Acquisition of Chinese relative clauses by deaf children in Hong Kong

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This paper is a study of how deaf children in Hong Kong acquire Chinese relative clauses. The relative clause is reported to be a difficult structure for deaf children (Friedmann & Szterman 2006). While it may be true for postnominal relative clauses, it is unclear whether prenominal relative clauses are equally difficult for deaf children. This paper explores this question by examining deaf children's comprehension and production of Chinese relative clauses via an elicited production task, a picture selection task and a dots-connecting task, which are all presented in written format. In addition to deaf children, typically developing Cantonese children and Cantonese adults with high Chinese proficiency are also recruited for comparison. The results show that deaf children fall behind typically developing Cantonese children in production. But deaf children with higher Chinese proficiency can perform similarly with typically developing Cantonese children. The error types and the types of non-RC responses produced by deaf children are also present in the data of typically developing Cantonese children, suggesting that deaf children do not undergo a different pathway in the development of relative clauses. While typically developing Cantonese children demonstrate non-significant subject advantage in production but object advantage in comprehension, deaf children do not demonstrate subject-object asymmetry in production and object advantage in comprehension.

Keywords: Chinese relative clause, typically developing Cantonese children, deaf children, subject-object asymmetry

1. Introduction

Relative clauses have been reported to be one of the most difficult structures for deaf children. It has been suggested that the difficulty results from a lack of syntactic movement in deaf children's grammar (cf. Friedmann & Szterman 2006). While these studies largely focus on how deaf children acquire postnominal

relative clauses, little is known on whether similar findings are observed with deaf children acquiring prenominal relative clauses. This paper attempts to explore this issue by investigating whether Hong Kong deaf children have knowledge of relativization. Since deaf children's performance in oral form may be limited by their hearing loss, this study examines how deaf children comprehend and produce Chinese relative clauses via the written form which largely follows Mandarin grammar. Do deaf children have the knowledge of Chinese relative clauses? If they do, does their performance demonstrate subject-object asymmetry? Are the acquisition patterns observed the same or different from typically developing children? All these questions will be addressed in this paper.

In the following sections, a review of the acquisition of relative clauses by typically developing and deaf children will be given, followed by a brief description of Chinese relative clauses and its acquisition. All this will serve as background for our exploration into Hong Kong deaf children's acquisition of Chinese relative clauses. Section 2 presents the method and results of an elicited production task for both typically developing and deaf children in Hong Kong. Section 3 describes the method and results of two comprehension tests of the same group of children. Section 4 summarizes the results in §2 and §3. Discussion and conclusions are given in the final section.

1.1 Acquisition of relative clauses

1.1.1 *Typically developing children*

How typically developing children acquire relative clauses has been studied for decades (Diessel & Tomasello 2005; Hamburger & Crain 1982; Sheldon 1974; Tavakolian 1981 for English; Friedmann & Novogrodsky 2004 for Hebrew; Brandt et al. 2009 for German; Hsu et al. 2009; Lee 1992 for Mandarin Chinese; Contemori & Belletti 2014; Guasti & Cardinaletti 2003 for Italian; Stavrakaki 2001, 2002; Varlokosta 1997 for Greek, to name just a few). Back in the 1970s, researchers began to explore whether certain types of relative clauses were more difficult than others. Sheldon (1974:275), for instance, classifies four types of relative clauses:

(1) a.   SS: **The dog**$_i$ [that ____$_i$ jumps over the pig] bumps into the lion.
     b.   SO: **The lion**$_i$ [that the horse bumps into ____$_i$] jumps over the giraffe.
     c.   OS: The pig bumps into **the horse**$_i$ [that ____$_j$ jumps over the giraffe].
     d.   OO: The dog stands on **the horse**$_i$ [that the giraffe jumps over ____$_i$].

Example (1) illustrates four types of relative clauses, SS, SO, OS, OO, which differ in whether they are center-embedded and whether the head noun and the gap have parallel function. While the first alphabet represents the grammatical role of

the head noun in matrix clause, the second alphabet refers to the grammatical role of the gap in the relative clause.

Earlier studies focus on the factors affecting children's comprehension of relative clauses. A number of factors have been reported to play an important role in facilitating children's comprehension and these factors include the felicity condition (Hamburger & Crain 1982), use of intransitive verb and inanimate object in the relative clause (Arosio et al. 2011 for Italian; Goodluck & Tavakolian 1982 for English; Lee 1992 for Chinese). Adani et al. (2010) also notes that pragmatic conditions, factors related to the lexicon and visual inspection of the scene, are important in eliciting children's production of relative clauses.

Over the decades, researchers have been interested in learning the order of difficulty of relative clauses. Considering relative clause structure, it has been observed that internally-headed relative clauses emerge at around age 2 (Isobe 2003, 2005; Ozeki & Shirai 2007), while externally-headed relative clauses appear at around age 4 (Guasti et al. 2012). Relative clauses occurring in copular construction (This is the sugar *that goes in there*) also precede those occurring in main clause construction (The horse *that pushed the goat* stands on the lion) (Diessel & Tomasello 2005). Relative clauses generated via wh-movement also emerge later than those not formed from wh-movement (Labelle 1990, 1996 for French; Goodluck et al. 2006 for Irish).

In addition to these findings, even more researchers have explored subject-object asymmetry. A number of studies report that subject relatives are easier in languages having postnominal relative clauses (Adani 2011; Adani et al. 2010; Arosio et al. 2006, 2009; Belletti & Contemori 2010 for Italian; Arnon 2010; Friedmann et al. 2009 for Hebrew; Booth et al. 2000 for English, to name just a few). Three hypotheses – Canonical Word Order, Filler-gap Linear Distance, and Structural Distance hypotheses – have been proposed to capture the subject-object asymmetry (see Hsu et al. 2009 and references cited therein). Both the Canonical Word Order and the Filler-gap Linear Distance hypotheses predict that subject relatives are easier in languages with postnominal relative clauses (e.g. English) and object relatives are easier in languages with prenominal relative clauses (e.g. Chinese). The Structural Distance Hypothesis assumes that the order of difficulty follows Keenan & Comrie's (1977) Noun Phrase Accessibility Hierarchy (NPAH); i.e. the lower the ranking of the grammatical role of the gap, the higher the degree of difficulty. Hence subject relatives are easier than object relatives; object relatives are easier than oblique relatives.

1.1.2   *Deaf children*
Relative clauses are also widely studied with atypically developing children because these children generally have difficulty learning complex structures. Most of these

studies focus on children with Specific Language Impairment (SLI). Relatively few studies deal with deaf children. Earlier studies examined severely and profoundly deaf college students' grammatical knowledge on relativization through a standardized language test (Quigley et al. 1976) or written sample (Berent 2009; Lillo-Martin et al. 1992). The results show that deaf college students could produce relative clauses, but the range of types of relative clauses used were limited (e.g. they used wh-relatives only with a subject gap). Deaf children also made errors that may or may not occur with hearing students. While resumptive NP error (where a resumptive NP is placed at the gap in the relative clause) is common to both groups of students, two errors, object-subject deletion (e.g. deletion of the subject *who* in *The dog chased the girl had on a red dress*) and incorrect forms of possessive (e.g. *I helped the boy's* [whose] *mother was sick*), are produced by deaf students only.

With advancements in hearing devices, studies exploring the development of relative clauses by orally-trained deaf children emerge. de Villiers (1988) conducted an elicited production task with deaf children aged 11 through 18 and found that relative clauses are acquired late. The developmental pattern, however, conforms to that of normally hearing children. In their review of this study, de Villiers et al. (1994), however, point out that the errors specific to deaf children, such as use of resumptive pronouns and relativization of the wrong noun phrase, suggest that deaf children have incomplete grammar. Friedmann & Szterman's (2006) study on Hebrew orally-trained deaf children, who have moderate to profound hearing loss, contributes further to our understanding of deaf children's development of relative clauses. This study reports the results of a series of experiments (i.e. sentence-matching task, preference task and picture description task) on comprehension and production of relative clauses by deaf children aged from 7;7 to 11;3. The major findings from the series of experiments are: (i) that orally-trained deaf children have language deficit in object relative clauses derived via syntactic movement; and (ii) that orally-trained deaf children perform better with relative clauses containing a resumptive pronoun than those containing a gap. Subsequent studies of this research team report similar results with other deaf children acquiring Hebrew (Friedmann et al. 2008; Friedmann et al. 2010; Friedmann & Costa 2011) and Palestinian Arabic (Friedmann et al. 2010; Friedmann & Costa 2011). In sum, the few studies reported show that how deaf children acquire relative clauses is still understudied.

1.2 Chinese relative clauses

Chinese relative clauses are typologically rare. While almost all SVO languages have postnominal relative clauses, Chinese, as an SVO language, has prenominal relative clauses, as shown in the following example (Li & Thompson 1981:580):

(2)   zhong shuiguo de nongren
      grow fruit   DE farmer
      '(the) farmer(s) who grow fruit.'

In example (2), the noun *nongren* 'farmer' is preceded by the relative clause *zhong shuiguo de* 'that grow fruit'. The head noun being relativized can be a subject, a direct object, an indirect object, obliques, genitive phrases and object of comparison (Chao 1968; Li & Thompson 1981; Tang 1979). Example (2) exemplifies a subject-gapped relative clause. The following example illustrates an object-gapped relative clause (Li & Thompson 1981:580):

(3)   tamen zhong de shuigo
      they grow DE fruit
      'the fruit that they grow.'

Mandarin relative clauses are prenominal and are marked by *de*. Note that Chinese relative clauses may contain a null head noun, as shown in the following examples (He 2001:74):

(4)   Relative clauses containing null head noun
      a.   na ben ta   xihuan de *e* bei ren   jie   zou le
           that CL s/he like   DE PASS person borrow go ASP
           'The volume that he likes is already loaned to other people.'
      b.   ta xihuan de *e* na ben bei ren   jie   zou le
           s/he like   DE that CL PASS person borrow go ASP
           'The volume that he likes is already loaned to other people.'

In addition, object relatives may be in the form of passives (Hsu et al. 2009:338):

(5)   Passive object relative clauses
      bei nuhai zhi   de na   zhi niu
      PASS girl   point DE that CL cow
      'The cow who is being pointed to by the girl.'

The passive object relative clause is a perfectly acceptable alternative to the object-gapped relative clause in Chinese (cf. Hsu et al. 2009).

1.3   Acquisition of Chinese relative clauses

Acquisition studies of Mandarin relative clauses tend to focus on the order of difficulty rather than children's knowledge of the syntax of relative clauses; reported results are mixed. Previous studies using an act-out task uniformly report that subject relatives are the easiest (Chang 1984; Cheng 1995; Chiu 1996; Lee 1992). The findings in these studies either fully or partly follow the predictions made by

Keenan & Comrie's (1977) Accessibility Hierarchy on Noun Phrases. Data collected from a truth-value judgment task do not find subject-object asymmetry in comprehension (Su 2004). Chan et al. (2011) adopt a picture pointing task and their data shows a non-significant subject advantage. Hu et al. (2016) report subject advantage when a character-sentence matching task is used.

Turning to production studies, the results are also mixed. Ning & Liu (2009) note that object-gap relatives appear first, followed by subject-gap relatives, adjunct-gap relatives and other complex relatives (e.g. passive relatives) in corpus data. Though object-gap relatives appear earlier than other types of relatives, both Cheng's (1995) and Hsu et al.'s (2009) elicited production studies show that Mandarin-speaking children perform better with subject-gap relatives than object-gap relatives. Hsu et al. (2009) also note that children produced ungrammatical relative clauses that contain a resumptive NP, missing embedded subject NP or multiple *de*. See the following examples (Hsu et al. 2009:343–344):

(6) Resumptive NP
xiao-nühai zai   kan   dianshi de (na-ge dianshi)
little-girl   DUR watch TV   DE that-CL TV
'the TV which the little girl is watching the TV'

(7) Dropping the embedded subject NP in the RCs
zuo-zhe de kache
sit-PROG DE truck
'the truck which ___ is sitting'
Compared to: the truck which the girl is sitting

(8) Uninterpretable clauses with multiple *de*
xiao-wuya zai   kan   de xiao-nühai zhui de na-zhi mao xiao-wuya
little-crow DUR watch DE little-girl   chase DE that-CL cat   little-crow
kan   de
watch DE

In addition to responses containing relative clauses, this study also reports a number of non-relative clause responses, including use of possessive marker *de*, using two separate sentences, using deictic answers, complement clause and using one only sentence (Hsu et al. 2009:356):

(9) Using the possessive marker *de*
na-ge   nanhai-de   dianshi
that-CL boy-DE(POSS) TV
'the boy's TV'

(10) Using two separate sentences
  xiao-gou zai   zhui   maomi. Maomi biancheng lanse le.
  little-dog DUR chase cat cat become blue LE
  'The little dog is chasing the cat. The cat became blue.'

(11) Using deictic answers
  zhe-yi-zhi   maomi/ nanhai na-tai   (dianshi)
  this-one-CL cat/ boy that-CL TV
  'this one cat'/'boy that one'

(12) Using complement clause
  wuya kan na-ge nühai zai   changge.
  crow watch that-CL girl DUR sing
  'The crow is watching the girl singing.'
  Compared to: 'The crow is watching the girl who is singing.'

(13) Using one only sentence
  na-ge   nanhai zai   kan   hong dianshi.
  that-CL boy DUR watch red   TV
  'The boy is watching the red TV.'
  (Expected answer: 'The TV that the boy is watching turned purple (red).')

In what follows, we shall see if similar patterns can be observed when a similar method is adopted in our investigation of the acquisition of Chinese relative clauses by typically developing Cantonese children and deaf children.

2.   Experiment 1: Elicited production

2.1 Participants

Three groups of participants – (i) adults, (ii) typically developing Cantonese children, and (iii) deaf children – participated in the experiment. The adult group consists of 25 normal-hearing Cantonese-speaking adults (Mean age: 19.6; range: 18–21) studying at one university. All of them scored the highest level in written Chinese in a public examination and hence have a good command of written Chinese. They serve as the reference group of the present study. Since little is known about whether typically developing Cantonese children in Hong Kong have the knowledge of relative clauses in written Chinese, a total of 179 normal-hearing Cantonese-speaking children (M = 9;5; range: 6;11 to 12;8) studying from level two to six at a primary school (hereafter P2 to P6) were recruited to participate in the experiment. While P2, P3, P5, and P6 each have 36 students, P4 has 35 students. All of these students do not have any kind of disabilities. This group of

children may be considered as an experiment group as well. The last group is twenty-three deaf children (chronological age: M = 10:10; range = 7;4 to 14;8; hearing age: M = 9;2; range: 5;6 to 12;8) studying in a mainstream school which adopts Sign Bilingualism such that Hong Kong Sign Language (HKSL) and Cantonese are the medium of instruction. All these children began learning Cantonese since the fitting of their hearing devices (average age of fitting: 1;7). They have been exposed to written Chinese since they were admitted to child care centres for the deaf or mainstream kindergarten (average age of admission to schools: 3;2). Eighteen of these deaf children have hearing parents and hence exposure to HKSL usually began after they were exposed to Cantonese (average age of initial exposure to HKSL: 6;l). Five have deaf parents and hence their HKSL input began earlier and is richer. Detailed biodata for the deaf children is given in Appendix. One may question why there is a big difference in the number of participants in the two child groups. As noted earlier, no one has done any research on how typically developing Cantonese children perform when they need to comprehend and produce relative clauses in written Chinese, the form that follows Mandarin grammar rather than Cantonese grammar. Recruiting students from different levels in the primary school may allow us to have a clearer picture of the time when typically developing Cantonese children can comprehend and produce Chinese relative clauses in written form. The deaf community is always the minority group in different places of the world given the small number of deaf people when compared with the majority hearing people. So the number of available deaf students is limited at the outset.

Since Chinese proficiency may vary among the children, both typically developing and deaf children were asked to complete an independent test of their written Chinese. The test consists of a variety of questions, including tests of word types (e.g. connectives, negators), word-reordering for different sentence structures (e.g. BA-construction, BEI-construction), arranging sentences into a short discourse, cloze passage, and a reading comprehension test. Four groups of typically developing students are formed on the basis a cluster analysis of the scores of the independent test:

Table 1. Groups of typically developing children

Groups	Number of children	Scores	School grades
1	47	31 – 47	P2 – P4
2	48	48 – 60	P2 – P6
3	50	61 – 74	P2 – P6
4	34	76 – 89	P3 – P6

Note. P refers to primary school.

In order to compare the performance of the deaf children and the typically developing children, deaf children are grouped as in Table 1:

Table 2. Groups of deaf children

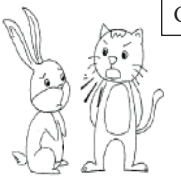| Groups	Number of children	Scores	School grades
Below Group 1	3 (1DD)	16 – 29	P1 – P3
1	14 (2DD)	31 – 47	P1 – P6
2	3 (1DD)	48 – 60	P5
3	3 (1DD)	61 – 74	P2 – P6

Note. P refers to primary school.

Most deaf children are grouped in the lowest Chinese proficiency group (i.e. Group 1). Few children are grouped into groups with higher Chinese proficiency (i.e. Group 2 and Group 3). Three children score below 30 and they are at the level below Group 1. Recall that 5 deaf children have deaf parents (i.e. deaf children of deaf parents, DD). The youngest one, C6-6-THY (hearing age: 6;6, P1) is grouped in 'Below Group 1'.[1] Two second youngest DD, C4-5-GTC (hearing age: 9;0, P3) and C4-1-CNW (hearing age: 8;1, P3) are grouped in Group 1. C2-2-SMY (hearing age: 10;6, P5) is grouped in Group 2 and C1-4-SMC (hearing age: 11;1; P6) is grouped in Group 1.

2.2 Test design and procedures

The test stimuli were presented in the format that looks similar to written exercises in Chinese lessons at primary schools in Hong Kong. In each question, the first paragraph describes the context for the production of relative clauses. In other words, the context is given in the form of texts rather than pictures. This paragraph is followed by a which-question that elicits the relative clause. A picture serving as the hint of the answer is placed next to the text. What the participant needs to do is to form a relative clause in written Chinese by using the hint of answer given by the picture. See Figure 1 for a sample question:

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[1]. The deaf children enrolled in the Jockey Club Sign Bilingualism and Co-enrolment in Deaf Education Programme were all named with a research code in the form of cohort group-student number-pseudoname (e.g. C1-4-SMC). The paper adopts the same way to refer to a particular deaf child.

1.　寵物店裏有三隻小貓和三隻白兔。一隻小貓在罵白兔，一隻小貓在稱讚白兔，一隻小貓在抱白兔。

哪一隻白兔不開心？ B

D _____不開心。

Figure 1. Sample question in written test
A — Context of RC (text): "There are three cats and three rabbits in the pet shop. One cat is scolding the rabbit; one cat is praising the rabbit and one cat is holding a rabbit."
B — Elicitation question (text): "Which rabbit is unhappy?"
C — Hint for the answer (picture)
D — Blank where children could write down their answer by using relative clause (i.e. 小貓罵的那隻白兔 'the rabbit that the cat is scolding' in this sample question) (text)

Both subject-gapped and object-gapped relative clauses are tested. They may also occur in subject condition or object condition. The verbs in the target answers are all action verbs.[2] The following table lists the types of relative clauses tested in Experiment 1:

Table 3. Types of relative clauses in Experiment 1

Test stimuli and expected answers	Condition	Gap
寵物店裡有三隻小貓和三隻白兔。一隻小貓在罵白兔，一隻小貓在稱讚白兔，一隻小貓在抱白兔。 'There are three cats and three rabbits in a pet shop. One cat is scolding a rabbit, one cat is praising a rabbit, one cat is holding a rabbit.' 哪一隻白兔不開心? Which rabbit is unhappy? **小貓罵的那隻白兔** 不開心。 '**The rabbit that the cat is scolding** is unhappy.'	Subj	Obj

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2. One anonymous reviewer points out that the verb types like psychic verbs and action verbs may lead to different performances in this task. The target relative clauses all contain action verbs while the matrix clause may either contain verb 'help' or psychic verbs like 'be happy' or 'be angry'. A closer examination of the data shows that the verb types given in the context and in the matrix clause do not lead to differences in the children's performances.

Table 3. (*continued*)

Test stimuli and expected answers		Condition	Gap
學校裡有三隻小狗和三隻綿羊。一隻綿羊在拉小狗，一隻綿羊在親小狗，一隻綿羊在踢小狗。 'There are three dogs and three sheep in a school. One sheep is pulling a dog, one sheep is kissing a dog, one sheep is kicking a dog.' 你想幫助哪一隻小狗? Which dog do you want to help? 我想幫助 <u>小羊踢的那隻小狗</u> 。 'I want to help **the dog that the sheep is kicking**.'		Obj	Obj
農場裡有三隻小馬和三隻小牛。一隻小馬在稱讚小牛，一隻小馬在推小牛，一隻小馬在背小牛。 'There are three horses and three cows on a farm. One horse is praising a cow, one horse is pushing a cow, one horse is carrying a cow on its back.' 哪一隻小馬比較頑皮? Which horse is naughtier? <u>推小牛的那隻小馬</u> 比較頑皮。 '**The horse that is pushing the cow** is naughtier.'		Subj	Subj
你在街道上看到三個男孩和三個女孩。一個男孩在拉女孩，一個男孩在追女孩，一個男孩在踢女孩。 'You see three boys and three girls in the street. One boy is pulling a girl, one boy is chasing a girl, one boy is kicking a girl.' 你喜歡哪一個男孩? Which boy do you like? 我喜歡 <u>追女孩的那個男孩</u>。 'I like **the boy that is chasing the girl**.'		Obj	Subj

Four questions for the four types of relative clause listed above were designed, making up a total of 16 questions eliciting relative clauses in written Chinese.

The test was implemented as a written Chinese test in classroom settings. All children have 30 minutes to complete the test. Since the design of the paper employs the task of 'writing according to the picture', which is commonly used in teaching Chinese in primary schools in Hong Kong, no pre-test practice was given. Both typically developing and deaf children were given simple instruction like 'You have 30 minutes to finish the Chinese test paper. Please write down your name on top of the test paper'. While typically developing children received instruction in Cantonese, deaf children received instruction in Hong Kong Sign Language. Adults invited to serve as the reference group of this research also completed the test paper in a classroom setting. They generally needed less than 30 minutes to complete the test.

2.3 Results

2.3.1 *Adults*

Out of 400 responses produced by the adults, all but one were relative clauses. The average accuracy rate of the adult group was 96.50%. The accuracy rate of each adult ranged from 87.50% (14/16) to 100.00% (16/16). A total of 13 errors out of 399 RC responses were observed. These errors included wrong head error (6 tokens), omission of DE (3 tokens), use of wrong verb (2 tokens), and wrong thematic role (2 tokens):

(14) Wrong head error
親 爺爺　　 的 女孩
kiss grandfather DE girl
'the girl who is kissing grandfather.'
Target answer:
女孩 親 的 爺爺
girl　kiss DE grandfather
'the grandfather whom the girl is kissing.'

(15) Omission of DE
踢 醫生 那 個 廚師
kick doctor that CL chef
'the chef who kicked the doctor.'
Target answer:
踢 醫生 的 廚師
kick doctor DE chef
'the chef who kicked the doctor.'

(16) Use of wrong verb
被 女孩 推 的那 個 爺爺
BEI girl　push DE that CL grandfather
'the grandfather who was pushed by the girl.'
Target answer:
女孩 親 的 爺爺
girl　kiss DE grandfather
'the grandfather whom the girl is kissing.'

(17) Wrong thematic role
被 小丑 背　　　　 著 的 男孩
BEI clown carry-on-the-back ASP DE boy
'the boy who is carried on the back by the clown.' (the boy = patient)
Target answer:

背　　　　　　小丑 的 男孩
carry-on-the-back clown DE boy
'the boy who is carrying the clown on the back' (the boy = agent)

The errors were small in number and may be considered performance errors. The adults performed equally well for both subject and object relatives and hence no significant difference between the two types of relatives are observed.

2.3.2   *Typically developing Cantonese children*

2.3.2.1   *Adult-like RC responses.* The relative clauses produced by typically developing children constitute 65.11% (1865/2864) of all the responses. 87.24% (1627/1865) are adult-like RC responses. The overall accuracy rates of Groups 1, 2, 3 and 4 of typically developing children are 65.99%, 82.82%, 92.43%, and 97.25% respectively. The following examples list the target responses produced by these children:

(18)   推　小牛 的 小馬
push cow   DE horse
'the horse that is pushing the cow'   (Group 1: KWT; 7;5; P2)

(19)   罵　哥哥　　　的 (爺爺)
scold elder-brother DE (grandfather)
'(the grandfather) who is scolding elder-brother'   (Group 2: WHH; 7;1, P2)

(20)   被 弟弟　　　打 的 哥哥
BEI younger-brother hit DE elder-brother
'the elder brother who was beaten by the younger brother'   (Group 1: LLH; 8;6; P3)

(21)   被 (小牛) 親 的 小貓
BEI (cow)   kiss DE cat
'the cat that is kissed (by the cow).'   (Group 2: LCH; 10;8; P5)

Examples (18) to (21) list four types of target responses. Example (18) is the expected answer where the relative clause 推小牛的 'that is pushing the cow' is followed by the head noun 小馬 'the horse'. Example (19) exemplifies the type of target answer where head noun is null. Examples (20) and (21) are passive object relatives. Example (21), however, involves short passive where the subject of the passive is omitted.

The typically developing Cantonese children also produced some unexpected but grammatical relative clauses, ranging from the use of a different verb (example (22)) or a different NP (example (23)), generic noun (example (24)), locative phrase (example (25)) and BA construction (example (26)):

(22) 拉 著 小丑 的 男孩
pull ASP clown DE boy
'the boy who is pulling the clown.'   (Group 2: LYL; 7;10; P3)
Expected verb: 背 'carry one's on the back'

(23) 在 咬 哥哥　　 的 妹妹
ASP bite elder-brother DE younger-sister
'the younger sister who is biting the elder brother'   (Group 2: LYT; 9;3; P4)
Expected NP: 弟弟 'younger brother' instead of 哥哥 'elder brother'

(24) 咬 人　　 的 妹妹
bite person DE younger-sister
'the younger sister who is biting a person'   (Group 2: FPS; 8;7; P3)
Expected NP: 弟弟 'younger brother' instead of 人 'person'

(25) 在 爸爸 背　上的 弟弟
at father back on DE younger-brother
'The boy who is on the back of his father.'   (Group 4: SLY; 10;11; P6)
Expected answer: 爸爸背的弟弟'the younger brother that the father is
carrying on his back.'

(26) 把 小丑 背　　　　 在背　上 的 男孩
BA clown carry-on-the-back at back on DE boy
'the boy who is carrying the clown on his back'   (Group 4: WJ; 11;4; P6)
Expected answer: 背小丑的男孩 'the boy who is carrying the clown on the
back'

All these examples are counted as grammatical relative clauses. Now let us consider further whether subject-object asymmetry is present in the performance of typically developing Cantonese children. See the following table:

Table 4. Accuracy of grammatical relative clauses of typically developing Cantonese children

Groups	Number of children	Subject-gapped relatives	Object-gapped relatives
1	47	108/151 (71.52%)	86/143 (60.14%)
2	48	191/228 (83.77%)	185/226 (81.86%)
3	50	285/301 (94.68%)	277/307 (90.23%)
4	34	253/256 (98.83%)	242/253 (95.65%)

The percentage is slightly higher for subject-gapped relatives. Paired sample t-tests show that there is no significant difference between subject-gapped and object-gapped relatives to be observed for all groups. The subject advantage is non-significant.

2.3.2.2 *Non-adult-like RC.* Typically developing Cantonese children also produce non-adult-like relative clauses. Nine types of non-adult-like relative clauses are observed and the occurrences of these responses are summarized in Table 5 below:

Table 5. Non-adult-like relative clauses produced by typically developing Cantonese children

Types		Subject-gapped relatives	Object-gapped relatives	Total
(i)	Omission of DE	57/99 (57.58%)	31/139 (22.30%)	88/238 (36.97%)
(ii)	Missing constituents in RC	8/99 (8.08%)	28/139 (20.14%)	36/238 (15.13%)
(iii)	Resumptive NP	19/99 (19.19%)	17/139 (12.23%)	36/238 (15.13%)
(iv)	Wrong head	12/99 (12.12%)	31/139 (22.30%)	43/238 (18.07%)
(v)	Wrong RC arguments	0/99 (0.00%)	3/139 (2.16%)	3/238 (1.26%)
(vi)	Wrong thematic role	1/99 (1.01%)	7/139 (5.04%)	8/238 (3.36%)
(vii)	Use of Cantonese *bei2*	1/99 (1.01%)	3/139 (2.16%)	4/238 (1.68%)
(viii)	Combinations of errors above	1/99 (1.01%)	19/139 (13.67%)	20/238 (8.40%)

Note. The ninth type of errors 'Combinations of errors above' involving combinations of (i) and (ii), (i) and (iii), (i) and (iv), (ii) and (iv), (iv) and (v) or (iv) and (vi).

Generally speaking, more non-adult-like responses occur with object-gapped relatives than subject-gapped relatives. Omission of DE, missing constituents in RC, resumptive NP and wrong head are four major errors occurring with both subject-gapped and object-gapped relatives, as shown in the following examples:

(27) Omission of DE
  a. child form
    背　　　　　小丑 那　個 男孩
    carry-on-the-back clown that CL boy
    'the boy who is carrying the clown on the back'
    (Group 1: CHY; 6;11; P2)
  b. adult form
    背　　　　　小丑 的 男孩
    carry-on-the-back clown DE boy
    'the boy who is carrying the clown on the back'

(28) Missing constituent in RC
  a. child form
    背　　　　　的 那　個
    carry-on-the-back DE that CL
    '(the younger brother) that (the father) is carrying on the back'
    (Group 2: SYT; 7;2; P2)

    b.   adult form
       爸爸 背　　　　　 的 那 個 弟弟
       father carry-on-the-back DE that CL younger-brother
       'The younger brother that the father is carrying on the back'

(29) Resumptive NP
    a.   child form
       小牛 在 親 小貓 的 小貓
       cow ASP kiss cat　 DE cat
       'the cat that the cow is kissing'　　　　　　(Group 1: LHT; 7;9; P3)
    b.   adult form
       小牛 親 的 小貓
       cow kiss DE cat
       'the cat that the cow is kissing'

(30) Wrong head
    a.   child form
       在 親 爺爺　　　 的 女孩
       ASP kiss grandfather DE girl
       'the girl who is kissing the grandfather'　　　　(Group 1: CN; 7;2; P2)
    b.   adult form
       女孩 親 的 爺爺
       girl kiss DE grandfather
       'the grandfather whom the girl is kissing'

These errors largely occur with children with lower Chinese proficiency, as shown in the following table:

Table 6. Major errors and proficiency level of typically developing Cantonese children

Groups	Omission of DE	Missing constituent in RC	Resumptive NP	Wrong head
1	45/88 (51.14%)	11/36 (30.56%)	22/36 (61.11%)	9/43 (20.93%)
2	35/88 (39.77%)	11/36 (30.56%)	8/36 (22.22%)	12/43 (27.91%)
3	6/88 (7.95%)	12/36 (33.33%)	6/36 (16.67%)	13/43 (30.23%)
4	1/88 (1.14%)	2/36 (5.56%)	0/36 (0.00%)	9/43 (20.93%)

Omission of DE occurs most often with Groups 1 and 2. Missing constituent in RC occurs almost evenly in Groups 1, 2 and 3. But it is a rare error for Group 4. Resumptive NP errors occur only in Groups 1, 2 and 3. Wrong head errors occur in all groups and the number of tokens is similar for four groups of children. Note that omission of DE may be resulted from Cantonese transfer. Cantonese relatives may be divided into classifier relatives and *ge3* relatives. Classifier relatives have

the order RC-that-CL. *Ge3* relatives are like Mandarin relatives marked with DE, but they are less commonly used. The order in example (27) resembles classifier relatives in Cantonese. Since the normal-hearing schoolchildren studied in this paper are all Cantonese monolinguals, it is not surprising to see Cantonese influence on their production in written Chinese where Mandarin grammar is used.[3]

2.3.2.3   *Non-RC responses.* The typically developing Cantonese children may not always produce relative clauses in the written test. Some of them left the blanks unfilled. Others produced unfinished or unintelligible responses. Few filled in locative phrase or wh-phrases. The major type non-RC responses are determiner phrases and simple declaratives. The following table summarizes the distribution of different types of non-RC responses produced by the typically developing Cantonese children.

Table 7. Types of non-RC responses produced by typically developing Cantonese children

Types		Total
(i)	Unfilled blanks	286/999 (28.63%)
(ii)	Unfinished 一隻小狗被小貓 'a dog was XXX by a cat'	8/999 (0.80%)
(iii)	Unintelligible 比小馬的小馬 '?than a horse's horse'	3/999 (0.30%)
(iv)	Locative phrase 在圖中 'in the picture'	8/999 (0.80%)
(v)	Wh-phrase 哪隻狗 'which dog'	2/999 (0.20%)
(vi)	Determiner phrase 小狗 'the dog'; 一個爺爺 'one grandfather'; 這個男孩 'this boy'; 第一個男孩 'the first boy'	415/999 (41.54%)
(vii)	Simple declarative 一個妹妹在推姐姐 'One younger sister is pushing the elder sister.'	277/999 (27.73%)

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3. Cantonese is the spoken language used by 90% of the population in Hong Kong. But Hong Kong people are literate in standard written Chinese which is based on Mandarin. See Yip & Matthews (2007) for a description of the Hong Kong speech community.

As shown in Table 7, the major non-RC responses are determiner phrase and simple declarative. See the following examples:

(31) Determiner phrase containing demonstrative
   a. child form
      這　隻 白兔
      this CL rabbit
      'This rabbit'   (Group 1: MHK; 7;1; P2)
   b. adult form
      小貓 罵　　的 白兔
      cat　scold DE rabbit
      'the rabbit that the cat is scolding'

(32) Determiner phrase containing ordinal
   a. child form
      第一個 廚師
      the-first cook
      'the first cook'   (Group 3: WCK; 7;2; P2)
   b. adult form
      踢　醫生　的 廚師
      kick doctor DE cook
      'the cook who is kicking the doctor'

(33) Simple declarative
   a. child form
      一　隻 小豬 在 追　　小象
      one CL pig　at chase elephant
      'a pig is chasing an elephant'   (Group 3: KCM; 11;7, P6)
   b. adult form
      追　　小象　　的 小豬
      chase elephant DE pig
      'the pig that is chasing the elephant'

The occurrence of non-RC responses is also tied to the children's Chinese proficiency level:

Table 8. Types of non-RC responses produced by different groups of typically developing Cantonese children

Types		Group 1	Group 2	Group 3	Group 4
(i)	Unfilled blanks	189/286 (66.08%)	69/286 (24.13%)	28/286 (9.79%)	0/286 (0.00%)
(ii)	Unfinished	0/8 (0.00%)	4/8 (50.00%)	4/8 (50.00%)	0/8 (0.00%)
(iii)	Unintelligible	2/3 (66.67%)	1/3 (33.33%)	0/3 (0.00%)	0/3 (0.00%)
(iv)	Locative phrase	8/8 (100.00%)	0/8 (0.00%)	0/8 (0.00%)	0/8 (0.00%)
(v)	Wh-phrase	1/2 (50.00%)	1/2 (50.00%)	0/2 (0.00%)	0/2 (0.00%)
(vi)	Determiner phrase	137/415 (33.01%)	138/415 (33.25%)	122/415 (29.40%)	18/415 (4.34%)
(vii)	Simple declarative	121/277 (43.68%)	101/277 (36.46%)	38/277 (13.72%)	17/277 (6.14%)
	Total number of non-RC responses	458/999 (45.85%)	314/999 (31.43%)	192/999 (19.22%)	35/999 (3.50%)

The non-RC responses largely occur with Group 1 (45.85%) and 2 (31.43%). The number is smaller for the groups of higher Chinese proficiency. Group 3 produced 19.22% of non-RC responses while Group 4 only produced 3.50%. The frequency of the use of a determiner phrase in place of a relative clause is generally high for Group 1 (33.01%), Group 2 (33.25%) and Group 3 (29.40%), but not for Group 4 (4.34%). The use of simple declaratives clusters in Group 1 (43.68%) and Group 2 (36.46%).

2.3.3   *Deaf children*

2.3.3.1 *RC responses and errors.* A total of 368 responses were collected from the written test. The majority of answers (77.99%, 287/368) do not contain relative clauses. Only 81 out of 368 (22.01%) are RC responses. The overall accuracy rate of the group 'Below Group 1', Groups 1, 2, and 3 are 0.00%, 53.13%, 6.25% and 77.08% respectively. However, all the RC responses are produced by 8 out of 23 deaf children. Three of them are deaf children of deaf parents (i.e. DD) and four of them have hearing parents. Their performance demonstrates individual differences. The accuracy rate varies from 12.50% to 100.00%. The performance of these children is given below:

Table 9. Performance of deaf children who produced responses containing relative clauses[4]

Groups	Deaf children	Parents	Chrono-logical age	Hearing age	Tokens of Adult-like RCs	Tokens of non-adult-like RCs	Accuracy
1	C3-1-CKY	Hearing	10;5	8;3	14/16	2/16	87.50%
1	C3-6-TSM	Hearing	10;1	9;6	10/16	0/16	62.50%
1	C4-1-CNW	Deaf	9;4	8;1	2/16	0/16	12.50%
1	C4-5-GTC	Deaf	9;6	9;0	8/16	4/16	50.00%
2	C2-6-WSY	Hearing	12;7	12;4	2/16	0/16	12.50%
3	C1-1-CTY	Hearing	11;10	11;1	7/16	0/16	43.75%
3	C5-3-PTY	Hearing	9;1	5;6	16/16	0/16	100.00%
3	C1-4-SMC	Deaf	13;0	12;6	15/16	1/16	93.75%

All deaf children from Group 3 produced RC responses. But not all deaf children from other groups produced relative clauses. 1 out of 3 deaf children from Group 2 and 4 out of 14 deaf children from Group 3 produced relative clauses. None of the deaf children whose Chinese proficiency is below Group 1 produced any relative clauses. When relative clauses were produced, they were in most cases correct. Four deaf children, C1-4-SMC (Group 1), C2-6-WSY (Group 2), C3-1-CKY (Group 1) and C4-5-GTC (Group 1), produced non-adult-like Chinese relative clauses. But the number was small; only 13 tokens of non-adult-like Chinese relative clauses were produced, as exemplified in the following examples:

(34) RC introduced by determiner and copular verb (6 tokens, all produced by
       C3-6-TSM, hearing age 9;6)
   a.   child form
        這 是 被 小貓 罵　 的 白兔
        this is BEI cat　 scold DE rabbit
        'this is the rabbit who is scolded by the cat'
   b.   adult form
        小貓 罵　 的 白兔
        cats　 cold DE rabbit
        'the rabbit that the cat scolded'

---

4. As noted earlier, deaf children were named in research codes under the Jockey Club Sign Bilingualism and Co-enrolment in Deaf Education Programme. In Table 9, deaf children were referred to with these codes in the column 'Deaf children'.

(35) Missing constituent (2 tokens, 1 produced by C1-4-SMC, 1 produced by C2-6-WSY)
    a.   child form
        在 背　　　　　　的 小男孩　　　　(C1-4-SMC, hearing age 13;0)
        ASP carry-on-the-back DE little-boy
        'the boy who carries (someone) on the back'
    b.   adult form
        背　　　　　　小丑 的 男孩
        carry-on-the-back clown DE boy
        'the boy who carries a clown on the back'

(36) Wrong head error (2 tokens, all produced by C3-1-CKY, hearing age 8;3)
    a.   child form
        親 爺爺　　　的 女孩
        kiss grandfather DE girl
        'the girl who kissed the grandfather'
    b.   adult form
        女孩 親 的 爺爺
        girl　kiss DE grandfather
        'the grandfather whom the girl kissed.'

(37) Resumptive NP error (3 tokens, all produced by C4-5-GTC, hearing age 9;0)
    a.   child form
        一 隻 綿羊 在 踢　小狗 的 小狗
        one CL sheep ASP kick dog　DE dog
        'the dog that the sheep kicked'
    b.   adult form
        綿羊 踢　的 小狗
        sheep kick DE dog
        'the dog that the sheep kicked'

The examples above illustrate different error types of RC responses given by deaf children. The error types include (i) RC introduced by determiner and copular verb, (ii) missing object in relative clauses, (iii) wrong head error, and (iv) resumptive NP error. Except for (i), all these errors have also been reported in the acquisition of Mandarin relative clauses (Hsu et al. 2009). These errors are also the major errors observed from the performance of typically developing Cantonese children in this study.

2.3.3.2 *Subject-object asymmetry?*. The data does not show any tendency for deaf children to perform better with subject-gapped relatives than with object-gapped relatives, as shown in the following table:

Table 10. Accuracy of subject-gapped and object-gapped relative clauses produced by deaf children

Groups	Children	Subject-gapped	Object-gapped
1	C3-1-CKY	7/8 (87.50%)	7/8 (87.50%)
1	C3-6-TSM	5/8 (62.50%)	5/8 (62.50%)
1	C4-1-CNW	2/8 (25.00%)	0/8 (0.00%)
1	C4-5-GTC	5/8 (62.50%)	3/8 (37.50%)
2	C2-6-WSY	0/8 (0.00%)	2/8 (25.00%)
3	C1-1-CTY	3/8 (37.50%)	4/8 (50.00%)
3	C5-3-PTY	8/8 (100.00%)	8/8 (100.00%)
3	C1-4-SMC	7/8 (87.50%)	8/8 (100.00%)

Three deaf children, C3-1-CKY, C3-6-TSM, and C5-3-PTY, performed equally well with subject-gapped and object-gapped relative clauses. Three deaf children, C1-4-SMC, C1-1-CTY, and C2-6-WSY performed better with object-gapped relative clauses and two deaf children, C4-1-CNW and C4-5-GTC, performed better with subject-gapped relative clauses. Their performance does not relate to their Chinese proficiency.

2.3.3.3 *Non-RC responses.* Recall that most deaf children did not produce responses containing relative clauses. When we look at the data more closely, we see that some children did not fill in their answers. Other non-RC responses are use of determiner phrase, simple declaratives, wh-questions, or biclausal sentences. The following table shows the distribution of different types of non-RC responses:

Table 11. Distribution of different types of non-RC responses produced by deaf children

Non-RC responses	Examples	Tokens (Percentage)
Unfilled blanks	N/A	13/281 (4.63%)
Determiner Phrase	一個女孩 'a girl'	21/281 (7.47%)
Simple declaratives	一個男孩在追女孩 'a boy is chasing a girl'	225/281 (80.07%)
Wh-phrase	哪一個男孩 'which boy'	16/281 (5.69%)
Biclausal sentences	女孩，因為她很乖 'a girl, because she is well-behaved'	6/281 (2.14%)

Note. The expected answer is 追女孩的男孩 'the boy who chased the girl' of all the non-RC-responses listed in the table.

Non-RC responses are largely in the form of simple declaratives. Other types of non-RC responses are small in number. The use of wh-question and biclausal sentences are errors each produced by one particular student. Though use of biclausal sentences is not observed with typically developing Cantonese children in this study, this non-RC response has been reported in the literature. So the types of non-RC responses produced by deaf children are also types of non-RC responses produced by typically developing children.

3.   Experiment 2: Comprehension tests

3.1 Participants

The participants in Experiment 2 are the same as those in Experiment 1. The three groups of participants, (i) adults, (ii) typically developing children and (iii) deaf children, were asked to do the written test on the comprehension of relative clauses after Experiment 1.

3.2 Method and test procedures

Two comprehension tests were designed to explore children's comprehension of Chinese relative clauses. Diessel & Tomasello (2005) note that relative clauses occurring in copular construction are easier than those occurring in main clause construction. In order to get a fuller picture of children's knowledge of Chinese relative clauses, the test sentences consist of both copular construction and main clause construction and these two forms of constructions are tested with two comprehension tasks.

Copular construction is tested with a picture selection task where children are asked to select the picture that matches the meaning of the test sentence. They may indicate that they cannot determine the answer by circling the question mark in the question. The following figure shows a sample question on the picture selection task:

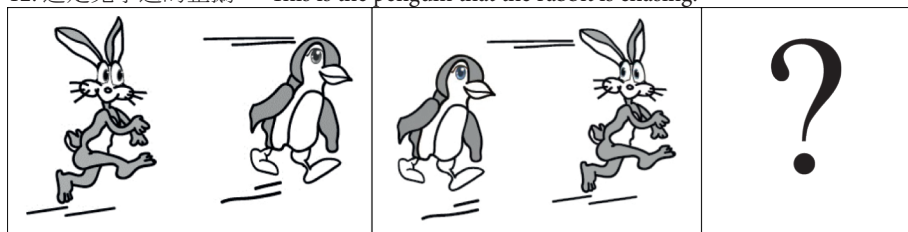12. 這是兔子追的企鵝。 'This is the penguin that the rabbit is chasing.'

Figure 2. Sample question of picture selection task on copular construction

The picture selection task contains four subject-gapped and four object-gapped relative clauses and seven fillers, making up a total of 15 questions.

Though it is possible to use the same task to examine children's comprehension of relative clauses in main clause construction, it is difficult to present two events (one for the main clause and the other for the relative clause) in one picture, especially when the two events are more naturally presented in sequence (e.g. 踢小馬的小羊在打小狗 'The sheep that kicked the horse is hitting the dog.'). Even if we can design items which involve synchronized events, the picture would become very complex, thus adding processing load in doing the task. Therefore a different task, dots-connecting task, is designed to investigate children's comprehension of relative clauses in main clause construction. The dots-connecting task consists of two subtests, one for test sentences in subject condition and one for object condition. In both subtests, a context is provided at the beginning of the task. (See (38) below):

(38) a. Subject condition
森林裡有不同的動物，牠們都喜歡不同的水果。請根據句子，用直線把圖片和相應的水果連起來。
'There are different animals in the forest. These animals like different kinds of fruit. Connect the dots of the picture and the right fruit with a line according to the sentence pairs.'

  b. Object condition
小文喜歡一些動物，又不喜歡另一些動物。請根據句子，用直線把小文和相應的動物連起來。
'John likes some animals and he dislikes other animals. Connect the dots of the picture of John and the right animal according to the sentence pairs.'

In both subtests, four sentence pairs are subject-gapped and four pairs are object-gapped. See the following figures for a sample question in the two subtests:[5]

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[5] One anonymous reviewer suggests a picture mask may be added in this task so that higher test accuracy can be achieved. Further research will explore how the dots-connecting task can be improved.
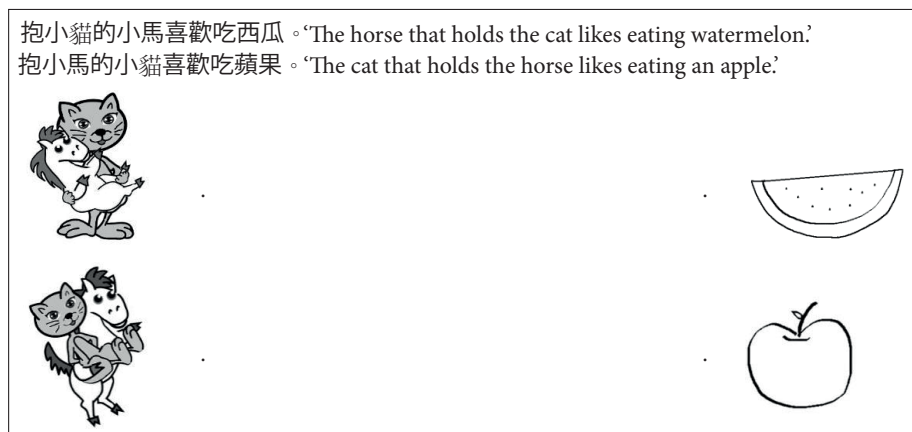
抱小貓的小馬喜歡吃西瓜。'The horse that holds the cat likes eating watermelon.'
抱小馬的小貓喜歡吃蘋果。'The cat that holds the horse likes eating an apple.'

Figure 3. Sample question of dots-connecting task for subject condition

小文不喜歡打熊貓的小狗。'John dislikes the dog that hits the panda.'
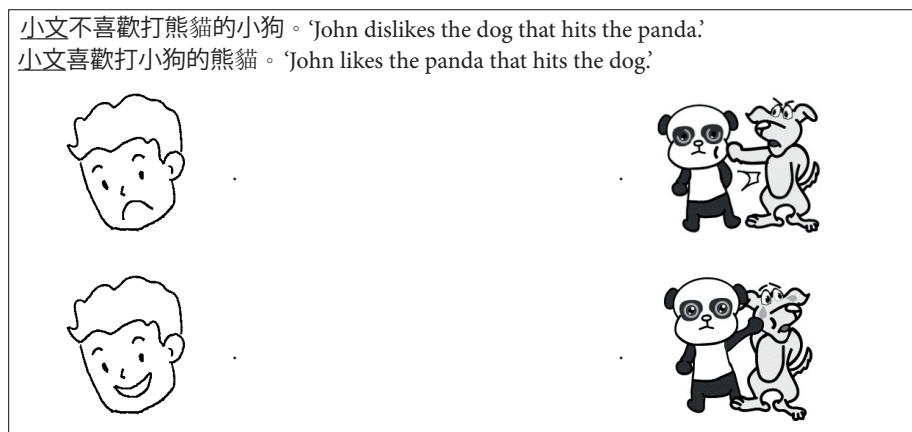小文喜歡打小狗的熊貓。'John likes the panda that hits the dog.'

Figure 4. Sample question of dots-connecting task for object condition

The participants need to connect the dots of the relative clause on one side to the object in the matrix clause on the other side. Take the sample question of the dots-connecting task for subject position as an example. After reading the first sentence containing a relative clause (i.e. 抱小貓的小馬喜歡吃西瓜。 'The horse that holds the cat likes eating watermelon.'), the participants need to identify the right picture on the left that describes the relative clause (the lower picture in this case). Then he/she needs to identify the object in the matrix clause on the right (upper picture in this case). Then he/she connects the dots of the two pictures (as shown in Figure 5 below).
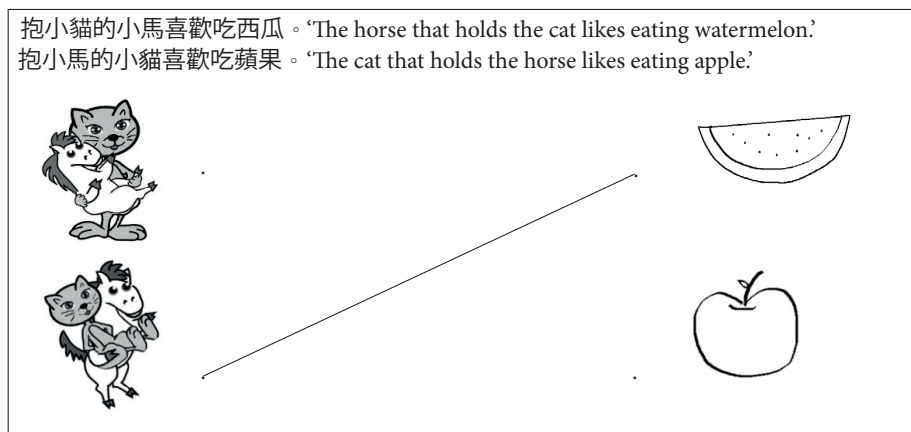
抱小貓的小馬喜歡吃西瓜。'The horse that holds the cat likes eating watermelon.'
抱小馬的小貓喜歡吃蘋果。'The cat that holds the horse likes eating apple.'

Figure 5. An example of how a dots-connecting task is done.

Similar to the elicited production task, this test was also implemented as a written Chinese test in classroom settings. All the children have 30 minutes to complete the test. Since circling the right answer in the picture description task and the dots-connecting task are common exercises children do in schools, no pre-test practice was given. Instruction given to different groups of participants are the same as that in the elicited production task.

3.3 Results

3.3.1 *Adults*

Similar to the production task, the adult group generally performed very well. Consider the picture selection task first. Except for four adults who answered one or two questions incorrectly, the remaining adults all reached 100% accuracy in this task. The overall accuracy rate was 96.00%. High accuracy rates for both subject and object relatives was observed. The two types of relative clause were not significantly different. The adult group also performed well in the dots-connecting task. The overall accuracy rate was 98.25%. Nineteen adults answered all the questions correctly. Five adults gave a wrong answer to the question. One adult made two wrong answers. Still, the accuracy was generally high, ranging from 87.50% to 100.00%. The number of wrong answers was almost equal in subject condition and object condition. While 3 wrong answers were found in subject condition questions, 4 wrong answers were observed in object condition questions. In sum, the adult group performed well in both comprehension tasks and no subject-object asymmetry in the performances observed.

3.3.2   *Typically developing Cantonese children*

The overall accuracy rate of the picture description task was high. The accuracy rate for Groups 1, 2, 3, and 4 were 77.13%, 82.55%, 89.75% and 94.12% respectively. The typically developing Cantonese children performed significantly better with object-gapped relatives (680/716, 96.23%) than subject-gapped relatives (533/716, 74.44%) in the picture selection task ($t(178) = -9.296$, $p = 0.000$). Now consider the performance of each group of children:

Table 12. Typically developing Cantonese children's performance in picture selection task

Groups	Number of children	Subject-gapped relatives	Object-gapped relatives
1	47	113/188 (60.11%)	177/188 (94.15%)
2	48	135/192 (70.31%)	182/192 (94.79%)
3	50	164/200 (82.00%)	195/200 (97.50%)
4	34	121/136 (88.97%)	135/136 (99.26%)

Accuracy of object-gapped relatives was significantly higher than subject-gapped relatives for all groups (Group 1: $t(46)= -5.808$, $p = 0.000$; Group 2: $t(47)= -5.520$, $p = 0.000$; Group 3: $t(48) = -4.023$, $p = 0.000$; Group 3: $t(33) = -3.943$, $p = 0.000$), suggesting the object advantage in comprehending relatives. No such advantage was observed with adult participants. The gap between the accuracy of the two types of relatives, however, was narrow for Groups 3 and 4 children who have higher Chinese proficiency.

The overall accuracy rate of the dots-connecting task was also very high. The overall accuracy for Groups 1, 2, 3, and 4 was 78.99%, 84.24%, 92.63% and 95.77% respectively. The results on the dots-connecting task also showed that object-gapped relatives were produced slightly better than subject-gapped relatives. In subject condition, the accuracy rate of object-gapped relatives was 95.25% (682/716) while that of subject-gapped relatives was 85.20% (610/716). In object condition, the accuracy rate of object-gapped relatives was 87.99% (630/716), and that of subject-gapped relatives was 81.15% (581/716). Consider the performance of each group of children:

Table 13. Typically developing Cantonese children's performance in dots-connecting task

Groups		Subject condition		Object condition	
	Number of children	Subject-gapped relatives	Object-gapped relatives	Subject-gapped relatives	Object-gapped relatives
1	47	143/188 (76.06%)	171/188 (90.96%)	128/188 (68.09%)	152/188 (80.85%)
2	48	156/192 (81.25%)	181/192 (94.27%)	143/192 (74.48%)	167/192 (86.98%)
3	50	182/200 (91.00%)	194/200 (97.00%)	181/200 (90.50%)	184/200 (92.00%)
4	34	129/136 (94.85%)	136/136 (100.00%)	129/136 (94.85%)	127/136 (93.38%)

Table 13 shows that object-gapped relatives are always performed better. It is true for both subject condition and object condition and for all levels of children. Paired sample t-test also shows that the two types of relative clauses are significantly different in both subject condition ($t(178) = -6.637$, $p = 0.000$) and in object condition ($t(178) = -3.068$, $p = 0.002$).

3.3.3   *Deaf children*

Deaf children generally perform better in the two comprehension tasks than in the production task. Object advantage is observed with deaf children in the picture selection task. The average accuracy with subject-gapped relatives is 76.09% (70/92) and that with object-gapped relatives is 92.39% (85/82). Paired sample t-test shows that there is a significant difference between subject-gapped and object-gapped relatives ($t(22) = -2.343$, $p = 0.029$), suggesting subject-object asymmetry in comprehending Chinese relative clauses.

But if we examine the performance by each group of deaf children, the object advantage is linked with deaf children's Chinese proficiency, as shown in Table 14 below:

Table 14. Deaf children's performance in picture selection task

Groups	Number of children	Subject-gapped relatives	Object-gapped relatives
Below Group 1	3 (1DD)	4/12 (33.33%)	11/12 (91.67%)
1	14 (2DD)	42/56 (75.00%)	53/56 (94.64%)
2	3 (1DD)	12/12 (100.00%)	10/12 (83.33%)
3	3 (1DD)	12/12 (100.00%)	11/12 (91.67%)

Table 14 shows that the two groups with the lowest proficiency (i.e. Below Group 1 and Group 1) performed better with object-gapped relatives than subject-gapped relatives. Groups 2 and 3 children who have higher levels of Chinese proficiency performed slightly better with subject-gapped relatives.

On the other hand, no significant difference between subject-gapped and object-gapped relatives is observed in the dots-connecting task. Deaf children performed well with both subject-gapped and object-gapped relative clauses in main clause construction. The average accuracy rates for subject-gapped and object-gapped relatives are 79.35% (73/92) and 83.70% (77/92) in subject condition and are 86.58% (71/92) and 72.83% (67/92) in object condition. The following table summarizes deaf children's performance in the dots-connecting task:

Table 15. Deaf children's performance in dots-connecting task

Groups		Subject condition		Object condition	
	Number of children	Subject-gapped relatives	Object-gapped relatives	Subject-gapped relatives	Object-gapped relatives
Below Group 1	3 (1DD)	6/12 (50.00%)	9/12 (75.00%)	7/12 (58.33%)	8/12 (66.67%)
1	14 (2DD)	44/56 (78.57%)	46/56 (82.14%)	42/56 (75.00%)	36/56 (64.29%)
2	3 (1DD)	12/12 (100.00%)	10/12 (83.33%)	11/12 (91.67%)	11/12 (91.67%)
3	3 (1DD)	11/12 (91.67%)	12/12 (100.00%)	11/12 (91.67%)	12/12 (100.00%)

Consider the subject condition first. Deaf children from the groups 'Below Group 1' and Group 1 performed slightly better with object-gapped relatives. But deaf children from Group 2 performed better with subject-gapped relatives. Deaf children from Group 3 performed equally well with the two types of relatives. In object condition, deaf children from the group 'Below Group 1' performed better with object-gapped relatives. This group of deaf children performed similarly in both subject condition and object condition. Deaf children from Group 2, however, performed slightly better with subject-gapped relatives. This is opposite to their performance in subject condition. Deaf children from Groups 2 and 3 performed equally well for two types of relatives in object condition. In sum, the results on deaf children's comprehension of relative clauses show that deaf children with lower Chinese proficiency tend to perform better with object relatives in both copular construction and main clause construction.

4. Overall results

Generally speaking, typically developing Cantonese children's performance on both comprehension and production of relative clauses improve as their Chinese proficiency improves. Deaf children's performance, on the other hand, demonstrates a high degree of variability. The following figure summarizes the performance of each group of participants in the comprehension task (i.e. picture description task and dots-connecting task) and production task (i.e. elicited production task).

	Below Group 1	Group 1	Group 2	Group 3	Group 1	Group 2	Group 3	Group 4	Adults
		Deaf children			Typically-developing Cantonese children				
EP	0.00%	53.13%	6.25%	77.08%	65.99%	82.82%	92.43%	97.25%	96.50%
PD	62.50%	84.82%	91.67%	95.83%	77.13%	82.55%	89.75%	94.12%	96.00%
DC	62.50%	75.00%	91.67%	95.83%	78.99%	84.24%	92.63%	95.77%	98.25%
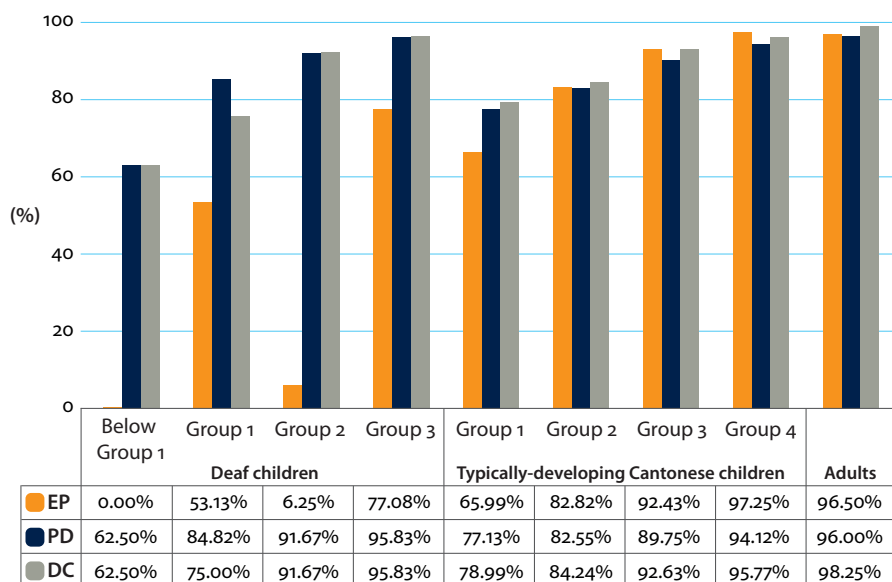
Figure 6. Performance of each group of participants in elicited production task (EP), picture selection task (PS) and dots-connecting task (DC)

Figure 6 shows that deaf children perform much better with the two comprehension tasks than the production task. This suggests that deaf children do have the knowledge of relative clauses. But they still need more time to reach native-like proficiency. The gap between comprehension and production is small for the group of typically developing Cantonese children. The performance of Groups 3 and 4 of typically developing Cantonese children is also very close to the adults' performance, suggesting that Chinese relative clauses are acquired. A caveat has to be noted here. The number of deaf children in Below Group 1, Group 2, and Group 3 is very small. There are only three deaf children in each of these groups. The comparison between deaf children and typically developing Cantonese children could be misleading given the small number of deaf children. Statistical

comparison is also not possible except for Group 1 of deaf children and Group 1 of typically developing children. However, no significant difference is found in these two groups of children.

Subject-object asymmetry in children's performance with relative clauses has been widely discussed. A related question is whether different groups of participants demonstrate subject-object asymmetry in their use of relative clauses. Adult accuracy rate is high for both subject-gapped relatives and object-gapped relatives. No subject-object asymmetry is observed. A non-significant subject advantage is observed with typically developing Cantonese children. Deaf children, demonstrate a high degree of diversity in their performance. Only eight deaf children (four from Group 1, one from Group 2, three from Group 3) produced adult-like relative clauses. As noted above, three of them performed equally well with both types of relative clause. Three demonstrate object advantage and two subject advantage. The result is too diverse to draw a conclusion for the group of deaf children.

As noted in the earlier section, both typically developing Cantonese children and deaf children made a considerable number of non-RC responses. They also made various kinds of errors. A question arises here as to whether the non-RC responses and errors made by the deaf children are the same as or different from those produced by typically developing Cantonese children. A comparison of the error types and non-RC responses produced by the two groups of children can help us to determine whether the development of relative clauses by deaf children deviates from that by typically developing children.

Consider the error types first. Figures 7a and b demonstrate the distribution of error types produced by deaf children and by typically developing Cantonese children. As noted above, deaf children tend to give a correct answer when an RC is produced. So the number of errors is as small as 13. The types of errors are also limited. Typically developing Cantonese children, on the other hand, produced a wider range of error types. Except for the error 'Use of Cantonese *bei2*' which is produced only by students from Group 1, all error types are produced by students with different levels of Chinese proficiency. In general, almost all the error types produced by deaf children are also error types produced by typically developing Cantonese children. The only error that is specific to deaf children is the error 'RC introduced by a determiner and a copular verb'. But this error type is produced by only one deaf child. So this error type may not represent a deaf-specific error. The comparison suggests that deaf children do not behave differently from the typically developing children as far as the error types are concerned.
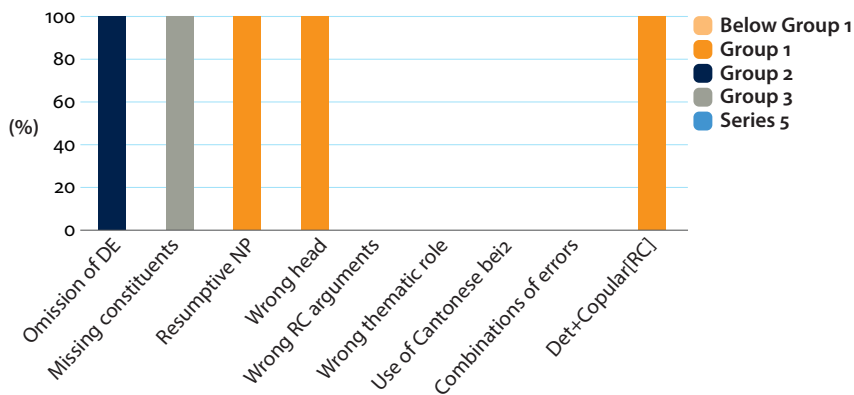
a. Deaf children
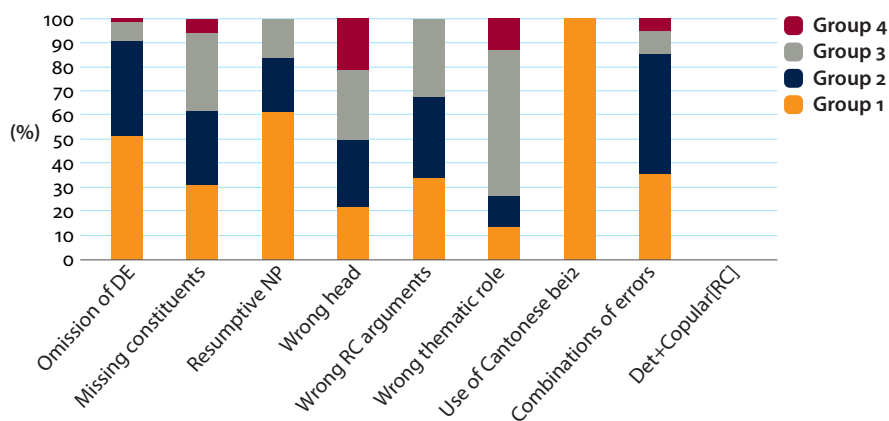
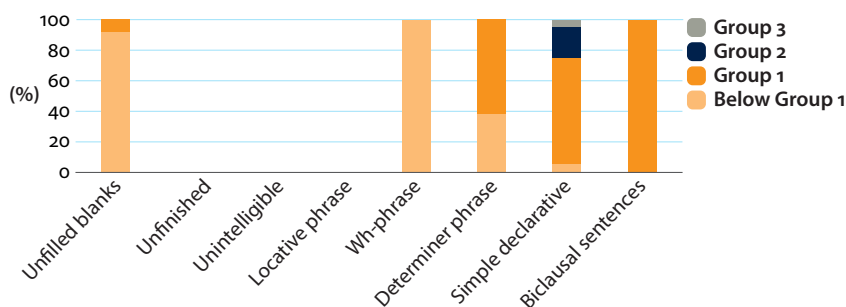**b.** Typically developing Cantonese children

Figure 7. Distribution of error types produced by deaf children and typically developing Cantonese children

Note. Det+Copular [RC] refers to the type of answer where the student introduce the RC by a determiner and a copular verb (e.g. 這是被小貓罵的白兔不開心 'This is the rabbit who is scolded by the cat and it is unhappy.')

Both groups of children also produced non-RC responses. There are eight types of non-RC responses observed: (i) unfilled blanks, (ii) unfinished answer, (iii) un-intelligible answer, (iv) use of locative phrase, (v) use of wh-phrase, (vi) use of determiner phrase, (vii) use of simple declarative, and (viii) use of biclausal sentences. Figures 7a and 7b demonstrate the distribution of these non-RC responses in the two groups of children. Deaf children with lowest Chinese proficiency tend to leave the answer unfilled. Deaf children with higher proficiency may use simple declaratives and determiners in place of RC responses. Typically developing Cantonese children produce a wide range of non-RC responses. The variety of

non-RC responses produced by typically developing Cantonese children is wide. But the range is smaller as Chinese proficiency increases. The types of non-RC responses produced by deaf children are also the types produced by typically developing Cantonese children except for the use of biclausal sentences. As noted in the previous section, this error type has been reported in the literature, so it is not a deaf-specific error. The results suggest that deaf children do not undergo a different pathway in the development of Chinese relative clauses.

a. Deaf children
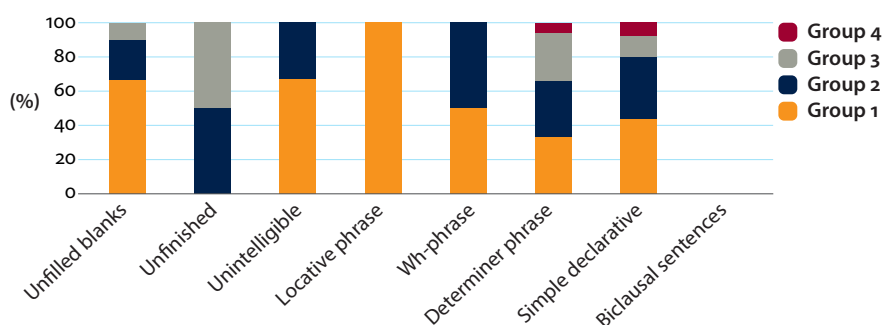
b. Typically developing Cantonese children

Figure 8. Distribution of non-RC responses produced by deaf children and typically developing Cantonese children

As noted in the previous section, only a small number of deaf children produced RC responses. Avoidance may therefore blur the picture of whether typically developing Cantonese and deaf children have the knowledge of Chinese relative clauses. The results from the comprehension tasks may give us a fuller picture. The accuracy rate of the comprehension tasks is generally high for both typically developing Cantonese children and deaf children. Consider the results further with the following figures:
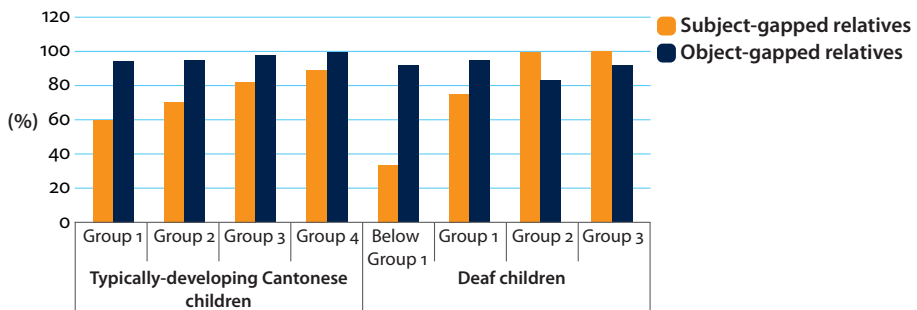
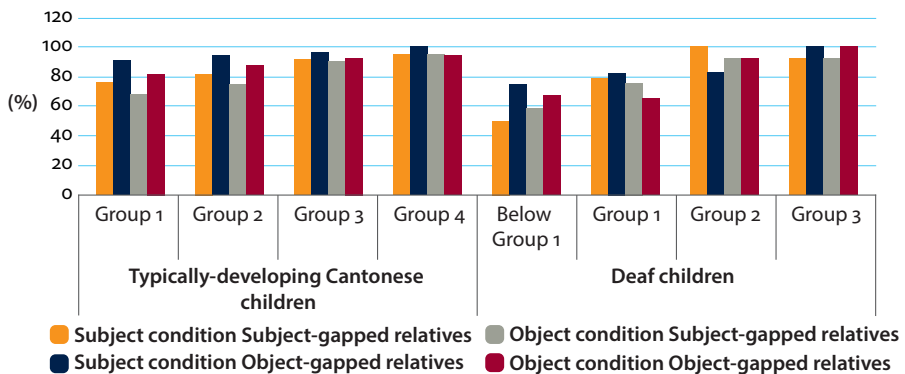**Figure 9.** Performance of picture description task

Figure 10. Performance of dots-connecting task

Figure 9 shows that typically developing Cantonese children at all levels of Chinese proficiency perform better with object-gapped relatives in the picture selection task. The performance by deaf children, on the other hand, is more diverse. Deaf children with lower Chinese proficiency (i.e. Below Group 1 and Group 1) perform better with object-gapped relatives. Deaf children with higher Chinese proficiency (i.e. Groups 2 and 3) perform better with subject-gapped relatives. This is opposite to the performance of typically developing Cantonese children. When we look at the results of dots-connecting task in Figure 10, a different picture can be seen. In subject condition, object-gapped relatives are performed better except for Group 2 of deaf children. The picture with object condition is more diverse. Typically developing Cantonese children from Groups 1 and 2 perform better with object-gapped relatives in object condition. But the performance with both types of relatives is close for typically developing Cantonese children from Groups 3 and 4. The performance with deaf children is more diverse. Object-gapped relatives are performed better by deaf children from Below Group 1 and Group 4. Subject-gapped relatives are performed better by deaf children from Group 1, contrasting with the typically developing Cantonese children with the same level of proficiency. Both

subject-gapped and object-gapped relatives are performed equally well for deaf children from Group 2. The following table summarizes whether object advantage is present in different tasks and in different groups of children:

Table 16. Object advantage shown in different tasks

Tasks	Typically developing Cantonese children	Deaf children
Elicited production	No (non-significant subject advantage)	No
Picture selection	Yes	Yes
Dots-connecting	Yes	No

Object advantage is observed with both comprehension tasks, but not for elicited production task for typically developing Cantonese children. On the other hand, object advantage is only observed from the picture selection task for deaf children. No asymmetry is observed with the elicited production and dots-connecting tasks. These results suggest that deaf children's knowledge of Chinese relative clauses is more variable than typically developing children.

5. Discussion and conclusions

This paper investigates whether deaf children have the knowledge of Chinese relative clauses. Twenty three deaf children, 179 normal-hearing Cantonese-speaking children and 25 Cantonese-speaking adult participants were tested for their comprehension and production of Chinese relative clauses via two written tests. It is observed that (i) deaf children's performance generally falls behind that of typically developing Cantonese children; (ii) the error types and types of non-RC responses produced by deaf children are also the error types and types of non-RC responses produced by typically developing children; and (iii) object advantage is observed in one task but not another for both deaf children and typically developing Cantonese children.

A number of questions arise at this point. First, why do typically developing Cantonese children demonstrate object advantage in the two comprehension tasks but not in the production task? Second, why do deaf children demonstrate variable performance in different tasks? What are the possible reasons explaining the gap between their production and comprehension of Chinese relative clauses? Finally, how do we account for the differences in the performance of typically developing Cantonese children and deaf children?

Consider the questions on the performance of typically developing children first. Typically developing Cantonese children show non-significant subject

advantage in production task, but significant object advantage in two comprehension tasks. While the results on production task supports the Structural Distance Hypothesis (which predicts subject advantage), the results on the comprehension tasks support the Canonical Word Order Hypothesis and Filler-gap Distance Hypothesis (which predict object advantage). The result on production also conforms to other studies that use the same methodology. As noted in §1, while studies of postnominal relative clauses generally report subject advantage, the findings are mixed in children's comprehension of prenominal Chinese relative clauses. Different findings are observed from different kinds of methods in comprehension tasks. Previous studies using the picture pointing task report a non-significant subject advantage. The picture selection task is similar to the picture pointing task. However, an opposite result is observed. Typically developing children perform better with object relatives regardless of their Chinese proficiency. The difference may be associated with (i) typically developing Cantonese children studied are at older age and (ii) the medium is a written test. Given the fact that written Chinese largely follows standard Mandarin, there is a need for children to translate between Cantonese and written Chinese. This could be one of the reasons why the results reported in this paper are different from what has been reported.

How about the deaf children? The results suggest that deaf children are able to comprehend Chinese relative clauses. But they have difficulty in producing them, evidenced by the fact that only eight children could produce relative clauses, regardless of which Chinese proficiency level they have. Do deaf children have the knowledge of Chinese relative clauses? Given the fact that deaf children perform well in comprehension tasks, one may assume that deaf children do have some knowledge of relative clauses. The fact that many of them fail to produce relative clauses in production task suggests that their knowledge of Chinese relative clauses is still developing. Comprehension always precedes production in the course of acquisition. Therefore the data suggests that deaf children's knowledge of Chinese relative clauses is developing at the time of testing. Another possible reason for the gap in performance is tied to the difficulty of the elicited production task. Both adults and typically developing Cantonese children tend to respond with a passive object relative rather than an object relative in elicited production task. The task may favor the use of passive object relatives. Passive is also a complex structure that takes time to develop. If deaf children's knowledge of passive is still not developed or in progress of development, their poor performance in the production task may be explained by a lack of knowledge of passive rather than a lack of knowledge of relative clauses. Further research is needed to verify this point.

Assuming that deaf children's knowledge of Chinese relative clauses is yet to be developed, a related question is whether their low performance on the production is tied to lack of syntactic movement. Friedmann & Szterman (2006) suggest

that deaf children's poor performance in comprehending and producing relative clauses without resumptive pronouns results from their lack of knowledge of syntactic movement. In this study, the Chinese relative clauses are all without resumptive pronouns. In other words, all items involve syntactic movement. A failure to comprehend and/or produce relative clauses in various tasks may point to a lack of knowledge of syntactic movement and/or a lack of knowledge of relative clauses. More solid evidence can be obtained if the tests contain relative clauses with resumptive pronouns. If deaf children perform better with relative clauses with resumptive pronouns than those without resumptive pronouns, then one is on a more solid ground to claim that deaf children's performance is tied to syntactic movement. Future research is needed to explore whether there is a difference in deaf children's comprehension of Chinese relative clauses with or without resumptive pronouns.

Deaf children's performance is similar to the typically developing Cantonese children in a number of ways. Almost all types of non-RC responses and error types produced by deaf children are also produced by typically developing Cantonese children. Deaf children, like the typically developing Cantonese children, perform better with object relatives in the picture selection task. However, it also clear that deaf children's performance is different from the typically developing Cantonese children's performance. First, only a small group of deaf children produced relative clauses in the production task and these deaf children are from different groups of proficiency. While general Chinese proficiency relates with typically developing children's performance in relative clauses, no such relationship is observed in the deaf children group. The results of the comprehension tasks for deaf children also demonstrate a high degree of diversity. One of the reasons why the tasks are presented in the form of written tests is to lower the barrier for the deaf children. However, one cannot deny the fact that written Chinese which follows Mandarin grammar shares a lot of similar properties with Cantonese. Hong Kong Sign Language, a language of visual-gestural modality, differs a lot from both Cantonese and Mandarin. For instance, verbs in Hong Kong Sign Language are marked with verb agreement and aspectual properties overtly. Hong Kong Sign Language also demonstrates relatively freer word order. The similarities between Mandarin Chinese and Cantonese may allow typically developing Cantonese children to learn Chinese relative clauses faster. Deaf children, on the other hand, need more time to learn Chinese relative clauses.

Acknowledgements

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Appendix: Biodata of Deaf Children

Deaf students	Chron. age	Hearing age	Grade	Hearing Status (better ear)	Hearing devices (left ear)	Hearing devices (right ear)	Age of fitting (left ear)	Age of fitting (right ear)	Age at initial exposure of HKSL	Years of HKSL exposure	Age of initial exposure of written Chinese	Years of exposure of written Chinese
C1-1-CTY	11;10	11;1	P6	88	No	CI	0;9	0;9	4;11	6;11	2;6	9;4
C1-3-LKY	13;10	12;7	P6	105	CI	No	1;6	3;2	6;11	6;11	3;6	10;4
C1-4-SMC*	13;0	12;8	P6	93	HA	HA	0;6	0;6	6;0	13;0	2;6	10;6
C1-5-TKH	14;8	12;8	P6	108	No	CI	2;0	2;0	7;8	6;11	5;8	8;11
C2-1-CYF	10;11	9;5	P5	108	CI	HA	2;6	1;9	5;0	5;11	2;6	8;5
C2-2-SMY*	11;6	10;6	P5	72	HA	HA	2;7	2;7	5;6	11;6	2;6	9;0
C2-3-TWK	13;1	9;11	P5	107	HA	HA	3;6	3;2	7;1	5;11	5;0	8;1
C2-5-WCY	12;9	9;10	P5	87	HA	HA	3;0	3;0	6;9	5;11	3;6	9;3
C2-6-WSY	12;7	12;4	P5	120	HA	HA	0;3	0;3	6;8	5;11	2;6	10;1
C3-1-CKY	10;5	8;3	P4	93	HA	HA	2;0	2;0	5;6	4;11	3;6	6;11
C3-2-CKW	10;10	9;3	P4	113	CI	HA	1;6	1;6	5;10	4;11	2;6	8;4
C3-5-OTN	10;9	8;10	P3	118	CI	No	1;11	n/a	5;10	4;11	2;6	8;3
C3-6-TSM	10;1	9;6	P4	108	CI	HA	0;7	0;7	5;2	4;11	3;6	6;7
C4-1-CNW*	9;4	8;1	P3	88	No	CI	1;6	1;3	5;5	9;4	3;0	6;4
C4-2-CWK	10;1	8;1	P3	120	No	CI	n/a	2;0	6;2	3;11	3;6	6;7
C4-3-CWL	10;1	8;1	P3	120	CI	No	n/a	2;0	6;2	3;11	3;6	6;7

Deaf students	Chron. age	Hearing age	Grade	Hearing Status (better ear)	Hearing devices (left ear)	Hearing devices (right ear)	Age of fitting (left ear)	Age of fitting (right ear)	Age at initial exposure of HKSL	Years of HKSL exposure	Age of initial exposure of written Chinese	Years of exposure of written Chinese
C4-4-CHY	9;9	7;0	P2	80	CI	HA	2;10	2;9	5;10	3;11	4;6	5;3
C4-5-GTC*	9;6	9;0	P3	95	HA	CI	0;6	0;6	5;6	9;6	2;6	7;0
C4-6-LYC	7;4	6;7	P1	106	CI	HA	1;3	0;9	5;5	1;11	3;5	3;11
C5-3-PTY	9;1	5;6	P3	87	HA	HA	3;7	3;8	6;2	2;11	4;0	5;1
C5-4-SLY	8;9	7;3	P2	117	CI	HA	1;5	2;6	5;10	2;11	2;6	6;3
C6-2-HYT	10;8	8;2	P2	110	CI	HA	2;6	2;6	8;9	1;11	2;6	8;2
C6-6-THY*	7;9	6;6	P1	113	HA	CI	0;6	1;3	5;10	7;9	1;11	5;10

Note.
* DD – deaf children of deaf parents; CI – cochlear implant; HA – hearing aids

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