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Production of Relative Clauses in Cantonese-Speaking Children with and without Developmental Language Disorder

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Abstract (148 words)

Developmental Language Disorder (DLD) has been explained as either a deficit deriving from an abstract representational deficit or as emerging from difficulties in acquiring and coordinating multiple interacting cues guiding learning. These competing explanations are often difficult to decide between when tested on European languages. This paper reports an experimental study of relative clause (RC) production in Cantonese-speaking children with and without DLD, which enabled us to test multiple developmental predictions derived from one prominent theory - emergentism. Children with DLD (N=22; aged 6;6-9;7) were compared with age-matched typically-developing peers (N=23) and language-matched, typically-developing children (N=21; aged 4;7-7;6) on a sentence repetition task. Results showed that children's production across multiple RC types was influenced by structural frequency, general semantic complexity, and the linear order of constituents, with the DLD group performing worse than their age-matched and language-matched peers. The results are consistent with the emergentist explanation of DLD.

Keywords:

Emergentist Approaches to Language; Developmental Language Disorder; Relative Clause Production; Cantonese; Language Acquisition; Child Language; Clinical Linguistics

1. Introduction

Developmental Language Disorder (DLD) is an impairment that primarily affects language development in children in the absence of biomedical conditions such as hearing loss, intellectual disability and Autism Spectrum Disorder (ASD). While not all aspects of language are equally affected, one consistent finding is that children with DLD have difficulty with complex aspects of grammar. One structure that has been featured in studies of grammatical problems in DLD is the relative clause (RC). Consider (1) and (2).

(1) [$_{\text{head noun}}$ The tiger$_i$] that [$_{RC}$ _$_i$ pushed the giraffe].

(2) [$_{\text{head noun}}$ The tiger $_i$] that [$_{RC}$ the giraffe pushed _$_i$].

Sentence (1) is a subject RC, so-called because the head noun (*the tiger*) occupies the subject role within the RC (in brackets). Sentence (2) is an object RC because this time the head noun occupies the object role in the RC. RCs have been extensively studied in the adult psycholinguistics and child language literature (see Kidd, 2011; Lau & Tanaka, 2021; Tanaka, Lau & Lee, 2024), where they have been used to test the competing predictions of different approaches to syntactic processing and development. In acquisition, structurally-oriented theories argue that sentence complexity derived from processes like syntactic derivation via movement operations influences acquisition (e.g., Friedmann, Belletti & Rizzi, 2009). In contrast, emergentist approaches claim that acquisition is cue-based, with children attending to multiple interacting cues to acquire structure (Bates & MacWhinney, 1987). In European languages, which the field has mostly studied (Kidd & Garcia, 2022; Lau & Tanaka, 2021), these theories often make the same predictions. However, in East Asian languages like Cantonese, the predictions diverge.

For instance, structural perspectives that subscribe to structural constraints (e.g. structural intervention (Friedmann et al., 2009)) predict a universal subject RC over object RC advantage cross-linguistically in accusative languages, because subjects in these languages constitute a higher position than objects in hierarchical syntactic representations (see Lau & Tanaka, 2021 for a comprehensive review and section 1.1 for further elaboration). Although emergentism differs from structural

accounts in considering the interaction of multiple experience-based, language-specific factors in affecting acquisition outcomes, these factors all converge to favor subject RCs in a language like English, making it impossible to tease apart the two diverging theories (see Chan et al., 2021 for a detailed discussion). As will be illustrated in section 1.1, the typological properties of Cantonese offer a unique opportunity to test the developmental predictions derived from emergentist perspectives, where factors pull in opposite directions to both favor and disfavor the processing of subject RCs when language specific experience such as the relationship between constructions and structural frequency are considered (see also Chan et al., 2021 for a similar discussion).

In this paper, we present a study of RC acquisition in Cantonese-speaking children with and without DLD. Unlike most past studies, we do not only test subject and object RCs, but instead test children's productive capacity on a wide range of RC types in the language. This allowed us to test multiple predictions from emergentism on RC acquisition and the underlying source of syntactic difficulties in children with DLD.

1.1. Theoretical accounts of DLD and subject-object asymmetry with special reference to Chinese.

In European languages, studies have consistently shown that children with DLD have difficulty producing and understanding RCs. Similar to work on individuals with typical development, most research has focused on subject and object RCs, with a consistent subject advantage reported (e.g. Adani et al., 2014, Frizelle & Fletcher, 2014a in English; Stavrakaki, Tasioudi & Guasti, 2015 in Greek; Friedmann & Novogrodsky, 2004, Friedmann, Yachini & Szterman, 2015 in Hebrew; Contemori & Garraffa, 2012 in Italian; De Lopez et al., 2014 in Danish; Rakhlin et al., 2016 in Russian).

The findings are consistent with both the structurally-oriented and emergentist approaches to syntactic development. On the one hand, the structurally-oriented approach predicts a subject advantage because, following the notion of Relativized Minimality (Rizzi, 1990, 2004), subject RCs are hierarchically less complex than object RCs, whose derivation requires movement across a greater

number of syntactic nodes. The explanation therefore places children with DLD's difficulty with RCs and particularly those that modify lower syntactic arguments as a representational deficit. In particular, structural perspectives such as the Computational Grammatical Complexity account (van der Lely, 2005) and the Edge Feature Underspecification Deficit (Wang & Yu, 2021, 2022) predict children with DLD to have representational deficits that result in a specific difficulty with movement-related structures including RCs, performing not only worse than their age-matched typically-developing (AM-TD) peers but also the younger typically-developing (YTD) children (i.e. the syntactic difficulties in DLD are more than just a general delay).

In contrast, the emergentist approach argues that multiple cues from basic factors like learner's language-specific experience, language-specific typology, and domain-general learning mechanisms coalesce to favor subject relatives over object relatives in English (O'Grady, 2011; Diessel & Tomasello, 2005). Emergentism considers the language difficulties in DLD as emerging from deficits in cognitive abilities that support language acquisition, such as their limited processing capacity (eg. Montgomery & Evans, 2009), slower processing speed (eg. Leonard et al., 2007) and weaker statistical learning skills (eg. Evans et al., 2009). As such, the emergentist perspective differs from structural accounts in allowing the prediction that language behaviors in children with DLD (although worse than their AM-TDs) could either be worse than (if the disorder/difficulty is more severe) OR resemble younger TD children whose cognitive abilities are less mature. Importantly, the emergentist perspective conceptualizes DLD as manifesting a global language delay, rather than a specific grammatical deficit with long dependency relations in movement-related structures, in children with DLD (Paradis, Crago & Genesee, 2006). As such, unlike structural accounts, emergentism would not predict children with DLD to exhibit difficulties specific to RCs or other movement-related structures. Rather, the prediction is that children with DLD should show difficulty with any complex structural pattern to which a coalition of features conspire to make a structure vulnerable to difficulty.

To our knowledge, there has been only one study recently published on RC comprehension (but not production) in Cantonese-speaking children with DLD (Lai, Chan & Kidd, 2023a), although

there is a growing body of research on RC acquisition in children acquiring Mandarin and other East Asian languages (e.g. Wang & Yu, 2021, 2022 in Mandarin; Sasaki, Schwartz, Hisano & Suzuki, 2021 in Japanese; and Yoo & Yim, 2021 in Korean; see section 1.4 below for the methodological limitations of the Mandarin DLD RC studies). However, unique typological features of Chinese (and indeed, other East Asian languages like Japanese, Korean, and Ainu) make them important languages in teasing apart the predictions of the structurally-oriented and emergentist approaches. Notably, while the structurally-oriented approach predicts a universal subject advantage, the emergentist approach predicts that acquisition will be moderated by a number of interacting variables, which align in European languages to predict a subject advantage, but do not align in Chinese languages like Cantonese and Mandarin.

For instance, O'Grady (2011) argues for a linear, least-effort processing mechanism that interacts with experience-based factors to determine processing cost, and suggested two particularly relevant factors in his processing-based account for RC acquisition: (i) general subject prominence that favors parsing a RC as describing the subject, hence it is less effortful to process a subject RC than an object RC; and (ii) the linear distance between the head noun (filler) and its so-called gap, in which a longer linear filler-gap dependency is associated with higher processing cost to maintain the filler and other intervening elements in working memory until the gap position is encountered. As such, general subject prominence is expected to be present across languages, especially in nominative-accusative languages (Lau & Tanaka, 2021); while the linear distance factor would be subject to cross-linguistic variations in terms of which RC type has shorter/ longer distance due to cross-linguistic differences in surface configurations. Importantly, in Chinese languages, the linear distance between the head and the gap is shorter in ORCs than in SRCs. Compare (3) versus (4), Cantonese SRC and ORC, respectively.

(3) Cantonese subject RC:

V O S

[$_{RC}$ _$_i$ 踢緊斑馬] 嗰 隻/ 嘅 [$_{head\ noun}$ 長頸鹿 $_i$]

156 tek3 gan2 baan1 maa5 go2 zek3 / ge3 coeng4 geng2 luk6

157 kick-PROG zebra that CL/ ge3 giraffe

158 'the giraffe that is kicking the zebra'

159

160 (4) Cantonese object RC:

161 S V O

162 [$_{RC}$ 斑馬踢緊 $_{i}$] 嗰 隻/ 嘅 [$_{head\ noun}$ 長頸鹿 $_{i}$]

163 baan1 maa5 tek3 gan2 go2 zek3 / ge3 coeng4 geng2 luk6

164 zebra kick-PROG that CL/ ge3 giraffe

165 'the giraffe that the zebra is kicking'

166

167 In addition, since learner's language-specific experience has an important theoretical status
168 in emergentist approaches, experience-based frequency effects are expected in acquisition and
169 processing (Ambridge et al., 2015): the more frequently a structure or pattern is experienced, the
170 stronger its representation and the more accessible (hence easier) processing becomes (O'Grady,
171 2010, 2011, 2021). Moreover, the acquisition of new, complex constructions such as RCs could be
172 facilitated by simpler related constructions with overlapping form and/ or function, as proposed in the
173 'construction conspiracy hypothesis' (Abbot-Smith and Brehens, 2006, for computational evidence
174 see Fitz et al., 2011). As such, frequency effects are indexed by not only the target constructions but
175 also their related constructions at a more general level defined by common mappings from linear
176 order to functional roles (Vasishth et al., 2013). In Cantonese, ORCs instead of SRCs (unlike English),
177 share surface similarity with frequently attested, canonical SVO sentences as notated in (4) because
178 of its cross-linguistically rare combination of prenominal RCs with SVO main clause word order (Dryer,
179 2013).

180 Thus, under the emergentist framework, acquisition phenomena that show a subject over
181 object advantage could be attributable to general subject prominence and other factors such as

effects of linear distance in a language (e.g. SRCs in English are associated with shorter linear distance, see again (1) versus (2)) converging to favor SRCs over ORCs; while acquisition phenomena that depart from a subject over object advantage (e.g. a lack of subject advantage or even an object advantage) could be attributable to general subject prominence being overridden by other competing factors such as effects of linear distance (see again (3) versus (4) in a language like Cantonese with object RC rather than subject RC having a shorter linear distance, as illustrative example) and language-specific experience (e.g. ORCs receiving further support from its surface similarity with frequently experienced, canonical SVO transitives; and see also Chan et al. (2021) showing object RC being more frequent than subject RC in adult child-directed speech in Cantonese). Interestingly, consistent with the emergentist approach, acquisition studies on Chinese have shown a distinctly variable pattern of acquisition in comparison to European languages, suggesting language-specific influences on acquisition (e.g. a robust object RC advantage as reported in Chen & Shirai (2015), Chan et al. (2021) and Yip & Matthews (2007) in Mandarin and Cantonese, see meta-analysis in Tanaka et al., 2024).

1.2. Testing predictions beyond the subject-object asymmetry

While past research has productively used SRCs and ORCs to compare theoretical approaches to acquisition, we argue here that examining more RC types has the potential to shed further light on the mechanisms underlying acquisition. Acquisition studies that have examined a broader range of relativized grammatical positions have often linked their conceptual discussions to the classical typological generalization, Keenan and Comrie's (1977) Noun Phrase Accessibility Hierarchy (NPAH; see Diessel & Tomasello, 2000, 2005 for studies on child English and German). NPAH is a putative, descriptive linguistic universal that concerns the relative accessibility of a noun phrase at various syntactic positions to relativization cross-linguistically: if a language allows relativization on a given position, then it should allow relativization on all other positions to its left in the hierarchy. Based on NPAH, a higher position is more accessible than a lower position. See (5) below.

(5) Noun Phrase Accessibility Hierarchy (> indicates "higher than"):

Subject (A)> Direct Object (P) > Indirect Object (IO) > Oblique (OBL) > Genitive (GEN) > Object of Comparison (OoC)

Although one study by Keenan and Hawkins (1987) showed that English-speakers' repetition of sentences was mostly consistent with NPAH, it should be noted that NPAH is a descriptive generalisation and makes no direct prediction about complexity in processing within individuals (Comrie, 2007). While making reference to NPAH in their study with 4-year-old English- and German-speaking children, Diessel and Tomasello (2005) only replicated differences in sentence repetition at higher points in the hierarchy (e.g., the subject RC advantage) and reported language-specific effects at lower points in the hierarchy, arguing for a multifactorial account of RC acquisition where semantic and conceptual simplicity, relationship between RC and simpler constructions, and structural frequency jointly influence acquisition outcomes.

Rather than testing whether NPAH predicts the order of sentence difficulty in Cantonese, we instead use its instantiation in Cantonese to test some key predictions derived from the emergentist approach, most notably concerning the role of structural frequency in acquisition. We argue that the emergentist approach actually makes prediction about the order of acquisition that differs from the complexity generalization made in the NPAH.

1.2.1. Difficulty between RC types.

Extending to other relativized positions, Cantonese presents some interesting language-specific properties that, on the emergentist approach, predict some lower positions to be easier than higher positions on NPAH. For instance, the acquisition of OBL-RCs are predicted to be comparatively easy in Cantonese as they share structural and functional similarities with the highly productive and frequently attested serial verb constructions, which occur in young Chinese children's naturalistic speech, from around 2-years onwards (Fung, 2011), as shown in (6) and (7) below.

(6) Oblique (OBL) RC:

N prep[1] N V N

[$_{RC}$ 媽媽 同佢 $_{i}$ 洗手] 嗰個/嘅 [$_{head\ noun}$ 妹妹 $_{i}$]

Maa4 maa1 tung4 keoi5 sai2 sau2 go2 go3 /ge3 mui4 mui2

mum for 3.SG. wash hands that CL/ ge3 little sister

'the little sister that mum washed hands for'

(7) Serial Verb Construction:

N V N V N

媽媽幫佢洗手

Maa4 maa1 bong1 keoi5 sai2 sau2

mum help 3.SG. wash hands

'mum helps her wash hands'

On the other hand, IO-RCs, ranked below DO but above OBL on NPAH, are predicted to cause significantly more difficulties than a supposedly lower-ranked position in Cantonese. IO-RCs in Cantonese are hindered by potential pronoun resolution issues that increase their processing demands, because the RC together with the head noun overlaps structurally and functionally with prepositional dative main clauses and as such the pronoun can be co-indexed with more than one possible referent (as shown in (8) below), thus increasing processing complexity.

(8) Indirect Object (IO) RC:

Interpretation 1: [$_{RC}$ 男仔送花畀佢 $_{i}$]嗰個/嘅[$_{head\ noun}$ 女仔 $_{i}$]

[1] Some linguists consider prepositions in Chinese as coverbs because they display some verbal properties (e.g. Li & Thompson, 1981; Francis & Matthews, 2006; Matthews & Yip, 2011).

naam4 zai2 sung3 faa1 bei2 keoi5 go2 go3 /ge3 neoi5 zai2

boy give flowers to 3.SG. that CL/ ge3 girl

'the girl that the boy gave flowers to'

Interpretation 2: 男仔$_k$送花畀佢$_k$嗰個/嘅女仔

'the boy gave flowers to his girl'

Interpretation 3: 男仔$_k$送花畀佢$_j$嗰個/嘅女仔

'the boy gave flowers to someone else's girl'

The predictions discussed so far stem from basic experience-based, language-specific factors such as relationship between constructions (i.e. similarity with simpler, known constructions) that affect structural frequencies in the learner's experience, and working memory demands (e.g. the linear distance factor). These factors are therefore expected to affect children with and without DLD in general.

1.2.2. Difficulty within a RC type

Emergentist approaches also make predictions about learner's differential competence between exemplars of the same RC type/position, especially when the exemplars vary in their processing demands or degree of similarity to frequent and simpler known constructions. For instance, within subject RCs, subject intransitive (S-) RCs are conceptually less complex than subject transitive (agent, A-) RCs, because the former denotes a simpler situation containing a single referent, while the latter denotes a transitive event involving two referents (Goodluck & Tavakolian, 1982). Diessel & Tomasello (2005) and Frizelle & Fletcher (2014a) reported that children found S-RCs easier than A-RCs in English and German. Since general semantic/ conceptual complexity should be applicable cross-

linguistically, Cantonese is predicted to show similar pattern, where S-RCs would be significantly easier than A-RCs.

In addition, Cantonese allows us to further test these perspectives on variations in acquisition difficulty between exemplars/subtypes within other relativized positions/types. Specifically, within OBL-RCs, the subtype OBLHelp RCs as in (9a) denote even closer semantic overlaps with the serial verb constructions (resembling "X help Y Verb Object"); while the other subtype OBLWith RCs as in (9b) denotes the meaning of companionship expressed by the prepositional phrase [*with* NP] as in "X with Y Verb Object". Although both subtypes use the same preposition and are structurally similar to serial verb constructions, OBLHelp RCs receive further support from being even semantically closer to the frequently occurring serial verb main clause constructions; and therefore are predicted to be easier than OBLWith RCs.

(9a) OBLHelp RC:

[$_{RC}$ 婆婆同佢 $_{i}$ 刷牙]嗰個/嘅[$_{head\ noun}$ 弟弟 $_{i}$]

po4 po2 tung4 keoi5 caat3 ngaa4 go2 go3 /ge3 dai4 dai2

grandma for 3.SG. brush teeth that CL/ ge3 little brother

'the little brother that grandma (helped) brushed his teeth for'

(9b) OBLWith RC:

[$_{RC}$ 哥哥同佢 $_{i}$ 搭巴士]嗰個/嘅[$_{head\ noun}$ 女仔 $_{i}$]

go4 go1 tung4 keoi5 daap3 baa1 si6 go2 go3 /ge3 neoi5 zai2

brother with 3.SG. take bus that CL/ ge3 girl

'the girl that the brother takes bus with'

Moreover, there are two types of Cantonese GEN-RCs: one in which the noun phrase carrying the resumptive genitive pronoun functions as subject in the RC (GENS) and the other in which the genitive noun phrase functions as direct object in the RC (GENO). See (10a) and (10b).

(10a) GENS RC:

[$_{RC}$ 佢$_{i}$ 隻狗仔追兔仔]嗰個/嘅[$_{head\ noun}$ 姨姨$_{i}$]

keoi5 zek3 gau2 zai2 zeoi1 tou3 zai2 go2 go3 /ge3 ji1 ji1

3.SG. CL dog chase rabbit that CL/ ge3 aunt

'the aunt whose dog chased the rabbit'

(10b) GENO RC:

[$_{RC}$ 妹妹錫佢$_{i}$ 隻貓仔]嗰個/嘅[$_{head\ noun}$ 伯伯$_{i}$]

mui4 mui2 sek3 keoi5 zek3 maau1 zai2 go2 go3 /ge3 baak3 baak3

little sister kiss 3.SG. CL cat that CL/ ge3 grandpa

'the grandpa whom the little sister kissed his cat'

While the subtypes GENS and GENO are both low in input frequency and structurally similar to SVO constructions, they differ crucially in the linear distance between the resumptive pronoun *keoi5* and the head noun as shown in (10a) and (10b) respectively above. Given the shorter linear distance in GENO, GENO is predicted to be easier than GENS. Comparing GENS vs GENO in Cantonese, therefore, provides a unique opportunity to test for effects of linear distance in affecting processing demands.

In terms of DLD vs TD peers, one might expect that the effects of subtypes within a RC type that stem from differences in semantic/conceptual complexity (S vs A), differences in proximity to

simpler learnt constructions (OBLHelp vs OBLWith), and differences in linear distance of the dependency (GENS vs GENO), could be even more prominent in children with DLD, considering their weaker cognitive abilities underlying acquisition and hence more susceptible to processing demands and experience-based effects.

1.3. Difficulty between RC Strategies

Further predictions on production preferences relating to the two relativization strategies in Cantonese could be formulated considering the primary role of learner's experience and input-based effects in acquisition. As illustrated in previous examples, Cantonese RCs can be constructed with a classifier (CL) or the particle *ge3*.[2] The two RC strategies are associated with different functional registers: CL RCs belong to the colloquial register; while *ge3* RCs are used in formal settings such as news reporting and literacy texts (Chan et al., 2011; Matthews & Yip, 2001). Thus, CL RCs are more frequently encountered in younger children's language experience and frequency effects would therefore favor CL RCs. However, in production, it is also possible that the particle *ge3* is more preferred by some (older) children who have more experience with formal registers and recognize *ge3* as a functionally informative relative marker[3]. Hence depending on the relative strength of these competing factors (i.e. frequency effects favoring CL RCs while functional informativeness favoring *ge3* RCs), emergentist perspectives allow prediction of a CL over *ge3* advantage or a *ge3* over CL advantage in production.

1.4. RC acquisition studies in Chinese DLD literature

[2] It is also possible to construct a RC in Cantonese by a combination of CL and *ge3*, referred to as the 'hybrid' strategy by Matthews & Yip (2001) which is described to be relatively rare in naturalistic speech and is outside the scope of the current investigation.

[3] Cantonese classifiers are considered multi-functional and can be either a linguistic marker of referentiality or a marker of relativization (Chan et al., 2021; see also Table 1 in Chan et al., 2021); whereas *ge3* unambiguously marks a modifier-modifiee relationship within a noun phrase and the noun following *ge3* is univocally the head noun. As such, *ge3* is considered a functionally informative relative marker.

There has been no published research on the syntactic competence of RCs in Cantonese DLD, despite a few published studies on their production of complex constructions like passives and wh-questions (Leonard et al., 2006; Wong et al., 2004). Rather, in Mandarin DLD literature, two recent RC production studies comparing subject and object RCs reported mixed findings of a significant A-RC over P-RC advantage in DLD and TD children in elicited production (Wang & Yu, 2021) ; but a lack of asymmetry (A-RC = P-RC) in all children in sentence repetition (Wang & Yu, 2022). While both studies claimed to support a syntactic representational deficit in children with DLD based on the consistent findings that they performed worse than both AM-TD and YTD children, there are methodological concerns about their sampling a YTD group being only one-year younger, which departs from the DLD literature conventions of including a group that is at least two years younger (e.g. Frizelle & Fletcher, 2014a). Crucially, it is unknown whether the reported differential performance between their DLD and YTD groups arose from the DLDs' specific difficulty with RCs or an overall better language competence in the YTD group, as their standardized language scores were also comparable with or even numerically better than the chronologically AM-TD. Given these limitations, further investigation that samples a group of younger, language-matched children and extends the investigation to more RC types is warranted to further test these theoretical perspectives.

To date there has been no published experimental studies examining a wide range of RC positions in the L1 Chinese and East Asian languages acquisition literature on children with TD versus DLD. This study is an empirical first in this regard. Focusing on testing the specific emergentist predictions as summarized in Table 1, we included two groups of age-matched (AM-TD) and younger, language-matched (YTD) typically-developing children to ascertain whether children with DLD have specific difficulty with RCs or a global impairment affecting both movement and non-movement related structures. Moreover, we included (i) a broad range of relativized positions to examine the relative difficulty between RC types; (ii) two subtypes of exemplars within certain RC types to examine relative difficulty within an RC type; and (iii) two relativisation strategies to examine relative difficulty of production between CL and *ge3* RCs.

[Table 1 around here]

2. Method

2.2. Participants

A total of sixty-six predominantly monolingual Cantonese-speaking children participated in this study. They were recruited from local mainstream primary schools or kindergartens that use Cantonese as medium of instruction in Hong Kong. The children were acquiring Cantonese as their first and home language; and learn English and Mandarin as second languages at school with exposure less than 20% of their awake time. Having been assessed by speech therapists, all participants passed hearing screening and their clinical status was confirmed by administering the standardized norm-referenced language tests, i.e. Hong Kong Cantonese Oral Language Assessment Scale (HKCOLAS, T'sou et al., 2006) for school-aged children; or the Cantonese version of the Reynell Developmental Language Scales (RDLS-R and RDLS-E; Hong Kong Society for Child Health and Development, 1987) for preschool children.

Twenty-three children were identified as DLD based on Bishop et al. (2017)'s recommendations in the diagnosis of DLD: (i) lack of competence even in the best language (which is Cantonese given the extensive and intensive exposure to the language; and lack of competence as indicated by scoring 1.25 SD below age means in at least two or more subtests in HKCOLAS[4]); (ii) negative functional impact affecting daily communication and/or educational progress reported by parents and/or schools[5]; (iii) existence of poor prognostic features where language difficulties are still evident beyond age 5; and (iv) absence of other biomedical conditions such as hearing disability, intellectual disability or ASD. One child with DLD was excluded due to un-codable data arising from technical issues during data collection. As such there were 22 DLDs and 23 AM-TDs aged between 6;6

[4] HKCOLAS contains six subtests, namely Test of Hong Kong Cantonese Grammar, Textual Comprehension Test, Word Definition Test, Lexical-Semantic Relations Test, Narrative Test, and Expressive Nominal Vocabulary Test.

[5] Information was obtained through parental questionnaires and/or school's referrals that expressed concerns about the child's oral language abilities/development and/or academic progress.

– 9;7, individually matched according to age (+ or -4 months) and grade. Similar to Frizelle & Fletcher (2014a), we also recruited a group of younger and language-matched typically-developing children (YTD) aged between 4;7-7;6. One YTD child was excluded because she did not attend all the experimental sessions. Hence, there were 21 language-matched YTD children, with each of them being about two years younger than a corresponding child with DLD.

A one-way ANOVA was performed to compare the three groups of children on the following variables, including age in months ($F(2,63) = 51.68$, $p<.001$), overall HKCOLAS language raw scores ($F(2,58) = 21.42$, $p<.001$), HKCOLAS subtest raw scores on story retelling ($F(2,58) = 12.81$, $p<.001$), production of complex sentences during story retelling ($F(2,58) = 6.49$, $p=.003$) and receptive grammar subtest ($F(2,58) = 21.86$, $p<.001$). Table 2 summarized results of these comparisons. Post-hoc Tukey's HSD Test indicated no statistically significant difference between DLD (*M*=91.05, *SD*=8.34, range=6;8 – 9;5) and AM-TD (*M*=90.39, *SD*=9.23, range= 6;6 – 9;7) in age, confirming the two groups were matched on age. The YTD children were considered language matched to the DLD group, based on no significant group differences in terms of their overall HKCOLAS language raw scores (YTD: *M*=196.94, *SD*=62.11, range=99-362; DLD: *M*=170.18, *SD*=58.01, range=55-263) and their subtest raw scores on story retelling (YTD: *M*=74.25, *SD*=23.57, range=41-130; DLD: *M*=58.91, *SD*=21.13, range=15-92) and especially on production of complex sentences during story retelling (YTD: *M*=14.69, *SD*=7.10, range=5-30; DLD: *M*=12.05, *SD*=7.45, range=1-24) and on receptive grammar subtest (YTD: *M*=39.56, *SD*=9.32, range=22-60; DLD: *M*=34.55, *SD*=7.36, range=24-51), as indicated by Post-hoc Tukey's HSD Tests. Note that five YTD children were excluded from these comparisons because they were below age 5 at the time of testing, younger than the target age range (age 5-12) of HKCOLAS and therefore were administered the Cantonese version of Reynell Developmental Language Scales instead of HKCOLAS to confirm their TD status.

[Table 2 around here]

2.3. Experimental Procedures

Our study used a sentence repetition task that has been commonly used in the cross-linguistic acquisition literature to investigate RC production (e.g. Diessel & Tomasello (2005); Kirjavainen, Kidd & Lieven, 2017; Frizelle & Fletcher, 2014a). Unlike elicited production tasks where children could still avoid production of the target structures, sentence repetition has a higher control over variables of interest in explicitly requiring children to repeat after the target structures, allowing testing of a broad range of RC types (Ambridge & Rowland, 2013). In clinical settings, sentence repetition tasks are also widely used as a measure of syntactic abilities and to identify children with DLD (Conti-Ramsden, Botting & Faragher, 2001). Our experiment was conducted at a quiet room in local schools from which the participants were recruited, or the speech therapy clinic of the university campus with which the second author is affiliated. At the beginning of our experimental task, children were introduced to a 'parrot-game', in which they were instructed by a researcher, who was trained in either linguistics or speech and hearing sciences, to repeat exactly the sentence heard after the beep sound. Each test sentence was pre-recorded and presented using a Microsoft Powerpoint slideshow, accompanied by a picture depicting the referents and the event expressed by a presentational RC. Children were to complete two practice trials before the task moved on to the test sentences, so that they understood the task requirements. A total of two sessions were required to complete this task, and each session lasted for about 10-15 minutes to ensure their attention was focused on the task.

2.4. Materials

A total of 64 test sentences and 16 fillers were designed for this study and divided into two scripts, each containing 40 items with an additional 2 practice trials at the beginning of the task. The order of the two scripts was counterbalanced between participants and the order of RC types within each script was pseudo-randomized, with the restriction that the following item could not be of the same RC type. Following Diessel and Tomasello (2005), our investigation extended to a wide array of relativized positions including subject (S; subject-RCs with an intransitive verb), agent (A; subject RCs with a transitive verb), patient/ object (P), indirect object (IO), oblique (OBL, including the subtypes of OBL-

Help and OBL-With; see 9a and 9b) and genitive (GEN, including the subtypes of GEN-S and GEN-O; see 10a and 10b). These various types of RCs were further manipulated into the classifier (CL) and *ge3* conditions, given previous findings of variations in processing of these two relativization strategies in Cantonese (Chan et al., 2018). There are four trials in each condition, as shown in Table 3 below. In addition, fillers were inserted between test sentences. These fillers were main clause constructions that do not involve A-bar dependencies such as SVO transitive clauses, serial verb constructions and topic-comment structures, serving as a measure of children's competence with non-RC, non-movement related constructions. All sentences were controlled for length (12-14 syllables long) and all RC test sentences controlled for animacy (all animate nouns). See supplementary materials for a complete list of the test and filler items.

[Table 3 around here]

2.5. Scoring

A score of 1 was given to an essentially correct repetition, where some minor changes that did not alter the meaning and structure of the test sentence were disregarded: for example, changes in demonstratives (e.g. 'this' to 'that'), classifiers, aspect markers, adverbials (or the lack of, e.g. '*tau4sin1*' (just now) to '*aam1aam1*' (just now)), or minor changes of RC-internal noun phrases or the head nouns to semantically similar NPs (e.g. '*mui4mui2*' little sister to '*neoi5zai2*' little girl). A response of the target structure (i.e. RC and the head noun) without the carrier phrase '*this is*…' was also accepted. However, no change of relativization strategy or target RC type was allowed.

On the other hand, a score of 0 was assigned to any incorrect repetition that would lead to significant changes to the meaning and structure of the test sentence. No mark was given to any ungrammatical sentences (e.g. '*This is the girl that car that just sat*'), no response or incomplete utterances (e.g. *'This is the sister that just'*) nor changes in relativization strategy (e.g. *'This is [RC] CL head noun' to 'This is [RC] ge3 head noun'*) , thematic roles of the NPs (e.g. '*This is the horse that kicked the cow*' to '*This is the cow that kicked the horse*') or responses with the target RC changed to other

RC types (e.g. '*This is the cat that the duck is kissing*' to '*This is the cat that is kissed by the duck*'). Another trained research assistant coded 15% of the data and inter-rater agreement was 100%.

3. Results

The study sample consisted of sixty-six children, 22 DLDs (6;7;17 – 9;4;26, *M*=7;6;28, *SD*=0;8;7) ; 23 AM-TDs (6;5;26 - 9;6;23; *M*=7;6;12, *SD*=0;9;6) ; 21 YTDs (4;7;14 – 7;6;4, *M*=5;6;27, *SD*=0;9;1). Table 4 reports children's production accuracy for each RC type (S, A, P, IO, OBLHelp, OBLWith, GENS, GENO) by language group (YTD, DLD, AM-TD) and by relativization strategy (CL versus *ge3*). Overall accuracy pattern shows children with DLD performed worse than their age-matched TD peers, as well as the younger, language-matched TD (YTD) group in all RC types.

Children's production accuracy (correct = 1) was predicted by Generalized Linear Mixed Effects Models (GLMM; Jaeger, 2008) using the lme4 package for Linear Mixed Effects (Bates & Maechler, 2010) in R (version 4.0.5; R Core Development Team, 2021. RC type (S, A, P, IO, OBLHelp, OBLWith, GENS, GENO; mean-centered), relativization strategy (CL versus *ge3*; mean-centered), language group (YTD versus DLD; DLD versus AM-TD; sliding contrast difference coding) and their interaction were entered as fixed effects. Random effects for participants were included (Barr, Levy, Scheepers & Tily, 2013). Table 5 reports the summary of GLMM analysis.

Results from the mixed effects model indicated significant main effects of RC type, where accuracy varied across the different types of RC, relativization strategy, suggesting a significant *ge3* over CL advantage, and language group, indicating that DLD group's overall RC production was worse than both YTD and AM-TD. There were also significant two-way interactions between RC type and language group YTD versus DLD and DLD versus AM-TD, suggesting that the ranking of difficulty of RCs was not uniform across the three groups. As a post-hoc analysis, emmeans pairwise comparisons were run for a GLMM model refitted with type (8 levels: S, A, P, IO, OBLHelp, OBLWith, GENS, GENO), language group (YTD versus DLD; DLD versus AM-TD; sliding contrast difference coding) and their interaction as fixed effects; and participants as random effects. Figure 1 reports the accuracy of each

RC type by language group; and Table A in supplementary materials presents the results of contrasts between each RC type in each language group.

We report further findings from post-hoc emmeans pairwise comparisons between each RC type based on the following dimensions: difficulty between RC types, and restricted and differential competence within a RC type in DLD.

3.2. Difficulty between RC types

The findings indicated no robust object (P-RCs) disadvantage, relative to A-RCs, in DLD nor in their younger, language matched TD peers. The non-significant difference between A- and P-RCs in both groups indicated that DLD and YTD children produced A- and P-RCs with comparable ease. A significant A > P advantage was observed only in the older, age-matched TD children. Moreover, across all three groups of children, OBL-RCs were fairly easy for children to produce in that the accuracy of both subtypes (ie. OBLHelp and OBLWith) was not significantly different from A-RCs and P-RCs. Unlike the developmental pattern of RCs in English and other European languages, IO-RCs were rather difficult to parse in Cantonese; they were as challenging as GEN-RCs for children to repeat, as indicated by the lack of significant difference between IO-RCs and the classically complex GEN-RCs (both GENS and GENO) in all children (except for the single instance of IO-RCs being significantly better than GENS observed in DLD only, which will be discussed further). Overall, IO- and GEN- RCs were the two RC types that had the lowest accuracies among all RC types across the three groups of children.

3.3. Restricted and differential competence within a RC type in DLD

Unlike their TD peers whose performance was comparable across the two types of subject RCs, children with DLD uniquely showed a significant difference in producing S- and A-RCs. Thus, within subject RCs, children with DLD found it significantly easier to produce the subject intransitive RCs (S-RCs) than subject transitive RCs (A-RCs), likely because S-RCs are conceptually less complex. Within OBL-RCs, there was also differential performance between the two subtypes in children with DLD.

Although there was no significant difference between the two subtypes of OBL-RCs (OBLHelp vs OBLWith) in all three groups of children, the DLD group showed differential competence between the two subtypes when their performance on each subtype in relation to IO-RCs was considered. Children with DLD , like the other two TD groups, also found OBLHelp significantly easier than IO-RCs to repeat; but when OBL-RCs were changed to another subtype (OBLWith), their performance with OBL-RCs dropped, resulting in no significant difference between OBLWith and IO-RCs. The other two TD groups (AM-TD and YTD), on the other hand, consistently found OBL(subtypes Help and With alike) significantly easier than IO-RCs to repeat. Hence, children with DLD demonstrated a more restricted competence than their TD peers with OBL-RCs. Similarly with the more complex GEN-RCs, the DLD group's performance was not uniform across the subtypes GENS and GENO, even though no significant statistical difference was registered between the two subtypes (GENS vs GENO, possibly due to low accuracies). Like the other two TD groups, children with DLD found GENO as difficult to repeat as IO-RCs resulting in no significant difference between GENO and IO-RCs; but when GEN-RCs were switched to another subtype (GENS), the DLD group's performance with GEN-RCs notably declined resulting in GENS being significantly worse than IO-RCs while both AM-TD and YTD still found GEN-RCs (subtypes GENS and GENO alike) equally difficult as IO-RCs to repeat. As such, children with DLD were unlike their TD peers, showing slight disadvantage with GENS than GENO.

[Table 4, Table 5 and Figure 1 around here]

In addition, to tease apart whether children with DLD exhibited specific difficulty with RCs (van der Lely, 2005; Wang & Yu, 2021, 2022) or had difficulties with production of sentences in general, a one-way ANOVA was conducted to compare the three groups of children on their production of the filler items (n=16) which are non-RC and non-movement related structures, $F(2,63) = 26.36$, $p<.001$. As homogeneity of variances cannot be assumed, the Welch's test was performed, indicating a significant difference between groups, $F_W(2,33.78) = 19.55$, $p<.001$. Post hoc Games-Howell test indicated that children with DLD (M=8.23, SD=4.78) were also significantly worse than their AM-TD

peers (*M*=14.83, *SD*=1.34) and their language-matched YTD peers (*M*=13.76, *SD*=2.70) in repeating the non-RC constructions.

4. Discussion

We reported on the first RC production study that examined a wide range of RC types in Cantonese-speaking children with and without DLD, an empirical first not only in the Chinese literature but also in the East Asian languages literature. Cantonese RCs present a unique opportunity to test the developmental predictions derived from emergentist perspectives. Specifically, we tested three dimensions in both children with TD and DLD: 1) difficulty between RC types, 2) difficulty within a RC type, and 3) difficulty between relativization strategies. We discuss our findings in light of the relevant factors in acquisition and their predictions for Cantonese.

Before we proceed to discussing each of these three dimensions, we first discuss the findings regarding DLD versus their TD peers. Compared to their age-matched TD peers, children with DLD scored significantly lower in their production of RCs. This aligns with the robust cross-linguistic evidence of difficulty with RCs in the DLD literature (e.g. Adani et al., 2014, Frizelle & Fletcher, 2014a in English; Stravrakaki et al., 2015 in Greek; Friedmann & Novogrodsky, 2004, Friedmann et al., 2015 in Hebrew; Contemori & Garraffa, 2012 in Italian; De Lopez et al., 2014 in Danish; Rakhlin et al., 2016 in Russian). Our results indicated that Cantonese-speaking children with DLD also scored significantly lower than the YTD group, consistent with Frizelle & Fletcher's (2014a) finding on English-speaking children with DLD and Wang & Yu's (2021, 2022) studies on Mandarin-speaking children with DLD. To delineate whether this means that children with DLD have a specific difficulty with movement related structures like RCs (as argued by structural accounts) or they have a global impairment / general difficulty affecting both movement and non-movement related structures (as argued by emergentist accounts), children's production of the filler items which are non-RC and non-movement related structures was analysed. The same pattern of results was obtained for non-movement related constructions, in which children with DLD scored significantly lower than both TD groups in repeating

these non-RC constructions. As such, our study findings show no evidence of a specific difficulty with movement-related constructions as argued by structural representational accounts of DLD such as the Computational Grammatical Complexity account (van der Lely, 2005) and the Edge Feature Underspecification Hypothesis (Wang & Yu, 2021, 2022). Rather, this pattern of finding concurs with domain-general cognitive-processing based accounts of DLD in terms of weaker cognitive abilities (e.g. Montgomery & Evans, 2009; Evans et al., 2009) that result in a global language delay in DLD (Paradis et al., 2006); and contribute to the DLD literature that not only RC production, but production of other non-movement related constructions is vulnerable in Cantonese-speaking children with DLD.

4.2. *Difficulty between RC types*

Regarding relative difficulty between RC types, recall that emergentist approaches could deviate from the NPAH in their predictions in the following scenarios. If there are language-specific facilitative effects that favor certain RC types, it is possible that RCs modifying lower syntactic positions could be easier to acquire than those that modify higher syntactic positions. If certain RC types are hindered by language-specific factors that tax their processing, it is also possible that RCs modifying higher syntactic positions could be more difficult than those modifying a lower position. Our results are consistent with the emergentist predictions: unlike the order or ease of acquisition of the different relativized positions derived from the NPAH ranking, Cantonese RCs demonstrate a reverse ranking of difficulty. Specifically, oblique RCs[6] (both OBLHelp and OBLWith), as predicted, were relatively easy for both TD and children with DLD to produce. Their OBL-RCs performance was not significantly different from subject (A-RCs) and object (P-RCs), likely due to the predicted facilitative effect from frequently experienced and early acquired serial verb constructions in the language. In addition, indirect object[7] (IO-RCs), which contain potential pronoun resolution issues that could increase processing demands, proved to be difficult for all children to repeat, as they were not significantly

[6] See example (6).
[7] See example (8).

609 different from the classically complex genitive RCs[8] (both genitive subject (GENS) and genitive object
610 (GENO))[9]. The finding of oblique RCs being not more difficult than object (P-RCs) in Cantonese is
611 similar to the finding of OBL-RCs not causing significantly more difficulties than P-RCs in Diessel &
612 Tomasello (2005)'s study on English and German-speaking children, Frizelle and Fletcher (2014a) on
613 English-speaking children with and without DLD, and Kirjavainen et al. (2017) on Finnish-speaking
614 children; while the finding of indirect object (IO-RCs) being significantly more difficult than oblique
615 RCs in Cantonese stands in contrast with the non-significant difference between IO- and OBL- RCs
616 reported in these studies. The authors also explained their findings from an emergentist, usage-based
617 perspective, identifying a core role for language-specific properties (i.e. similarity with other simple
618 constructions) that would affect distributional frequencies in the learner's experience, and other
619 processing factors such as working memory capacity and general semantic/ conceptual complexity.
620 Moreover, another language-specific finding relates to the lack of a robust object (P-RCs)
621 disadvantage in Cantonese. Both DLD and their younger, language matched YTD peers produced
622 subject (A-RCs) and object (P-RCs) with comparable ease; whereas a significant A > P-RCs advantage
623 was observed only in the older, age-matched TD children. Thus, our data does not show an across-
624 the-board subject-over-object advantage or an object disadvantage. The lack of a robust P-RCs
625 disadvantage in Cantonese is also unlike the developmental trajectory of RCs in English and other
626 European languages, where a robust subject RC advantage in acquisition studies was reported when
627 factors such as animacy contrast and the discourse status of the NP were controlled (e.g. Diessel &
628 Tomasello, 2005 in English and German; Friedmann, Belletti & Rizzi, 2009 in Hebrew; Contemori &
629 Belletti, 2014 in Italian; see meta-analysis in Tanaka et al., 2024), and also unlike the broad consensus
630 of a difficulty with P-ORCs as a characteristic feature of DLD in the literature (e.g. Adani et al., 2014,
631 Frizelle & Fletcher, 2014a in English; Stavrakaki et al., 2015 in Greek; Friedmann & Novogrodsky, 2004,
632 Friedmann et al., 2015 in Hebrew; Contemori & Garraffa, 2012 in Italian; De Lopez et al., 2014 in

[8] See examples (10a-b).
[9] Except for IO-RCs being significantly better than GENS observed in DLD only, which will be discussed in detail in Section 4.3.

Danish; Rakhlin et al., 2016 in Russian). On the contrary, our result is again consistent with emergentist predictions for Cantonese RCs: object (P-RCs) were hypothesized to not cause more difficulty than subject (A-RCs), because P-RCs resemble frequently occurring, early acquired SVO transitive constructions and are associated with shorter linear filler-gap distance; thus the acquisition of object RCs, rather than subject RCs, can be supported by the higher structural frequencies in the learner's experience and are relatively less taxing to process for working memory.

Furthermore, the significant A over P-RCs advantage in the older AM-TD children (6;6-9;7) appears to indicate a shift in subject/ object RC preferences during the course of development. Similar to the current finding of an A = P RCs in the younger TD children (4;7-7;6), another study of ours (Chan et al., 2021) tested RC production in an even younger group of Cantonese-speaking TD children (3;1-3;11) and also observed a lack of object disadvantage, with even a clear P-over-A RCs advantage in their production. These variations manifested over the course of development could be accounted for by emergentism, because the effects of multiple factors could vary in strength across the course of development at different ages. For instance, experience-based factors like structural input frequency and processing demands associated with linear filler-gap distance may have a stronger effect at younger ages when children's cognitive abilities are limited; whereas the effect of general subject prominence could be more prominent at older ages as children develop a more abstract and interconnected linguistic system as they develop towards the adult state. Such variation in development cannot be accounted for by structural perspectives, which predict a uniform subject RC advantage across ages, considering only structural principles and constraints as the primary determinants in acquisition. Future research could examine this further ideally using a longitudinal design.

4.3. Difficulty within an RC type

Emergentist approaches also make further predictions about learner's differential competence between exemplars of the same RC type/position, especially when the exemplars vary in

their processing demands or degree of similarity to frequently-encountered, early-acquired simpler constructions. Positing the nature of difficulty in children with DLD as deficits in cognitive abilities, these effects are expected to be even more prominent among children with DLD. As confirmed by our study, restricted competence between exemplars of the same position was observed particularly in the DLD group. For instance, in the subject position, Cantonese children with DLD performed significantly better in the production of subject intransitive (S-RCs) than transitive (A-RCs), contrasting with their TD peers who performed uniformly across the two subtypes. This is consistent with Frizelle and Fletcher (2014a)'s findings in English-speaking children with DLD. Cross-linguistically, the subject intransitive S-RCs are semantically/conceptually less complex with only a single referent modified by the RC; whereas A-RCs denote a transitive activity containing an additional referent (Goodluck & Tavakolian, 1982). As such, our results demonstrate that Cantonese-speaking children with DLD are more prone to effects of general semantic/conceptual complexity than their TD peers.

Relative to their TD peers, children with DLD also showed a more restricted competence when producing RCs on other relativized positions. Recall that our study includes the two subtypes within oblique RCs (i.e. OBLHelp[10] vs OBLWith[11]) because their semantic differences can potentially impact on acquisition ease, following the emergentist perspective that considers the facilitative effects from simpler constructions in language learning when there is form and/or functional overlap. There is suggestive evidence that the degree of similarity to simpler, related constructions affects the production of RCs in these children with DLD. Although no significant difference between the two subtypes of oblique RCs was detected, the DLD group's differential competence with these two subtypes of OBL-RCs was notable in the comparisons with indirect object (IO-RCs) (see also Frizelle & Fletcher, 2014a: 261-262, for a similar approach of comparisons[12]). Unlike their TD peers, who

[10] See example (9a).
[11] See example (9b).
[12] Frizelle & Fletcher (2014a) used similar arguments to compare two subtypes of RCs with another RC type (in their case, it was S vs A with ORCs), where they examined S and A as subject RCs and also separately as within type exemplars. They concluded that subject intransitive RCs (S) are easier than subject transitive RCs (A) based on comparisons with ORCs- there was no significant difference between S and A in their study.

681 performed consistently across the two subtypes (i.e. finding OBL-RCs (subtypes Help and With alike)
682 significantly easier than IO-RCs), children with DLD's accuracy in repeating oblique RCs declined
683 notably in subtype OBLWith, resulting in a lack of significant difference between OBLWith and IO-RCs.
684 Subtype OBLWith was predicted to be slightly disadvantaged, because semantically it is relatively
685 more distant and therefore may not receive as much support as OBLHelp from the simple, frequently
686 occurring serial verb main clause constructions. While the TD children's stable performance with OBL-
687 RCs (OBLHelp and OBLWith alike) in our study may reflect their abilities to generalize across exemplars
688 and identify the constructional relationship between the subtypes, DLD's differential performance
689 with the two subtypes of OBL-RCs is consistent with the literature's observation that DLD children are
690 worse than their TD peers in generalizing across exemplars (e.g. Stokes & Fletcher, 2000; Fletcher et
691 al., 2005 on Cantonese aspect marker; Riches, Faragher & Conti-Ramsden, 2006 on English verb
692 schema use; see Hsu & Bishop (2010) for a summary of more cross-linguistic evidence).

693 Moreover, we observed differential competence between exemplars within genitive (GEN-
694 RCs) that is particularly evident among the children with DLD in our study. Recall that within the classic
695 complex GEN-RCs, we tested for the linear distance effects potentially underlying the processing of
696 subtypes genitive subject[13] (GENS) and genitive object[14] (GENO) RCs as they present a clean case.
697 Children with DLD, like the other two TD groups, produced GENO at comparable accuracies as IO-RCs,
698 as suggested by the insignificant difference between GENO and IO-RCs. However, when the condition
699 was changed to the other subtype (GENS), their genitive RCs performance dropped, resulting in GENS
700 being significantly worse than IO-RCs. Both AM-TD and YTD, by contrast, repeated GEN-RCs (GENS and
701 GENO alike) at similar accuracy as IO-RCs. As such, our result is consistent with domain-general
702 accounts of DLD positing reduced cognitive abilities such as memory limitations, leading children with
703 DLD being more prone to linear distance effects than their TD peers in producing genitive RCs.

[13] See example (10a).
[14] See example (10b).

Specifically, children with DLD found GENS more challenging, when they were taxed further with a longer linear distance between the resumptive pronoun and head noun.

4.4. *Difficulty between RC strategies*

Finally turning to relativization strategies, our study found an overall significant *ge3* over CL advantage in all children. Recall that the two strategies differ in register, in which CL RCs are more often used in colloquial speech, contrasting with *ge3* RCs that are more common in formal registers such as news reporting and literacy texts (Chan et al., 2011; Matthews & Yip, 2001). Input frequency favors CL RCs as they are more frequently encountered than *ge3* RCs in younger children's language environment. However, in production, it is also possible that the functional informativeness of *ge3* RCs, which unambiguously marks a structure as a RC, are more preferred by older children who have more experience with formal registers.

Children's preference for using *ge3* over CL RCs in our production task could therefore be an indicator of their development of recognizing *ge3* as an informative relative marker, which serves as a morphosyntactic cue to signal the structure of a RC to the hearer in speech planning. A relevant remark for clarification is that it is not the case that these children did not have knowledge of CL RCs. Our error analyses revealed that a good percentage of the errors (over 50% in both TD groups and about 43% in the DLD group) made in the CL condition was due to changes in relativization strategy: all three groups of children tended to respond using *ge3* or a hybrid of both CL + *ge3* or *ge3* + CL when asked to repeat CL RCs, resulting in a score of '0'. This finding reflects children's growing knowledge of the constructional relationship between CL-RCs and *ge3* RCs.

Building upon findings of the current study, future research could analyze the errors children with DLD made in their repetitions of RC constructions and examine the error patterns in RC production by Cantonese-speaking children with and without DLD, for a comprehensive profile of children's RC competence (see Frizelle and Fletcher (2014b) for a similar approach). It will be of theoretical interest to also consider the role of experience-based, language-specific properties such

as relationship between constructions (e.g. competition between related constructions and/or the relation of known constructions to the learning of new ones) in accounting for the errors attested and the strategies children with and without DLD adopt to mitigate their difficulties with RC production. Our sentence repetition task measures children's syntactic knowledge of RCs. The task implicates both comprehension and production, since participants must first extract the meaning of the target sentence and reconstruct the sentence (Potter & Lombardi, 1990, 1998; Ambridge & Rowland, 2013). Related future work could build upon corpus studies and studies investigating on-line comprehension (e.g., Lai et al., 2023a, Lai et al., 2023b).

5. Conclusion

This paper is novel in both Chinese and East Asian RC literature to extend investigation to a broad range of relativized positions and is the first to document RC production of Cantonese-speaking children with DLD. We confirmed that RC production is indeed vulnerable in these children, where the DLD group scored significantly lower than not only their age-matched TD peers but also the language-matched YTD children. Importantly, these children with DLD also scored lower than the two TD groups in non-RC, non-movement related constructions, suggesting that children with DLD have difficulties with production of sentences in general but not a specific difficulty of movement-related constructions as proposed by structurally-oriented accounts of DLD (e.g. van der Lely, 2005; Wang & Yu, 2021, 2022).

Theoretically, we tested the developmental predictions derived from emergentist perspectives in three dimensions that bear richly on the theme of variations (i.e. difficulty between RC types, difficulty within a RC type, and difficulty between RC strategies). All three groups of children showed a ranking of difficulty inconsistent with the NPAH across RC types, and a *ge3* over CL advantage in Cantonese RC production. There is also suggestive evidence of children with DLD's exhibiting more restricted competence within a RC type, compared to their TD peers. These findings reflect language-specific effects of structural frequency (which is also related to relationship between

constructions), general semantic/conceptual complexity and linear distance processing demands in children's RC production; and are better predicted and explained by emergentist approaches to language acquisition.

Practically, the current findings could inform test item selection when one develops new assessment tasks for monolingual and multilingual Cantonese-speaking children. For instance, there is evidence to justify incorporating RCs as test items in sentence repetition tasks, which have been shown to be sensitive in identifying children with DLD. Moreover, we encourage clinicians to consider the relationships between the complex constructions and simpler, frequently experienced constructions in the target language, and to identify the possible (simpler) source construction(s) for the more complex constructions, when they develop interventions for Cantonese-speaking children with DLD. For instance, whether they would train children first with the simpler source constructions to facilitate constructing the more complex construction. On the other hand, we are also aware that some current trends encourage a top-down approach, rather than a bottom-up approach, to train children with the complex constructions first, instead of the simpler constructions, and then examine whether there would be facilitation of the simpler related constructions. Regardless, one key practical significance arising from our current study is for clinicians to recognize the relationships between constructions in the target language.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Contributor Roles Taxonomy (CRediT) Statement

Conceptualization: JL, AC, EK; Methodology: JL, AC, EK; Software: JL, AC; Validation: JL, AC, EK; Formal analysis: JL, AC, EK; Investigation: JL, AC; Resources: AC; Data curation: JL; Writing - Original Draft: JL;

Writing - Review and Editing: AC, EK, JL; Visualisation: JL; Supervision: AC, EK; Funding acquisition: JL, AC.

Data Availability

The original data and analysis scripts are accessible on Open Science Framework (OSF) repository: https://doi.org/10.17605/OSF.IO/FJYSN . The test items presented in this study are included in the supplementary materials. Further inquiries can be directed to the corresponding author.

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1012 **Table 1.** *Developmental predictions derived from emergentist perspectives for the acquisition of*

1013 *Cantonese RCs in children with DLD.*

	Emergentist perspectives
DLD vs TD peers	A global language delay in DLD (i.e. not a specific difficulty with RCs): DLD < AM-TD; DLD < YTD OR DLD = YTD
Difficulty between RC types	A lower position can be easier than a higher position, if supported by experience-based frequency effects (see predictions for OBL RCs for more details) ; **OR** A higher position can be more difficult than a lower position, if hindered by other language-specific factors that tax its processing (see predictions for IO RCs for more details)
Difficulty within a RC type	Differential and restricted competence between exemplars of an RC type (given their variations in processing demands), and this phenomenon being more prominent in DLD than TD children: - Semantic/ conceptual complexity: within subject RCs, intransitive S-RCs will be easier than transitive A-RCs; - Proximity to familiar constructions: within oblique RCs, OBLHelp may be easier than OBLWith because OBLHelp is closer to serial verb constructions; - Linear distance: within genitive RCs, GENO may be easier than GENS given its shorter linear distance between the resumptive pronoun and the head noun.
Difficulty between RC strategies	CL may be easier than *ge3* **OR** *ge3* may be easier than CL in production, depending on the relative strength of the competing

	constraints (frequency effect favors CL RCs but functional informativeness favors GE RCs)

DLD: Developmental Language Disorder; AM-TD: age-matched typically developing peers; YTD: younger language-matched typically developing peers

1016 **Table 2.** *Characteristics of DLD, AM-TD and YTD groups, with One-Way ANOVA results*

	DLD (n=22)		**AM-TD (n=23)**		**YTD (n=21)**				
	M	***SD***	***M***	***SD***	***M***	***SD***	***F*(2, 63)**	***p***	**Tukey's HSD**
Age	91.05	8.34	90.39	9.23	66.86	9.03	51.68	<.001	DLD = AM-TD; DLD, AM-TD > YTD
	DLD (n=22)		**AM-TD (n=23)**		**YTD[1] (n=16)**				
	M	***SD***	***M***	***SD***	***M***	***SD***	***F*(2, 58)**	***p***	**Tukey's HSD**
HKCOLAS Total	170.18	58.01	269.74	37.94	196.94	62.11	21.42	<.001	DLD = YTD; DLD, YTD < AM-TD
HKCOLAS Story Retelling	58.91	21.13	88.57	14.59	74.25	23.57	12.81	<.001	DLD = YTD; DLD < AM-TD; AM-TD = YTD
HKCOLAS Story Retelling-Complex Sentences	12.05	7.45	19.04	5.16	14.69	7.10	6.49	.003	DLD = YTD; DLD < AM-TD;

									AM-TD = YTD
HKCOLAS Receptive Grammar	34.55	7.36	48.48	4.88	39.56	9.32	21.86	<.001	DLD = YTD; DLD, YTD < AM-TD

	DLD (n=22)		**AM-TD (n=23)**		**YTD[1] (n=5)**	
	M	***SD***	***M***	***SD***	***M***	***SD***
Reynell Receptive	N/A		N/A		57.00	1.73
Reynell Expressive	N/A		N/A		64.60	5.32

DLD: Developmental Language Disorder; AM-TD: age-matched typically developing peers; YTD: younger language-matched typically developing peers

[1]Five YTD children were excluded from the one-way ANOVA group comparisons, because they were below age 5 at the time of testing, younger than the target age range (age 5-12) of HKCOLAS and therefore were administered the Cantonese version of Reynell Developmental Language Scales instead of HKCOLAS to confirm their TD status.

1021 **Table 3.** *Number of test items in each condition.*

Relativized Positions	**Relativized Strategies**		**Total Number of Items**
	Classifier (CL) RCs	***ge3* RCs**	
Subject (S) (Intransitive verb in RC)	4	4	8
Agent (A) (Transitive verb in RC)	4	4	8
Patient (P)	4	4	8
Indirect Object (IO)	4	4	8
Oblique (OBL)	8 (4 OBL-Help; 4 OBL-With)	8 (4 OBL-Help; 4 OBL-With)	16
Genitive (GEN)	8 (4 GEN-S; 4 GEN-O)	8 (4 GEN-S; 4 GEN-O)	16

1022

1023 **Table 4.** *Children's production accuracy (Mean and Standard Deviation) for each RC type by relativization strategy and language group*

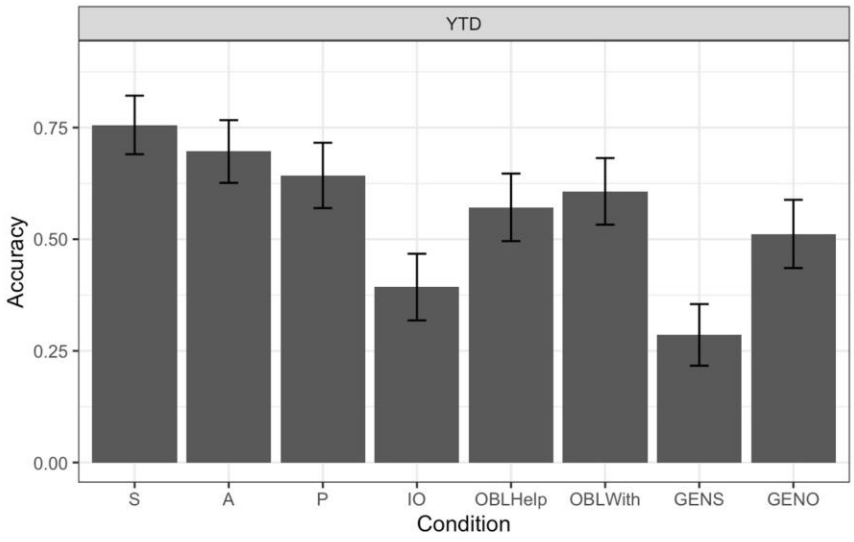
		S		A		P		IO		OBLHelp		OBLWith		GENS		GENO	
		M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
DLD	**CL**	0.47	0.50	0.32	0.47	0.35	0.48	0.23	0.42	0.27	0.45	0.25	0.44	0.11	0.32	0.06	0.23
(n=22)	***ge3***	0.59	0.49	0.35	0.48	0.34	0.48	0.16	0.37	0.40	0.49	0.27	0.45	0.05	0.21	0.18	0.39
	Total	0.53	0.50	0.34	0.47	0.35	0.48	0.19	0.40	0.34	0.47	0.26	0.44	0.08	0.27	0.12	0.33
AM-TD	**CL**	0.61	0.49	0.61	0.49	0.49	0.50	0.33	0.47	0.53	0.50	0.52	0.50	0.33	0.47	0.27	0.45
(n=23)	***ge3***	0.85	0.36	0.78	0.41	0.52	0.50	0.55	0.50	0.67	0.47	0.71	0.46	0.35	0.48	0.53	0.50
	Total	0.73	0.45	0.70	0.46	0.51	0.50	0.44	0.50	0.60	0.49	0.61	0.49	0.34	0.47	0.40	0.49
YTD	**CL**	0.75	0.44	0.65	0.48	0.64	0.48	0.24	0.43	0.51	0.50	0.55	0.50	0.25	0.44	0.43	0.50
(n=21)	***ge3***	0.76	0.43	0.74	0.44	0.64	0.48	0.55	0.50	0.63	0.49	0.67	0.47	0.32	0.47	0.60	0.49
	Total	0.76	0.43	0.70	0.46	0.64	0.48	0.39	0.49	0.57	0.50	0.61	0.49	0.29	0.45	0.51	0.50

1024 S: Subject; A: Agent; P: Patient; IO: Indirect Object; OBLHelp: Oblique Help; OBLWith: Oblique With; GENS: Genitive Subject; GENO: Genitive Object

1025 **Table 5.** *GLMM analysis summary for fixed effects predicting RC production accuracy.*

Fixed Effect	***β***	***SE***	***z***	***P***	**Effect sizes (in odds ratios)**
(Intercept)	-0.30	0.14	-2.22	<0.05*	0.74
RC Type / Condition	-0.27	0.02	-15.63	<0.001***	0.77
Relativization Strategy (CL)	-0.61	0.16	-3.77	<0.001***	0.54
Language Group (YTD vs DLD)	-1.60	0.34	-4.76	<0.001***	0.20
Language Group (DLD vs AM-TD)	1.50	0.33	4.55	<0.001***	4.48
RC Type/ Condition : Relativization Strategy (CL)	-0.05	0.03	-1.49	0.14	0.95
RC Type/ Condition : Language Group (YTD vs DLD)	-0.09	0.04	-2.06	<0.05*	0.92
RC Type/ Condition : Language Group (DLD vs AM-TD)	0.09	0.04	2.10	<0.05*	1.09
Relativization Strategy (CL) : Language Group (YTD vs DLD)	0.17	0.40	0.42	0.67	1.19
Relativization Strategy (CL) : Language Group (DLD vs AM-TD)	-0.52	0.40	-1.30	0.19	0.60
RC Type/ Condition : Relativization Strategy (CL) : Language Group (YTD vs DLD)	0.08	0.09	0.99	0.32	1.09
RC Type/ Condition : Relativization Strategy (CL) : Language Group (DLD vs AM-TD)	0.01	0.08	0.08	0.94	1.01

1026


YTD
Accuracy
0.00
0.25
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GENS
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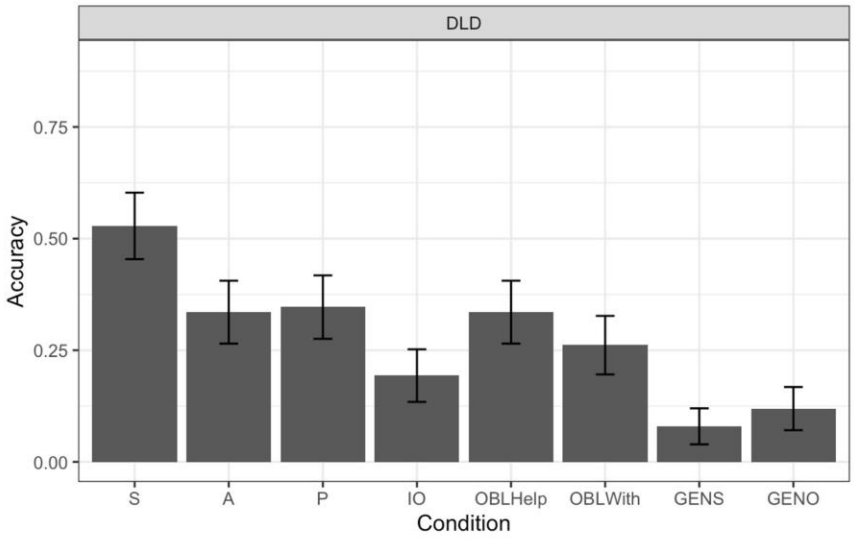
DLD
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0.00
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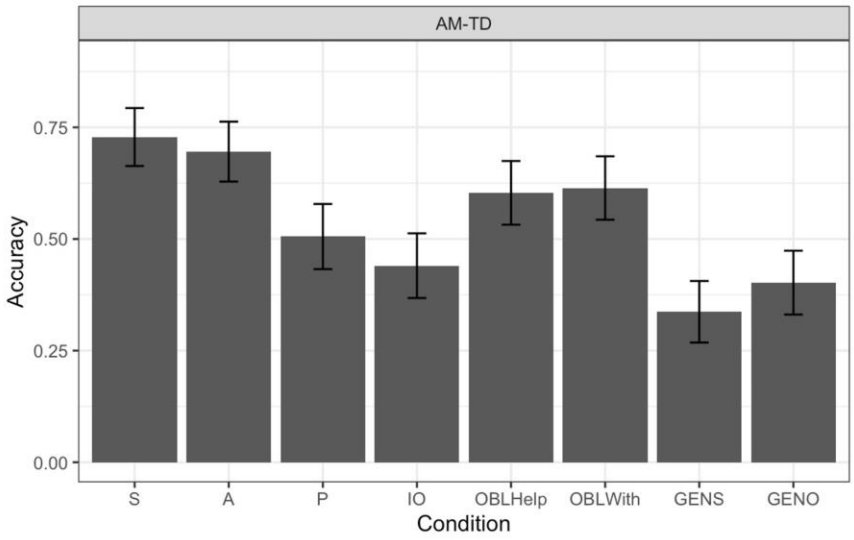
GENS
GENO
Condition


AM-TD
Accuracy
0.00
0.25
0.50
0.75
S
A
P
IO
OBLHelp
OBLWith
GENS
GENO
Condition

1027

1028

Figure Captions

***Figure 1*.** Children's production accuracy for each RC (sub)type by language group.

Supplementary Materials Captions

List of Cantonese RC Test Items

List of Filler Items

Table A. *Contrasts between each RC type in each language group*.

Supplementary Materials: List of Cantonese RC Test Items

Carrier phrase:

呢 隻 係 [RC] (嗰) CL/ ge3 head noun (RC: relative clause; CL: classifier; ge3: relative marker)

Nei1 zek3 hai6 [RC] (go2) CL/ ge3 head noun

This CL is [RC] (that) CL/ ge3 head noun

'This is [RC] (that) CL/ ge3 head noun'

<u>Subject (S)</u>

CL RCs	*ge3* RCs
1. 啱啱飛上屋頂嗰隻雀仔 ngaam1ngaam1 fei1 soeng5 nguk1deng2 go2 zek3 zoek3zai2 just-now fly up roof that CL bird 'the bird that just flew up to the roof'	1. 啱啱瞓喺草地上面嘅牛仔 ngaam1ngaam1 fan3 hai2 cou2dei6 soeng5min6 ge3 ngau4zai2 just-now sleep at grass above ge3 cow 'the cow that just slept on the grass'
2. 頭先瞓喺樹下底嗰個男仔 tau4sin1 fan3 hai2 syu6 haa6dai2 go2 go3 naam4zai2 just-now sleep at tree below that CL boy 'the boy that just slept under the tree'	2. 頭先坐喺車入面嘅女仔 tau4sin1 co5 hai2 ce1 jap6min6 ge3 neoi5zai2 just-now sit at car inside ge3 girl 'the girl that just sat in the car'
3. 頭先坐喺門口嗰隻貓仔 tau4sin1 co5 hai2 mun4hau2 go2 zek3 maau1zai2 just-now sit at door that CL cat 'the cat that just sat at the door'	3. 頭先飛落草叢嘅蝴蝶 tau4sin1 fei1 lok6 cou2cung4 ge3 wu4dip2 just-now fly into bush ge butterfly 'the butterfly that just flew into the bush'
4. 啱啱趴喺地下嗰隻豬仔	4. 啱啱企喺門外面嘅鴨仔

ngaam1ngaam1 paa1 hai2 dei6haa6 go2 zek3 zyu1zai2 just-now lie at floor that CL pig 'the pig that just lied on the floor'	ngaam1ngaam1 kei5 hai2 mun4 ngoi6min6 ge3 ngaap3zai2 just-now stand at door outside ge3 duck 'the duck that just stood at the door'

Agent (A)

CL RCs	*ge3* RCs
1. 啱啱捉到牛仔嗰隻獅子 ngaam1ngaam1 zuk1dou2 ngau4zai2 go2 zek3 si1zi2 just-now catch-ASP cow that CL lion 'the lion that just caught the cow'	1. 啱啱追到兔仔嘅貓仔 ngaam1ngaam1 zeoi1dou2 tou3zai2 ge3 maau1zai2 just-now chase-ASP rabbit ge3 cat 'the cat that just chased the rabbit'
2. 頭先踢親大象嗰隻斑馬 tau4sin1 tek3can1 daai6zoeng6 go2 zek3 baan1 maa5 just-now kick-ASP elephant that CL zebra 'the zebra that just kicked the elephant'	2. 頭先摸到狗仔嘅豬仔 tau4sin1 mo2dou2 gau2zai2 ge3 zyu1zai2 just-now touch-ASP dog ge3 pig 'the pig that just touched the dog'
3. 啱啱嚇到雞仔嗰隻老鼠 ngaam1ngaam1 haak3dou2 gai1zai2 go2 zek3 lou5syu2 just-now scare-ASP rooster that CL mouse 'the mouse that just scared the rooster'	3. 啱啱撞到青蛙嘅白兔 ngaam1ngaam1 zong6dou2 cing1waa1 ge3 baak6tou3 just-now push-ASP frog ge3 rabbit 'the rabbit that just pushed the frog'
4. 頭先撞親哥哥嗰個妹妹 tau4sin1 zong6can1 go4go1 go2 go3 mui4mui2 just-now push-ASP brother that CL sister	4. 頭先踩到妹妹嘅男仔 tau4sin1 caai2dou2 mui4mui2 ge3 naam4zai2 just-now step-ASP sister ge3 boy

'the sister that just pushed the brother'	'the boy that just stepped on the sister'

Patient (P)

CL RCs	*ge3* RCs
1. 啱啱馬騮捉到嗰隻熊貓 ngaam1ngaam1 maa5lau1 zuk1dou2 go2 zek3 hung4maau1 just-now monkey catch-ASP that CL panda 'the panda that the monkey just caught'	1. 啱啱男仔推到嘅女仔 ngaam1ngaam1 naam4zai2 teoi1dou2 ge3 neoi5zai2 just-now boy push-ASP ge3 girl 'the girl that the boy just pushed'
2. 頭先斑馬咬親嗰隻長頸鹿 tau4sin1 baan1maa5 ngaau5can1 go2 zek3 coeng4geng2luk6 just-now zebra bite-ASP that CL giraffe 'the giraffe that the zebra just bit'	2. 頭先黑熊錫嘅大笨象 tau4sin1 hak1hung4 sek3 ge3 daai6ban6zoeng6 just-now bear kiss ge3 elephant 'the elephant that the bear just kissed'
3. 啱啱姐姐嚇親嗰個小朋友 ngaam1ngaam1 ze4ze1 haak3can1 go2 go3 siu2pang4jau5 just-now sister scare-ASP that CL child 'the child that the sister just scared'	3. 頭先蝴蝶嚇親嘅蜜蜂 tau4sin1 wu4dip2 haak3can1 ge3 mat6fung1 just-now butterfly scare-ASP ge3 bee 'the bee that the butterfly just scared'
4. 頭先鴨仔追住嗰隻青蛙 tau4sin1 ngaap3zai2 zeoi1zyu6 go2 zek3 cing1waa1 just-now duck chase-ASP that CL frog 'the frog that the duck just chased'	4. 啱啱姨姨踩親嘅叔叔 ngaam1ngaam1 ji1ji1 caai2can1 ge3 suk1suk1 just-now aunt step-ASP ge3 uncle 'the uncle that the aunt just stepped on'

Indirect Object (IO)

CL RCs	*ge3* RCs
1. 叔叔遞個波畀佢嗰個女仔 suk1suk1 dai6 go3 bo1 bei2 keoi5 go2 go3 neoi5zai2 uncle pass CL ball to 3.sg that CL girl 'the girl to whom the uncle passed a ball'	1. 婆婆送粒糖畀佢嘅女仔 po4po2 sung3 lap1 tong4 bei2 keoi5 ge3 neoi5zai2 grandma give CL candy to 3.sg ge3 girl 'the girl to whom grandma gave a candy'
2. 姨姨借本書畀佢嗰個叔叔 ji1ji1 ze3 bun2 syu1 bei2 keoi5 go2 go3 suk1suk1 aunt lent CL book to 3.sg that CL uncle 'the uncle to whom the aunt lent a book'	2. 男仔送花畀佢嘅姨姨 naam4zai2 sung3 faa1 bei2 keoi5 ge3 ji1ji1 boy give flower to 3.sg ge3 aunt 'the aunt to whom the boy gave a flower'
3. 狗仔送蘋果畀佢嗰隻鴨仔 gau2zai2 sung3 ping4gwo2 bei2 keoi5 go2 zek3 ngaap3zai2 dog give apple to 3.sg that CL duck 'the duck to whom the dog gave an apple'	3. 羊仔攞杯奶畀佢嘅牛仔 joeng4zai2 lo2 bui1 naai5 bei2 keoi5 ge3 ngau4zai2 sheep pass CL milk to 3.sg ge3 cow 'the cow to whom the sheep passed a cup of flower'
4. 蜜蜂遞支花畀佢嗰隻蝴蝶 mat6fung1 dai6 zi1 faa1 bei2 keoi5 go2 zek3 wu4dip2 bee pass CL flower to 3.sg that CL butterfly 'the butterfly to whom the bee passed a flower'	4. 伯伯遞報紙畀佢嘅婆婆 baak3baak3 dai6 bou3zi2 bei2 keoi5 ge3 po4po2 uncle pass newspaper to 3.sg ge3 grandma 'the grandma to whom the uncle passed a newspaper'

Oblique (OBL)

Subtype: OBLHelp

CL RCs	*ge3* RCs
1. 男仔同佢梳頭嗰個女仔 naam4zai2 tung4 keoi5 so1 tau4 go2 go3 neoi5zai2 boy for 3.sg comb hair that CL girl 'the girl for whom the boy combed her hair'	1. 姐姐同佢著襪嘅 BB ze4ze1 tung4 keoi5 zeok3 mat6 ge3 BB sister for 3.sg wear socks ge3 BB 'the baby for whom the sister put on socks'
2. 弟弟同佢抹手嗰個小朋友 dai4dai2 tung4 keoi5 mat3 sau2 go2 go3 siu2pang4jau5 brother for 3.sg wash hands that CL child 'the child for whom the brother washed his hands'	2. 弟弟同佢扎頭髮嘅姨姨 dai4dai2 tung4 keoi5 zaat3 tau4faat3 ge3 ji1ji1 brother for 3.sg tie hair ge3 aunt 'the aunt for whom the brother tied her hair'
3. 姐姐同佢洗面嗰個弟弟 ze4ze1 tung4 keoi5 sai2 min6 go2 go3 dai4dai2 sister for 3.sg wash face that CL brother 'the brother for whom the sister washed his face'	3. 哥哥同佢剪頭髮嘅婆婆 go4go1 tung4 keoi5 zin2 tau4faat3 ge3 po4po2 boy for 3.sg cut hair ge3 grandma 'the grandma for whom the brother cut her hair'
4. 鴨仔同佢梳毛嗰隻狗仔 ngaap3zai2 tung4 keoi5 so1 mou4 go2 zek3 gau2zai2 duck for 3.sg brush hair that CL dog 'the dog for whom the duck brushed its hair'	4. 羊仔同佢冲涼嘅馬騮 joeng4zai2 tung4 keoi5 cung1loeng4 ge3 maa5lau1 sheep for 3.sg shower ge3 monkey 'the monkey for whom the sheep took a shower'

Subtype: OBLWith

CL RCs	*ge3* RCs
1. 女仔同佢散步嗰個伯伯 neoi5zai2 tung4 keoi5 saan3bou6 go2 go3 baak3baak3 girl with 3.sg walk that CL grandpa 'the grandpa with whom the girl took a walk'	1. 叔叔同佢玩積木嘅女仔 suk1suk1 tung4 keoi5 waan2 zik1muk6 ge3 neoi5zai2 uncle with 3.sg play lego ge3 girl 'the girl with whom the uncle played legos'
2. 海龜同佢砌模型嗰隻兔仔 hoi2gwai1 tung4 keoi5 cai3 mou4jing4 go2 zek3 tou3zai2 sea-turtle with 3.sg make model that CL rabbit 'the rabbit with whom the sea turtle made models'	2. 叔叔同佢散步嘅男仔 suk1suk1 tung4 keoi5 saan3bou6 ge3 naam4zai2 uncle with 3.sg walk ge3 boy 'the boy with whom the uncle took a walk'
3. 貓仔同佢睇書嗰隻兔仔 maau1zai2 tung4 keoi5 tai2 syu1 go2 zek3 tou3zai2 cat with 3.sg read books that CL rabbit 'the rabbit with whom the cat read books'	3. 馬騮同佢玩砌圖嘅狗仔 maa5lau4 tung4 keoi5 waan2 cai3tou4 ge3 gau2zai2 monkey with 3.sg play puzzle ge3 dog 'the dog with whom the monkey played with puzzles'
4. 媽媽同佢買餸嗰個伯伯 maa4maa1 tung4 keoi5 maai5 sung3 go2 go3 baak3baak3 mother with 3.sg buy groceries that CL grandpa 'the grandpa with whom the mother got groceries'	4. 兔仔同佢睇表演嘅羊仔 tou3zai2 tung4 keoi5 tai2 biu2jin2 ge3 joeng4zai2 rabbit with 3.sg watch show ge3 sheep 'the sheep with whom the rabbit watched a show'

Genitive (GEN)

Subtype: GENS

CL RCs	*ge3* RCs
1. 佢隻雀仔追蝴蝶嗰個姨姨 keoi5 zek3 zoek3zai2 zeoi1 wu4dip2 go2 go3 ji1ji1 3.sg CL bird chase butterfly that CL aunt 'the aunt whose bird chased the butterfly'	1. 佢隻狗錫媽媽嘅伯伯 keoi5 zek3 gau2 sek3 maa4maa1 ge3 baak3baak3 3.sg CL dog kiss mother ge3 grandpa 'the grandpa whose dog kissed the mother'
2. 佢隻狗嚇親豬仔嗰個叔叔 keoi5 zek3 gau2 haak3can1 zyu1zai2 go2 go3 suk1suk1 3.sg CL dog scare-ASP pig that CL uncle 'the uncle whose dog scared the pig'	2. 佢條蛇咬弟弟嘅婆婆 keoi5 tiu4 se4 ngaau5 dai4dai2 ge3 po4po2 3.sg CL snake bite brother ge3 grandma 'the grandma whose snake bit the brother'
3. 佢隻貓踩親兔仔嗰個婆婆 keoi5 zek3 maau1 caai2can1 tou3zai2 go2 go3 po4po2 3.sg CL cat step-ASP rabbit that CL grandma 'the grandma whose cat stepped on the rabbit'	3. 佢隻馬騮追住叔叔嘅妹妹 keoi5 zek3 maa5lau1 zeoi1zyu6 suk1suk1 ge3 mui4mui2 3.sg CL monkey chase-ASP uncle ge3 sister 'the sister whose monkey chased the uncle'
4. 佢隻龜撞到雞仔嗰個男仔 keoi5 zek3 gwai1 zong6dou2 gai1zai2 go2 go3 naam4zai2 3.sg CL turtle push-ASP rooster that CL boy 'the boy whose turtle pushed the rooster'	4. 佢隻青蛙嚇親姐姐嘅哥哥 keoi5 zek3 cing1waa1 haak3can1 ze4ze1 ge3 go4go1 3.sg CL frog scare-ASP sister ge3 brother 'the brother whose frog scared the sister'

Subtype: GENO

CL RCs	*ge3* RCs
1. 妹妹望住佢隻貓嗰個伯伯 mui4mui2 mong6zyu6 keoi5 zek3 maau1 go2 go3 baak3baak3 sister stare-ASP 3.sg CL cat that CL grandpa 'the grandpa whom the sister stared at his cat'	1. 叔叔摸佢隻兔仔嘅女仔 suk1suk1 mo2 keoi5 zek3 tou3zai2 ge3 neoi5zai2 Uncle pat 3.sg CL rabbit ge3 girl 'the girl whom the uncle patted her rabbit'
2. 叔叔捉佢隻馬騮嗰個女仔 suk1suk1 zuk1 keoi5 zek3 maa5lau1 go2 go3 neoi5zai2 uncle catch 3.sg CL monkey that CL girl 'the girl whom the uncle caught her monkey'	2. 婆婆餵佢隻貓嘅男仔 po4po2 wai3 keoi5 zek3 maau1 ge3 naam4zai2 grandma feed 3.sg CL cat ge3 boy 'the boy whom the grandma fed his cat'
3. 伯伯摸佢隻兔仔嗰個弟弟 baak3baak3 mo2 keoi5 zek3 tou3zai2 go2 go3 dai4dai2 grandpa pat 3.sg CL rabbit that CL brother 'the brother whom the grandpa patted his rabbit'	3. 弟弟錫佢隻狗嘅姨姨 dai4dai2 sek3 keoi5 zek3 gau2 ge3 ji1ji1 brother kiss 3.sg CL dog ge3 aunt 'the aunt whom the brother kissed her dog'
4. 爸爸錫佢隻雀仔嗰個姐姐 baa4baa1 sek3 keoi5 zek3 zoek3zai2 go2 go3 ze4ze1 dad kiss 3.sg CL bird that CL sister 'the sister whom the father kissed her bird'	4. 姐姐嚇親佢隻鴨仔嘅弟弟 ze4ze1 haak3can1 keoi5 zek3 ngaap3zai2 ge3 dai4dai2 Sister scare-ASP 3.sg CL duck ge3 brother 'the brother whom the sister scared his duck'

Supplementary Materials: List of Filler Items

1. 熊貓後面跟住隻黑色嘅狗仔。

   hung4maau1 hau6min6 gan1zyu6 zek3 hak1sik1 ge3 gau2zai2

   Panda back follow-ASP CL black *ge3* dog

   '(At) the panda's back, there is a black dog following.'

2. 今朝早窗出面一直落住大雨。

   gam1 ciu4zou2 coeng1 ceot1min6 jat1zik6 lok6zyu6 daai6jyu5

   Today morning window outside always down-ASP big-rain

   'Outside of the window this morning, it has been raining heavily.'

3. 貓仔打爛咗枱上面隻玻璃杯。

   maau1zai2 daa2laan6zo2 toi4 soeng5min6 zek3 bo1lei1bui1

   Cat broke-ASP table top CL glass

   'The cat broke the glass on the table.'

4. 貓仔好開心咁食緊碟上面嗰啲魚。

   maau1zai2 hou2hoi1sam1gam2 sik6gan2 dip2 soeng5min6 go2 di1 jyu4

   Cat very-happy-ADV eat-ASP dish top that PL fish

   'The cat is happily eating those fish on the dish.'

5. 媽咪送咗一份生日禮物畀妹妹。

   maa1mi4 sung3zo2 jat1 fan6 saang1jat6 lai5mat6 bei2 mui4mui2

   Mum give-ASP one CL birthday present give sister

   'Mum gave a birthday present to the sister.'

6. 女仔遞咗枝牛奶畀好肚餓嘅弟弟。

   neoi5zai2 dai6zo2 zi1 ngau4naai5 bei2 hou2tou5ngo6 ge3 dai4dai2

   Girl pass-ASP CL milk to very-hungry *ge3* brother

   'The girl passed a bottle of milk to the hungry brother.'

7. 車入面有三個好開心嘅小朋友。

   ce1 jap6min6 jau5 saam1 go3 hou2hoi1sam1 ge3 siu2pang4jau5

   Car inside has three CL very-happy *ge3* children

   'Inside of the car, there are three very happy children.'

8. 嗰個男仔已經食咗好多麵喇。

   go2 go3 naam4zai2 ji5ging1 sik6zo2 hou2do1 min6 laa1

   That CL boy already eat-ASP many noodles SFP

   'That boy has already eaten a lot of noodles.'

9. 呢架紅色嘅巴士入面係無人嘅。

   ne1 gaa3 hung4sik1 ge3 baa1si2 jap6min6 hai6 mou4 jan4 ge3

   This CL red *ge3* bus inside is no one SFP

   'Inside of this red bus, there is no one.'

10. 公園裡面見到個伯伯喺度散步。

    gung1jyun4 leoi5min6 gin3dou2 go3 baak3baak3 hai2dou6 saan3bou6

    Park inside see-ASP CL grandpa there walk

    'Inside of the park, (I) saw a grandpa take a walk.'

11. 嗰個男仔鍾意每朝早去跑步。

    go2 go3 naam4zai2 zung1ji3 mui5 ciu1zou2 heoi3 paau2bou6

    That CL boy like every morning go run

    'That boy likes going for a run every morning.'

12. 呢個叔叔身型係高高瘦瘦嘅。

    ne1 go3 suk1suk1 san1jing4 hai6 gou1gou1sau3sau3 ge2

    This CL uncle body-build is tall-slender SFP

    'This uncle's body build is tall and slender.'

13. 女仔孭住個綠色書包去返學。

    neoi5zai2 me1zyu6 go3 luk6sik1 syu1baau1 heoi3 faan1 hok6

    Girl carry-ASP CL green backpack go back school

    'The girl carries a green backpack to go to school.'

14. 今日嘅功課妹妹好快就做完喇。

    gam1jat6 ge3 gung1fo3 mui4mui2 hou2faai3 zau6 zou6jyun4 laa1

    Today ge3 homework sister very-quick ADV complete SFP

    'Today's homework, the sister has already completed them very quickly.'

15. 馬路中間企咗個好精神嘅警察。

    maa5lou6 zung1gaan1 kei2zo2 go3 hou2zing1san4 ge3 ging2caat3

    Road center stand-ASP CL very-spirit ge3 policeman

    'At the center of the road, there is a well-spirited policeman.'

16. 嫲嫲鍾意每個星期日晚去跳舞。

maa4maa2 zung1ji3 mui5 go3 sing1kei4jat6 maan5 heoi3 tiu3mou5

Grandma like every CL Sunday night go dance

‘Grandma likes going to dance every Sunday night.’

Supplementary Materials

Table A. *Contrasts between each RC type in each language group*.

	YTD				DLD				AM-TD			
	β	***SE***	***z***	***P***	***β***	***SE***	***z***	***P***	***β***	***SE***	***z***	***P***
S - A	0.36	0.27	1.33	n.s.	0.96	0.24	3.99	p <.01 (S > A)	0.19	0.25	0.76	n.s.
S - P	0.65	0.26	2.46	n.s.	0.90	0.24	3.76	p <.01 (S > P)	1.18	0.25	4.82	p < .0001 (S > P)
S - IO	1.89	0.26	7.18	p < .0001 (S > IO)	1.83	0.27	6.91	p < .0001 (S > IO)	1.51	0.25	6.10	p < .0001 (S > IO)
S - OBLHelp	1.01	0.26	3.89	p < .01 (S > OBLHelp)	0.96	0.24	3.99	p <.01 (S > OBLHelp)	0.69	0.25	2.80	n.s.
S - OBLWith	0.83	0.26	3.18	p <.05 (S > OBLWith)	1.38	0.25	5.52	p <.0001 (S > OBLWith)	0.64	0.25	2.57	n.s.
S - GENS	2.46	0.27	9.01	P < .0001 (S > GENS)	2.96	0.34	8.80	p <.0001 (S > GENS)	2.04	0.25	8.06	p < .0001 (S > GENS)

S - GENO	1.30	0.26	5.02	p <.0001 (S > GENO)	2.47	0.30	8.29	p <.0001 (S > GENO)	1.70	0.25	6.83	p <.0001 (S > GENO)
A - P	0.29	0.25	1.15	n.s.	-0.06	0.25	-0.25	n.s.	0.99	0.24	4.10	p <.01 (A > P)
A - IO	1.54	0.25	6.04	p <.0001 (A > IO)	0.87	0.27	3.25	p <.05 (A > IO)	1.32	0.24	5.42	p <.0001 (A > IO)
A - OBLHelp	0.66	0.25	2.61	n.s.	-0.00	0.25	0.00	n.s.	0.50	0.24	2.06	n.s.
A - OBLWith	0.48	0.25	1.88	n.s.	0.42	0.25	1.65	n.s.	0.44	0.24	1.82	n.s.
A - GENS	2.11	0.26	7.98	p <.0001 (A > GENS)	2.00	0.34	5.92	p <.0001 (A > GENS)	1.85	0.25	7.43	p <.0001 (A > GENS)
A - GENO	0.95	0.25	3.78	p <.01 (A > GENO)	1.51	0.30	5.03	p <.0001 (A > GENO)	1.51	0.24	6.17	p <.0001 (A > GENO)
P - IO	1.24	0.25	5.00	p <.0001 (P > IO)	0.93	0.27	3.48	p <.05 (P > IO)	0.32	0.23	1.40	n.s.
P - OBLHelp	0.36	0.25	1.48	n.s.	0.06	0.25	0.25	n.s.	-0.49	0.23	-2.10	n.s.
P - OBLWith	0.19	0.25	0.75	n.s.	0.48	0.25	1.89	n.s.	-0.55	0.24	-2.34	n.s.

(Continued)	**YTD**				**DLD**				**AM-TD**			
	β	***SE***	***z***	***P***	***β***	***SE***	***z***	***P***	***β***	***SE***	***z***	***P***
P - GENS	1.82	0.26	7.02	p <.0001 (P > GENS)	2.06	0.34	6.11	p <.0001 (P > GENS)	0.86	0.24	3.61	p <.01 (P > GENS)
P - GENO	0.66	0.25	2.67	n.s.	1.57	0.30	5.24	p <.0001 (P > GENO)	0.52	0.23	2.21	n.s.
IO - OBLHelp	-0.88	0.25	-3.60	p <.01 (IO **<** OBLHelp)	-0.87	0.27	-3.25	p <.05 (IO **<** OBLHelp)	-0.82	0.24	-3.47	p <.05 (IO **<** OBLHelp)
IO - OBLWith	-1.06	0.25	-4.30	p <.001 (IO **<** OBLWith)	-0.45	0.28	-1.65	n.s.	-0.87	0.24	-3.70	p <.01 (IO **<** OBLWith)
IO - GENS	0.58	0.25	2.26	n.s.	1.13	0.35	3.20	p <.05 (IO > GENS)	0.53	0.24	2.24	n.s.
IO - GENO	-0.59	0.24	-2.41	n.s.	0.64	0.32	2.02	n.s.	0.19	0.23	0.82	n.s.
OBLHelp - OBLWith	-0.18	0.24	-0.74	n.s.	0.42	0.25	1.65	n.s.	-0.06	0.24	-0.24	n.s.
OBLHelp - GENS	1.45	0.26	5.71	p <.0001	2.00	0.34	5.92	p <.0001	1.35	0.24	5.60	p <.0001

				(OBLHelp > GENS)				(OBLHelp > GENS)				(OBLHelp > GENS)
OBLHelp - GENO	0.29	0.24	1.21	n.s.	1.51	0.30	5.03	p <.0001 (OBLHelp > GENO)	1.01	0.24	4.26	p <.001 (OBLHelp > GENO)
OBLWith - GENS	1.63	0.26	6.37	p <.0001 (OBLWith > GENS)	1.58	0.34	4.61	p =.0001 (OBLWith > GENS)	1.40	0.24	5.81	p <.0001 (OBLWith > GENS)
OBLWith - GENO	0.47	0.24	1.94	n.s.	1.09	0.31	3.57	p <.01 (OBLWith > GENO)	1.06	0.24	4.48	p <.001 (OBLWith > GENO)
GENS - GENO	-1.16	0.25	-4.59	p = .0001 (GENS **<** GENO)	-0.49	0.38	-1.30	n.s.	-0.34	0.24	-1.43	n.s.

S: Subject; A: Agent; P: Patient; IO: Indirect Object; OBLHelp: Oblique Help; OBLWith: Oblique With; GENS: Genitive Subject; GENO: Genitive Object