This study modeled the associations between extrinsic demographic factors and children's speech acquisition in Hong Kong Cantonese. The speech of 937 Cantonese-speaking children aged 2;4 to 6;7 in Hong Kong was assessed using a standardized speech test. Demographic information regarding household income, paternal education, maternal education, presence of siblings and having a domestic helper as the main caregiver was collected via parent questionnaires. After controlling for age and sex, higher maternal education and higher household income were significantly associated with better speech skills; however, these variables explained a negligible amount of variance. Paternal education, number of siblings and having a foreign domestic helper did not associate with a child's speech acquisition. Extrinsic factors only exerted minimal influence on children's speech acquisition. A large amount of unexplained variance in speech ability still warrants further research.
Running Head: Demographic factors and speech acquisition

The impact of extrinsic demographic factors on Cantonese speech acquisition
Abstract

Aims: This study modeled the associations between extrinsic demographic factors and children’s speech acquisition in Hong Kong Cantonese.

Method & Procedure: The speech of 937 Cantonese-speaking children aged 2;4 to 6;7 in Hong Kong was assessed using a standardized speech test. Demographic information regarding household income, paternal education, maternal education, presence of siblings, and having a domestic helper as the main caregiver was collected via parent questionnaires.

Outcomes & Results: After controlling for age and sex, higher maternal education and higher household income were significantly associated with better speech skills; however, these variables explained a negligible amount of variance. Paternal education, number of siblings, and having a foreign domestic helper did not associate with a child’s speech acquisition.

Conclusions & Implications: Extrinsic factors only exerted minimal influence on children’s speech acquisition. A large amount of unexplained variance in speech ability still warrants further research.

Keywords: demographic factors, speech acquisition, Cantonese, risk factors
Factors that impact on children’s interactions within their environment may contribute to speech and language delay. Through identifying potential risk factors, the likelihood of a child having speech and language difficulties may be estimated. From a management perspective, extrinsic environmental factors are considered to be modifiable compared with intrinsic factors such as age and sex. If significant underlying risks and protective factors can be identified, relevant preventive programs can be designed. This study aimed to investigate the contribution of potential extrinsic factors that may influence the speech acquisition of Cantonese-speaking children aged 2;4 to 6;7 in Hong Kong. Five extrinsic factors relevant to the context of Hong Kong were examined: household income (as a proxy for socio-economic status), paternal education, maternal education, presence of siblings, and having a domestic helper as the main caregiver. The intrinsic factors of age and sex were discussed in To, Cheung, and McLeod (in press). They reported that age was significantly related to the acquisition of initial consonants, final consonants, vowels/diphthongs, and lexical tones; while sex was significant for all except lexical tones (To et al. in press). With this information in mind, age and sex were controlled for in the present study.

**Influence of Socioeconomic Status**

There are many differing definitions of socio-economic status (SES), and differing definitions and analysis techniques impact whether or not SES is found to be a significant risk or protective factor for speech and language difficulties (Harrison and McLeod 2010; Nelson, Nygren, Walker, and Panoscha 2006). For example, SES has been reported as an individual variable (such as parental education, household income, or occupation), or a composite of these variables. Some reviewed studies adopt a univariate analysis, which only considered one single variable at a time and do not take into account the effect of other potential confounding variables.
For multivariate studies, the factors that a study takes into account may produce various results. Within the literature on children’s speech and language outcomes, family socioeconomic status (SES) has been examined as a potential predictor of children’s verbal ability (e.g., Hoff-Ginsberg 1998). Harrison and McLeod (2010) reviewed 22 cohort and case-control studies that investigated numerous variables. Five of them included family SES to see if it was a potential risk factor for speech and language impairment. Among them, only one reported that children from low SES families had a higher risk of speech and language problems (Singer et al. 2001), while the rest showed no significant effect (Campbell et al. 2003, Choudhury and Benasich 2003, Yoshinaga-Itano et al. 1998, Zubrick et al. 2007). For example, Campbell and his colleagues (Campbell et al. 2003) studied the potential risk factors of speech delay of unknown origin. They found that maternal education, rather than a composite SES score, was a useful predictor of a child’s speech status. Similarly, no association between SES and speech sound ability has been reported in three large scale studies, namely, the Iowa Articulation norms project (Smit, Hand, Freilinger, Berenthal and Bird 1990), the British normative study (Dodd et al. 2003), and the New Zealand Articulation norm project (Moyle 2005). The factors applied in definitions of SES, however, varied across these three studies. Smit et al. (1990) made use of parent education level, that is, high school or less, 1-3 years beyond high school, and 4 or more years beyond high school. Dodd et al. (2005) employed a 6 level SES scale based on the social ranking established by a commercial information company (http://www.caci.co.uk). This ranking was estimated by the SES of an individual’s residential area in terms of the postal code. Moyle (2005) used the social ranking of children’s schools, which was based on the proportions of students from low SES, to estimate children’s SES. The discrepancy between different SES scales and different methods in estimating the SES of a child’s family (e.g., based on the school they attend,
or residential postcodes) may mask significant findings (Law 1992).

**Influence of Parental Education Level**

Entwisle and Astone (1994) recommended separating the analysis of parental education level from family income when studying a child's development even though these two variables have a close association. This is particularly important to speech and language development as parental education level (especially maternal education level) has been regarded as a representative indicator of environmental support for the language learning of a child (Nelson et al., 2006; Tomblin 1996; U.S. Preventative Services Task Force, 2006). In speech acquisition, mixed results have been reported. Dollaghan et al. (1999) used percentage of consonants correct (PCC) as their outcome measure of speech ability and reported no significant association with maternal education. A significant effect of maternal education was reported by Campbell et al. (2003) who found that low maternal education was a risk factor for speech delay as determined by the Speech Delay Classification System (SDCS, Shriberg et al. 1997). The effect of maternal education appeared to be mediated by the quantity and quality of a mother’s talk showing that the higher the maternal education level, the more mothers talk to their children. Hoff-Ginsberg (1994) reported that mothers with a higher education level tended to talk to their child more frequently and produce multiple utterances on one conversational topic.

For younger children, it seems that maternal education may not be significantly related to speech and language ability. Reilly et al. (2009) reported that maternal education was not significantly associated with a child’s communication ability at 24 months. Zubrick et al. (2007) investigated the effect of a number of risk variables related to late language emergence (LLE) and claimed that a child’s positive family history of communication disorders as well as his/her prenatal, perinatal, and obstetric characteristics were the most predictive of LLE. On the other
hand, most extrinsic factors, including maternal education level and household income, were not significant predictors of LLE at 24 months in the Zubrick et al. study.

A solid conclusion concerning the effect of parental education level on a child’s speech and language skills is difficult to draw from the above mixed findings. A clearer picture can be seen by comparing all the studies as in the review by Harrison and McLeod (2010). Studies reporting a significant association between maternal education and a child’s speech and language status often involved older children at age three or above, whereas studies reporting the lack of an association mainly focused on young children aged from 13 to 24 months. This may suggest an interaction effect between maternal education and age, that is, the effect of maternal education varies during the course of speech and language development and is particularly important when a child’s speech starts to develop rapidly after the age of two years.

**Influence of Siblings**

A number of research studies have suggested that first-born children and single children are usually verbally ahead of later-born children and those with siblings, at least in the early years (Berglund et al. 2005, Fenson et al. 1994). In their review, Harrison and McLeod (2010) reported that five out of six studies showed a significant effect of family size and birth order on a child’s speech and language ability. For example, in the Zubrick et al. (2007) study, the only significant extrinsic factor that could predict LLE at two years of age was the presence of siblings. Being an only child had a protective effect against LLE. Besides their review, Harrison and McLeod (2010) also carried out a cohort study on 4983 Australian preschoolers and found that having older siblings increased the risk of “parent-reported expressive speech and language concern” and attending speech and language therapy services; but was a protective factor for parent-reported receptive language concern. The mediated effect was explained by the amount of resources
available to a child in terms of language input and attention from the caregivers (Downey 2001). The amount of adult interaction time of a child with siblings may be diluted when compared to that available to a single child (Downey 2001, Zubrick et al. 2007). First born children during early years and single children can have access to more adult language models, while later-born children and children with more siblings may have fewer opportunities to experience one-to-one interaction with their caregiver when compared to their older siblings at an early age.

**Influence of Foreign Domestic Helpers**

Since the early 1990’s, many Hong Kong families have employed foreign domestic helpers to help with household duties and child-minding. The parents in these families usually have long working hours. In addition, since paid maternity leave in Hong Kong is relatively short, lasting for 10 weeks, most mothers have to resume work six to eight weeks after giving birth to their babies. Many working mothers employ a domestic helper to look after their children. In recent years, the number of domestic helpers in Hong Kong has increased dramatically. In 2006, they made up approximately 3.4% of the population of Hong Kong according to the Hong Kong bi-census data (Hong Kong SAR Government 2007) and most of them were from the Philippines, Indonesia and Thailand. English is one of the official languages in the Philippines but not in Indonesia and Thailand. Domestic helpers live with their employer's family. Many of the domestic helpers from the Philippines speak English, their second or later language, as the medium of communication with their employer and the family. Some domestic helpers learn Cantonese after their arrival at Hong Kong but their proficiency in speaking Cantonese and English varies substantially. Despite the growing number of foreign domestic helpers, their effect on children’s speech and language development is relatively unexplored, and existing findings are mixed (Chan and McBride-Chang 2005, Cheuk and Wong 2005). These available studies
have focused on language skills, and have not explored in depth the impact on children’s speech acquisition.

The Present Study

The studies of the environmental factors affecting speech and language development reviewed above have shown inconsistent outcomes. A number of studies applied simple correlation coefficients or regressions with individual predictor analyses which are not sufficient to model development accurately. The present study aimed to focus on five extrinsic factors relevant to the context of Hong Kong (household income, paternal education, maternal education, number of siblings, and having a domestic helper as the main caregiver) to investigate the unique contribution of these factors on a child’s speech acquisition while controlling for the intrinsic factors of age and sex. By the use of multivariate regression, more than one predictive variable was taken into account simultaneously in the model. The effects of these potential risk factor variables that may predict speech acquisition in children could then be assessed.

Method

Participants

The present study drew participants from a large scale study on speech acquisition among Cantonese-speaking children in Hong Kong (To et al. in press). A total number of 1,060 children aged from 2;4-6;7 and their parents were included in the overall study. The parents were requested to fill out a questionnaire on demographic information. Among the 1,016 children, 937 of them returned a fully completed questionnaire. Children were grouped into 8 age groups, with the mean age of 2;6, 3;0, 3;6, 4;0, 4;6, 5;0, 5;6, and 6;0 years. Each age group was divided by sex with approximately equal numbers of boys and girls. Group size ranged from 50 to 80 participants with an average of 65.64 for each sex (see Table 1). In the Hong Kong education
system, children can start nursery school from the age of two years or half-day kindergarten from three years. In the current cohort, only a small number of children had not started preschool. Since many nurseries and primary schools in Hong Kong provide inclusive education, the sample might have included a small number of children with mild disabilities. With this sampling method, the obtained cohort legitimately represented the population being studied.

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Table 1 about here
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Procedure

Parents of the children received an invitation letter that explained the purpose of the study. They returned the signed consent form if they agreed to their child’s participation in the study. Parents were also requested to complete a questionnaire on information about the monthly household income of the family, parental education, number of siblings of the child, and the child’s main caregiver (see Appendix A).

Description of Variables

**Household income (monthly) (ordinal scale).** The monthly household income scale had three levels, “< HK$10,000”, “HK$10,000 - HK$30,000” and “> HK30,000”, which were devised based on the income of Hong Kong residents in the age band of 22 to 65 in the population bi-census of 2006 (Census and Statistics Department 2007) (US$1 is approximately equal to HK$7.8).

**Maternal and paternal education level (ordinal scale).** The education level of each child’s mother and father was coded independently into 3 levels: “primary level or below”, “secondary level”, and “tertiary level or above”.

**Siblings (ordinal scale).** The questionnaire requested information about the number of
siblings a child had.

**Domestic helper (nominal scale).** A four-category scale for main caregiver, namely, “parents”, “grandparents”, “domestic helper”, and “others” (e.g., other relatives), was used. Parents were allowed to choose more than one category for this item. In order to explore the effect of having a domestic helper on a child’s speech ability, the focus of the analysis would be to compare (a) children whose caregiver was mainly the domestic helper alone with (b) children who had parents or grandparents as the main caregivers, either with or without a domestic helper. Thus, the “domestic helper” was only counted if that was the only category selected by parents. In other words, this variable was dichotomized into having a domestic helper as the only main caregiver or not.

**Speech acquisition.** Speech performance was measured using the *Hong Kong Cantonese Articulation Test* (HKCAT) (Cheung, Ng and To 2006) which is a standardized speech assessment tool examining all Cantonese initial consonants, final consonants, vowels, diphthongs, and tones. The maximum possible score of HKCAT is 56. The outcome variable included in the model was the composite score from the HKCAT, which is the number of correct phonemes and lexical tones that a child produced during the test. Each child was assessed individually by a qualified speech-language pathologist (SLP). All the speech samples were audio-recorded using minidisc recorders (either Sony Mz-B100 portable MD recorder or Sharp MD-MT290H(S) MD recorder) and were transcribed by two experienced SLPs. Samples from five males and five females from each age band, were randomly selected and independently scored by the other assessor. Point-to-point agreement between the two assessors was high (98.3%). More detailed description can be found in To et al. (in press).

**Statistical Analysis**
The statistics computer program SPSS 19.0 (IBM Corp., 2010) was the software used to conduct the following analyses.

**Univariate analyses.** Before the multivariate regression analysis, univariate analyses were performed using Pearson’s correlation coefficient \( r \) for the continuous data (age) and Spearman’s correlation coefficient \( r_s \) for the nominal and ordinal data (sex, household income, paternal education, maternal education, number of siblings, and domestic helper).

**Multivariate analyses.** A linear scatter plot was used to examine the linearity of the continuous variable of age with the HKCAT composite scores. A consistent curvilinear relationship was observed (see figure 1), the variable of age was then underwent data transformation so that they could fit into the regression model. A hierarchical stepwise regression was then conducted for the analysis of the correlation between the extrinsic variables and speech acquisition. The major advantage of this method was the ability to control confounding variables as well as examining the unique contribution of each individual variable after adjusting other variables. Two influential intrinsic factors, age and sex, were also put into the model to control their effect on the outcome so as to give a clear picture of the unique contribution of each extrinsic factor.

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**Figure 1 is about here**

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**Results**

Among the 1,016 children, 937 of them (92.2%) returned the questionnaire. Table 2 displays descriptive statistics for the seven independent variables with the HKCAT scores. The number of siblings each child had ranged from 0 to 3. Among the 937 respondents, 272 of them reported that domestic helpers were one of the caregivers of the child and 180 of them had domestic
helpers as the sole caregivers. The variable of age was categorized into eight age groups for the display of the mean HKCAT performance. Plots of the HKCAT scores of the six variables (i.e., sex, household income, maternal education, paternal education, number of sibling, and domestic helpers) against age groups are shown in figures 2 to 6 respectively. Figure 2 reveals that girls slightly outperformed the boys and the differences were generally consistent. Figure 3 illustrates that the higher level of household income had some influence on the HKCAT scores, suggesting children from families with higher household income appeared to have higher HKCAT scores than children from lower household income families. Figure 4 shows different maternal education levels against age group. Between ages 2;6 to 3;6, there is a remarkable discrepancy between mothers having lowest education level than the other two categories. Such a pattern may suggest an interaction between age and maternal education. As a result, an interaction term (age X maternal education) was generated and was later entered into the regression model to capture this pattern. Figure 4 shows that paternal education may also have a similar pattern as for maternal education. However, where there was an increased discrepancy between the lowest maternal education class and the other maternal education classes for ages 3;0 and 3;6, for paternal education, there was a smaller discrepancy between the education groups at a greater number of children’s ages. An interaction term between age and paternal education was also generated to be entered into the model. Children with no siblings appeared to perform slightly better than those with one or more siblings but the influence was small as shown in figure 6. Finally, children who had a domestic helper as the main caregiver performed similarly to the children who did not (figure 7).

**Univariate analyses**

The last two columns in Table 2 summarize the results of the univariate analyses with the
Pearson’s and Spearman’s correlation coefficient and $p$ values. The variables of age, sex and household income, were found to correlate significantly with the HKCAT scores while the variables of maternal education level, paternal education level, number of siblings, and having domestic helper as the main caregiver were not significant if the traditional cut-off $p$-value of .05 is used. However, given the inconsistent findings in the literature relating to the impact of these variables on speech acquisition, these variables were included in the regression model in order to explore their contribution. This is because the traditional significance level of .05 may fail to identify variables which may be important (Bursac et al. 2007).

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Figures 2 to 6 about here
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Multiple regression analyses

As mentioned before, the variable of age showed a quadratic function with the composite score in the simple regression plot. This variable was subject to natural log transformation twice to obtain a more linear relationship with the HKCAT scores. The variable of $\ln(\ln(\text{age}))$ was entered into the model.

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Tables 2 and 3 about here
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The variables being introduced into the model were assigned in an a priori order based on their importance as described in the literature. Given the considerable evidence of the relation between maturation and speech acquisition, the variable of age was put into the model first and followed by sex in the second series. The variable of household income was put into the model in the third series. In the fourth series, the maternal education variable was entered and followed by the interaction term (age X maternal education), paternal education, and the other interaction
term (age X paternal education). The variable of number of siblings and having a foreign domestic helper as the main caregiver were introduced last.

The results of the final model of the hierarchical stepwise regression are summarized in table 4. The multiple $R^2$ of all these variables (i.e., 0.399, the $R^2$ value after the variable of “domestic helper” was input) indicates that about 39.9% of the variance in the composite score was explained. The multiple $R$ was 0.63 (i.e., the square root of 0.399), which suggests a substantial correlation between the predictor variables and the HKCAT scores.

The contributions of each individual variable in explaining the variance of the HKCAT scores can be observed in the differences in $R^2$ using partial $F$ tests. When the variable related to age (i.e., (ln(ln(age)))) was entered in the equation first, it significantly accounted for the largest proportion (34.8%) of variance in the HKCAT scores. Sex accounted for an additional, significant 1.5% of the variance after holding the variable of ln(ln(age)) constant. After the 36.3% of variance attributed to ln(ln(age)) and sex had been controlled for, the household income explained a further 1.0% of the variance. The addition of the variable of maternal education and the interaction term of age X maternal education further accounted for 2.30%. The remaining variables only explained 0.3% of the extra variance of the HKCAT composite scores.

The predictive power of each variable can be estimated from the estimated coefficients, that is, the $b$ values and the $p$-values in the final model. The paternal education level, the interaction between the age and paternal education, the number of siblings and having a domestic helper as the only main caregiver were not useful in predicting a child’s HKCAT scores (all $p$ values > .05). These findings were generally consistent with those obtained from the univariate analyses and the only difference between the two analyses was that maternal education and its interaction with age were significant in the multivariate analysis.
Unsurprisingly, when other variables were controlled for, the age variable (ln(ln(age))) was the most important and significant predictor, with the coefficient of 27.16. The contribution of sex was much less than the age with a beta value of 1.35. Maternal education level and its interaction with age was a significant predictor. As shown in figure 3 the effect of maternal education was more remarkable in early years (before 3;6) than later years. The contributions of the remaining variables were very small and non-significant. In summary, the unique contribution to the HKCAT performance had been accounted for by these five variables was around 40% leaving a large proportion of explained variance.

**Discussion**

This study explored the effect of various extrinsic factors on children’s speech acquisition in Cantonese. Higher household income and higher maternal education level were significantly associated with better speech production ability. The effect of maternal education level was also related to the child’s age. The interaction between maternal education level and age implies that a stronger effect was observed during the early years of childhood. On the other hand, paternal education level, having a domestic helper, and the number of siblings did not contribute significantly to speech sound development. The total variance explained by these three significant extrinsic factors was only 3.3%.

**Age and Sex**

The intrinsic factors of age and sex were the best predictors of HKCAT scores. The quadratic function of age with the composite scores indicates the nonlinearity of the relationship. This relationship was characterized by the largest growth in the early years from 2 to 4. The rate decelerated and reached a plateau once children entered primary schools at the age of 6;0. This curve shape of quadratic function is similar to those reported in previous normative studies in the
English-speaking population (e.g., see McLeod 2012, for a review of studies of English-speaking children’s speech sound acquisition), but the plateau among the Cantonese-speaking children appeared two years earlier. Earlier acquisition of Cantonese may be accounted for by the simpler syllable structure and fewer consonants than in English (So and Dodd 1995, To et al. in press). This age variable has been described as a macro-variable comprising many other intrinsic components such as maturation of motor skills, cognitive ability, and linguistic maturity (Winitz 1969). The macro nature of age explains why the variable ln(ln(age)), which was derived from age, accounted for the largest amount of variance (34.8%) in HKCAT scores. Sex explained an additional 1.5% of variance, which was consistent with a previous meta-analysis that found that girls always surpassed boys in various aspects of verbal behaviors (Hyde and Linn 1988). As the effect sizes reported in all the reviewed studies in the meta-analysis were very small, Hyde and Linn concluded that the apparent difference was negligible. This observation was generally complementary to the present finding that sex played a statistically significant yet complex role in typical speech acquisition. However, a sex effect would probably be more prominent in clinical speech sound disorders since being male has been identified as one of the risk factors for speech sound disorders (e.g., Campbell et al. 2003, Harrison and McLeod 2010, Law et al. 1998, McLeod and McKinnon 2007, Shriberg et al. 1986, Smit et al. 1990).

Other Variables

After controlling for the effects of age and sex, the remaining variables together only account for an additional 3.3% of the total variance. Higher levels of household income appeared to be beneficial in promoting speech acquisition and maternal but not paternal education showed some association in predicting a child’s speech performance. The effect of maternal education on children’s speech varied in the course of development as shown in the significant interaction
between the child’s age and maternal education. The influence was more apparent between the period 2;6 and 4;0 and diminished remarkably from 4 years onwards. This pattern may reflect the time when children most rely on maternal support as the source of speech and language input. Children from families with higher household incomes and with highly educated mothers do not necessarily gain from the specific professional knowledge of their mothers. It would most likely be the quantity and quality of interaction these mothers provide to their children that acts as the key to better speech sound production ability. The present findings of very slight effect of the extrinsic factors also may not directly support the implementation of parent training programs as a beneficial management option for young children at risk of speech problems.

Having one or more sibling did not significantly associate with differences in speech production ability and the corresponding variance explained was very small (0.2%). Although it may be believed that parents with more than one child might have more household chores to manage and their talking time and attention to their children is shared among the siblings, having siblings can in fact provide opportunities for sharing and learning among children. If the siblings already have a mature speech system, they may also provide good speech models.

The influence of having a foreign domestic helper as the only main caregiver was not a significant predictor of speech acquisition scores on the HKCAT, at least from 2;6 years onwards as shown in the present study. This finding is contrary to a common belief in Hong Kong that having foreign domestic helpers with non-native pronunciation at home may hamper the speech acquisition of a child. In Hong Kong, preschool children may attend full-day nurseries (7 hours/day) or half-day kindergartens (3 hours/day). Domestic helpers need to perform most household chores in addition to child-minding. If a child who attends kindergarten in the morning, s/he may spend the afternoon with the domestic helper including lunch and nap time.
Working parents usually return home from work after 6pm and can then spend time interacting with their children. This child will therefore have native speech and language models of local Cantonese from his/her teachers and parents in addition to the non-native domestic helpers to counter balance any effect of the non-native speech input.

**Overall Conclusions and Future Studies**

After the effect of age and sex was controlled for, two extrinsic factors, maternal education level and household income, made a very small contribution to children’s speech acquisition in Hong Kong Cantonese. A timing effect was also observed such that the association of maternal education had a stronger influence before age four years. The factors of paternal education level, the number of siblings, and having a domestic helper as the primary caregiver did not contribute significantly to the children’s speech acquisition. The overall model explained 39.9% of the variances leaving 60.1% of the variances unexplained. This observation is consistent with a previous study that risk factors only accounted for a small amount of variation (5-6%) in early communication skills (Reilly et al. 2006) and may point to the minimal effect of these general environmental factors in shaping children’s speech acquisition. Instead, other biologically predetermined factors may play a more important role in the course of speech and language development (Reilly et al. 2006). Future studies including other potential risk factors such as children’s temperament, attention span, and mood would be warranted (Harrison and McLeod 2010, Shriberg 2010).

**References**


Table 1

*The Age and Sex of the Participants*

<table>
<thead>
<tr>
<th>Age group (yr;mth)</th>
<th>Range (yrs)</th>
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<th>SD (yrs)</th>
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<th>N female</th>
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<td>44</td>
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<td>0.19</td>
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<td>126</td>
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Total                  | 455         | 517        | 937      |
Table 2
*Descriptive Statistics of the Hong Kong Cantonese Articulation Test Scores and its Correlations with Different Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$N$</th>
<th>HKCAT mean (SD)</th>
<th>$r$</th>
<th>$p$-value</th>
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<td></td>
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<td>93</td>
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<td>.54**</td>
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<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>482</td>
<td>51.36 (6.19)</td>
<td>.15**</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>M</td>
<td>455</td>
<td>49.36 (4.70)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Household income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>266</td>
<td>51.02 (5.58)</td>
<td>.07*</td>
<td>.03</td>
</tr>
<tr>
<td>Mid</td>
<td>493</td>
<td>50.57 (5.45)</td>
<td></td>
<td></td>
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<tr>
<td>Low</td>
<td>178</td>
<td>49.85 (5.75)</td>
<td></td>
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</tr>
<tr>
<td><strong>Paternal education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary or above</td>
<td>231</td>
<td>50.88 (5.79)</td>
<td>.05</td>
<td>.11</td>
</tr>
<tr>
<td>Secondary</td>
<td>648</td>
<td>50.61 (5.37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary or below</td>
<td>58</td>
<td>49.31 (6.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maternal education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary or above</td>
<td>190</td>
<td>50.41 (6.45)</td>
<td>.038</td>
<td>.25</td>
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<tr>
<td>Secondary</td>
<td>687</td>
<td>50.81 (5.06)</td>
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</tr>
<tr>
<td>Primary or below</td>
<td>60</td>
<td>48.40 (7.23)</td>
<td></td>
<td></td>
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<tr>
<td><strong>Number of siblings</strong></td>
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<td></td>
</tr>
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<td>0</td>
<td>429</td>
<td>50.63 (5.73)</td>
<td>-.028</td>
<td>.38</td>
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<td>1</td>
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<td>50.68 (5.36)</td>
<td></td>
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<td>2</td>
<td>83</td>
<td>50.02 (5.36)</td>
<td></td>
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<td>3</td>
<td>8</td>
<td>48.63 (5.55)</td>
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<tr>
<td><strong>Domestic helper</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>175</td>
<td>50.58 (5.23)</td>
<td>-.001</td>
<td>.97</td>
</tr>
<tr>
<td>No</td>
<td>762</td>
<td>50.59 (5.60)</td>
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*Note.* **$p$-value <.01. *$p$-value <.05. #Pearson’s $r$ was calculated for ratio data (i.e., age) whereas Spearman’s $r_s$ was calculated for ordinal and nominal data (i.e., sex, household income, paternal education, maternal education, number of siblings, and domestic helper).
Table 4

*Hierarchical Multiple Regression Analysis Predicting the Variance in Children’s Scores on the Hong Kong Cantonese Articulation Test Scores*

<table>
<thead>
<tr>
<th>Variables added</th>
<th>Multiple $R^2$</th>
<th>$R^2$ Change</th>
<th>$F$ Change</th>
<th>$b$</th>
<th>$p$</th>
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<tbody>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>ln(ln(age))</td>
<td>.348</td>
<td>.348</td>
<td>498.59</td>
<td>27.16</td>
<td>&lt;.001</td>
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<tr>
<td>sex</td>
<td>.363</td>
<td>.015</td>
<td>21.97</td>
<td>1.35</td>
<td>&lt;.001</td>
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<td>income</td>
<td>.373</td>
<td>.010</td>
<td>14.31</td>
<td>.503</td>
<td>.044</td>
</tr>
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<td>maternal education</td>
<td>.378</td>
<td>.005</td>
<td>7.79</td>
<td>3.603</td>
<td>.004</td>
</tr>
<tr>
<td>interaction1 (age X maternal education)</td>
<td>.396</td>
<td>.018</td>
<td>27.55</td>
<td>-.689</td>
<td>.014</td>
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<tr>
<td>paternal education</td>
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<td>.001</td>
<td>.79</td>
<td>1.37</td>
<td>.251</td>
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<tr>
<td>interaction2 (age X paternal education)</td>
<td>.397</td>
<td>.000</td>
<td>.633</td>
<td>-.253</td>
<td>.332</td>
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<td>number of siblings</td>
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<td>.002</td>
<td>.367</td>
<td>-.409</td>
<td>.056</td>
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<td>domestic helper</td>
<td>.399</td>
<td>.000</td>
<td>.005</td>
<td>.028</td>
<td>.941</td>
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</tbody>
</table>

*Note.* ln(ln(age)) = the variable of age after two times of natural log transformation
Figure legends

*Figure 1.* Scatterplot of the Hong Kong Cantonese Articulation Test (HKCAT) composite scores against age.

*Figure 2.* Relationship between the composite *Hong Kong Cantonese Articulation Test* scores and sex.

*Figure 3.* Relationship between the composite *Hong Kong Cantonese Articulation Test* scores and household income.

*Figure 4.* Relationship between the composite *Hong Kong Cantonese Articulation Test* scores and maternal education level.

*Figure 5.* Relationship between the composite *Hong Kong Cantonese Articulation Test* scores and paternal education level.

*Figure 6.* Relationship between composite *Hong Kong Cantonese Articulation Test* scores and sibling status.

*Figure 7.* Relationship between composite *Hong Kong Cantonese Articulation Test* scores and having domestic helper as the main caregiver.
Composite HKCAT scores

Figure 1. Scatterplot of the composite Hong Kong Cantonese Articulation Test scores against age.
Figure 2. Relationship between the composite Hong Kong Cantonese Articulation Test scores and sex.
Figure 3. Relationship between the composite Hong Kong Cantonese Articulation Test scores and household income.
Figure 4. Relationship between the composite Hong Kong Cantonese Articulation Test scores and maternal education level.
**Figure 5.** Relationship between the composite Hong Kong Cantonese Articulation Test scores and paternal education level.
Figure 6. Relationship between composite Hong Kong Cantonese Articulation Test scores and sibling status.
Figure 7. Relationship between composite *Hong Kong Cantonese Articulation Test* scores and having domestic helper as the main caregiver.
Appendix A

Questions Asking for Demographic Information:

1. How many siblings does the child have (not including the child himself or herself)?

   幼兒共有多少個兄弟姊妹(不包括幼兒自己)？

   __________ (個)

2. Who is the child’s main caregiver? 幼兒主要由誰人照顧？

   □ Parents   □ Grandparents   □ Domestic helpers   □ Others:
   父/母   祖父/母   傭人   其他: __________

3. What is the father’s highest education level? 幼兒父親教育程度

   □ Primary school or below   □ Secondary school   □ Institute, University or above
   小學或以下   中學   專上、大學或以上

4. What is the mother’s highest education level? 幼兒母親教育程度

   □ Primary school or below   □ Secondary school   □ Institute, University or above
   小學或以下   中學   專上、大學或以上

5. What is the range of the total monthly household income?

   □ <HK$10,000   □ HK$10,000-HK$30,000   □ >HK$30,000