



<b>Title</b>	<b>Relationship between private speech and performance in social problem solving task in preschool children</b>
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**Relationship between private speech and performance in social problem solving task  
in preschool children**

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Abstract

This study documented the developmental course of private speech and investigated the relationship between private speech and task performance in a social task. 40

Cantonese-speaking preschool children recruited were assigned into three groups (3-, 4- and 5-year-old). They were required to manipulate interaction partner's mental state and propose solutions to cooperate or compete with the interaction partner in finding treasures.

Task-irrelevant private speech was found to decrease with age while muttering and lip movement increased with age. Task-relevant private speech showed an inverted-U age pattern.

Results also revealed a significant positive correlation between private speech and total solution scores (performance measurement), and insignificant correlation between private speech and total belief question scores (performance measurement). Implications and future directions were discussed.

Vygotsky (1986) found that apart from social speech, young children also produce

speech which is addressed to themselves or to no particular hearers. This type of speech is named private speech. Private speech is a means for young children to verbalize their thoughts to help self-regulating, planning, and guiding their behavior (Vygotsky, 1986). According to Vygotsky (1986), social experience facilitates the development of higher cognitive processes such as planning and executive functioning which are shifted from social to personal plane through private speech. Usually, children work together with experienced members on demanding tasks (Berk & Spuhl, 1995). By means of private speech, the regulatory role provided by experienced members is gradually taken by children (Winsler, Diaz, & Montero, 1997). Children treat private speech as a tool of thought for planning and guiding their behavior to meet the demands of difficult tasks and to achieve higher task competence in the early phases of task mastery (Berk & Spuhl, 1995). Once the children attain certain success in the task, private speech is transferred from externalized to internalized and less audible form called inner speech as they no longer need overt private speech for self regulation (Berk & Spuhl, 1995).

#### *Private speech and task performance*

Numerous prior studies found that frequency of private speech production correlates positively with task performance (Berk, 1986; Winsler et al., 1997) provided that task difficulty is optimal to children. Goodman (1981) found that preschool children who complete the puzzle solving task with high incidence of private speech especially

verbalization of thoughts and plans are more proficient and are able to solve the puzzle faster.

Winsler et al. (1997) also proved that private speech relates to success in a selective attention task which requires children to choose a card that shares the same color or shape of two pictures among other distracters.

#### *Research gap in empirical studies*

Private speech studies have largely focused on children's performance on problem solving tasks which require physical solutions, for example, puzzle solving task (Goodman, 1981) or have academic nature, for example, math seatwork (Berk, 1986). Vygotsky's theory of functional significance of private speech on cognitive development of the children was sufficiently supported by these studies. Yet relationship of private speech and performance on problem solving tasks requiring interpretation of others' beliefs or thoughts has not been examined. This kind of task is defined as social problem solving task in this study.

Undoubtedly, social development is also crucial for children's healthy growth. They need to interact with peers and teachers in most of their school time, for example, building up friendship with the peers, engaging in group activities, and collaborating with neighbors in the classroom. It is worthwhile to investigate the influence of private speech on other aspects that are also fundamental to children, for example, social development. One of the primary aims of this study is to investigate the effect of private speech on task performance in a social problem solving task.

*Private speech and social problem solving task*

Task described by Sodian, Taylor, Harris, and Perner (1991) was adopted in this study. It requires preschool children to use Theory of mind (ToM) which is the ability to interpret beliefs, feelings and thoughts of the others (Premack & Woodruff, 1978) to manipulate the interaction partner's mental state and propose solution to cooperate or compete with the interaction partner in finding a treasure. Children are also required to answer questions which tap their understanding of beliefs and memory during the task. To highlight that the problem solving task has social nature, interaction partners are assigned with own personality (one is a nice mate while the other is a nasty mate) and are given mental states during the experiment. For example, in the cooperative condition, the interaction partner dances happily when the children help him to find the treasure. In the competitive condition, he is unhappy and tilts his head down if the children mislead him to a wrong location.

Traditional false belief tasks, for instance, Sally-Anne task, appearance-reality task or Smarties task were not chosen in this experiment because they are close-ended tasks with only one single solution. However, the social problem solving task mentioned in the study of Sodian et al. (1991) is an open-ended task with a few possible solutions. The incidence of private speech is higher when children are engaging in an open-ended task (Berk & Krafft, 1998). Thus, it is more effective to reflect on the relationship between private speech and task performance. Subjects were encouraged to speak freely during the experiment. Private speech

emitted was coded into level one (task-irrelevant), level two (task-relevant), or level three (external manifestations of inner speech) private speech according to coding system defined by Berk (1986) (see Appendix A).

#### *Private speech and task difficulty*

Apart from nature of the task, task difficulty is another factor that influences the amount of private speech emitted. Many researchers confirmed that there is a positive correlation between task difficulty and the amount of private speech produced by children, however, the above finding does not hold if the task is either too difficult or too simple (Behrend, Rosengren, & C Perimutter, 1989; Frauenglass & Diaz, 1985). When the task is too simple, children are able to perform it automatically without producing overt private speech for guiding. Yet children are not ready to take over the self-regulatory role if the task is too difficult. In the study of Sodian et al. (1991), children were found to act systematically, which means they could distinguish when to cooperate and when to compete with the interaction partners at around age four to five. Nevertheless, only minority of three-year-old children showed this ability. Based on the above results, three to five-year-old preschool children were chosen as the subjects in this study. It is believed that the social problem solving task is within their zone of proximal development and thus private speech production can be maximized.

#### *The developmental course of private speech*

A lot of studies have documented the developmental course of private speech from

externalized to internalized form (Frauenglass & Diaz, 1985; Winsler et al., 1997). Frauenglass and Diaz (1985) found an interaction between the number of overt relevant private speech serving self-regulatory function, and the number of whispering and muttering. Self-regulatory private speech declines while muttering and whispering increase. This provides a clear evidence to support internalization of private speech proposed by Vygotsky (1986). Frequency of overt private speech is proved to be the highest in children during their preschool years and internalization occurs gradually after they enter elementary school (Berk, 1986; Winsler, Carlton, & Barry, 2000). In addition, Vygotsky (1986) predicted that relevant (level two) private speech has an inverted-U relationship with age. Winsler et al. (1997) validated the inverted-U, curvilinear relationship between frequency of children's level two private speech and age in a selective attention task. The peak was found to be at around three and a half to four-year-old (Winsler et al., 1997). The developmental course of private speech production in a social problem solving task will be examined in this study.

### *The present study*

This study has two aims: first, to document and validate the developmental course of private speech in a social problem task. It is hypothesized that private speech production will show similar age patterns proposed by Vygotsky and results from the previous studies. For level one private speech, it is predicted that no special age pattern will be found based on the finding of Winsler et al. (1997). It is hypothesized that level two private speech will have an



inverted-U relationship with age as predicted by Vygotsky (1986). According to the results suggested by Winsler, De León, Wallace, Carlton, and Willson-Quayle (2003), it is predicted that level three private speech will increase with age due to private speech internalization.

The second aim is to investigate the effect of private speech on performance in a social problem solving task. The task requires subjects to propose solutions to cooperate or compete with the interaction partner in finding a treasure and to answer questions which tap their understanding of beliefs and memory. Thus, task performance is determined by (1) degree of sophistication of the solutions applied and (2) accuracy in answering the questions. Based on the self-guiding and regulating function of private speech, it is reasonable to predict that children will also use private speech to assist themselves in problem solving in the present study. It is hypothesized that there will be a positive correlation between total proportion of level two and three private speech (total number of level two and three private speech utterances divided by total number of private speech utterances including all three levels), and task performance. Children who have higher total proportion of level two and three private speech will apply more sophisticated solutions and will be more successful in inferring interaction partners' beliefs. Level two and three private speech are task-relevant and are used for assisting in problem solving while level one's is task-irrelevant, thus only level two and three private speech are included in the analysis. The present study will contribute to the understanding of the effect of private speech on social development and the developmental

course of private speech production in Cantonese population.

## Method

### *Subjects*

51 preschool children were recruited as subjects. Yet 11 children were discarded due to the following reasons. Four data were incomplete due to the subjects' behavioral problem or unwillingness to involve in some procedures of the experiment. The other seven data were discarded due to experimental errors. Thus, only data obtained from the remaining 40 subjects were used for data analysis in this study.

The remaining 40 subjects (20 boys and 20 girls) aged between 3; 1 to 5; 11 were recruited from five local kindergartens. The four kindergartens are in the Southern district and the other one is in Wan Chai district. All subjects are Cantonese-speaking and they were reported to have no history of receiving speech therapy by the caregivers. Subjects were assigned into three age groups (three-year-old, four-year-old and five-year-old) according to their chronological age. The subject information was listed in Table 1.

Table 1

### *Background Information of the Subjects*

Age group	Subsample size ( <i>n</i> )	Age range	Mean age ( <i>M</i> )
3-year-old	13	3; 1 to 3; 10	3; 5
4-year-old	14	4; 1 to 4; 11	4; 6

5-year-old

13

5; 1 to 5; 11

5; 5

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*Materials*

A 60 x 40-cm erasable whiteboard was served as the playing surface. Four 10 x 20-cm colored (red, blue, black, and brown) opaque paper boxes with lids were used as hiding locations. The treasure made up of chocolate was put into the pocket of a 15-cm tall doll whose feet were mounted with felt-tip pens. Removable tracks left on the board after the doll was moved across the board to one of the hiding locations. A whiteboard eraser could be used for removing the tracks left. An additional felt-tip pen was also provided for thickening the tracks to make them more visible. Two 20-cm tall hand puppets named king and robber were the interaction partners. All materials are similar to those used by Sodian et al. (1991) except that colored sticker was substituted by chocolate as the treasure in this study because chocolate is believed to be more reinforcing and motivating for young children.

*Procedure*

The experiment was conducted by two experimenters (E1 and E2) in a room at The Prince Philip Dental Hospital. All subjects were seen individually. They were first assessed with The Hong Kong Cantonese Receptive Vocabulary Test (HKCRVT) (Cheung, Lee, & Lee, 1997) to estimate their verbal intelligence by either E1 or E2. The order of the HKCRVT administrators was counterbalanced. Then, they were invited to decorate the Mrs. Potato

Head by using a variety of accessories with the two experimenters. This procedure was treated as warm up so that children could get some familiarity to both experimenters.

Experiment two described by Sodian et al. (1991) was adopted and administrated. The version of the experiment was slightly modified to reduce the experiment duration so that it is not tiring for the children and to match the aims of this study. The biggest modification was that initial warm up phase designed to ensure that children can grasp the concept of ‘making the task easy’ and ‘making the task hard’ for the interaction partners to find the treasures originally was cancelled because even children from the youngest age group could follow and participate in the task well without including initial warm up phase in the piloting experiments. The experiment was recorded by both voice recorder and digital video recorder for subsequent private speech coding.

*Introduction of doll and puppets* – Children were invited to participate in a ‘hide-and-peek’ game. A doll named 小明 (a simple Cantonese name that is easy to be memorized) and the treasure made up of chocolate were introduced. E1 explained that 小明 was going to one of the colored boxes to hide the chocolate. Caps of the felt-tip pens mounted on the feet of 小明 were taken off. 小明 then walked over the board and hid the chocolate in one of the boxes by E1. After that, E1 drew children’s attention to the clear trail of footprints left by 小明 and emphasized that 小明 left footprints on the board wherever he walked. E1 demonstrated that footprints could be removed with eraser so that ‘one cannot

know where 小明 had walked'. 小明 then walked over the board and hid the chocolate once again. E1 demonstrated that the additional pen could be used to thicken the trail of the footprints through drawing parallel lines on them so that 'one can clearly know where 小明 had walked'. Children assisted in both removing footprints with eraser and thickening footprints with additional pen.

The additional pen and eraser were placed on the right side of the board after demonstration. The other things were returned to their original status. E1 explained that 小明 was going to hide the chocolate in one of the boxes and the children would try to locate it. Then, children were asked to turn their face to the opposite side and were called back after the chocolate was hidden by E1. If the children were not able to find the treasure successfully, E1 would guide them to pay attention to where 小明 had walked. The procedures were repeated until the children could spontaneously locate the treasure to ensure that all of them could grasp the association between footprints and hiding location. After that everything was returned to its original status.

*Introduction of King and Robber* – E1 then introduced the two interaction partners, king and robber, to the children. To avoid confusion, E2 acted king with normal voice and acted robber with evil voice. King was a nice mate and would share the treasure with the children when he found it. Demonstration was given. Robber was a nasty mate and if he found the treasure, he would steal it away. Demonstration was also given. After that

everything was returned to its original status.

*Experiment phase* – Children were then invited to participate in the hide-and-seek game with king (cooperative condition) and robber (competitive condition). One trial for each condition was done. The condition order was counterbalanced across subjects. Children were encouraged to speak freely before the game started. In competitive condition, E2 left the room with robber. Children were told to make the task hard for robber to find the chocolate. They were then instructed to move 小明 across the board to one of the boxes and put the treasure inside it. After that, E1 asked: “Who went outside with E2?” to ensure that children knew clearly which condition they were participating in. E1 said that robber would come back to find the chocolate soon and children were asked to do something to make the task hard for robber. E1 then asked: “What can you do to make robber cannot find the chocolate?” For those who did not think of any feasible solution spontaneously, E1 would point to the eraser and the additional pen, and gave a hint by saying: “Should you remove the footprints with eraser or thicken the footprints with the pen?” After choosing a suggestion, children were encouraged to carry out the action. The presentation order of these two suggestions was counterbalanced across subjects. Additional probe: “Could you do something else to ensure that robber cannot find the chocolate?” was further given to children who could only think of a general solution (solution that was less misleading for Robber). Additional probe was intended to elicit a more advanced solution from the children. When

children indicated that they had finished, memory question: “Where did you hide the chocolate?” and belief question: “Robber will return soon. Which box will he think the treasure is in when he comes back?” were asked by E1. After that, robber came back and found the chocolate. The robber basically followed the evidence (if any) that the children left on the board while he was searching for the chocolate. If the children wiped all footprints, E1 secretly told E2 where the chocolate was, and E2 searched for the chocolate in another box that was not the true hiding location. Chocolate was given to children who could show misleading effort.

In cooperative condition, the same procedures were carried out, except that children were asked to make the task easy and help king to find the chocolate. King searched for the chocolate by following the same ways as Robber did. Chocolate was given to children who could show helping effort and directed king to find the treasure successfully.

### *Measures*

*Private speech* – Children’s private speech production was transcribed from the video tapes and voice records by E1. Same as the previous researches, the unit of private speech analysis is utterance which is defined as “either a complete sentence, a sentence fragment or clause with intentional markers of termination, a conversational turn, or any string of speech which is temporally separated from another by at least three seconds” (Winsler, 1998, p. 22-23). Distinction between social speech and private speech was made while coding the

children's speech. According to Fernyhough and Fradley (2005), utterance accompanied by experimenter's name, eye contact, physical contact or gaze to experimenter during or within two seconds of an utterance was considered as social speech. Any question addressed to the experimenter, utterance shared the same topic as experimenter's previous utterance and utterance produced after a social utterance in less than two seconds were also social speech. Private speech was other utterance which did not meet the above listed criteria. All private speech was then further coded into level one (task-irrelevant), level two (task-relevant), or level three (external manifestations of inner speech) private speech according to the coding system defined by Berk (1986) (see Appendix A). Private speech was regarded as task-relevant (level two) if it was related to the solution, for example, “刷咗呢啲腳印先啦” (wipe away these footprints) and “再畫多條線” (draw one more track) or was related to the interaction partner's belief, for example, “咁國王就會搵到個朱古力收埋咗係邊啦” (King will find out where the chocolate is). Task-irrelevant (level one) private speech was defined as speech that was unrelated to the task, for example, “等我寫自己個名先” (Let me write my name). Lip and tongue movement or inaudible muttering (i.e., children showed clear mouthing of words that were inaudible while he was laying tracks to an empty box) was coded as level three private speech. Inter-rater coding reliability for private speech was determined. Four randomly-selected videotapes (ten percent of the total sample) were coded by a trained rater. Percentage of agreement for type of speech (private speech or social speech)



was 100% and for type of private speech (level one, two or three private speech) was 96%.

In addition, proportion of level one, level two, and level three private speech (regardless of task condition) were calculated for each subject. They were calculated by using the formula below: number of level one or level two or level three private speech utterances divided by total number of private speech utterances including all three levels.

*Task performance* – Task performance of the subjects was determined by two parameters: (1) degree of sophistication of the solutions – solutions applied were classified into general solution, advanced solution or ineffectual solution for each task condition (see Appendix B for corporative condition and Appendix C for competitive condition). Advanced solutions (rated two solution scores) were defined as more helpful/ misleading for the interaction partner. Examples of children's advanced solution included: thickening the tracks while drawing a sweet in front of the hiding location (corporative condition), and removing the original footprints while drawing false tracks to an empty box (competitive condition). General solutions (rated one solution score) were solutions that were less helpful/ misleading for the interaction partner. Examples of children's general solution included: thickening the trail of footprints with additional pen (corporative condition) and wiping away all footprints with eraser (competitive condition). Ineffectual solutions (rated null mark) were solutions showing no helping/ misleading efforts, for example, thickening the tracks in the competitive condition. Solution scores in two conditions were added up as total solution

scores, (2) accuracy in answering the questions – belief question scores were calculated for each subject. To confirm that children could truly infer the beliefs of the interaction partners but not by guess, their ability in memorizing the true hiding location (reflected in memory question) was also considered. Thus, one mark was given only when both memory and belief question were answered correctly. For those failed, null mark was given. Belief question scores in two conditions were added up as total belief question scores.

## Results

### *The developmental course of private speech*

To determine whether total rate of private speech (total number of private speech utterances divided by total minutes that the children spent on problem solving) differs in the three age groups, one-way analysis of variance (ANOVA) with total rate of private speech as the dependent variable and the three age groups as the independent variable was conducted. Results revealed that the total rate of private speech did not differ systematically by age,  $F(2, 39) = 1.85, p > .05$  and thus different levels of private speech were further investigated separately. Two-way repeated ANOVA with age (three-, four- and five-year-old) served as the independent variable and proportion of three types of private speech (three levels: level one, two and three private speech) as the repeated measure was conducted to document the age pattern of different levels of private speech. The relationship between mean proportion of each private speech level with age was graphically illustrated in Figure 1. Results showed that

the main effect of types of private speech and the main effect of age were both insignificant.

In addition, there was a significant interaction between age and types of private speech,  $F(4, 74) = 2.92, p < .05$ , which implied that three types of private speech followed different age-related patterns.

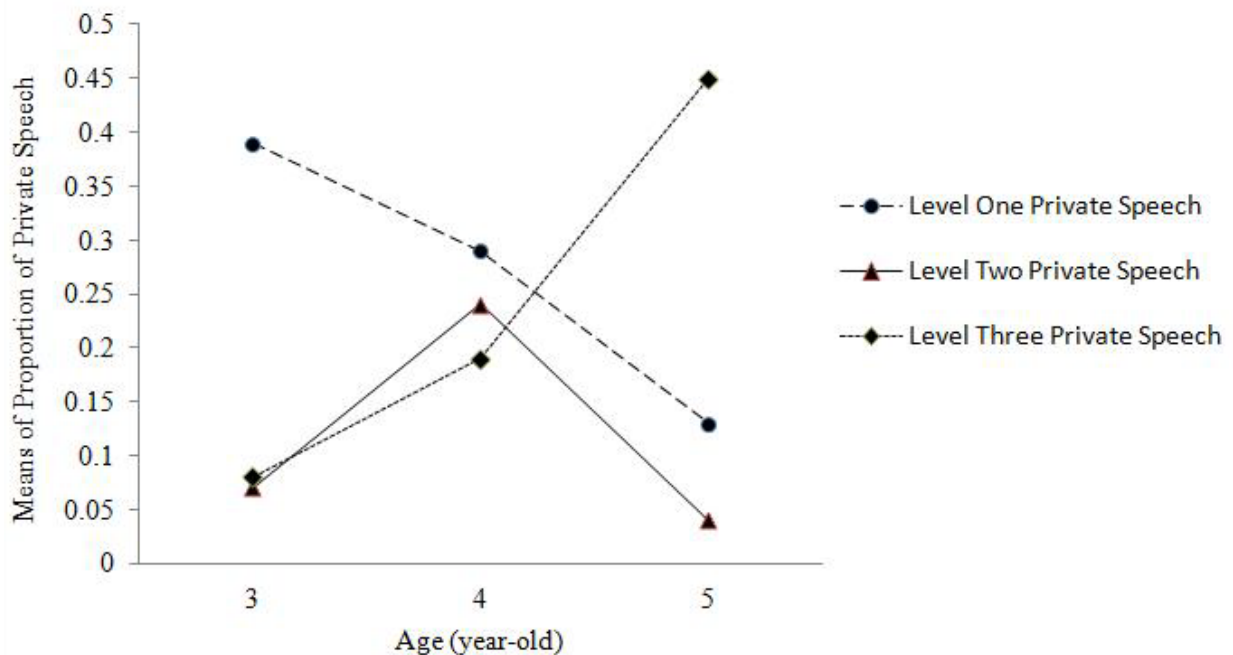


Figure 1. Developmental course of children's use of level one, level two, and level three private speech.

It was noted that mean proportion of level one private speech decreased with age. Level two type exhibited the inverted-U age pattern. The peak was found at age 4. For level three type, it showed an increasing pattern with age. Simple effect analyses found that the mean proportion of level one private speech did not differ by age,  $p > .05$ . Five-year-old children's mean proportion of level two private speech was marginally significantly lower than four-year-old children,  $p < .07$ . Yet three-year-old and four-year-old children's mean

proportion of level two private speech did not differ significantly,  $p > .05$ . For level three type, three-year-old children's mean proportion of level three private speech was not significantly lower than four-year-old children,  $p > .05$ , but was significantly lower than five-year-old children,  $p < .05$ . In addition, four-year-old children's mean proportion of level three private speech was marginally significantly lower than five-year-old children,  $p < .08$ .

As noted in Figure 1, three-year-old children's private speech largely made up of level one type (0.39). Simple effect analyses demonstrated that the mean proportion of level one private speech (0.39) was significantly higher than level two private speech (0.07),  $p < .05$ , and was marginally significantly higher than level three private speech (0.08),  $p < .06$ , in three-year-old children. For four-year-old children, the mean proportion of each level's private speech did not differ significantly,  $p > .05$ . Nevertheless, five-year-old children's private speech was largely level three type (0.45). Results of simple effect analyses revealed that the mean proportion of level three private speech (0.45) was marginally significantly higher than level one type (0.13),  $p < .06$ , and was significantly higher than level two type (0.03),  $p < .01$ , in five-year-old children.

#### *Effect of private speech on task performance*

To examine the second hypothesis that children who have higher total proportion of level two and three private speech will have better task performance, Pearson product moment correlation coefficient was conducted to assess the correlations between total

proportion of level two and three private speech, and (1) total solution scores ; (2) total belief question scores separately for the total sample. Total proportion of level two and three private speech was found to positively correlate with total solution scores,  $r = 0.40, p < .05$ , which reflected that children who had higher total proportion of level two and three private speech did attain higher total solution scores as expected in the experiment. Yet total proportion of level two and three private speech did not correlate significantly with total belief question score,  $r = 0.22, p > .05$ .

Verbal intelligence reflected in HKCRVT scores in this study is one variable that has been proven to affect young children's incidence of private speech production (Berk & Garvin, 1984; Kohlberg, Yaeger, & Hjertholm, 1968). In order to understand the correlation merely between total proportion of level two and three private speech production, and task performance, effect of verbal intelligence should be held constant. Partial correlation coefficient (controlling for HKCRVT scores) was also conducted to assess the pure correlation between total proportion of level two and three private speech production, and (1) total solution scores; (2) total belief question scores separately for the total sample. After verbal intelligence was partial out, the positive correlation between total proportion of level two and three private speech and total solution scores held,  $p^r = 0.34, p < .05$ . Yet proportion of level two and three private speech still did not correlate significantly with total belief question scores,  $p^r = 0.12, p > .05$ . In addition, it was noted that the positive relationship

between total proportion of level two and three private speech, and total solution score was less significant (from  $p = .01$  to  $p = .03$ ) after the HKCRVT score was partial out.

## Discussion

### *The social problem solving task*

It was observed that most of the subjects enjoyed interacting with the partners and participating in the social problem solving task. The task is found to be suitable for private speech study although it is the first time to use social task to investigate private speech production in preschool children. The reasons are as follow: first, as mentioned earlier, children may not produce private speech if the task is either too simple or too difficult. Many subjects did produce at least one private speech utterance, which proves that the social task adopted is within the subjects' zone of proximal development. Yet the task is slightly challenging for three-year-old children because the percentage of three-year-old children (46%) who did not produce any private speech utterance throughout the task was higher compared to four-year-old (29%) and five-year-old (38%) children. Second, in the present study, different levels of private speech showed similar age-patterns found by previous private speech studies which adopt cognitive problem solving tasks (i.e., puzzle solving). This provides evidence to support that the social task adopted is suitable for studying private speech production in children.

### *The developmental course of private speech*

Mean proportion of level one private speech was found to decrease with age. This result was different from the hypothesis which predicted that no special age pattern would be found. The present experiment is slightly challenging for younger children. It was observed that they were generally less focused and were easily distracted by the experiment materials. Hence, more task-irrelevant private speech was produced by young children. Yet children become more competent when they get older and thus are more motivated to attempt to do the problem solving. It is reasonable that mean proportion of level one private speech decreased with age. Level two private speech showed the inverted-U age pattern predicted by Vygotsky (1986), which was consistent with the hypothesis. For level three type, it showed an increasing pattern with age predicted by Winsler et al. (2003), which were also consistent with the hypothesis. An interaction between mean proportion of level two (overt and relevant) private speech and level three private speech (inaudible muttering and lip movement) was observed. Mean proportion of level two private speech declined while mean proportion of level three private speech increased, this provides an evidence to prove internalization of private speech proposed by Vygotsky (1986).

#### *Relationship between private speech and task performance*

It was hypothesized that there would be a positive correlation between private speech and task performance. Results of partial correlation coefficient (controlling for HKCRVT score) found a significant positive correlation between total proportion of level two and three

private speech, and total solution scores, which was consistent with the hypothesis. Yet total proportion of level two and three private speech did not correlate significantly with total belief question scores, which was out of expectation. Private speech relevance was determined by whether it was related to the solution or the interaction partner's belief in this study. It was noted that 83.7% of level two private speech emitted by the children (regardless of age) had relations with task solutions. Children make use of overt private speech mentioning about task solutions as a tool of thought for guiding them in proposing optimal solution to cooperate with king or compete with robber. Yet 16.3% of level two private speech emitted by the children (regardless of age) had relations with the interaction partner's belief. It is likely that level three private speech show similar distribution. Only minority of level two private speech emitted were used for helping young children to interpret the interaction partner's belief. The discrepancy in children's purposes in producing level two private speech explain why there was a significant positive correlation between total proportion of level two and three private speech, and total solution scores but not total belief question scores.

Another possible explanation is that children were given sufficient time to propose task solutions after they were instructed to make the task easy or hard for the interaction partners. Experimenter stayed behind the children and let them work independently until they indicated that they had finished, so that they had the opportunity to produce private speech freely.



However, children tended to respond immediately after the belief question was asked by the experimenter. Experimenter stayed beside the children and waited for their answer. The stressful atmosphere created might suppress children to use private speech for self-guiding.

Over the past years, there were many studies investigated the relation between private speech and task performance. However, the results were inconsistent as three different types of relationship were found. Some studies have reported positive relationships (Goodman, 1981; Winsler, Diaz, McCarthy, Atencio, & Chabay, 1999; Winsler et al., 1997), which were in agreement with the present study. Some researchers also found negative correlations (Frauenglass & Diaz, 1985) or no correlations (Goudena, 1987). Winsler et al. (1997) explained that the relation between private speech and task performance is dynamic and may vary regarding the task difficulty or children's competence. Winsler et al. (1997) further elaborated that if the task is very easy or very difficult for the children, they will not produce overt private speech for self-guiding. There will be no relation between private speech and task performance since the children keep silent in most of the time. When the task is at medium level of difficulty, private speech will be used as a tool to aid problem solving in children and hence positive correlation will be found. If the children is in early stage of competence and the task is difficult for them, overt private speech is possible to happen simultaneously with task failure and negative relationship between private speech and task performance will be found. For this study, positive correlation was found between private

speech and task performance in three- to five-year-old preschool children who were cautiously selected as subjects based on the results reported by Sodian et al. (1991) and were confirmed to be at medium level of task competence. This finding provides an evidence to support the interpretation of Winsler et al. (1997) that positive relationship between private speech and task performance can be found when the task is at medium level of difficulty.

### ***Implications***

There are numerous implications of the present study. First, it is noted that children use private speech for self-regulation during a social task. Private speech is indeed effective to help children in thinking suitable solutions to cooperate or compete with the others. It is likely that private speech plays an important role in social development of the children. Teachers and parents should understand that private speech serves as a problem solving tool for young children and therefore private speech production should be encouraged rather than suppressed whenever children are involved in social tasks. Second, this study is a preliminary study to examine the relationship between private speech and task performance in a social problem solving task. More researches can be done to understand the influence of private speech on social development or even other developments that are fundamental to children in depth. Finally, this study can also be used to investigate other special populations such as Autism and Specific Language Impairment in the future researches.

*Limitations of the present study and further research directions:*

It is important to emphasize that this study serves as a preliminary study to examine the relationship between private speech and task performance in a social task. There are a few methodological limitations that can be improved in the future studies. First, this study examined children's immediate performance rather than long term performance. The relationship between private speech and task performance is very dynamic and thus private speech is believed to be more strongly associated with future success (Winsler et al., 1997). The hypotheses proved in the present study have to further confirm through longitudinal studies which include measure of children's long term social performance. Second, this study investigated children's private speech in an experimental setting which may not sufficiently reflect children's private speech production in daily social situations. Subsequent studies may observe children's private speech in social tasks in the naturalistic classroom or home setting. The third limitation is that the names of the interaction partners (king and robber) may be uncommon and too difficult for preschool children. King and robber were translated as 國王 and 賊仔 in Cantonese respectively in this study. It was observed that only a few subjects could give correct answer to the question: "Who went outside the room with E2?" Some children could only provide semantically-related words as answers, for example, 皇后 and 小偷. A few parents also reflected that 國王 and 賊仔 were difficult vocabularies for the children. Due to children's unfamiliarity to the vocabulary of 國王 and 賊仔, their personality (one was a nice mate while the other was a nasty mate)

may not be very distinctive for the children which may turn out affect the solution proposed by them. For researchers who would like to make use of interaction partners in the future studies, they may need to select two characters that are distinctive in personality but also have simple names.

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## Appendix A

*Private Speech Coding System (Berk, 1986)*

Private speech level	Description	Examples
Level one	Self-stimulating, task-irrelevant private speech	a) Word play and repetition; b) Task-irrelevant affect expression; c) Comments to absent, imaginary or nonhuman others
Level two	Task-relevant externalized private speech	a) Describing one's own activity and self-guiding comments; b) Task-relevant, self-answered questions; c) Reading aloud and sounding out words; d) Task-relevant affect expressions (e.g., "I did it!", "This is hard.")
Level three	Task-relevant external manifestations of inner speech.	a) Inaudible muttering (remarks involving clear mouthing of words which cannot be heard); b) Lip and tongue movement (no clear mouthing of words, just lip and tongue movements)



## Appendix B

*Scoring Scheme for Degree of Sophistication of the Solution in the Corporative Condition*

Type of solution	Solution score	Description	Examples of children's solution
Advanced solution	2	Solutions that are more helpful for king	<ul style="list-style-type: none"> <li>- Thickening the tracks while removing lid of the box that has chocolate;</li> <li>- Thickening the tracks while drawing a sweet in front of the true hiding location</li> </ul>
General solution	1	Solutions that are less helpful for king	<ul style="list-style-type: none"> <li>- Thickening the tracks only</li> </ul>
Ineffectual solution	0	Solutions showing no helping efforts	<ul style="list-style-type: none"> <li>- Wiping away all tracks;</li> <li>- Wiping away the original tracks while laying false tracks to a empty box</li> </ul>

## Appendix C

*Scoring Scheme for Degree of Sophistication of the Solution in the Competitive Condition*

Type of solution	Solution score	Description	Examples of children's solution
Advanced solution	2	Solutions that are more misleading for robber	- Wiping away the original tracks while laying tracks to one or more empty boxes (except laying tracks to all four boxes)
General solution	1	Solutions that are less misleading for robber	- Wiping away all the tracks only; - Laying tracks to all four boxes
Ineffectual solution	0	Solutions showing no misleading efforts	- Thickening the tracks; - Removing lid of the box that has chocolate