subserved by the prefrontal cortex (Miller & Cohen, 2001). This pertains to a variety of abilities that are utilized in the attainment of goals, that is, inhibitory control, cognitive shifting, and working memory (Garon, Bryson, & Smith, 2008; Hughes, 1998; Lehto, Juujaervi, Kooistra, & Pulkkinen, 2003; Miyake et al., 2000; see also Wiebe, Espy, & Charak, 2008 and Zelazo & Müller, 2002). This ability has been shown to develop rapidly in preschool years and this is supported by maturation of the prefrontal cortex during this time (Diamond, 2002; Moriguchi & Hiraki, 2009; Zelazo & Müller, 2002).

Previous research on executive function has focused extensively on the complex cognitive control process in young children, using tasks such as the Dimensional Change Card Sort (DCCS) and the day/night task (Kloo & Perner, 2005; Gerstadt, Hong, & Diamond, 1994; Simpson & Riggs, 2005a, b; Zelazo, Frye, & Rapus, 1996). However, recently, executive function has also been examined within social contexts (e.g., Lewis & Carpendale, 2009). Moriguchi, Kanda, Ishiguro, and Itakura (2010) state that cognitive control processes might be more social than previously believed; indeed, it has been shown that social observation may affect the performance of young children in tasks that involve executive function. Moriguchi, Lee, and Itakura (2007) used a social modification of the DCCS task to show that executive control in young children may be affected by observing the actions of another. A standard DCCS task requires children to place cards that contain images with two dimensions, such as color and shape (e.g., yellow houses, red cups), into trays containing target cards (e.g., a yellow cup, a red house). Children are then asked to sort the cards first according to one dimension (e.g., color) and then according to the other dimension (e.g., shape). Extensive research across several cultures has shown that most three-year-olds will fail to make the switch to the other dimension while four- and five-year-old children can make the switch (Carlson & Moses, 2001; Kirkham, Cruess, & Diamond, 2003; Kloo & Perner, 2005: Moriguchi & Itakura, 2008; Zelazo, Müller, Frye, Marcovitch, 2003). During the modified social DCCS task, instead of merely sorting the cards, pre-schoolers watch an adult model sort the cards according to one dimension (e.g., shape) and are then asked to sort the cards according to the second dimension (e.g., color). The results show that most three-year-olds fail to sort the cards according to the second dimension and instead persevere in sorting them according to the first, observed, dimension. Hence, the evidence indicates that social observation may interfere with executive control processes in children.

Moriguchi, Kanda et al. (2010) argue that children commit perseverative errors as a result of social observation because while watching another's actions, they internally simulate those actions and this leads them to execute those actions even when instructed to act in a different manner. There is some supporting evidence for this explanation. For example, children do not commit perseverative errors after observing another if that person is not confident in using the designated rule (Moriguchi et al., 2007). In this situation, children are less likely to mentally simulate the person's actions. In addition, children's actions are not affected by the observation of a robot's "actions" (Moriguchi, Kanda, et al., 2010; Moriguchi, Minato, et al., 2010). Recent neuroimaging data have shown that adult participants more strongly activate the premotor areas (related to action preparation and simulation) when observing human actions than when observing a robot's actions (Tai et al., 2004). Given this evidence, it may be the case that children also fail to simulate a robot's actions and this would lead to fewer perseverative behaviors following the observation of a robot.

Previous research has shown that social observation has an effect on executive control in children. The present study aimed to extend these previous findings in two important ways. One limitation of previous research is that it has shown only those social observation effects that result from the use of DCCS tasks. Therefore, I investigated whether similar social effects would arise as a result of using other tasks. The DCCS task is widely used to index general aspects of executive control, and in particular cognitive shifting, in preschool children (Garon et al., 2008; Zelazo et al., 2003). Therefore, my focus was on another component of executive function, namely inhibitory control. In order to specifically achieve this, I used Stroop-like tasks such as the day/night and the black/white task. These tasks require children to respond to a pair of pictures; for example, in the black/white task, children respond “black” when shown a white card, and “white” when shown a black card. The children were told to suppress the tendency to respond according to the color of the card and instead activate a conflicting response. These tasks are a measure often used to index the development of inhibitory control in young children (although it has been suggested that the tasks burden both working memory and inhibitory components in children) (Gerstadt et al., 1994; Simpson & Riggs, 2005a, b). The first aim of this study was to examine, using this Stroop-like task, whether social observation has an effect on the performance of young children. The second aim was to examine whether social observation could facilitate and improve performance during an inhibitory control task, even as it adversely affected performance. Although previous studies have shown that social observation disturbs executive control in children (Moriguchi et al., 2007; Moriguchi, Kanda et al., 2010), there is only limited evidence that social observation helps young children in performing these tasks. In a report by Towse (2000), it was demonstrated that observation of the second rule improved performance in the

DCCS. Therefore, theoretically, it is possible that social observation can facilitate inhibitory control in children. If children can mentally simulate another's inhibitory processes during an inhibitory control task, via observation, then this may function as a form of practice for their own completion of the inhibitory control task. Indeed, it has been shown that children's executive control can be improved by practice (Diamond, Barnett, Thomas, & Munro, 2007; Frye, Zelazo, & Palfai, 1995; Thorell et al., 2009). Given these considerations, the present study examined whether social observation could facilitate inhibitory control in young children.

In Experiment 1, I gave three- and four-year-old children a Stroop-like, black/white task and observed the effect of social observation on their subsequent performance in this task. Children were grouped according to one of three conditions: Neutral, facilitation, and interference. In the neutral condition, children were presented with the standard version of the task that instructed them to respond "white" to a black card and "black" to a white card. In the facilitation condition, children observed a correct demonstration of the task (a demonstrator responded "white" to a black card, and "black" to a white card) before being given the task themselves. In the interference condition, children observed an incorrect demonstration (a demonstrator responded "black" to a black card, and "white" to a white card) before being given the task. Taking into consideration previous research using the DCCS task, my hypothesis was that social observation would both facilitate and interfere with performance during the black/white task.

Experiment 1

Method

Participants

The participants comprised 66 three- (*M* = 41.9 months, SD = 3.2, age range = 36–47 months, 32 boys and 34 girls) and 35 four-year-old children (*M* = 52.5 months, SD = 3.3, age range = 48–59 months, 22 boys and 13 girls). Participants were recruited from nursery schools in Kyoto and Joetsu. None were reported as having any developmental abnormalities. All children were from Japanese middle-class families. Informed consent was obtained from parents or nursery staff members for each child prior to their involvement in the study. Children were randomly assigned to one of the three aforementioned conditions: A neutral condition (23 three- and 11 four-year-old children), a facilitation condition (23 three- and 10 four-year-old children), or an interference condition (20 three- and 14 four-year-old children). Mean ages (ranges) by condition were 45.8 months (36–59 months) in the neutral condition, 45.0 months (36–58 months) in the facilitation condition, and 45.7 months (36–54 months) in the interference condition. There were no significant age differences among the conditions.

Children were divided into two age groups within each condition group (younger group and older group) on the basis of the mean age of each group. Thus, Experiment 1 had a 2 (age group) × 3 (condition) experimental design.

Materials

Two kinds of cards (either black or white) of size 12.5 × 9.5 cm were used. There were 16 cards in total, of which half were black, and half, white.

Procedure

Neutral condition. The procedure was essentially the same as the black/white task used by Simpson and Riggs (2005b). Each child was tested individually for approximately 5 mins.

Each child was seated at a table, across from the experimenter. During the warm-up phase, each child was presented with both a black and a white card and asked to name the color of the card (i.e., black or white). All the children were able to answer correctly. The experimenter repeatedly gave each child the following task instruction: "*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.*"

During the practice phase, each child was shown a white card but no instructions were given. If a child failed to answer, the experimenter prompted them in the following manner: "*What do you say for this white card*?" If a child answered correctly, the experimenter praised the child and proceeded to a practice trial with a black card. If the child answered correctly to this trial, the experimenter praised the child and the test phase was given. If the child answered incorrectly or did not respond at all to either of the trials, the trials were considered practice and the experimenter repeatedly reminded the child of both rules. Beginning with the card that the child had identified incorrectly, the experimenter would then begin again with the white card. This procedure was repeated, until the child answered the two practice trials correctly (up to two times). If the child failed to answer correctly after six practice trials, then the practice trials were coded as failed and no further trials were undertaken.

The test phase comprised 14 trials. Seven black and seven white cards were presented in a pseudo-random sequence. Cards were presented in the order w, b, b, w, w, b, b, w, b, w, w, b, w, b (where b is black and w is white). If a child hesitated in answering, then the experimenter prompted the child in the following manner: "*What do you say for this card*?" At no time did the experimenter use the words "black" or "white" as a prompt.

Facilitation condition. The procedure in the facilitation condition was the same as that for the neutral condition, except for a demonstration phase between the practice and test phases.

During the demonstration phase, the experimenter told the child that a female demonstrator would complete the game first. The demonstrator correctly performed 16 black/white task trials (e.g., responding “white” to a black card). The order in which the cards were presented in this task was the same as that in the neutral condition (i.e., 2 practice trials; 14 test trials). Following the demonstration, children were instructed about the rule in the following manner: “*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’*.” Then, they were presented with the second practice phases in order to determine whether they could recall the rule. If a child performed the second practice phases correctly, then the test phase (14 trials) was given. If the child failed to answer correctly after two practice trials, then they were coded as having failed to remember the rule and received no further trials.

Interference condition. The procedure for the interference condition was the same as for the facilitation condition with the exception that the demonstrator failed to perform correctly in all 16 trials during the demonstration phase (i.e., responding “black” to a black card, and “white” to a white card).

Results and Discussion

Data from 12 children (4 three-year-old children in the neutral condition, 3 three-year-old and 1 four-year-old children in the facilitation condition, and 4 three-year-old children in the interference condition) who failed to answer correctly during the practice phases (i.e., answering “white” on presentation of a white card, and “black” on presentation of a black card), were excluded from the analyses. The remaining children all answered correctly during the practice phases. It is possible to suggest that children in the interference condition were more likely to fail the practice trials than those in the facilitation condition. However, there were no significant differences among conditions in the number of children excluded ($p > .10$).

The two dependent variables analyzed were response accuracy and response latency. Response accuracy (0–14) was measured as the number of correct trials over a session. Response latency was measured from the time a child first saw the black or white cards until he or she gave a verbal response. Response latency was included whenever a child performed correctly. All sessions were videotaped and coded.

Response accuracy for each condition is depicted in Figure 1. A two-way analysis of variance (ANOVA) was conducted using age group (younger, older) and condition (neutral, facilitation, interference) as factors. Further, there were significant main effects of age group (F (1, 83) = 11.405, $p < .01$, ή = .14) and condition (F (2, 83) = 4.634, $p < .02$, ή = .10). A follow-up analysis was conducted in order to examine the effects of condition using Tukey’s honestly significant difference (HSD) test. The results revealed that children in the interference condition showed a significantly worse performance than those in either the neutral or facilitation condition ($p < .05$). There were no significant interactions among factors (F (2, 83) = 1.075, $p > .34$, ή = .03). These results revealed that older children were more likely than younger children to perform the black/white task correctly. This is consistent with findings from a previous study (Simpson & Riggs, 2005b). The finding of this study, that children in the interference condition performed worse than those in the neutral condition, is also comparable to those of previous DCCS studies (e.g., Moriguchi et al., 2007). However, children in the facilitation condition performed at a similar level to those in the neutral condition.

Response latency in each age group is depicted in Figure 2. Some participant data was excluded from the analyses because latency data was missing owing to experimenter error (One three –year-old and one four-year-old children in the neutral condition, one three

–year-old and one four-year-old children in the facilitation condition, and one three –year-old and two four-year-old children in the interference condition). Data from children whose response latency was greater than two standard deviations above the mean was also excluded (Three three –year-old children in the neutral condition, two three –year-old children in the facilitation condition and one three-year-old child in the interference condition). The final sample comprised 25 children in the neutral condition, 25 children in the facilitation condition, and 26 children in the interference condition. A two-way ANOVA was conducted, with age group (younger, older) and condition (neutral, facilitation, interference) as factors. There was a significant main effect for condition (F (2, 70) = 3.499, $p < .04$, ή = .09), but no significant effect for age group (F (1, 70) = 0.301, $p > .58$, ή = .00). A follow-up analysis was conducted in order to examine effects of condition using Tukey's HSD test. The results showed that children in the interference condition performed the task significantly faster than those in the neutral condition ($p < .05$). There were no significant interactions among factors (F (2, 70) = 0.782, $p > .46$, ή = .02). In terms of response accuracy, these results were somewhat different in that performance in the interference condition differed from that in the neutral condition but not from the facilitation condition.

An examination of the individual data focused on high and low performers. High performers were defined as children whose response accuracy was more than 13 trials, and low performers, as those whose response accuracy was less than 2 trials. Thirteen children in the neutral condition, ten children in the facilitation condition, and eight children in the interference condition were classified as high performers. There were no significant differences in the proportion of high performers among conditions (χ^2 (2, N = 89) = 1.838, $p > .38$). It should be noted that none of the children in the neutral and facilitation conditions were classified as low performers, whereas five children in the interference condition did fall into this classification. Fisher's exact tests revealed that children in the interference condition were marginally more likely to be low performers than those in both the neutral ($p < .06$) and facilitation conditions ($p < .06$).

Finally, I examined the relationship between response accuracy and response latency. Previous research has shown higher response accuracy to be correlated with shorter response latency (Gerstadt et al., 1994). A correlation analysis found a significant, positive correlation between response accuracy and response latency (r (76) = .29, $p < .02$). This showed a significant relationship between higher response accuracy and longer response latency.

During Experiment 1, the response accuracy of children in the interference condition was significantly lower than that in either of the two other conditions. This suggests that the observation of incorrect demonstrations introduced significant interference and that this had a bearing on performance in the black/white task. The individual data analyses further supported this result. However, children in the interference condition performed more quickly than those in the neutral condition but not in the facilitation condition. The finding that children in the interference condition performed faster than those in the neutral condition seems to be inconsistent with previous study results. Gerstadt et al. (1994) reported that in day/night tasks, younger children show lower response accuracy and *longer* response latency than older children. In this study, lower response accuracy was associated with longer response latency. In contrast, my study showed lower response accuracy in the interference condition associated with shorter response latency. These differences may be a result of the children's observations of the demonstration in that this may have generally shortened the children's response times. Indeed, response latency in conditions that included a demonstration for example, the facilitation condition [M = 1,360 ms] and the interference condition [M = 1,216 ms]) was shorter than in the neutral condition (M = 1,635 ms). The

ANOVA analyses yielded significant differences between the neutral and interference conditions but not between the neutral and facilitation conditions. Nevertheless, a *t*-test for direct comparisons revealed significant differences between the neutral and facilitation conditions (t (48) = 2.054, $p < .05$.) Therefore, observations of the demonstration in both the facilitation and interference condition groups may shorten response latency times.

I also found children's response accuracy in the facilitation condition to be broadly the same as that in the neutral condition. This seems to suggest that social observation does not have a facilitation effect on the performance of children in the black/white task. Thus, Experiment 2 further examined whether social observation facilitated performance in black/white tasks. As discussed, the black/white task burdens children in terms of both inhibitory control and working memory (Gerstadt et al., 1994). In order to perform this task, children must simultaneously hold two rules in mind (e.g., respond "black" to a white card, and "white" to a black card), inhibit the tendency to respond according to the actual color of the card, and activate a conflicting response. Therefore, it is possible that in this experiment, social observation may imply that children in the facilitation condition fail to either learn the task rules (working memory) and/or to suppress the response tendency (inhibitory control). In Experiment 2, I reduced the working memory load created by the task and examined whether children could learn the response tendency (inhibitory control) from their social observation.

In Experiment 1, children in the facilitation condition were required to observe a sequence shown during the demonstration. They were then asked to execute the same sequences in the black/white task. By contrast, in Experiment 2, children observed the demonstrator's single response. For example, the demonstration showed either a "black" response to a white card *or* a "white" response to a black card rather than a sequence of responses. Immediately after this demonstration, children were asked to execute the same task (e.g., the same color card was presented). Thus, in this experiment, the demonstrator and children took turns performing the task. This meant that the procedure exacted few working-memory demands. If young children can learn the response tendency from social observation, children in Experiment 2 would improve their task performance because of social observation alone.

Experiment 2

Method

Participants

Participants were 12 three- (*M* = 44.8 months, SD = 1.1, range = 43–47 months, 8 boys and 4 girls) and 14 four-year-old children (*M* = 50.9 months, SD = 1.8, range = 48–54 months, 7 boys and 7 girls). All were recruited from nursery schools in Joetsu and none were reported as having any developmental abnormalities. Moreover, all participants were from Japanese middle-class families. Informed consent was obtained from the parents of all children prior to their involvement in the study. I compared performance levels of children in Experiment 2 with those in the neutral condition in Experiment 1. There was no significant difference in age (measured in months) among the conditions.

Materials and Procedure

In this experiment, 30 cards—15 black and 15 white—were prepared. The procedure was almost identical to the procedure used in the neutral condition for Experiment 1 with the exception that in each trial, children executed the task immediately after observing the actions of the demonstrator. If the child performed the practice phase correctly, they were instructed to execute the task after observing the demonstrator’s responses. Thus, the children and the demonstrator took turns in giving their responses when cards were presented by the experimenter. For example, first, the experimenter presented a black card to the demonstrator, and the demonstrator gave the correct response “white.” Then, the child was presented with a black card and asked for his/her response. Both demonstrators and children were given 14 trials each.

Results and Discussion

Six of the children failed to answer correctly during the practice phase, so their data were excluded from the analysis. The remaining children all answered correctly during the practice phase. Response latency data for three of the children were missing owing to experimenter error. The task performance of children in Experiment 2 was broadly similar to the level of performance seen in those participating in the neutral condition of Experiment 1 (74.8%). There was no significant difference between the two conditions, t (48) = –0.906, $p > .37$. However, there was a significant difference in response latency between these groups, t (40) = 4.639, $p < .001$. The mean response latency of children in Experiment 2 was 1,105 ms compared with a response latency of children in the neutral condition of 1,635 ms.

An analysis was conducted to compare the results obtained from the first half of the experiment with those obtained from the second half in order to assess whether increased levels of social observation had an increased facilitating effect on performance levels. Paired-t tests revealed no significant difference between the first and second half of the experiment in either accuracy, t (19) = –0.142, $p > .88$, or response times, t (16) = –1.112, $p > .28$.

Again, these results show that social observation did not significantly improve children’s performance in the task. Specifically, they failed to learn a demonstrated response from the social observation of the actions of another person. By contrast, children in Experiment 2 showed shortened response latency compared with the neutral condition in Experiment 1. These results may be seen as consistent with the interpretations derived from the results of Experiment 1, as the shorter response latency in the interference condition of Experiment 1 may have been directly due to the fact that an observation of a demonstration had occurred. Similarly, in Experiment 2, children may have performed the task more quickly than those in the neutral condition of Experiment 1 because children in Experiment 2 observed the demonstrator's actions whereas in the neutral condition, no demonstrations were observed. Nevertheless, in combination with the results of Experiment 1, it appears that social observation may not improve performance levels in the execution of inhibitory control tasks in children.

General Discussion

The present study examined the effect of social observation on the inhibitory control processes of young children. There were three main findings: first, that social observation did affect children's performance levels during black/white tasks; second, that social observation significantly interfered with children's inhibitory control in performing those tasks; and third, most importantly, that social observation did not facilitate children's inhibitory control. These findings will now be explored in greater detail.

The present study replicated and extended some findings from previous research studies that used the DCCS task. It has been previously shown that social observation affects the executive control processes of young children (Moriguchi et al., 2007; Moriguchi, Minato et al., 2010). For example, Moriguchi et al. (2007) show that performance levels of young children in DCCS tasks are strongly affected by social observation of another's actions. However, social effects have been reported only in relation to DCCS tasks and it is unclear whether the same effect can be observed in relation to other executive-function tasks. My study used black/white tasks rather than DCCS tasks and found that the performance levels of children executing a black/white task were affected by the social observation of another person’s actions.

One of the primary important findings of my study was that, contrary to my hypothesis, social observation disturbed children’s performance levels in inhibitory control tasks but did not facilitate them. The results of Experiment 1 show that children in the interference condition perform significantly less effectively than those in the neutral condition (the latter of whom had not observed any demonstrations). These results indicate that performance levels were easily and adversely affected by an “incorrect” demonstration. In contrast, children in the facilitation condition showed performance levels that were similar to those in the neutral condition. Therefore, social observation did not appear to facilitate performance in black/white tasks. Experiment 2 further confirmed that social observation might not easily facilitate performance in black/white tasks.

The results show that social observation affects cognitive shifting and inhibitory control differently. Previous studies show that social observation both facilitates and interferes with cognitive shifting (Moriguchi et al., 2007; Towse, 2000) but that inhibitory control, while disrupted, is not improved by social observation. I suggest that this may be due to differences in task difficulty. In the case of DCCS tasks, most children perform perfectly until the age of 4 (Moriguchi, et al., 2012; Zelazo et al., 1996). However, response accuracy in the day/night Stroop task improves after 4 years of age (Gerstadt et al., 1994). Simpson and Riggs (2005b) show that the developmental pattern relating to performance in both the day/night and black/white task is similar. Therefore, it is likely that response accuracy in black/white tasks improves after the age of 4. Given this evidence, I speculate that task difficulty is appreciably different between the black/white and DCCS task and that the facilitation of performance in an inhibitory control task may be more difficult than in a cognitive shifting task.

The results of my study were inconsistent with results of studies that utilize DCCS tasks (Towse et al., 2000), but may be consistent with previous research that has found that executive function in children is not easily improved. It has traditionally been suggested that supporting the development of executive function in young children is not easy (Frye et al., 1995). Indeed, Kloo and Perner (2003) report that intensive and explicit training over a few weeks is needed in order to improve children's performance on DCCS tasks. Similarly, Dowsett and Livesey (2000) show that repeated training, over several days, may enhance children's performance in inhibitory control tasks. Some recently implemented training programs have successfully improved children's executive function (Diamond et al. 2007; Thorell et al., 2009), but it appears that supporting the development of executive function in children is still difficult. In light of the existing empirical evidence, it is not perhaps surprising that merely exposing a child to a stranger's demonstration did not serve to improve their executive processing skills. However, it does seem likely that repeated exposure to such demonstrations, over several days, might enhance executive skills. Alternatively, children may require an opportunity to reflect upon the observed actions and then translate these observations into their own actions. In addition, feedback from an experimenter or tester may have a significant impact on any improvement in performance (e.g., Rueda et al., 2005).

It is possible to consider the performance results of children in the facilitation or interference condition in terms of the simulation model described above. Moriguchi, Kanda, and colleagues (2010) argue that children's behavior is affected by social observation because they internally simulate the actions of another person. Their study showed that—for example, during DCCS tasks—children commit perseverative errors after social observation because they internally simulate another's actions during their observation and then execute those actions despite being instructed to select a different action (Moriguchi, Kanda et al., 2010). It was evident that the same internal mechanism arose during my study tasks. In the interference condition, the demonstrator showed “incorrect” responses (responding “black” to a black card, and “white” to a white card) and it is important to note that the children easily simulated the “incorrect” demonstration because they had been given the response set prior to the experiment. As children have the automatic tendency to say “black” to a black card, and “white” to a white card, this implied that they could easily simulate the responses seen during this social observation. When required to respond “black” to a white card and “white” to a black card during the test phase, this simulation affected their execution of the task. As a result, their performance was easily interfered with. It is possible to argue that children in the interference condition simply failed to remember the task rule, and reverted instead to the “black to a black card” rule. However, it should be noted that I presented the children with two practice trials immediately prior to their test trials and that children in the interference condition performed just as well as children in the facilitation condition during these practice trials. This shows that children did recall the task rule, thereby allowing them to complete the practice trials successfully, but that simulation may have disturbed their executive function and affected their performance during the test phase.

By contrast, children in the facilitation condition may have had difficulty in simulating the demonstrations seen during their social observation. During the facilitation condition, the demonstrator provided “correct” responses (i.e., “black” to a white card and “white” to a black card). As children may not have an automatic tendency to respond in this manner, they may have failed to simulate the demonstrator’s actions. If so, then this simulation may not have affected their performance in executing the tasks. Therefore, social observation may have had the effect of promoting a child’s automatic response (i.e., “black” to a black card), but not their effortful response (i.e., “black” to a white card). Although the manner of response (i.e., manual vs. vocal response) differs between DCCS and black/white tasks, the simulation model can still provide an explanation for the results in both types of study.

In addition, the response-latency results can also be explained by the simulation model. In Experiment 1, children in the facilitation or interference condition performed more quickly than those in the neutral condition. Moreover, children's response latency in Experiment 2 was significantly shorter than their response latency in the neutral condition in Experiment 1. These results suggest that the response times of children executing these tasks are shortened by the observation of another person's actions. In viewing this from the simulation model perspective, it is possible to see that children may have mentally simulated some actions during the observed demonstrations even if simulating the demonstrated actions is more difficult in the facilitation condition. Therefore, these children may be better prepared to respond to the stimuli in the experiment compared to those children who did not observe any demonstration. Observation of another's actions may have resulted in a child's action preparation that subsequently resulted in faster action execution (shorter response latency) during the test phases.

Finally, although I argued that social observation affected inhibitory control in young children, it might be possible that the results in the present study (that is, children's performances in the black/white tasks were affected by social observation) may not mean that inhibitory control per se was affected by social observation. For example, as described before, the black/white task includes working memory as well as inhibition. I controlled the effect of working memory in the facilitation condition (Experiment 2), but not in the interference condition. Thus, the possibility that social observation may have affected other aspects of the black/white tasks (e.g., working memory demands) cannot be totally denied in the current experiments.

In conclusion, the present study shows that social observation may interfere with, but not easily facilitate, the performances in executive control tasks for young children. However, these results may not be conclusive in meaning that social observation never facilitates executive control in young children and social observation indeed interfered with inhibitory control per se. Research that is specifically designed to explore these areas is required in order to test the validity of these ideas and hypotheses in the future.

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Figure Captions

Figure 1. Response accuracy in Experiment 1. Number of correct responses per condition. Error bars indicate SE.

Figure 2. Response latency in Experiment 1. Error bars indicate SE.

Figure 1

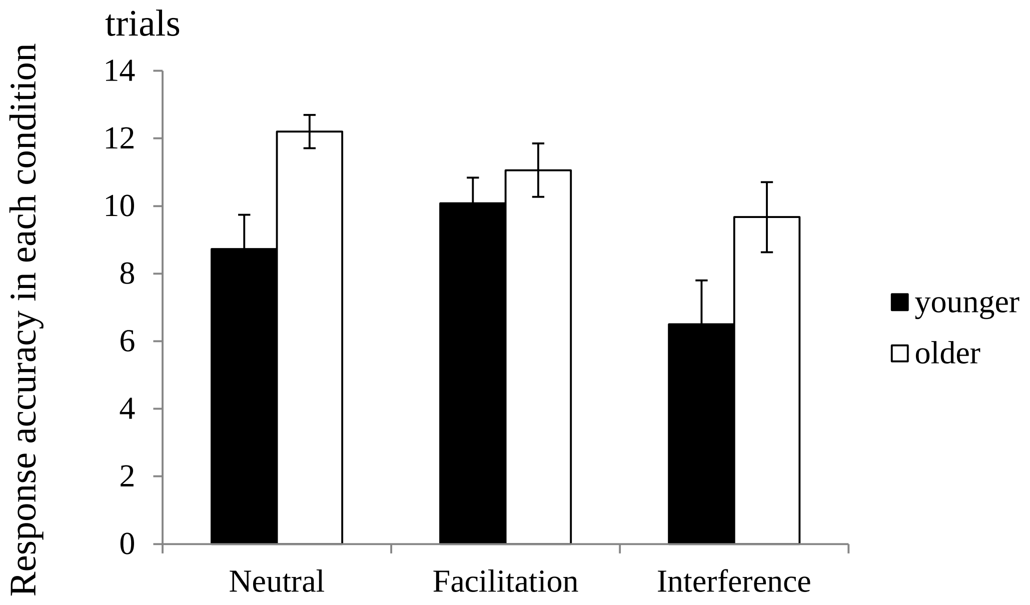
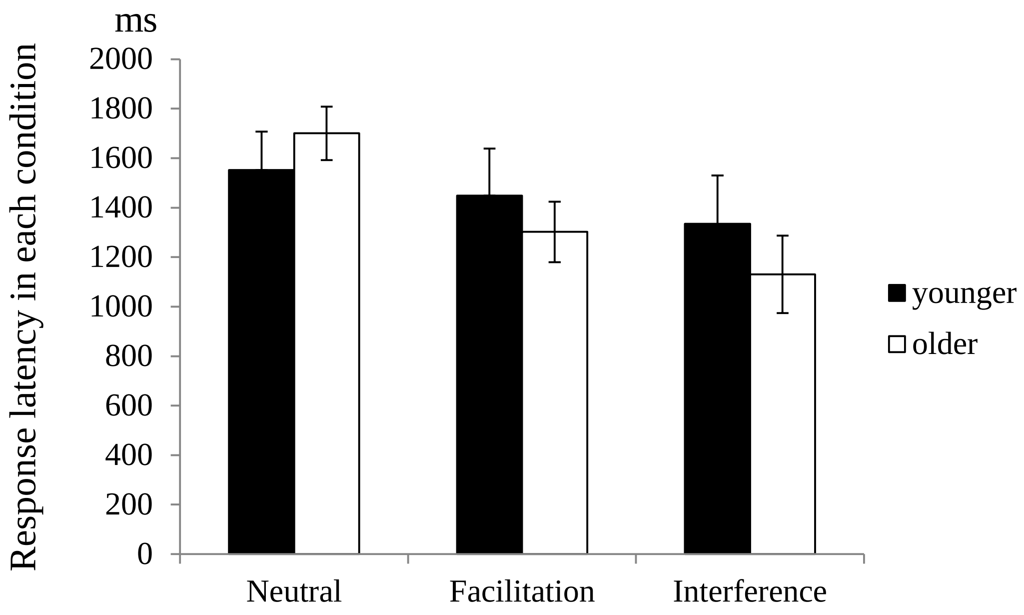

Response accuracy in each condition trials
14
12
10
8
6
4
2
0
Neutral
Facilitation
Interference
younger
older

Figure 2


ms
Response latency in each condition
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Neutral
Facilitation
Interference
younger
older