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Chinese Grammatical Development of Deaf and Hard of Hearing Children in a Sign Bilingualism and Coenrollment Program

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The literacy development of d/Deaf and hard of hearing (d/Dhh) children has always been a matter of grave concern among educators, and grammatical knowledge is said to constitute a major component such development. The present article reports on a study that examined the development of Chinese grammar among groups of d/Dhh and hearing children who received education through a sign bilingualism and coenrollment (SLCO) approach. Findings from administration of a prestandardized assessment tool showed that while the d/Dhh children generally lagged behind their hearing peers at all levels, the gap began to narrow from Primary 2 onward, and they caught up with their hearing peers in most except for a few grammatical constructions by Primary 4. Qualitative analysis revealed a similar developmental profile and similar degrees of difficulty in mastering the more complex constructions in written Chinese between the two groups of children.

Keywords: sign bilingualism and coenrollment, deaf education, literacy, grammatical development, written Chinese

In recent years, advances in hearing assistive technology, especially cochlear implantation, have resulted in improvement in many d/Deaf and hard of hearing (d/Dhh) children's speech perception abilities. However, results related to their literacy and academic development are less consistent, and such a development is characterized by high individual variation (Harris, 2016). For instance, Dillon and Pisoni (2006) and Sarant et al. (2015) found the reading scores of a considerable percentage of elementary school children with cochlear implants (CIs) to be within the average range of test norms, implying that early intervention and cochlear implantation could potentially lead to d/Dhh children's development of age-appropriate reading skills. On the other hand, Qi and Mitchell (2012) observed that a gap still existed in implanted children's academic achievement compared to that of their hearing peers. Another study, by Tomblin et al. (2018), found that hearing level predicted reading achievement. Children with mild and moderate hearing loss progressed in reading from ages 5 to 8 years, similarly to their hearing controls. However, children with severe hearing

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loss were reported to lag significantly behind the hearing controls in reading at age 8.

Among the components crucial for literacy development, research generally centers on d/Dhh children's phonological and orthographic awareness, vocabulary knowledge, and reading skills (see Mayberry et al., 2011, for a meta-analysis of studies of d/Dhh children's reading achievement). On the other hand, only a few studies have focused on examining d/Dhh children's grammatical knowledge, commonly perceived as the "building blocks" of sentences in production and comprehension. Antia et al. (2020) looked at the language and reading progress of a group of d/Dhh children from kindergarten to grade 2 in primary education. These children all showed a delay in language and reading relative to the norms established for hearing children. Particularly in language, the d/Dhh children found English syntax more challenging than vocabulary. The findings summarized above suggest a complex language learning situation for d/Dhh children. Notwithstanding early prescription of hearing aids or CIs and early speech training, they face the challenge of developing the necessary literacy skills to read printed texts and thereby gain access to curriculum content. In the literature, adequate reading comprehension and writing in a spoken language requires not only knowledge of vocabulary but also syntactic or morphosyntactic knowledge for combining morphemes into grammatical constituents to form simple or complex sentences.

Hong Kong presents a unique situation that poses a significant challenge to d/Dhh children. From birth, their home language is oral Cantonese, the target language for speech training. However, when they enter primary education, they are expected to learn written Chinese, which is not based on the grammar of Cantonese but on that of Mandarin Chinese, for reading and writing development. In the present study, we aimed to uncover how Hong Kong d/Dhh children develop grammatical knowledge of written Chinese under these circumstances and to examine whether they could eventually catch up with their hearing peers in written Chinese development, given the fact that both groups of children begin receiving exposure to written Chinese at similar times in their education (i.e., upon entry into primary education). A corollary research question was whether d/Dhh children's exposure to Hong Kong Sign Language (HKSL) in a sign bilingualism and coenrollment (SLCO) learning environment affects their development of written Chinese.

In the following sections, we will first introduce some studies on the difficulties d/Dhh children often face when acquiring spoken language grammar and the impact of sign language exposure on their spoken language development. Second, we will provide a brief sketch of the language situation in Hong Kong and the unique language environment of the SLCO Program. As for language measurement, we will introduce the Chinese Grammatical Assessment (CGA), which we designed to measure the grammatical knowledge of written Chinese between the d/Dhh children and their hearing peers in this study. Next, we will summarize the findings, and in the last section, we will discuss whether previously acquired linguistic knowledge interacts with the children's development of written Chinese. We conclude the article with some implications of SLCO education for d/Dhh children's language development, some limitations of the study, and future research directions.

Language Development of d/Dhh Children

Grammatical Competence

Language competence is said to be modular, having its cognitive system constituted by knowledge of different domains of language associated with phonology, vocabulary, morphology, syntax, semantics, and pragmatics. Hearing children developing such knowledge domains in different spoken languages as their first language display a similar language acquisition process and achieve mastery without difficulty during the first few years of life. Children who are d/Dhh and who acquire sign language as their first language from birth with input from Deaf parents are observed to behave similarly to hearing children acquiring a spoken language (Guasti et al., 2014). Yet because of their hearing loss, d/Dhh children acquiring a spoken language may demonstrate different levels of attainment in those domains of linguistic knowledge (Mayberry et al., 2002). Investigating deaf children's theory of mind, Schick et al. (2007) observed that it was not general language knowledge per se but the combined effect of vocabulary knowledge and specific knowledge of sentential complements that predicted the children's development. Additionally, whereas deaf children of hearing parents showed a significant delay in developing theory of mind, deaf children of Deaf parents performed on par with age-matched hearing controls. Reviewing a set of studies on the development of grammatical competence by d/Dhh children who were implanted as early as before age 2, Duchesne (2016) found that although these children could acquire vocabulary knowledge at appropriate age norms, many of them still faced many difficulties in developing grammatical knowledge.

Acquiring morphosyntax poses a significant challenge to d/Dhh children. In English or Italian, many associated grammatical elements are unstressed, causing additional difficulty in speech perception (Antia et al., 2020; Guasti et al., 2014). Geers et al. (2009) found that only 33% and 40% of d/Dhh kindergarteners with CIs, respectively, scored within one standard deviation of hearing peers in the receptive and expressive morphosyntax assessment, a finding that suggested that many of them still showed a delay in such development. In another study, by Hay-McCutcheon et al. (2008), implanted children all scored below average in a test of English morphosyntax.

On the other hand, some studies have shown an effect of age of implantation on children's literacy development. In a study by López-Higes et al. (2015), d/Dhh children who had received CIs before age 2 demonstrated comparable performance to that of their hearing peers in reading comprehension of Spanish morphosyntax. Additionally, early-implanted children performed significantly better on verbal inflectional morphology than children who had received CIs later, at ages 2–5. Guasti et al. (2014) studied Italian-speaking children with CIs and found that phonology, lexicon, semantics, and pragmatics were not particularly vulnerable to acquisition difficulties. Instead, morphosyntax was found to be the most challenging for these children. The 33 implanted children in their study were 2 years behind their hearing peers in acquiring clitic pronouns, with a higher omission rate for third person. That inflectional morphology and other functional categories (e.g., relative pronouns and complementizers) pose difficulty for d/Dhh children may be due to the lack of phonetic salience with these categories because they are generally short and unstressed, despite already aided by hearing devices.

While the levels of attainment may differ between d/Dhh children and their hearing peers, the studies cited above revealed similarities in the errors produced by both groups of children. For instance, both groups initially tended to omit the functional morphemes for agreement and tense. However, this stage of development was prolonged for d/Dhh children only. From a language acquisition viewpoint, de Villiers et al. (1994) questioned the nature of spoken language input that oral d/Dhh children acquiring English were exposed to. According to de Villiers et al., the input might be too "impoverished" for oral d/Dhh children to identify "linguistic triggers" for acquiring certain syntactic structures; consequently, these children experience a delay and miss the critical period of language acquisition. The studies cited above converge on d/Dhh children's difficulty acquiring spoken language morphosyntax despite early intervention. These findings about their grammatical development indirectly explain why they lag behind their hearing peers in literacy development and academic achievement.

Communication Mode and Language Outcomes

To date, much research has focused on implanted d/Dhh children's oral language outcomes, especially their speech perception and production. Nevertheless, some researchers have examined whether adding sign language to d/Dhh children's linguistic repertoire positively affects their acquisition of spoken language; however, the results have been inconclusive.

An early study by Connor et al. (2000) examined the expressive and receptive vocabulary of d/Dhh children with CIs. Half adopted spoken and signed communication, while the other half only communicated via spoken language. Compared with hearing norms, both groups were delayed for about 3 years at a mean age of 7, and signed language knowledge did not appear to improve their performance. Harris et al. (2017) found that children who communicated via spoken language attained higher vocabulary scores than those who communicated via signed language, although both groups lagged behind their hearing peers.

More recently, Antia et al. (2020) reported some positive gains in English vocabulary and syntax among d/Dhh children who were educated in a bimodal bilingual program. Antia et al. measured the language of three groups of young d/Dhh children controlled for their auditory access and classroom communication: a spoken-only group, who had auditory access to and acquired spoken language only; a signed-only group, who were unimodal visual learners and acquired signed language only; and a bimodal bilingual group, who had auditory access to spoken language and visual access to signed language and acquired both languages. The test battery included vocabulary (i.e., children were asked to name pictures in either spoken or signed words), receptive and expressive English syntax, receptive American Sign Language syntax, and reading. The results showed that all three groups scored below the published hearing norms in the spoken language measures, especially reading comprehension. However, they showed significant gains in vocabulary, receptive English syntax and fingerspelling phonological awareness over time. In addition, the spoken-only and the bimodal bilingual d/Dhh groups had higher English syntax scores than the signed-only group. Another finding was that the signed-only and the bimodal bilingual groups also demonstrated significant gains in receptive American Sign Language syntax.

According to the researchers, accessibility to language input through the auditory or the visual modality facilitated the children's development of the respective languages. Nevertheless, in a systematic review of the literature, Fitzpatrick et al. (2016) concluded that there was insufficient evidence to determine whether the use of signed language potentially facilitates spoken language acquisition. Additionally, no evidence suggested that adding a sign language to d/Dhh children's linguistic repertoire would impede their spoken language development.

In sum, early diagnosis of hearing loss, early intervention, and improved hearing technology have bolstered d/Dhh children's speech perception and articulation skills. However, reports on gains in reading and writing are less consistent, and the development of literacy skills remains a significant challenge for many d/Dhh children, especially those with severe and profound hearing loss.

d/Dhh Children's Grammatical Development in Written Chinese

Although many studies have highlighted that phonological awareness is of primary importance to reading comprehension in English, other studies, especially those involving Mandarin Chinese, a nonalphabetic language, found morphological and syntactic knowledge to contribute significantly to reading comprehension (Chan & Yang, 2018; Ching & Nunes, 2015). Zhao et al. (2020) investigated the effect of sentence-level comprehension (e.g., comprehending simple subject-verb-object [SVO] structures, pivotal sentences, and some complex sentences) and sentence fluency (i.e., determining within 3 minutes if the sentences are correct or not) on the reading comprehension of a group of d/Dhh children enrolled in grades 3–6 in deaf schools in Mainland China. Regression analysis showed that sentence-level comprehension alone did not significantly predict d/Dhh children's passage comprehension in grades 3 and 4. On the other hand, the combined effect of sentence-level comprehension and sentence fluency significantly predicted passage comprehension in grades 5 and 6. In other words, only those d/Dhh students in higher grades, but not those in lower grades, could construct a meaningful representation of syntactic and semantic knowledge of written Chinese to support their reading comprehension.

Other studies have analyzed d/Dhh students' lexical and grammatical errors in written Chinese using writing samples and data from sentence construction. They reported errors in word formation (Liang & Liu, 2008), misuse of adjectives (Liang & Wang, 2007), misuse of directional verb compounds (Chen et al., 2016), and syntactic errors in simple and complex sentences (Wang et al., 2018). Li (2015) focused on a specific grammatical structure that is said to pose difficulty for d/Dhh children—*passives* in Mandarin Chinese (i.e., the object becomes the syntactic subject, and the subject is demoted to the object position in the order of $NP_{[patient]}$-*bei*-$NP_{[agent]}$-VP, with *bei* being analyzed as a passive marker). Using a series of elicitation procedures, Li examined the production and comprehension of *passives* in Mandarin Chinese by deaf students ages 14–24 years who studied in schools and colleges for the deaf in Mainland China. Results revealed that about half of these deaf students failed to comprehend *passives* like the order above. For some deaf students, even if they had mastered the syntactic word order of *passives*, they were still not sensitive to the telic event constraint of the embedded verb phrase and the transitive requirement of the verb.

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In the Hong Kong context, there have also been a few studies on d/Dhh children's acquisition of specific Chinese grammatical structures in either oral Cantonese or written Chinese, such as *passives* in oral Cantonese (Yiu, 2012), *nominal expressions* in written Chinese (Hu & Tang, 2014), and *relative clauses* in oral Cantonese (Lam, 2015, 2017). Yiu (2012) focused on oral d/Dhh children's acquisition of the *passive marker* "*bei2*" in oral Cantonese. He observed a similar acquisition process with the d/Dhh children in his study when comparing them with hearing peers, initially assuming the grammatical subject in *passives* to be the agent of the event. Hu and Tang (2014) collected a sample of narratives in written Chinese produced by a group of SLCO d/Dhh children from Primary 2 to 5 and examined their performance on nominal expressions. Since subject bare nouns for definite referents are allowed in written Chinese but not in oral Cantonese, one research question was whether these children could differentiate this property of nominal expressions between these two languages. The written data revealed a prevalent use of bare nouns in written Chinese either for definite or indefinite referents, the latter disallowed in both oral Cantonese and written Chinese but permitted in HKSL. This finding offered some preliminary evidence that crosslinguistic interaction was at work. In another study, Lam (2017) reported SLCO d/Dhh children's comprehension and production of *relative clauses* in written Chinese. She found that these children lagged behind the hearing controls in producing relatives. However, d/Dhh children with high Chinese proficiency could perform at a level similar to that of the hearing controls. When analyzing their errors, Lam pointed out that the d/Dhh children's developmental profile did not deviate from that of their hearing peers, although they experienced difficulty in producing *relative clauses*. In sum, the grammatical difficulties faced by d/Dhh children in the Hong Kong context corroborated the findings in the earlier language acquisition studies and those that attempted to measure d/Dhh children's knowledge of English grammar (Cannon et al., 2020; Cannon & Kirby, 2013).

The Present Study

Goal of the Study

In the present study, we aimed to examine how and to what extent d/Dhh children receiving education in a mainstream school in Hong Kong that adopted the SLCO approach mastered a representative set of syntactic and morphosyntactic structures in written Chinese as used in Hong Kong. We assumed that such knowledge of written Chinese constitutes an essential component of their literacy development. Additionally, we wanted to verify if the d/Dhh children could perform on par with their hearing peers in grammatical assessment since they were studying together in the same SLCO classroom.

Language Situation and SLCO Education in Hong Kong

The sociolinguistic situation in Hong Kong has led to a complex phenomenon of language use in society. According to the Hong Kong government's 2016 population by-census (Government of Hong Kong, 2018), Cantonese, a dialect of Chinese, was spoken by about 88.9% of the population. Chinese printed texts adopt Cantonese pronunciation and traditional characters. Complications arise when the written texts appearing in textbooks, newspapers, public documents, etc., do not necessarily follow the grammar of oral Cantonese but Mandarin Chinese, which is a variety of

Chinese used in Mainland China. This creates a "discontinuity" from oracy to literacy development among Cantonese-speaking children and adversely affects the d/Dhh children's development of reading and writing skills for education.

Hong Kong practices universal neonatal screening and early identification. Children who are d/Dhh are prescribed hearing aids or CIs and receive speech training in oral Cantonese, with a wait time of about 6–9 months after diagnosis. When they reach the age of 4 or 5 years, they are taught how to read written Chinese words and later sentences using Cantonese pronunciation during preschool education. Therefore, it is highly probable that they assume that Chinese texts in print follow the grammar of oral Cantonese. Intensive literacy training begins when children enter primary education at around age 6. Under normal circumstances, one would expect them to rely primarily on their relatively stable knowledge of oral Cantonese to acquire written Chinese grammar. However, in the case of d/Dhh children in Hong Kong, the commonly reported individual variation in oral Cantonese development in preschool education only implies that they are still at different stages of oral Cantonese development. In other words, this transition from oracy to literacy upon entering primary education poses a significant challenge to d/Dhh children as they are expected to cope with developing oral and literacy skills grounded in two linguistic systems that are still in flux. Currently, English and Chinese are taught as school subjects. Although the government promotes using Putonghua to teach Chinese as a subject, oral Cantonese remains the primary medium of instruction for all other school subjects and a language for daily communication at school and in society.

In educating d/Dhh students, the government adopts an inclusive and oralist approach in mainstream school settings. Between 2003 and 2006, attempts to set up a sign bilingual program at the only deaf school in Hong Kong failed. To sustain the use of HKSL to support d/Dhh children's education, the SLCO Program was organized in a mainstream school in 2006. To date, SLCO education has been firmly anchored in a kindergarten, a primary school, and a secondary school, all of which encourage d/Dhh children to study with hearing children in the SLCO class. This model has also been extended to some nurseries and childcare centers for typically developing children. Except for the nursery and childcare centers, about five or six d/Dhh children are admitted to year 1 of the SLCO kindergarten each year. These children will stay within the SLCO system as long as possible until they graduate from secondary education. The whole school approach to SLCO education allows Deaf teachers and hearing teachers to coplan, coteach lessons and comanage hearing and d/Dhh children in the classroom. Outside the classroom, these teachers co-organize support for extracurricular activities to ensure the full participation of d/Dhh students in school activities. In the school environment, daily communication, from school assemblies and announcements to peer interactions in the classroom, involves HKSL and Cantonese. Over time there emerges a community of bimodal bilingual users comprising both teachers and students, deaf and hearing.

Methodology

Chinese Grammatical Assessment: Materials and Procedures

Clinical efforts in Hong Kong generally involve early identification and

intervention targeting oral Cantonese skills. There are tools for assessing children's oral Cantonese. For instance, the Hong Kong Test of Preschool Oral Language was developed for preschool children between the ages of 2 years 6 months and 5 years 11 months (Wong et al., 2019). Another tool targeting primary school children, the Hong Kong Cantonese Oral Language Assessment Scale, was designed to profile the overall Cantonese ability, receptive and expressive, of children with different etiologies, including children with hearing loss (T'sou et al., 2006). There are no objective tools for measuring or profiling children's grammatical knowledge of written Chinese, which largely reflects the grammar of Mandarin Chinese. The present study aimed to fill this gap. To address this need, we developed an online assessment platform—the Chinese Grammatical Assessment (CGA)—to measure primary school children's written Chinese grammar. The tool consists of 12 typical syntactic and morphosyntactic structures of Mandarin Chinese, with a total of 75 items, such as the *grammatical aspect morphemes 在[zoi6]* as a "*progressive aspect marker*" and *了[liu5]* as a "*perfective aspect marker*," the *morphosyntactic marker 把[baa2]* for causatives (i.e., $NP_{[agent]}$-*baa2*-$NP_{[patient]}$-VP) and *被[bei1]* for passives ($NP_{[patient]}$-*bei1*-$NP_{[agent]}$-VP), *relative clause*, *negation*, *question*, and so forth. Depending on the specific syntactic/morphosyntactic properties of the grammatical structures being assessed, three tasks were designed: picture-sentence matching (PSM), picture selection (PS), and word ordering (WO).

In the PSM task, participants judged if the meaning of the sentence they read matched the picture on a drawing board (see Figure 1). Table 1 summarizes the categories of grammatical structures covered in the PSM task.

Figure 1. Example of the Picture-Sentence Matching Task

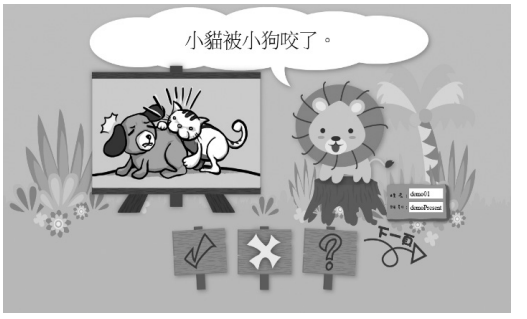


Table 1. Grammatical Structures in the Picture-Sentence Matching Task

Grammatical structure	Example	Grammatical knowledge
Aspect	男孩 在 喝 牛奶. *Boy ASP drink milk* "The boy is drinking milk."	Interpretation of the progressive aspect marker 在[zoi6] and the perfective aspect marker 了[liu5]
BAA-constructions	男孩 把 門 推開 了. *Boy BAA door open ASP* "The boy opened the door."	Differentiation of the NP's thematic role in *baa2*-constructions, [$NP_{[agent]}$-*baa2*-$NP_{[patient]}$-VP]
Passives	門 被 男孩 推開 了. *Door BEI boy open ASP* "The door was opened by the boy."	Differentiation of the NP's thematic role in passives, [$NP_{[patient]}$-bei1-$NP_{[agent]}$-VP]
Quantification	所有 學生 都 回家 了. *All student DOU go-home ASP* "All students went home."	Interpretation of universal quantifiers 所有 [so2jau5] "all" and 每[mui5] "every"

Notes. PSM = picture-sentence matching task. NP = noun phrase. VP = verb phrase. ASP=aspect.

Take Chinese *passives* with the morphosyntactic marker 被[bei1] as an example. Cannon and Kirby (2013) reported that d/Dhh students relied heavily on the canonical $S_{[agent]}$-V-$O_{[patient]}$ word order as a strategy for their interpretation of noun-verb-noun (NVN) strings in English, thus interpreting the first noun consistently as an agent, not a patient in the event. Consequentially, the students failed to correctly interpret an NVN sequence that did not canonically map onto this SVO order. Similarly, with a passive sentence like example 1 below, in which the word order is $NP_{[patient]}$-*bei1*-$NP_{[agent]}$-VP, if d/Dhh children adhered strictly to the canonical SVO word order strategy, they would misinterpret the passive sentence as an active sentence by assigning an agent interpretation to the first NP, "cat". In written Chinese grammar, a transitive-causative sentence requires the use of the morphosyntactic marker 把[baa2] in the word order $NP_{[agent]}$-*baa2*-$NP_{[patient]}$-VP, as shown in example 2:

(1) 小貓 被 小狗 咬 了 (passive)
cat *BEI* *dog* *bite* *ASP*
Meaning: The cat was bitten by the dog.

(2) 小貓 把 小狗 咬 了
(*ba*-construction)
cat *BAA* *dog* *bite* *ASP*
Meaning: The cat bites the dog.

In the PS task, participants chose one out of three pictures that matched the meaning of the target sentence. They could select the picture containing a question mark if unsure about the answer (see Figure 2).

Figure 2. Example of the Picture Selection Task



The pictures for the distractors correspond to the common errors reported in previous language acquisition studies. Take Chinese *relative clauses* (RCs) as an example. Example 3 below is a *subject-gap RC* in which the embedded clause does not follow the canonical NVN strings. Again, if children relied on the canonical word order strategy, they would misinterpret the subject gap of the embedded clause and take the first NP (i.e., "dog") in example 3 to be the agent that "pulls the goat". Table 2 summarizes the grammatical structures covered in the PS task.

(3) 拉 著 小狗 的 小羊
pull ASP dog DIK goat
在 刷牙 (subject-gap RC)
ASP brush teeth
Meaning: The goat that is pulling the dog is brushing its teeth.

The WO task investigated children's knowledge of syntactic word order of a set of typical grammatical structures in written Chinese. These structures show differences in word order syntax between written Chinese, oral Cantonese and HKSL. As shown in example 4, *negator* 不 in 不看 "not read", is preverbal in written

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Table 2. Grammatical Structures in the Picture Selection Task

Grammatical structure	Example	Grammatical knowledge
Comparatives	男孩 比 女孩 高. *Boy compare girl tall* "The boy is taller than the girl."	Interpretation of comparative sentences having a morphosyntactic marker 比[bei2] "compare"
Reflexive and pronoun	男孩 的 爸爸 幫 自己 洗澡. *Boy DIK father help self wash* "The boy's father is washing himself."	Identification for the antecedent of reflexive 自己[zi6gei2] "self" and pronoun 他[taa1] "him"
Relative clauses	男孩 抱 著 的 小貓 在 睡覺. *Boy hold ASP DIK cat ASP sleep* "The cat that the boy holds is sleeping."	Interpretation of subject relatives (SS) and object relatives (SO)

Notes. SS = subject-gap relative clauses. SO = object-gap relative clauses. ASP = aspect.

Chinese (see example 4), which is the same as oral Cantonese (e.g., *唔*食 "*not* eat"); however, the *negator NOT* is clause-final in HKSL (see example 5):

(4) 哥哥 不 看 書
(written Chinese negative sentence)
Elder-brother not read book
Meaning: Elder brother doesn't read books.

(5) ELDER^BROTHER READ^BOOK NOT (HKSL negative sentence)
Meaning: Elder brother doesn't read books.

In the WO task, participants were instructed to arrange several individual Chinese words or chunks of Chinese words to form a sentence that matched the picture on the screen (see Figure 3). We used this task to examine whether the d/Dhh children could master crucial syntactic word orders in written Chinese and whether crosslinguistic interaction existed between HKSL, oral Cantonese and written Chinese. Table 3 summarizes the grammatical structures covered in the WO task.

Figure 3. Interface for the Word Ordering Task



In the present study, the assessment was incorporated into an online platform and required two sessions of 20 minutes each to complete all tasks. Two researchers and one school teacher administered the sessions with children from Primary 1 to Primary 4. Before the assessment, the d/Dhh and the hearing children had to complete an independent vocabulary comprehension test to indicate if they understood the meaning of the vocabulary adopted in the test items. We also provided instructions in both HKSL and oral Cantonese. There were a few trials before the assessment to familiarize the children with the test procedures and task requirements. All test items, randomized within each task, were

Table 3. Grammatical Structures in the Word Ordering Task

Grammatical structure	Example	Grammatical knowledge
Double object constructions	老師 給 男孩 一 本 書. *Teacher give boy one CL book* "The teacher gave a book to the boy."	Word order of direct object (DO) and indirect object (IDO) in double object constructions: NP-$V_{[ditransitive]}$-$NP_{[DO]}$-$NP_{[IDO]}$
Locative constructions	牆 上 掛 著 一 幅 畫. *Wall on hang ASP one CL picture* "There is a picture hanging on the wall."	Word order of locative constructions: Loc NP-V-$NP_{[theme]}$
Modals	男孩 會 說 英文. *Boy can speak English* "The boy can speak English."	Word order of preverbal modals (e.g., 會[wui2] "can"): NP-modal-V-NP
Negation	男孩 不 去 學校. *Boy not go school* "The boy won't go to school."	Word order of the preverbal negator 不[bat1] "not,": NP-negator-VP
Questions	男孩 在 哪裡 打 籃球? *Boy PREP where play basketball* "Where does the boy play basketball?"	Word order of in situ wh- questions and A-not-A questions

Notes. NP = noun phrase. V = verb. VP = verb phrase. PREP = preposition. CL = classifier.

presented in written Chinese, and the children read them quietly before offering a response. As a general working principle, data from children with a vocabulary test score lower than 70% would be discarded. In total, data from 2 d/Dhh and 15 hearing children upon entry into primary education (i.e., P0), 3 hearing children in P2, and 1 hearing child in P3 were discarded from the analysis.

Participants

The d/Dhh children covered in the present study had to meet four criteria:

- They had at least 1 year of intensive exposure to HKSL at the SLCO kindergarten and some written Chinese before entering primary education.
- They had severe to profound hearing loss (i.e., average loss at 500Hz, 1K Hz, and 2K Hz in their better ear higher than 70dB).
- They had no other reported disabilities.
- They passed the vocabulary pretest.

Twenty-nine d/Dhh children were included in the present study: 19 girls and 10 boys. One child had an auditory brainstem implant, 20 had a CI, and 8 wore hearing aids (HAs). Among these d/Dhh children, 5 were born to deaf parents (DD), and 1 of the DD children had a mother who was a user of Chinese Sign Language (i.e., C4-1, see Table 2). The rest were born of hearing parents (DH) who generally spoke Cantonese at home. This study combined DD and DH children into one group of d/Dhh children since there were very few DD children. Moreover, since they were distributed over different levels, it offered little basis to compare their performance reliably with that of the DH children. Table 4 summarizes the relevant background attributes of all 29 d/Dhh children in the study.

Table 4. Backgrounds and Frequency of Participation of all 29 d/Dhh Children

	Level									
Subject ID	**P0**	**P1**	**P2**	**P3**	**P4**	**Gender**	**Age at primary school admission (yrs.mos)**	**HL (dB)**	**Hearing device**	**Child and parent status**
C1-1					√	F	5.9	88	CI	DH
C1-2					√	F	8.2	118	CI	DH
C1-3					√	M	7.9	105	CI	DH
C1-4					√	M	7.1	93	HA	DD
C1-5					√	M	8.7	108	CI	DH
C2-1				√	√	M	6.1	108	CI	DH
C2-2				√	√	F	6.6	72	HA	DD
C2-3				√	√	M	8.2	107	HA	DH
C2-5				√	√	M	7.8	87	HA	DH
C2-6				√	√	F	7.7	120	HA	DH
C3-1			√	√	√	F	6.5	93	HA	DH
C3-2			√	√	√	F	6.9	113	CI	DH
C3-5		√	√	√	√	F	6.9	118	CI	DH
C3-6			√	√	√	F	6.2	108	CI	DH
C4-1	√	√	√	√	√	F	6.4	88	CI	DD
C4-2	√	√	√	√	√	F	7.2	120	CI	DH
C4-3	√	√	√	√	√	F	7.2	120	CI	DH
C4-4	√	√	√	√		F	7.8	80	CI	DH
C4-5	√	√	√	√	√	F	6.6	95	CI	DD
C4-6		√	√			F	6.5	106	CI	DH
C5-3	√	√	√	√	√	M	6.2	87	HA	DH
C5-4	√	√	√	√		F	6.9	117	CI	DH
C5-5	√	√				M	6.8	115	ABI	DH
C6-1	√					M	6.5	97	HA	DH
C6-2	√	√	√	√		F	8.9	110	CI	DH
C6-6		√	√			M	6.9	113	CI	DD
C7-4	√	√				F	7.3	98	CI	DH
C8-5	√					F	6.4	83	CI	DH
C9-8	√					F	6.7	102	CI	DH

Notes. d/Dhh = d/Deaf and hard of hearing. P0 = entry into primary education. P1 = end of Primary 1. P2 = end of Primary 2. P3 = end of Primary 3. P4 = end of Primary 4. HL = degree of hearing loss (dB). CI = cochlear implant. HA = hearing aids. ABI = auditory brainstem implant. DD = deaf child of deaf parents. DH = deaf child of hearing parents.

A total of 176 hearing children who were classmates of the d/Dhh children in the SLCO classes were recruited for the present study to serve as controls. They differed in hearing status but had been educated in the same SLCO environment as the d/Dhh children since the beginning of their primary education; hence, they shared a similar duration of written Chinese instruction. The performance of the hearing children provided a general reference for the examination of the d/Dhh children's development of grammatical knowledge at different levels. It should be noted that some d/Dhh children were 0.5 to 2.5 years older than their hearing peers when they were enrolled in the SLCO primary school. Another difference was the duration of HKSL input between the two groups of children. Unlike the d/Dhh children, who had previously received at least 1 year of daily HKSL input, the hearing children only began to learn HKSL when they entered the SLCO class of the primary school (i.e., P0). To gauge baseline performance, the CGA was administered to both the d/Dhh and the hearing children upon entry into the SLCO Program (i.e., P0). At this level, the CGA was administered to all children individually due to their young age and preschool experience, with assistance from a hearing teacher fluent in HKSL in case the child was deaf or hard of hearing. The CGA was administered again to the SLCO class of d/Dhh and hearing children in a computer room at the end of each school year from Primary 1 to Primary 4. Table 5 presents the accumulated numbers of d/Dhh and hearing children who studied together and participated in the assessment each year. It should be noted that there was a steady increase in the number of d/Dhh children who participated in the annual assessment over the years. There was some fluctuation in the number of hearing children due to the school's decision to provide SLCO experience for more hearing children, as pressure from parents to place their hearing child in the SLCO class had mounted since the launch of the program.

Results

Overall Performance

Results revealed that both the d/Dhh and hearing children developed knowledge of written Chinese grammar from P0 to P4 incrementally, as shown in Figure 4. Although the d/Dhh children were found to lag behind their hearing peers consistently across the 4 years of assessment, the gap narrowed as they moved to senior levels. At P4, although statistically the performance of the d/Dhh children was still significantly behind that of their hearing peers, $t(23.8) = -3.275$, $p = .003$, the overall accuracy scores of these two groups of children were quite close to each other (P4 d/Dhh children, $M = 84\%$, $SD = 8$; P4 hearing children, $M = 91\%$, $SD = 6$).

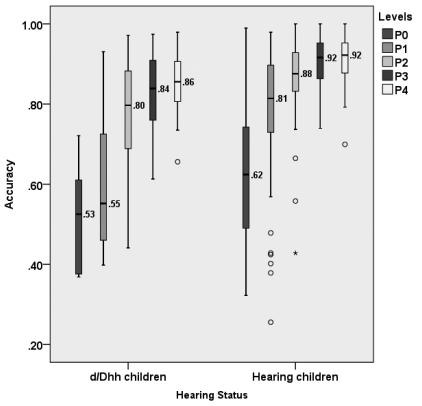
Table 5. Number of d/Dhh and Hearing Children by Level

	Level					
Participants	P0	P1	P2	P3	P4	Total
d/Dhh children	13	13	14	17	19	76
Hearing children	68	80	41	55	59	303

Notes. P0 = entry into primary education. P1 = end of Primary 1. P2 = end of Primary 2. P3 = end of Primary 3. P4 = end of Primary 4. d/Dhh = d/Deaf and hard of hearing.

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Figure 4. Overall Performance of d/Deaf and Hard of Hearing (d/Dhh) and Hearing Children on the Chinese Grammatical Assessment



Notes. P0 = entry into primary education. P1 = end of Primary 1. P2 = end of Primary 2. P3 = end of Primary 3. P4 = end of Primary 4. d/Dhh = d/Deaf and hard of hearing.

A two-way ANOVA was conducted with hearing status (d/Dhh vs. hearing) and level (P0, P1, P2, P3, and P4) as independent variables. The results revealed no interaction effect between hearing status and level, $F(4, 369) = 2.362$, $p = .053$, partial $\eta^2 = .025$, but there was a main effect of hearing status and level: hearing status, $F(1, 369) = 45.465$, $p < .001$, partial $\eta^2 = .110$; level, $F(4, 369) = 56.668$, $p < .001$, partial $\eta^2 = .381$. A series of *t* tests comparing the performance of the d/Dhh children and their hearing peers at each level also indicated that the hearing children's CGA performance was significantly better than the d/Dhh children's: P0, $t(79.0) = -2.242$, $p < .05$; P1, $t(91.0) = -4.395$, $p < .001$; P2, $t(53.0) = -2.165$, $p < .05$; P3, $t(19.8) = -3.224$, $p < .01$; P4, $t(23.8) = -3.275$, $p < .01$. The difference was especially significant at P1, as the hearing children made considerable progress in mastering written Chinese after one year of intensive training in writing and reading skills.

We further conducted a within-group one-way ANOVA on the performance of the d/Dhh and hearing children separately to determine if a difference existed across levels independently. Results of the one-way ANOVA of the d/Dhh and the hearing children's performance indicated a significant improvement across levels for both groups, as shown in Table 6.

However, post hoc Tukey tests showed that the hearing children made significant progress only from P0 to P1 ($p < .001$) and from P1 to P2 ($p < .001$). From P2 onward, no significant difference was found between levels. The high accuracy scores, mostly above 90%, with a small standard deviation at the senior levels, suggest that the hearing children at P3 or P4 gradually mastered the grammatical structures of written Chinese tested with the CGA. The results also suggest that studying in the SLCO environment and learning HKSL as an additional language did not adversely affect these hearing children's development of written Chinese.

Table 6. One-Way ANOVA of d/Dhh and Hearing Children's Performance on the Chinese Grammatical Assessment by Level

Results	d/Dhh children	Hearing children
One-way ANOVA	$F(4, 71) = 22.949$, $p < .001$	$F(4, 298) = 61.799$, $p < .001$
Post hoc test (Tukey's HSD)	P0 vs. P1: $p = .606$ (n.s.) P1 vs. P2: $p < .01$ P2 vs. P3: $p = .766$ (n.s.) P3 vs. P4: $p = .996$ (n.s.)	P0 vs. P1: $p < .001$ P1 vs. P2: $p < .05$ P2 vs. P3: $p = .320$ (n.s.) P3 vs. P4: $p = .999$ (n.s.)

Notes. P0 = entry into primary education. P1 = end of Primary 1. P2 = end of Primary 2. P3 = end of Primary 3. P4 = end of Primary 4. d/Dhh = d/Deaf and hard of hearing.

Turning to the d/Dhh children, one-way ANOVA across levels revealed a significant difference (see Table 6). Post hoc Tukey tests showed that, unlike their hearing peers, the d/Dhh children made significant progress not from P0 to P1 ($p = .606$, n.s.) but from P1 to P2 ($p < .01$), a finding that suggests a possible delay by 1 year relative to the hearing peers. In other words, the d/Dhh children needed approximately 2 years to begin mastering most of the grammatical structures of written Chinese to support their literacy skills development. As shown in Figure 4, the narrowing of the gap between the d/Dhh children and their hearing peers, from 26 percentage points at P1 (P1 d/Dhh children, $M = 55\%$; P1 hearing children, $M = 81\%$) to just 8 points at P2 (P2 d/Dhh children, $M = 80\%$; P2 hearing children, $M = 88\%$), suggests that the gradual mastery of written Chinese grammar even among the d/Dhh children over time was not deflected by their development of the HKSL grammar. However, more empirical research is necessary to unfold the nature of crosslinguistic interaction in the bimodal bilingual development of these children, especially the interaction between HKSL and Chinese grammar. The present findings at least corroborate the observation of Tang et al. (2014) that the SLCO children's development of HKSL, oral Cantonese and written Chinese is positively correlated.

Just as we observed a lack of significant within-group difference between levels from P2 onward among the hearing controls, we saw a similar trend among the d/Dhh children. The lack of between-level differences from P2 onward could be accounted for by the fact that both groups of children obtained quite high accuracy scores at P3 and P4 (P3 d/Dhh children, $M = 84\%$; P3 hearing children, $M = 92\%$; P4 d/Dhh children, $M = 86\%$; P4 hearing children, $M = 92\%$). For the d/Dhh children, although the high accuracy scores implied a close approximation to the target grammar, we reckoned that they still had problems with some highly complex structures, such as relative clauses and locative constructions, which we will discuss later in the present article.

Comparing d/Dhh and Hearing Performance on Individual Grammatical Structures

In this section, we examined SLCO children's performance on individual grammatical structures in detail. Tables 7–9 present their accuracy scores for the grammatical structures at each level. To recapitulate, although the d/Dhh children were generally not on par with their hearing peers in their CGA performance, their accuracy scores in most grammatical structures were quite high when they reached P3 and P4. Only in the scores of four grammatical structures did we observe a performance at or below 80%, including *passives* (P3 d/Dhh children, $M = 78\%$; P4 d/Dhh children, $M = 80\%$) in the PSM task, *relative clauses* (P3 d/Dhh children, $M = 66\%$; P4 d/Dhh children, $M = 68\%$) in the PS task, as well as *double object constructions* (P3 d/Dhh children, $M = 76\%$; P4 d/Dhh children, $M = 75\%$) and *locative constructions* (P3 d/Dhh children, $M = 50\%$; P4 d/Dhh children, $M = 55\%$) in the WO task. In contrast, their hearing peers showed a relatively lower score only in *relative clauses* (P3 hearing children, $M = 74\%$; P4 hearing children, $M = 74\%$). In other words, the d/Dhh children experienced more difficulty mastering some grammatical structures than their hearing peers while narrowing the gap between them.

Table 7. Comparing d/Dhh and Hearing Children's Performance on Four Grammatical Structures in the Picture-Sentence Matching Task

Structure	Hearing status	Level				
		P0	P1	P2	P3	P4
		M % (*SD*)	*M* % (*SD*)	*M* % (*SD*)	*M* % (*SD*)	*M* % (*SD*)
Aspect	d/Dhh	76 (19)	66 (21)	77 (17)	87 (14)	86 (14)
	Hearing	80 (16)	85 (18)	87 (15)	90 (12)	91 (14)
	t test	$p = .445$	$p < .01$	$p < .05$	$p = .261$	$p = .180$
BAA-construction	d/Dhh	65 (32)	54 (34)	84 (25)	91 (25)	91 (17)
	Hearing	78 (26)	88 (20)	87 (24)	95 (10)	95 (15)
	t test	$p = .138$	$p < .01$	$p = .792$	$p = .498$	$p = .363$
Passives	d/Dhh	27 (28)	37 (40)	77 (33)	78 (35)	80 (24)
	Hearing	32 (32)	54 (40)	79 (28)	87 (19)	88 (20)
	t test	$p = .596$	$p = .154$	$p = .836$	$p = .332$	$p = .160$
Quantification	d/Dhh	56 (25)	62 (24)	85 (20)	84 (22)	84 (26)
	Hearing	75 (20)	88 (17)	96 (08)	98 (06)	96 (12)
	t test	$p < .01$	$p < .01$	$p = .063$	$p < .05$	$p = .079$

Notes. P0 = entry into primary education. P1 = end of Primary 1. P2 = end of Primary 2. P3 = end of Primary 3. P4 = end of Primary 4. d/Dhh = d/Deaf and hard of hearing.

Table 8. Comparing d/Dhh and Hearing Children's Performance on Three Grammatical Structures in the Picture Selection Task

Structures	Hearing status	Level				
		P0	P1	P2	P3	P4
		M % (*SD*)	*M* % (*SD*)	*M* % (*SD*)	*M* % (*SD*)	*M* % (*SD*)
Comparatives	d/Dhh	58 (40)	63 (35)	79 (29)	90 (15)	91 (15)
	Hearing	67 (29)	81 (25)	89 (22)	93 (14)	93 (14)
	t test	$p = .353$	$p = .098$	$p = .169$	$p = .454$	$p = .594$
Reflexive and pronoun	d/Dhh	51 (21)	63 (24)	92 (14)	93 (13)	98 (05)
	Hearing	66 (26)	83 (26)	88 (16)	92 (14)	94 (10)
	t test	$p = .058$	$p < .05$	$p = .398$	$p = .923$	$p < .05$
Relative clauses	d/Dhh	50 (14)	53 (19)	57 (23)	66 (20)	68 (21)
	Hearing	53 (25)	69 (27)	74 (26)	74 (23)	74 (22)
	t test	$p = .515$	$p < .05$	$p < .05$	$p = .201$	$p = .318$

Notes. P0 = entry into primary education. P1 = end of Primary 1. P2 = end of Primary 2. P3 = end of Primary 3. P4 = end of Primary 4. d/Dhh = d/Deaf and hard of hearing.

As shown by the results in Tables 7–9, at P0, when the d/Dhh and the hearing children were at the initial stage of acquiring written Chinese grammar, both groups showed relatively poorer performance in some structures, such as *passives* (P0 d/Dhh children, $M = 27\%$; P0 hearing children, $M = 32\%$) in the PSM task, and *locative constructions* (P0 d/Dhh children, $M = 12\%$; P0 hearing children, $M = 32\%$) and *modals* (P0 d/Dhh children, $M = 36\%$; P0 hearing children, $M = 57\%$) in the WO task. On the other hand, both groups managed to attain relatively higher scores for *grammatical aspect* in the PSM task (P0 d/Dhh children, $M = 76\%$; P0 hearing children, $M = 80\%$) and *negation* (P0 d/Dhh children, $M = 88\%$; P0 hearing children, $M = 88\%$) in the WO task. After 1 year of intensive training in reading and

Table 9. Comparing d/Dhh and Hearing Children's Performance on Five Grammatical Structures in the Word Order Task

Structure	Hearing status	Level				
		P0	P1	P2	P3	P4
		M % (*SD*)	*M* % (*SD*)	*M* % (*SD*)	*M* % (*SD*)	*M* % (*SD*)
Double object constructions	d/Dhh	52 (41)	58 (33)	82 (28)	76 (30)	75 (32)
	Hearing	64 (28)	78 (26)	80 (23)	86 (19)	89 (18)
	t test	$p = .346$	$p < .05$	$p = .826$	$p = .128$	$p = .086$
Locative constructions	d/Dhh	12 (22)	19 (27)	48 (40)	50 (25)	55 (33)
	Hearing	32 (35)	53 (31)	73 (25)	80 (23)	85 (17)
	t test	$p < .05$	$p < .001$	$p < .05$	$p < .001$	$p < .05$
Modals	d/Dhh	36 (21)	59 (31)	76 (30)	88 (20)	93 (14)
	Hearing	57 (35)	84 (28)	93 (14)	98 (08)	97 (10)
	t test	$p < .01$	$p < .01$	$p = .069$	$p = .063$	$p = .233$
Negation	d/Dhh	88 (28)	94 (11)	91 (19)	99 (06)	97 (08)
	Hearing	88 (19)	93 (17)	93 (16)	99 (06)	98 (06)
	t test	$p = .971$	$p = .870$	$p = .667$	$p = .947$	$p = .600$
Questions	d/Dhh	50 (20)	75 (27)	86 (17)	94 (08)	93 (08)
	Hearing	56 (27)	86 (17)	91 (15)	95 (06)	94 (08)
	t test	$p = .478$	$p < .05$	$p = .317$	$p = .540$	$p = .624$

Notes. P0 = entry into primary education. P1 = end of Primary 1. P2 = end of Primary 2. P3 = end of Primary 3. P4 = end of Primary 4. d/Dhh = d/Deaf and hard-of-hearing.

writing in written Chinese (i.e., from P0 to P1), the hearing children displayed more significant gains in the development of many grammatical structures between P0 and P1. In contrast, a significant gain in Chinese grammatical knowledge by the d/Dhh children did not show up until after 2 years of exposure to written Chinese (i.e., end of P2), indicating that these children needed more time to associate the Chinese words and grammatical representations with the words and sentences in print. At this level, except for *locative constructions* (P2 d/Dhh children, $M = 48\%$) in the WO task and *relative clauses* (P2 d/Dhh children, $M = 57\%$) in the PS task, the accuracy scores for all other structures were higher than 76% and some were even higher than 90% (i.e., *negation*: P2 d/Dhh children, $M = 91\%$; *reflexive and pronoun*: P2 d/Dhh children, $M = 92\%$). Further *t* tests comparing the performance on individual structures between the d/Dhh children and the hearing peers at each level revealed that, from P2 onward, most structures did not show a significant difference (see Table 7–9), except for *grammatical aspect* and *relative clauses* at P2, *quantification* at P3, and *locative constructions* at all levels. The structures that consistently challenged both the d/Dhh and the hearing children were *relative clause*s and *locative constructions*, as the scores at P4 revealed.

In sum, the d/Dhh children's overall grammatical development lagged behind that of their hearing peers. However, over time, these children managed to narrow the gap and achieve no statistical difference with their hearing peers in many structures. The statistically significant difference in the overall performance between the two groups of children was probably contributed by the big difference in their performance on most grammatical structures at P0 and P1 and *relative clauses* especially *locative constructions* at most levels. Nevertheless, the data show that

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both d/Dhh and hearing children experienced similar ease (e.g., *negation* and *grammatical aspect*) and difficulty (e.g., *relative clause*s and *locative constructions*) in acquiring the grammatical structures in written Chinese, albeit in different degrees.

Discussion

The present study examined whether d/Dhh children receiving education in a SLCO environment could acquire knowledge of a set of representative grammatical structures in written Chinese to support their literacy development. A corollary research goal was to determine if their development was similar to that of their hearing peers in order of acquisition of the grammatical structures and rate of development. Although the results showed that the d/Dhh children lagged behind their hearing peers at each level (i.e., experienced a slower rate of development), the gap narrowed over time between the two groups. That the d/Dhh children initially lagged behind their hearing peers significantly reveals they experienced a relatively higher degree of difficulty in the learning process. Unlike their hearing peers, most of the d/Dhh children sustained the lack of a strong foundation in oral Cantonese when their formal primary education began, which might have adversely affected their development of another spoken language—written Chinese—the grammar of which does not overlap entirely with oral Cantonese. In terms of order of acquisition, where the observations were based on the relative order of difficulty of the grammatical structures as displayed by the children in the CGA, the findings showed that both groups of children took a similar route of development, sharing structures that were acquired early such as *negation* and *grammatical aspect*, and structures that were acquired late such as *relative clauses* and *locative constructions*. No structure was observed to be easier for d/Dhh children but more difficult for their hearing peers. Despite a slower rate of development, the continuous increase in the d/Dhh children's accuracy scores reveals that their grammatical development did not plateau but was gradually approximating their hearing peers' competence level. In fact, from P2 onward, the accuracy scores for many of these structures did not show significant differences between the hearing and the d/Dhh children (see details in Tables 7–9).

One concern among parents and educators is whether studying in the SLCO environment with an additional language—HKSL—has a detrimental effect on the learning of Chinese by both groups of children. The present findings do not suggest this was the case because both groups of children systematically developed knowledge of written Chinese incrementally from P0 to P4. The hearing children attained very high accuracy scores from P2 onward. By P4, 11 out of 12 grammatical structures showed an accuracy score ranging between 85% and 98%, indicative of their general mastery of these grammatical structures. A similar development by the d/Dhh children was observed, albeit occurring at a slower rate. By P4, the accuracy scores of 7 out of 12 of these grammatical structures ranged between 86% and 98%. Meanwhile, the relatively lower accuracy scores for some structures, such as *relative clauses* and *locative constructions*, suggest that the d/Dhh children fell short of full mastery at the time of this study. Yet, their hearing peers did not attain above 90% with these structures either, a finding that implies that both groups of children were merely experiencing different degrees of difficulty in acquiring such structures.

Lederberg et al. (2013) argued that good skills in a first language are a necessary but not a sufficient condition for achieving reading in a second language. If the learning environment is sufficiently conducive to providing readily accessible language experiences, it is possible to see little or no delay in d/Dhh children's literacy development. In the Hong Kong context, amid the "discontinuity" between the development of oracy and literacy skills, SLCO education shares some characteristics with the conventional model of sign bilingual education to some extent. It emphasizes early exposure to HKSL and the involvement of Deaf teachers as linguistic and education role models in this program. However, it differs in terms of the learning environment and the timing of spoken language input. SLCO education is organized in a mainstream setting. Since d/Dhh children study with hearing children in the same classroom, they receive oral language input through daily interactions with hearing peers and teachers alongside HKSL much early. Moreover, coteaching practices between a hearing teacher and a Deaf teacher enable separation between spoken and signed languages in terms of linguistic input and a flexible code choice between HKSL and oral Cantonese as the language for accessing information among the children.

It should be noted that the language of communication in the SLCO environment generally involves a choice between HKSL and a few oral languages in descending order from high to low frequency, i.e., HKSL > Cantonese > Mandarin > English. When d/Dhh children are immersed in this learning environment, they experience frequent code-switching between oral and visual languages over and above the exposure to written Chinese in print, including textbooks, storybooks, school notices and the like. Such frequent switches between languages may enhance their metalinguistic knowledge about these languages in acquisition. Furthermore, Tang et al. (2015) reported that teachers of d/Dhh children were conscientious about highlighting to the children the grammatical differences between HKSL and Manually Coded Chinese (i.e., signed Cantonese or signed written Chinese). Therefore, the frequent code switching and the teachers' pedagogical efforts to raise students' awareness about the grammatical differences between HKSL and Chinese may facilitate early linguistic differentiation. Therefore, the d/Dhh children's relatively weaker knowledge of oral Cantonese upon entry into SLCO primary education seems to be compensated by their consistent exposure to this language in the school environment through daily interactions with their hearing peers and teachers, which in turn supports the development of written Chinese as the d/Dhh children's knowledge of oral Cantonese improved.

Taken as a whole, our findings show that the hearing children and the d/Dhh children's development of written Chinese grammar was not disadvantaged by their exposure to HKSL while receiving education in the SLCO environment. Moreover, from P2 onward, the performance on most grammatical structures between the two groups of children was almost comparable. Nevertheless, the d/Dhh children experienced initial difficulty with this learning task and continuous difficulty mastering some highly complex structures in written Chinese.

Did children studying in the SLCO environment tap their existing linguistic resources through previous learning experiences when they developed knowledge of written Chinese grammar? Our findings revealed that the hearing children

needed about one to at most two years to master most of the grammatical structures in written Chinese. As we have said, such performance could be accounted for by the hearing children using their knowledge of oral Cantonese, their first language, when they began developing knowledge of written Chinese grammar from P0 onward. As for the d/Dhh children, their foundation of oral Cantonese was weaker than their hearing peers when they entered primary education. When written Chinese in the Hong Kong context is read using Cantonese pronunciation, and when specific overlapping linguistic properties exist between oral Cantonese and written Chinese, it is highly probable that the d/Dhh children initially mistook the learning of written Chinese as the learning of Cantonese in print. A closer analysis of some of the grammatical structures (i.e., *questions*, *negation*, *passives*, *modals*, and *ba-constructions*) in the written Chinese assessment showed an overlap with oral Cantonese in terms of syntactic representations, although the function words to form the necessary structures are different. For instance, in Cantonese passives, the marker 俾[*bei*] may appear as a homonymic main verb meaning "give," contrasting 被[*bei*] as a pure passive marker in written Chinese. Therefore, the d/Dhh children might initially interpret 被[*bei*] in *passives* in written Chinese, not as a passive marker, but as a lexical verb "give," thus causing difficulty in processing the meaning of the sentences. In other words, linguistic affinity, especially the overlapping syntactic or morphosyntactic representations between the two dialects of Chinese, may lead to crosslinguistic interaction between the d/Dhh children's developing grammar of oral Cantonese and written Chinese, and possibly vice versa, a common phenomenon in bilingual acquisition.

Evidence that the d/Dhh children in the present study approached the acquisition of written Chinese with relatively weaker knowledge of oral Cantonese than their hearing peers may be found in a study by Lam (2015), who examined how 24 SLCO d/Dhh children (ages ranging from 6 years 7 months to 13 years 11 months) and 50 hearing children (ages ranging from 3 years 10 months to 5 years 10 months) acquired *relative clauses* in oral Cantonese. Results of an oral elicitation task revealed that only 38.12% of the d/Dhh children's productions contained a *relative clause*, as against 71.43% of the hearing controls' productions. The d/Dhh children's inadequate knowledge of complex syntactic operations for *Cantonese relative clauses* might explain why they demonstrated persistent difficulty acquiring this structure, even though oral Cantonese and written Chinese share a relatively similar syntactic organization. Initial adherence to the canonical NVN strategy is also reported in typically developing children acquiring *relative clauses* in Mandarin Chinese (Cheng, 1995). The d/Dhh children in our study seemed to be behaving similarly. Therefore, when applying the canonical NVN strategy in comprehending the relative clauses, they had great difficulty identifying the subject gap that precedes the verb *pull* in the sentence (see example 6).

(6) Verb——Object——Subject——Verb
(subject-gap RC in written Chinese)
拉 著 小狗 的 小貓 在
pull ASP dog DIK cat ASP
刷牙
brush teeth
Meaning: The cat that is pulling the dog is brushing its teeth.

Adherence to an inappropriate NVN strategy was also observed in the d/Dhh children's performance on *locative constructions*. As shown in example 7, the canonical SVO mapping strategy failed to support the d/Dhh children's comprehension of such constructions since the grammatical subject is not associated with an agent, but a locative NP followed by a localizer上[*soeng*] "*on*" in the example.

(7) Location Verb Subject
桌 上 放 著 一
desk on put ASP one
本 書
CL book
Meaning: On the desk laid a book.

To recapitulate, a WO task was adopted to test the children's word order knowledge of *locative constructions*. While both groups of students preferred an animate to an inanimate locative NP in the grammatical subject position initially, this difficulty persisted among the d/Dhh children till. P4, as shown by their accuracy score (i.e., 55%) when compared with their hearing peers (i.e., 85%). This perennial difficulty experienced by the d/Dhh children in acquiring *relative clauses* and *locative constructions* made us wonder whether they could eventually fully master these highly complex structures or whether such knowledge stays "incomplete" from an ultimate attainment perspective. Therefore, we recommend future research on d/Dhh children's acquisition of these complex constructions when they continue to receive Chinese language education in their secondary education.

Did the d/Dhh children who were consistently exposed to HKSL in the SLCO environment use knowledge of this language to acquire written Chinese? The unavailability of a tool to measure the children's knowledge of HKSL is a limitation of the present study. To obtain some qualitative results, we focused on the d/Dhh children's knowledge of word order in written Chinese due to interesting crosslinguistic differences in word orders between HKSL and written Chinese. Data from the WO task targeting the syntactic position of function words in written Chinese were extracted for analysis. In HKSL, function words like *negators*, *modals*, and *wh-words* are clause-final, whereas in written Chinese, *negators* and *modals* are preverbal and *wh-words* are in situ. Results revealed that the d/Dhh children at P2 had already attained 91%, 86%, and 76% for *negation*, *wh-question*, and *modals*, respectively. Such high accuracy scores suggest the children's early differentiation in word order between HKSL and written Chinese. The number of errors implicating HKSL influence was relatively low, and they were only observed at P0 and P1. For instance, we recorded, at these two levels, 3 out of 9 errors for negative sentences (see example 8a, below), 11 out of 41 errors for modal sentences, and 12 out of 38 errors for *wh-questions*. From P2 onward, the number of such errors dropped systematically. Although the hearing children had also been exposed to HKSL since P0, the number of errors reflecting HKSL grammar was even lower. This suggests little interaction between their developing grammar of HKSL and written Chinese. This is understandable since these students had already established a strong foundation of oral Cantonese grammar, and modality and linguistic affinity would encourage them to resort more to oral Cantonese than HKSL grammar in the learning of written Chinese.

[137.189.85.75] Project MUSE (2024-10-10 07:01 GMT) Chinese University of Hong Kong

(8) a. *哥哥 看 書 不。
(HKSL order)
Elder brother read book not
Meaning: Elder brother doesn't read books.
b. 哥哥 不 看 書。
(written Chinese and oral Cantonese order)
Elder brother not read book
Meaning: Elder brother doesn't read books.

A more obvious crosslinguistic interaction effect was observed with *double object constructions* where all three languages show differences in the order of the ditransitive verb and its direct object and indirect object:

(9) Double-object constructions

a. HKSL: $NP_{(SUB)}$-$NP_{[DO]}$-$V_{[ditransitive]}$-$NP_{[IDO]}$ (see example 10a)
b. Cantonese: $NP_{(SUB)}$-$V_{[ditransitive]}$-$NP_{[DO]}$-$NP_{[IDO]}$ (see example 10b)
c. Written Chinese: $NP_{(SUB)}$-$V_{[ditransitive]}$-$NP_{[IDO]}$-$NP_{[DO]}$ (see example 10c)

Generally speaking, both the d/Dhh and the hearing children produced more errors following the Cantonese word order from P0 to P4, which suggests more interaction between Cantonese and written Chinese than between HKSL and written Chinese. Focusing on the d/Dhh children, in total, they produced 30 out of 92 (33%) errors indicating interaction with their knowledge of HKSL (see example 10a), as against 51 out of 93 (55%) errors revealing knowledge of Cantonese (see example 10b). In other words, the d/Dhh children accessed knowledge of both HKSL and oral Cantonese in developing *double object constructions* in written Chinese, but more so from Cantonese than from HKSL. On the contrary, the hearing children's errors were primarily attributable to their knowledge of Cantonese (i.e., 166 out of 257 errors in total, 65%), and their knowledge of HKSL contributed so little to their erroneous performance (i.e., 16 out of 257 errors in total, 6%).

(10)

a. *我 一 幅 畫 送 媽媽
(HKSL order)
I one CL picture give mother
Meaning: I gave a picture to mother.
b. *我 送 一 幅 畫 媽媽
(Cantonese order)
I give one CL picture mother
Meaning: I gave a picture to mother.
c. 我 送 媽媽 一 幅 畫
(written Chinese order)
I give mother one CL picture
Meaning: I gave a picture to mother.

In other words, although crosslinguistic interaction between the developing grammar of HKSL, oral Cantonese, and written Chinese was observed initially, the d/Dhh children tended to differentiate the HKSL and Chinese grammars early, as suggested by their performance on the word orders associated with function words in *negation*, *modals* and *wh-questions*. Some other interactions took a little longer to disentangle, like *double object constructions* involving ditransitive verbs, where the word orders in the three languages differ. The perceived modality and linguistic affinity between oral Cantonese and written Chinese attracted more crosslinguistic interaction for both groups of children than that arising from their knowledge of HKSL.

The findings also suggest that when children have developed knowledge of more than one grammar, they will use it to support their acquisition of additional languages. The d/Dhh and hearing children are no exception, and the process is independent of modality. In research on second language acquisition and bilingual acquisition, crosslinguistic interaction is a commonly observed language acquisition phenomenon. Both the d/Dhh and the hearing children were behaving like other learner groups. They became increasingly adept at differentiating HKSL from Chinese grammar, as shown by the lesser interaction between HKSL and written Chinese than between oral Cantonese and written Chinese. This finding corroborates the observations in the child language acquisition literature that children are sensitive to differentiating lexical and function words, and their relative order in the target language at a very young age. Their emerging word order grammar at the multiword stage seldom deviates from the target language (Guasti, 2002). Future investigation into the acquisition of other grammatical structures of written Chinese is necessary to look for more possible clues about the conditions for crosslinguistic interaction between HKSL and Chinese.

Conclusion

The present study investigated the development of written Chinese in groups of d/Dhh and hearing children who received sign bilingual education in a coenrollment learning environment. Although the d/Dhh children were found to be lagging behind their hearing peers in their overall performance, detailed analysis by level from P0 to P4 revealed their potential to perform on par with their hearing peers on a majority of grammatical structures by the time they reached Primary 3 and 4. While the results have demonstrated some positive effects of the SLCO education on d/Dhh children's written Chinese development, more research is necessary to confirm whether they can ultimately achieve native-like competence in highly complex structures like *relative clauses* and *location constructions*. As said, knowledge of grammar is an essential component supporting literacy skills development, especially reading comprehension, and these constructions are commonly found in written Chinese texts. Last, the CGA can be normed among school-age children in Hong Kong to compare school-age d/Dhh and hearing children with and without sign language support.

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Conflicts of Interest

No conflicts of interest were reported.

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