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Do Girls Outperform Boys in Early Syntactic Development? Negative Evidence from Mandarin-Speaking Preschoolers

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Abstract: This study aimed to verify the sex differences seen in our previous study on early syntactic development among Cantonese-speaking children with the same corpus design but a different Chinese language: Mandarin. The utterances produced during half-hour play activities by 192 Beijing children, ranging from 3 to 6 years, were collected in the Early Child Mandarin Corpus and analyzed in this study. Their syntactic development was measured in terms of mean length of utterance (MLU), sentence type and structure, syntactic complexity, and verb pattern. The statistical analyses indicated significant age differences in MLU, sentence types and structures, and syntactic complexity. However, no sex or age-by-sex differences in MLU were found. This negative evidence indicates that sex difference is neither universal nor cross-language. The implications for early childhood education and future studies are discussed.

Keywords: sex differences; syntactic development; Mandarin-speaking children

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1. Introduction

Girls outperforming boys in early language development has been repeatedly reported and is widely accepted by developmental psycholinguists (Eriksson et al. 2012; Lange et al. 2016; Tse et al. 2002). The early work conducted by Anastasi (1958) reported that females might be superior to males in language abilities from childhood to adulthood. Since then, many studies have reported similar findings. For example, Eriksson et al. (2012) found that girls performed better than boys in early communicative gestures, productive vocabulary, and combining words. Additionally, the well-established and widely cited study on Cantonese-speaking preschoolers conducted by Tse et al. (2002) focused on sex differences in early syntactic development. They analyzed the utterances spoken by children ages 3 to 5 during spontaneous play and found that girls produced longer sentences in terms of Mean Length of Utterance (MLU), with more diverse and complex structures than those of boys. However, this girl superiority phenomenon has been challenged by a recent systematic literature review (Etchell et al. 2018), which concludes that sex differences in language development may be negligible in most developmental stages and might simply be due to the different rates of maturation between the sexes. Accordingly, Etchell et al. (2018) suggest that more research is needed to provide normative information about early language development and the related sex differences. Therefore, this study is intended to replicate the study of Tse et al. (2002) with Mandarin-speaking young children, using the same communication tasks and design. Additionally, the finding will provide crosslinguistic evidence to support or reject the widely accepted phenomenon of girl superiority.

1.1. Early Syntactic Development in Chinese Children

Syntax refers to the grammatical arrangement of words in sentences, and syntactic development in Chinese is measured by the MLU, sentence type and structure, syntactic

complexity, and verb pattern (Tse and Li 2011). Brown (1973) was the first to adopt MLU to evaluate early syntactic development in American children, calculating the total number of morphemes (units of meaning) rather than words to indicate the length of utterances. As the Chinese language has no graphemic transformation, Chinese psycholinguists chose to use either the number of characters in transcriptions or the number of words (usually composed of two or more characters) to measure the length of utterances and MLU (Tse and Li 2011). Accordingly, counting MLU by characters or words has led to different results in evaluating the syntactic development in Chinese children. Tse et al. (2002) adopted the number of Chinese characters of each utterance in transcriptions to measure the length of utterance. Additionally, Tse and Li (2011) also adopted the number of Chinese characters as the indicator; therefore, this study also employed the number of Chinese characters to measure the length of each utterance. However, there are problems associated with using MLU as the single indicator of syntactic development in children. MLU itself does not provide a comprehensive measure of children's acquisition of syntax, as sentences with the same MLU may possess quite different levels of syntactic complexity (Tse and Li 2011). There is also a lack of a commonly recognized definition of what constitutes a word in some languages, such as Chinese, making it even more difficult for psycholinguists to arrive at a universal coding and assessment scheme for MLU. Furthermore, MLU might be reliable for measuring syntactic development in early childhood but not for school years. Therefore, syntactic complexity has been employed as another key indicator of syntactic growth in Tse et al. (2002) and Tse and Li (2011).

As the key indicator of syntactic development, syntactic complexity has been widely adopted by Chinese psycholinguists. For example, an early study by Zhu (1979) found that the sentences produced by Mandarin-speaking children were made increasingly complex by adding modifiers, serial verb construction, and using subject and predicate as object or subject. Additionally, another study on Cantonese (Kwong 1990) found a significant age effect in syntactic development, with increases in the complexity of modifiers such as subject-predicate as object or subject seen. In particular, Kwong (1990) reported a significant spurt in syntactic complexity in the utterances produced by 4-year-olds. Additionally, the proportion of declarative sentences with simple modifiers increased significantly from age 3 to age 4, achieving 60% of all utterances in children's speech by age 5. However, this figure was much lower than that of Zhu (1979), which was 85.2% for 5-year-old Mandarin speakers. Tse et al. (2002) attributed this difference in proportion to the sampling differences and the language differences between Cantonese and Mandarin. Tse et al. (2002) sampled 492 Cantonese-speaking children and found that the time between age 3 and age 4 could be regarded as the critical period for developing syntactic complexity, such as more addition of modifiers, serial verb construction, and use of subject and predicate as object or subject. Therefore, Tse and Li (2011) proposed the framework of syntactic analysis for early childhood Cantonese: (1) without modifier; (2) with simple modifier; (3) with complex modifier; (4) with subject-predicate as subject or object. This framework will also be employed to measure the syntactic complexity in this study.

In addition to syntactic complexity, sentence types, sentence structures, and verb pattern have also been used by Chinese psycholinguists to measure syntactic development. For instance, Tse et al. (2002) and Tse and Li (2011) proposed and verified a framework for analyzing Cantonese-speaking children's sentence types, sentence structures, and verb patterns. First, they confirmed that young children's sentence types could include: (1) declarative sentence; (2) interrogative sentence; (3) exclamation sentence; (4) negation sentence; (5) imperative sentence; (6) incomplete sentence; and (7) English and other words. Second, Tse et al. (2002) and Tse and Li (2011) classified young children's sentences into five types: (1) single-word sentence; (2) simple declarative; (3) subjectless sentence; (4) subject-predicate sentence; and (5) compound sentence. Third, they analyzed the verb patterns in Cantonese declaratives using the following typology: (1) with intransitive verb; (2) with transitive verb; (3) with co-verbs or verbs in serial expression modifier; (4) link verb; and (5) without verb. This typology of sentence has proven comprehensive and

inclusive for early childhood Cantonese and thus could be used in this study. For details, please refer to Table A1. The family of Chinese languages includes many dialects such as Cantonese, Hakka, Hu, Mandarin, Min, etc. Cantonese is the lingua franca in Southern China, Hong Kong, Macau, and many Chinatowns in North America. Spoken by some 70 million people, Cantonese has no official standard written form and thus is not used in formal business and government communications. However, Mandarin (widely known as Putonghua) has been designated as the official spoken language across Mainland China, Taiwan, and Singapore (Tse and Li 2011). This study will follow the framework developed by Tse and Li (2011).

1.2. Gender Differences in Early Language Development

The existing studies on this topic have generally revealed that girls outperform boys in early language development (Guthrie and Greaney 1991; Joseph 2000; Tse et al. 2002; Tse and Li 2011). For example, girls' first-word production occurs earlier than that of boys, and girls are quicker to acquire a vocabulary and utter understandable speech. They are also faster at learning grammatical skills, quicker to articulate, achieve rapid speech, and produce longer sentences of greater complexity (Shaywitz et al. 1995). In addition, girls score higher than boys in narrative and expository reading in several countries, whereas boys have been disadvantaged throughout development (Warwick 1992). Additionally, this girl's superiority or advantage in language development is even evident in later life, with males being more likely to stutter or experience aphasia after a stroke and slower to achieve rehabilitation (Joseph 2000). However, in a critical review, Wallentin (2009) noted that most studies reported sex differences based on p values, usually marginally significant. Furthermore, many studies had a small sample size; thus, the significance might be false positive. Therefore, Wallentin (2009) concluded there might be no sound evidence for gender differences in language development. However, this literature review has focused on adult studies, leaving the gender difference in young children unconfirmed.

Recently, there have been many studies examining gender differences in early language development. Etchell et al. (2018) conducted another systematic literature review of the studies, focusing on sex differences in brain structure and function relevant to language. They critically reviewed the consistency of any sex differences and how the differences change over age. However, only 15 of the 26 reviewed studies reported correcting for multiple comparisons, whereas 11 failed to do so. Among those 15 studies, 13 reported significant differences, and two did not. Additionally, three of the 15 studies had small samples and cautioned the interpreting issues with p values and a lack of correlation with behavioral values. They found that the percentage of robust studies reporting significant sex differences was lower than that of less rigorously conducted studies. Furthermore, Etchell et al. (2018) were also concerned about publication and author bias. For example, journal editors tend to publish those studies with significant gender differences, and the sex of the first author will possibly affect whether the article finds sex differences or not. Accordingly, they concluded that: (1) evidence for sex differences in brain and language development is limited; (2) sex differences often interact with factors such as age and task. Overall, the sex difference in language development is not as significant as previously thought. Accordingly, they suggest that sex differences in language might be more prominent during certain developmental stages but negligible in other stages due to the different developmental rates between the sexes. Etchell et al. (2018) imply that more studies are needed to understand whether there is a sex difference in language development and how it changes over age.

However, most of these studies and literature reviewed were carried out in the European-American languages, leaving the Chinese languages (i.e., Cantonese and Mandarin) understudied. The widely cited study on gender differences in early child Cantonese was conducted by Tse et al. (2002), who found significant age and sex effects in early syntactic development. In particular, the significant sex differences include girls outperforming boys in mean utterance length, some sentence types and structures, and syntactic complexity, with a significant age-by-sex interaction in the group of 4-year-olds. The period

between age 3 and age 4 was identified as critical for syntactic development, as many linguistic changes occurred at this time. Growth in the ability to use compound sentences was the most significant contributor to the increased MLU. Accordingly, Tse et al. (2002) suggested that the biological, psychological, and sociocontextual factors might contribute to these sex differences in language performance. However, they have missed one possible interpretation that this sex difference in syntactic development might be caused by the different maturation rates between the sexes (Etchell et al. 2018). It is thus urgently needed to duplicate this study using another Chinese language (e.g., Mandarin) with other samples (e.g., Beijing preschoolers). To fill this gap, this study is conducted in Beijing, where young children acquire and speak Mandarin Chinese at home and in preschool (Li 2014).

1.3. The Context of This Study

The above literature review indicates inconsistent evidence of sex differences in early language development. A variety of factors might cause this inconclusive status. For example, age effects have frequently been reported to interact with sex differences (Etchell et al. 2018). Therefore, future studies shall examine age differences and age-sex interactions to confirm the sex differences in early language development. Furthermore, suppose there are non-significant sex differences but significant age and age-by-gender differences. In that case, it could be more accurately characterized as a difference in maturation between the sexes rather than 'sex differences'. Accordingly, this study will explore the age, gender, and age-by-gender differences in early syntactic development among Mandarin-speaking preschoolers in Beijing. Second, Etchell et al. (2018) found that sex differences in language development might depend on specific task parameters. In particular, they suggested that the emergence of sex differences might depend on the tasks' nature (i.e., perception, production, or judgments) and complexity (i.e., syllables, single words, or entire sentences). However, most lab experiments have specific and limited language tasks and stimuli; thus, they might not be able to collect comprehensive, inclusive, and genuine data to demonstrate the real picture of sex differences in language development. It is thus necessary to adopt the corpus approach, a unique, powerful research paradigm with some obvious strengths. For example, Tse and Li (2011) have summarized its four strengths: (1) it is a database ready for multi-purpose analyses by independent researchers and the public, allowing duplication of the psycholinguistic studies; (2) it provides a primary source of evidence allowing theories to be developed, examined, and refined; (3) it empowers scholars to return to sources to re-test the validity of tentative or hypothetical analyses; (4) it allows a systematic analysis of the actual patterns of authentic language in natural texts. Therefore, this study will elicit data from a well-established corpus, the Early Child Mandarin Corpus (Li and Tse 2011), to explore the age, sex, and sex-by-age differences in early syntactic development. Accordingly, the following research questions guided this study:

1. Are there significant age differences in Beijing preschoolers' syntactic development?
2. Are there significant sex differences in Beijing preschoolers' syntactic development?
3. Are there significant sex-by-age differences in Beijing preschoolers' syntactic development?

2. Materials and Methods

2.1. Participants

This Early Child Mandarin Corpus has followed the same design as the Early Child Cantonese Corpus by Tse et al. (2002) and has been established by the same team (Li and Tse 2011) using the Beijing sample. As the capital of China, Beijing is a monolingual city that only allows the use of Mandarin Chinese (Putonghua) in daily communication (Li et al. 2022). This purely monolingual environment has made young children acquire Mandarin Chinese as their first language without other languages' significant interference. To assure the sample's representativeness, the Corpus has employed a 3-step stratified sampling approach. First, four districts were randomly sampled from the 16 districts of Beijing: the Eastern, Western, Haidian, and Chaoyang. Second, one public and one private preschool were randomly sampled from each participating district, resulting in

eight participating preschools. Third, four age groups (2.5 years, 3.5 years, 4.5 years, and 5.5 years) of children were randomly sampled from each participating preschool, with six children (3 boys, 3 girls) for each age group. In total, this Beijing sample recruited 192 preschoolers between 24 months and 66 months. Their parents were also invited to complete a survey for this study. To reduce the effects of these variations on early child language development, we deliberately chose participating preschools of different backgrounds and teaching approaches.

2.2. Videotaped Communication Task

A free-play corner was set up in the classroom of the children selected. The area was furnished with toys that included cooking materials, food, fruit, furniture, electrical appliances, hospital-related materials, and toy vehicles used by Tse et al. (2002) and Tse and Li (2011). It included: cooking materials, food and fruit, furniture and electrical appliances, hospital materials, and vehicles. The range of toy categories was proven to meet the needs and interests of both genders and individual preferences and the different age groups in Tse et al. (2002) and Tse and Li (2011). Six children were randomly sampled from each age group class and paired into a dyad (boy/girl, boy/boy, and girl/girl). Each dyad was left in the free-play corner for 30 min. They were encouraged to talk while playing, and the 30-min conversations were recorded in video and audio formats. Researchers were allowed to observe and casually oversee the children during the free-play sessions. However, teachers, researchers, and adults were prohibited from intervening in the children's activities. Therefore, there were no other children in the room.

2.3. Transcription

Each conversation is transcribed by a trained native Mandarin speaker with enough detail to capture every audible word and word fragment, together with overlapping speech. The researcher supervised initial transcriptions to ensure their validity. Transcription included non-word fillers ("uh") and such other vocalizations as laughter. Unrecognized and inaudible utterances are identified in the transcription by "#". All participants are anonymously coded. After transcription of each section of the conversation, the researcher checks the transcript while watching the video to ensure the accuracy of each transcript. Inconsistencies between transcription and video are resolved. Transcriptions are then further coded to analyze the level of syntactic development. Participants' transcripts are in individual files so that MLU and other syntactic development measures can be calculated for each child. Punctuation is removed, and actual characters alone are calculated. Words unrelated to a sentence, such as "uh . . . " or "oh . . . " and produced without context do not count as utterances. Unrecognized and inaudible utterances marked "#" are calculated, provided they are in a sentence. Further segmentation of produced speech into utterances and characters then takes place, using guidelines from Lund and Duchan (1988). The end of an utterance is marked by a drop or rise in pitch followed by a definite pause or at the end of a sentence so that each sentence is treated as a separate utterance even when two or more are voiced without a pause in a single breath. A compound sentence, two subject-predicate constructions joined by a conjunction, counts as a single utterance. Chinese often have two subject-predicate constructions with no conjunctions; whether they constitute a compound sentence is decided by judging the relationship between them. Fillers are omitted from character counts. Disfluencies and character repetition count as only one character unless being used to add emphasis to meaning (e.g., in "I . . . I . . . I . . . want that", "I" counts as a single character, but in "No! No! No! You should not do that!" "No" counts as three characters). The total number of characters produced by the child divided by the total number of utterances in the conversation gives that child's MLU.

2.4. Data Analysis

The total number of characters produced by the child divided by the total number of utterances in the conversation gives that child's MLU. MLU in this study is calculated

in terms of the number of characters. When working with Chinese-speaking children's syntactic development in their preschool age, it has been shown that counting MLU in morphemes and MLU in words has a minor difference (Klee et al. 2004; Yip and Matthews 2006). This is due to the absence of inflectional or derivational morphology in written and spoken Chinese. Cheung (1998) and Kok (2011) have further demonstrated the high correlation (r = 0.98) between calculating MLU in words and MLU in characters in Mandarin-speaking children aged 1–6 years old. Therefore, counting characters, as seen in the transcription, is adopted in this study to avoid making potentially arbitrary decisions on identifying a morpheme or word for the language spoken by the child. Previous research with Mandarin-speaking children (Klee et al. 2004; Yip and Matthews 2006; Kok 2011) had demonstrated the high correlation between MLU in morphemes, words, and characters, making this a very reliable method in determining the MLU of children.

2.5. Utterance Analysis

In addition to MLU, sentence types, sentence structures, syntactic complexity, and verb pattern are analyzed to reveal the stage of syntax development. This coding framework has repeatedly proven comprehensive and inclusive by Tse et al. (2002) and Tse and Li (2011). For details, please refer to Table A1.

1. The sentence types observed include interrogatives, declaratives, imperatives, exclamations, and sentences containing English words.
2. The sentence types most often used are declarative and contain more syntax elements. Therefore, understanding sentence structure requires analysis of declarative structures; other categories include single-word sentences, sentences with no subject, subject-predicate sentences, and compound sentences.
3. Modifiers must be considered to understand how complex the syntax of a declarative is. For example, a declarative may be categorized as a sentence with no modifier, a simple modifier, complex modifiers, and modified by subject-predicate. In particular, according to Dryer (2007), simple modifiers include articles, adjectives, demonstratives, or numerals, whereas complex modifiers include genitive or possessive modifiers and relative clauses.
4. Understanding declarative verb patterns requires studying how verbs are used. For example, a declarative may be categorized as a sentence without a verb, an intransitive verb, a transitive verb, a co-verb, and a copula verb. For each item in each area, frequency and percentage are calculated.

Trained research assistants did the above coding under the researcher's supervision. The researcher and the research assistant first coded 10% of the corpus. Comparison of the coding revealed a mutual agreement of over 90%, leading to excellent inter-coded reliability. The researcher then continued to code half of the corpus, and research assistants coded another half.

3. Results

This section may be divided into subheadings. It should provide a concise and precise description of the experimental results, their interpretation, and the experimental conclusions that can be drawn.

3.1. Mean Length of Utterance

The means and standard deviations of the number of utterances and the Mean Length of Utterance (MLU) for the four age groups were calculated. As shown in Table 1, the mean number of utterances was 134.85 for all 192 participants, and the overall MLU was 4.90, rising from 3.68 to 5.97 for 2.5-year-olds to 5.5-year-olds. A two-way ANOVA (age-by-sex) was applied to the MLU and yielded a significant effect for age, $F = 37.05$, $p < 0.001$, $\eta^2 = 0.38$, power = 1.00 at the 0.05 level (default level). In contrast, there was no significant effect for sex, $F = 1.49$, $p > 0.10$, and no significant age by sex effects, $F = 0.14$, $p > 0.10$, even though boys displayed a higher MLU than girls among all age groups (see Figure 1).

According to Cohen's (1977) guidelines on effect size, $\eta^2 = 0.01$ was regarded as having a small effect size, $\eta^2 = 0.06$ as having a medium effect size, and $\eta^2 = 0.14$ as having a large effect size. Post hoc Tukey HSD test was applied, and significant differences were found between all age groups except 4.5 years and 5.5 years. There were significant differences between 2.5 years and 3.5 years, Q = 3.23, $p < 0.01$; between 2.5 and 4.5 years, Q = 7.53, $p < 0.001$; between 2.5 and 5.5 years, Q = 9.59, $p < 0.001$; between 3.5 and 4.5 years, Q = 4.30, $p < 0.001$; between 3.5 and 5.5 years, Q = 6.36, $p < 0.001$. Therefore, the findings here with $\eta^2 > 0.14$ significantly indicated an age-related development trend in the MLU.

Table 1. Means and standard deviations for total utterances and MLU.

	Total Utterances		MLU		Boys' MLU (n = 96)		Girls' MLU (n = 96)	
Sample	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
2.5 years	73.75	63.71	3.68	1.34	3.80	1.34	3.56	1.35
3.5 years	87.88	88.23	4.45	1.21	4.55	1.04	4.36	1.38
4.5 years	155.35	81.96	5.48	1.01	5.51	1.06	5.46	0.97
5.5 years	222.44	101.06	5.97	1.08	6.15	1.13	5.80	1.02
Total	134.85	102.99	4.90	1.46	5.00	1.45	4.79	1.48

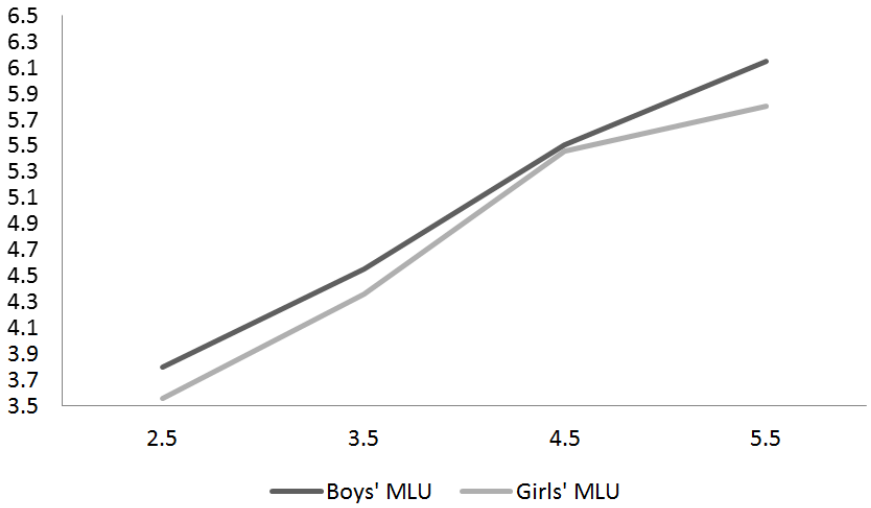

Figure 1. Gender differences in the MLU for the sample (N = 192).

Given the plausible interaction effect between gender typing of play materials and the gender of playmate proposed by Trautner (1995), a supplementary two-way ANOVA was applied with a subsample of 128 children of same-sex dyads. These children played with a partner of the same sex in the 30 min interval, either in a boy-boy or a girl-girl setting. As presented in Table 2, there was a similar increasing trend in the mean number of utterances, with 73.75 for 2.5-year-olds, 87.88 for 3.5-year-olds, 155.35 for 4.5-year-olds, and 222.44 for 5.5-year-olds. The MLU in this subsample also showed a significant effect for age, F = 31.51, $p < 0.001$, $\eta^2 = 0.44$, power = 1.00 at the 0.05 level (default level). Again, although boys displayed a higher MLU than girls among all age groups, there was no significant effect for sex, F = 0.72, $p > 0.10$, and no significant age-by-sex effects, F = 0.52, $p > 0.10$ (see Figure 2). Post hoc Tukey HSD test on the subsample set also found a significant difference between all age groups except 4.5 years and 5.5 years. There were significant differences between 2.5 years and 3.5 years, Q = 3.20, $p < 0.01$; between 2.5 and 4.5 years, Q = 7.11, $p < 0.001$; between 2.5 and 5.5 years, Q = 8.83, $p < 0.001$; between 3.5 and 4.5 years, Q = 3.93, $p < 0.001$; between 3.5 and 5.5 years, Q = 5.63, $p < 0.001$. Therefore, the findings in this subsample

indicated a significant age-related development in the MLU, identical to the results for the mixed-gender dyads.

Table 2. Means and standard deviations for the subsample (N = 128).

	MLU		Boys' MLU (n = 64)		Girls' MLU (n = 64)	
Sample	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
2.5 years (n = 32)	3.70	0.95	3.72	0.93	3.68	1.01
3.5 years (n = 32)	4.52	1.17	4.69	1.11	4.34	1.23
4.5 years (n = 32)	5.52	0.82	5.44	0.82	5.59	0.84
5.5 years (n = 32)	5.95	1.07	6.14	1.10	5.75	1.03
Total (N = 128)	4.92	1.33	5.00	1.33	4.84	1.34

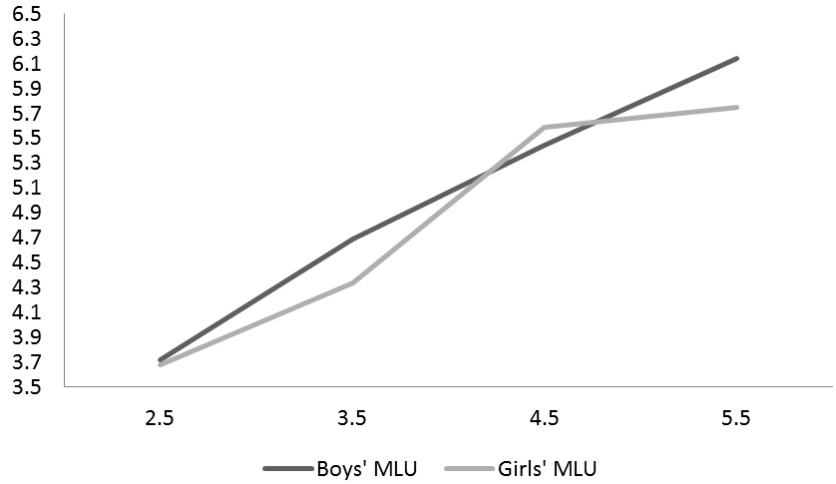

Figure 2. Gender differences in MLU for the subsample (N = 128).

3.2. Sentence Type

The distribution of sentence types by sex across age groups is presented in percentages in Table 3. A two-way ANOVA (age-by-sex) applied and yielded showed a significant effect of age for interrogative sentences, F = 3.77, $p < 0.001$, $\eta^2 = 0.058$, power = 0.81 at the 0.05 level (default level). A significant effect of age for imperative sentences was also found, F = 3.66, $p < 0.001$, $\eta^2 = 0.056$, power = 0.79 at the 0.05 level. There was also a significant age effect for exclamations, F = 4.36, $p < 0.01$, $\eta^2 = 0.066$, and power = 0.87 at the 0.05 level. There was no significant sex effect or age-by-sex interactions for any sentence types. Post hoc Tukey HSD test revealed a significant difference for interrogative sentences at age 2.5 and age 3.5, Q = 3.33, $p < 0.01$. There was also a significant difference for imperative sentences at age 2.5 and age 5.5, Q = 3.19, $p < 0.01$. A significant difference was also found for exclamatory sentences at age 2.5 and age 3.5, Q = 3.43, $p < 0.01$.

Table 3. Sentence types by gender and age groups.

	2.5 Years		3.5 Years		4.5 Years		5.5 Years	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Declarative	64.76	63.99	62.93	65.48	61.83	66.34	62.54	63.11
Interrogative	14.96	15.12	23.24	20.57	20.68	17.79	18.73	18.24
Imperative	5.60	5.97	6.73	7.71	9.24	7.76	9.72	11.24
Exclamation	14.65	10.70	5.59	6.06	7.84	7.92	8.84	7.34
With English	0.03	0.05	0.52	0.17	0.42	0.17	0.17	0.07

3.3. Sentence Structure

The distribution of sentence structures by gender across age groups is presented in Table 4. A two-way ANOVA (age-by-sex) was applied to the different sentence structures and yielded a significant effect for age in the subject-predicate, $F = 11.83$, $p < 0.001$, $\eta^2 = 0.16$, power = 1.00 at the 0.05 level (default level). A significant negative effect for age in single-word sentences was also found, $F = 11.19$, $p < 0.001$, $\eta^2 = 0.15$, power = 1.00 at the 0.05 level. A highly significant age effect was also found for compound sentences, $F = 15.04$, $p < 0.01$, $\eta^2 = 0.20$, and power = 1.00 at the 0.05 level. There was no significant effect for sex or age-by-sex interaction for any sentence structures. Post hoc Tukey HSD test revealed a significant difference for subject-predicates at age 2.5 and age 4.5, $Q = 5.23$, $p < 0.001$; at age 2.5 and age 5.5, $Q = 4.73$, $p < 0.001$; at age 3.5 and age 4.5, $Q = 3.10$, $p < 0.05$; and at age 3.5 and age 5.5, $Q = 2.60$, $p < 0.05$. There was also a significant difference for single-word sentences at age 2.5 and age 4.5, $Q = 4.57$, $p < 0.001$; at age 2.5 and age 5.5, $Q = 4.89$, $p < 0.001$; at age 3.5 and age 4.5, $Q = 2.98$, $p < 0.05$; and at age 3.5 and age 5.5, $Q = 3.30$, $p < 0.01$. A significant difference was also found for compound sentences at age 2.5 and age 4.5, $Q = 3.56$, $p < 0.01$; at age 2.5 and age 5.5, $Q = 6.34$, $p < 0.001$; at age 3.5 and age 5.5, $Q = 4.81$, $p < 0.001$; and at age 4.5 and age 5.5, $Q = 2.79$, $p < 0.05$.

Table 4. Sentence structures by age and gender groups (%).

	2.5 Years		**3.5 Years**		**4.5 Years**		**5.5 Years**	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Subjectless sentence	26.47	23.28	25.42	24.40	25.34	23.60	24.72	25.80
Subject-predicate	33.68	30.80	39.77	38.12	47.65	49.76	47.86	46.40
Single word sentence	39.10	41.08	32.27	36.48	24.02	23.30	21.85	23.21
Compound sentence	0.75	0.67	2.53	1.00	2.99	3.34	5.57	4.60

3.4. The Use of Modifiers

The percentages of different modifiers used in their declaratives were considered to analyze the syntactic complexity of the utterances produced by the four age groups. The result is shown in Table 5. The four age groups produced a decreasing percentage of sentences without modifiers from 3.5 years onwards. However, there was an increase in utterances with simple modifiers from 2.5 years until 5.5 years. An increase in utterances with complex modifiers was also found, from 2.5 to 5.5 years. For utterances with subject-predicate as subject or object, there was also an increase from 3.5 years until 5.5 years. A two-way ANOVA (age-by-gender) was applied to the declaratives without modifiers, simple modifier, complex modifiers, and subject-predicate as subject or object. A significant negative effect of age for declaratives without modifier was found, $F = 2.93$, $p < 0.05$, $\eta^2 = 0.046$, power = 0.69 at the 0.05 level (default level). A significant effect of age for declaratives with complex modifiers was also found, $F = 10.32$, $p < 0.001$, $\eta^2 = 0.14$, power = 1.00 at the 0.05 level. A highly significant age effect was also found for declaratives with subject-predicate as subject or object, $F = 7.50$, $p < 0.001$, $\eta^2 = 0.11$, power = 0.99 at the 0.05 level. There was no significant sex effect or age-by-sex interactions for any declaratives with different modifiers. Post hoc Tukey HSD test revealed a significant difference for the declaratives with complex modifiers at age 2. ages and age 4.5, $Q = 3.49$, $p < 0.01$; at age 2.5 and age 5.5, $Q = 5.06$, $p < 0.001$; and at age 3.5 and age 5.5, $Q = 3.87$, $p < 0.01$. There was also a significant difference for declaratives with subject-predicate as subject or object at age 2.5 and age 5.5, $Q = 3.78$, $p < 0.01$; at age 3.5 and age 5.5, $Q = 4.37$, $p < 0.001$; and at age 4.5 and age 5.5, $Q = 2.70$, $p < 0.05$.

Table 5. Sentence modifiers by age and gender.

	2.5 Years		3.5 Years		4.5 Years		5.5 Years	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Without modifier	75.47	73.76	73.03	76.51	67.45	70.84	65.26	66.08
With simple modifier	23.43	19.64	23.60	20.98	26.30	23.98	25.67	27.19
With complex modifier	0.93	2.01	3.11	2.39	5.90	4.56	8.15	5.70
With SP as subject or object	0.16	0.42	0.25	0.12	0.35	0.62	0.92	1.03

3.5. Verb Patterns

The distribution of verb patterns by gender across age groups is presented in percentages in Table 6. A two-way ANOVA (age-by-sex) was applied to the declaratives with different verb patterns and showed a significant negative effect of age for the declaratives without verbs, $F = 5.85$, $p < 0.01$, $\eta^2 = 0.087$, power = 0.95 at the 0.05 level (default level). A significant effect of age for the declaratives with intransitive verbs was also found, $F = 3.46$, $p < 0.05$, $\eta^2 = 0.053$, power = 0.77 at the 0.05 level. There was also a significant effect of age for the declaratives with transitive verbs, $F = 3.63$, $p < 0.05$, $\eta^2 = 0.056$, power = 0.79 at the 0.05 level. A highly significant age effect was found for declaratives with co-verbs, $F = 6.40$, $p < 0.001$, $\eta^2 = 0.95$, power = 0.97 at the 0.05 level. There was no significant sex effect or age-by-sex interactions for any of the verb patterns. Post hoc Tukey HSD test revealed a significant difference for declaratives without verbs at age 2.5 and age 5.5, $Q = 2.92$, $p < 0.05$; at age 3.5 and age 4.5, $Q = 2.70$, $p < 0.05$; and at age 3.5 and age 5.5, $Q = 3.74$, $p < 0.001$. There was also a significant difference for declaratives with intransitive verbs at ages 3.5 and 5.5, $Q = 3.20$, $p < 0.01$. Declaratives with transitive verbs also showed a significant difference at ages 3.5 and 5.5, $Q = 3.87$, $p < 0.05$. A significant difference was also found for declaratives with co-verbs at ages 2.5 and 4.5, $Q = 3.93$, $p < 0.01$, and at ages 2.5 and 5.5, $Q = 3.37$, $p < 0.01$.

Table 6. Verb patterns by age and gender.

	2.5 Years		3.5 Years		4.5 Years		5.5 Years	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Without verb	41.94	44.24	44.32	47.64	37.36	35.43	31.10	34.37
Intransitive verb	22.98	19.93	18.26	18.56	22.89	21.51	25.90	24.63
Transitive verb	23.36	21.01	24.07	18.81	25.28	26.86	29.61	27.77
Co-verb	2.06	1.06	2.67	2.73	3.68	5.19	4.19	3.86
Copula verb	9.67	9.60	10.67	12.26	10.80	11.01	9.20	9.38

4. Discussion

This study is dedicated to duplicating the work of Tse et al. (2002) and verifying the sex differences in early syntactic development with the same corpus design but a different Chinese language: Mandarin. However, significant effects were found for age but not for sex. This finding is inconsistent with that of Tse et al. (2002), providing empirical evidence for the assumption (Etchell et al. 2018) that the so-called 'sex differences in language development' should be more accurately characterized as a difference in syntactic development between the sexes. This section discusses these findings and their educational implications.

4.1. Age Differences in Syntactic Development

First, this study has verified the significant age effect in MLU found in other studies, including the pioneer study of Yang and Zhang (1974) on Mandarin-speaking children in Taiwan. Additionally, there have been consistent results on the statistically significant effect of age on the length of sentences in Cantonese and Mandarin (Li 1980; Kwong 1990; Tse et al. 2002; Zhang et al. 2008). All these studies jointly indicated that young

children's MLU increased as their age increased. In particular, this study found significant differences between children of 2.5 years and 3.5 years and between 3.5 years and 4.5 years and nonsignificant differences between 4.5 years and 5.5 years. In the previous study on Cantonese-speaking children, Tse et al. (2002) found that a very distinctive growth in syntactic development would occur in children around the age of 4, and this growth would slow down from 4 to 5 years. The two studies shared the same corpus design. Still, they found different developmental patterns: Mandarin-speaking children had significant age differences from 2.5 to 4.5 years, whereas Cantonese-speaking children had significant age differences around 4.0 years. This indicates that Cantonese-speaking Hong Kong children might have different patterns or rates of syntactic development from Mandarin-speaking Beijing children. This assumption, however, needs further verification from longitudinal and crosslinguistic studies between Beijing and Hong Kong.

Second, this study also found significant age differences in interrogatives, imperatives, and exclamations. This finding is generally consistent with Tse et al. (2002), who found a significant age effect in early child Cantonese interrogatives. In other words, the two studies yielded similar results in terms of age development. However, there was a drastic increase in the use of interrogatives between 2.5 years and 3.5 years, from 15.04% to 21.91%, and the differences between these two age groups were shown to be statistically significant in this study. This seemed to be an earlier increase in the use of interrogatives than the findings in Tse et al. (2002), which was around 4 years old. Again, this finding indicates that Mandarin-speaking Beijing children might be relatively earlier in syntactic development than Cantonese-speaking Hong Kong children.

Third, this study found significant age differences in sentence structure: single-word sentences decreased over age, whereas subject-predicate and compound sentences increased significantly. This showed that as children aged, they added more grammar elements in their sentences and thus made their sentences longer, which was reflected in their differences in MLU. This finding was in line with the previous studies on Cantonese-speaking preschool children in Hong Kong by Kwong (1990) and Tse et al. (2002). Kwong (1990) showed that the age effect on MLU was not due to the increase in word particles in sentences but was caused by an increase in different types of grammatical forms, while Tse et al. (2002) demonstrated significant effects of compound sentences on MLU when children compound two or even more simple sentences together in their utterances. When these children increased in age, they produced utterances with more types of grammatical forms, which caused an increase in MLU.

Fourth, this study also found that modifiers increased over age; older children produced fewer declaratives without modifiers but more declaratives with simple modifiers, with complex modifiers, and declaratives with subject-predicate as subject or object. This age effect was significant for declaratives without modifiers, complex modifiers, and subject-predicate as subject or object. Children want to communicate more complex ideas to others with increased cognitive ability. Therefore, it would be important for children to learn to use modifiers in their sentences to add more details and meaning to their speech. This usage of more complex modifiers contributed to the lengthening of sentences and was reflected in the increase in MLU.

Last, this study revealed a statistically significant age effect in declaratives without verbs and declaratives with transitive verbs, intransitive verbs, and co-verbs. In their early years, children usually focused on uttering nouns that were names of the things they saw. As children matured, they could describe actions and talk about the state of the subjects of sentences and what they were doing. Using these different types of verbs added to the complexity of sentences, and sentences lengthened as children increased in age. Tse et al. (2002) demonstrated that the use of co-verb significantly contributed to the variation of MLU. When children used co-verb in their sentences, the co-verb acted as a prepositional-like verb to take or complement an object and formed a phrase in sequence with another verb phrase to refer to the same action. In this way, there was more description of the subject's action, enriching the content and thus the syntactic complexity of sentences. In this

study, the age effect on co-verbs displayed a sudden increase in the age group of 3.5 years to 4.5 years, increasing sharply from 2.70% to 4.43%. This finding was in line with the notion of distinctive syntactic complexity around the age of 4 in the study of Tse et al. (2002).

4.2. Sex Differences in Syntactic Development

This study found neither sex nor age-by-sex effects in syntactic development, providing empirical evidence to reject the widely accepted belief that girls outperform boys in their language development. The large-scale studies on Mandarin-speaking preschoolers in Taiwan (Yang and Zhang 1974) and Cantonese-speaking preschoolers in Hong Kong (Tse et al. 2002; Li et al. 2013) reported a similar result that girls outperformed boys in the length of sentences during the preschool years. However, this study generated contradictory findings: no statistically significant sex difference was found in any syntactic features. Furthermore, after controlling for the partner's sex effect, this study found no significant sex difference in MLU in the subsample. This finding is consistent with the Peabody Picture Vocabulary Test (PPVT; Dunn and Dunn 2007) and the Expressive Vocabulary Test (EVT; Williams 1997), which reported no significant sex differences in language performance.

In a systematic review, Etchell et al. (2018) suggested two possible causes of the sex differences in language performance: (1) age might interact with sex difference, as the latter might reflect the different rates of maturation between the sexes; (2) task might also interact with sex difference, as its nature (i.e., perception, production, or judgments) and complexity (i.e., syllables, single words, or entire sentences) will cause different responses from boys and girls. However, this study did not find any age-by-sex differences; thus can rule out the first influential factor: age. In addition, this study followed the same communication task and corpus design (Tse et al. 2002), thus ruling out the second influential factor: task. Therefore, this study's no sex difference finding, in conjunction with the significant difference in Tse et al. (2002), indicated that the sex differences in syntactic development might not necessarily be universal or cross-language. Instead, it might reflect different developmental rates in language between the sexes in different samples. In this study, the Beijing preschoolers showed no significant sex differences in syntactic development, indicating that boys and girls might share the same developmental rates. In contrast, the Hong Kong preschoolers in Tse et al. (2002) demonstrated significant sex differences in syntactic development, demonstrating different developmental rates. Sociocontextual differences or Cantonese-Mandarin differences might cause these differences between Beijing and Hong Kong preschoolers. Therefore, further studies are needed to confirm the real cause.

4.3. Conclusions, Limitations, and Implications

In summary, this corpus-based study has provided evidence for the existence of age differences in syntactic development among Mandarin-speaking preschoolers. MLU and syntactic complexity increased with age, and there was a distinctive growth spurt around age 4. After that, the increase in MLU and syntactic complexity slowly leveled off. However, no significant sex differences were found, and boys demonstrated a slightly higher overall MLU than girls. Therefore, it would be worthwhile to look into the influence of parental and educational factors on language development and whether boys receive more resources from parents than girls in Beijing, the capital city of China, in line with the common belief in the Chinese culture that boys are of more value, causing home language environment that favors boys, or whether the single child policy that was implemented in China between 1980 and 2016 allowed parents to focus their provision of resources to their single child that promotes their syntactic development.

This study has some limitations. First, the communication task of the corpus was a 30-minute free-play session, in which dyad children were accompanied only by toys and a peer. Thus, they might not have produced as many sentences, as they participate in activities more inducive to language production, such as classroom discussion and story-telling. Second, the cross-sectional nature of this corpus has limited us from making

consolidated conclusions about the developmental patterns in early childhood Mandarin. Future studies may consider adopting a longitudinal design to understand how children acquire syntax and what developmental characteristics they demonstrate.

Nevertheless, this study has challenged the widely accepted view of girl's superiority in early language development and has raised some questions about early child syntactic development in the Chinese context. Future research is needed to corroborate these findings with larger and more representative samples in other Chinese cities of different backgrounds. Furthermore, further research should investigate the influence of socio-environmental factors on children's language development in the Chinese context. In addition, this study's finding has provided educators with insights when making curriculum plans. In particular, age-appropriate curricula should be designed to provide necessary language input to facilitate young children's syntactic development.

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Appendix A

Table A1. The Framework of Syntactic Analysis proposed by Tse and Li (2011).

Variable	Attribute
Length of utterances	— Number of utterances — MLU
Sentence types	— Declarative sentence — Interrogative sentence — Exclamation sentence — Negation sentence — Imperative sentence — Incomplete sentence — English and other words
Structures of declaratives	— Single-word sentence — Simple declarative — Subjectless sentence — Subject-predicate sentence — Compound sentence
Syntactic complexity of simple declaratives	— Without modifier — With simple modifier — With complex modifier — With subject-predicate (SP) as subject or object

Table A1. *Cont.*

Variable	Attribute
Verb patterns in declaratives	— With intransitive verb — With transitive verb — With co-verbs or verbs in serial expression modifier — Link verb — Without verb

Reference: Tse and Li (2011). Early child Cantonese: facts and implications (Vol. 42). Walter de Gruyter.

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