Brain & Language 254 (2024) 105425

Contents lists available at ScienceDirect

Brain and Language

journal homepage: www.elsevier.com/locate/b&l

Research Article

Production of relative clauses in Cantonese-speaking children with and without Developmental Language Disorder

Jane Lai [a,b,*], Angel Chan [a,b,c,**], Evan Kidd [d,e,f]

[a] Department of Chinese and Bilingual Studies, The Hong Kong Polytechnic University, 11 Yuk Choi Road, Hung Hom, Kowloon, Hong Kong Special Administrative Region
[b] Research Centre for Language, Cognition, and Neuroscience, The Hong Kong Polytechnic University, 11 Yuk Choi Road, Hung Hom, Kowloon, Hong Kong Special Administrative Region
[c] The Hong Kong Polytechnic University – Peking University Research Centre on Chinese Linguistics, 11 Yuk Choi Road, Hung Hom, Kowloon, Hong Kong Special Administrative Region
[d] Max Planck Institute for Psycholinguistics, Wundtlaan 1, 6525 XD Nijmegen, The Netherlands
[e] The Australian National University, Canberra, ACT 2600, Australia
[f] ARC Centre of Excellence for the Dynamics of Language, Canberra, ACT 2600, Australia

ARTICLE INFO

Keywords:
Emergentist approaches to language
Developmental Language Disorder
Relative clause production
Cantonese
Language acquisition
Child language
Clinical linguistics

ABSTRACT

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.

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).

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

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

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

* Corresponding author at: Department of Chinese and Bilingual Studies, The Hong Kong Polytechnic University, 11 Yuk Choi Road, Hung Hom, Kowloon, Hong Kong Special Administrative Region.
** Corresponding author at: Department of Chinese and Bilingual Studies, The Hong Kong Polytechnic University, 11 Yuk Choi Road, Hung Hom, Kowloon, Hong Kong Special Administrative Region.
E-mail addresses: jane-man-yu.lai@connect.polyu.hk (J. Lai), angel.ws.chan@polyu.edu.hk (A. Chan), evan.kidd@anu.edu.au (E. Kidd).

https://doi.org/10.1016/j.bandl.2024.105425
Received 10 May 2023; Received in revised form 16 May 2024; Accepted 20 May 2024
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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, 2023), 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 $_i$]

tek3 gan2 baan1 maa5 go2 zek3 / ge3 coeng4 geng2 luk6

kick-PROG zebra that CL/ ge3 giraffe

'the giraffe that is kicking the zebra'

(4) Cantonese object RC:

S V O

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

baan1 maa5 tek3 gan2 go2 zek3 / ge3 coeng4 geng2 luk6

zebra kick-PROG that CL/ ge3 giraffe

'the giraffe that the zebra is kicking'

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

Thus, under the emergentist framework, acquisition phenomena that show a subject over 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)[1] 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'

(continued on next page)

[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).

(*continued*)

(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 $_{i}$]

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

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
Developmental predictions derived from emergentist perspectives for the acquisition of 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 *ge3* RCs)

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

[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.

2. Method

2.1. 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 – 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.

2.2. 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.

2.3. 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.

2.4. 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

[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.

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.

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.

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

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

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

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

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

as random effects. Fig. 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.

3.1. 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.

3.2. 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

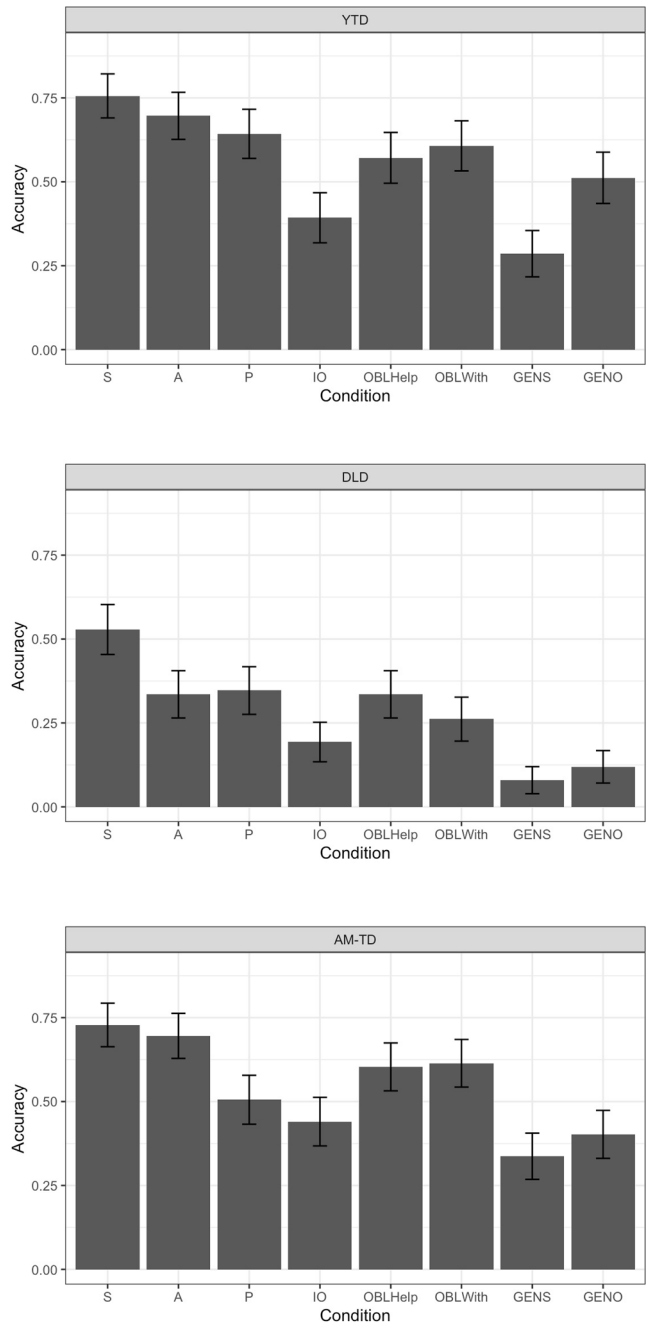

Fig. 1. Children's production accuracy for each RC (sub)type by language group.

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.

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; Stavrakaki 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.

4.1. *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 different from the classically complex genitive RCs[8] (both genitive subject (GENS) and genitive object (GENO)).[9] The finding of oblique RCs being not more difficult than object (P-RCs) in Cantonese is similar to the finding of OBL-RCs not causing significantly more difficulties than P-RCs in Diessel & Tomasello (2005)'s study on English and German-speaking children, Frizelle and Fletcher (2014a) on English-speaking children with and without DLD, and Kirjavainen et al. (2017) on Finnish-speaking children; while the finding of indirect object (IO-RCs) being significantly more difficult than oblique RCs in Cantonese stands in contrast with the non-significant difference between IO- and OBL- RCs reported in these studies. The authors also explained their findings from an emergentist, usage-based perspective, identifying a core role for language-specific properties (i.e. similarity with other simple constructions) that would affect distributional frequencies in the learner's experience, and other processing factors such as working memory capacity and general semantic/ conceptual complexity.

Moreover, another language-specific finding relates to the lack of a robust object (P-RCs) disadvantage in Cantonese. Both DLD and their younger, language matched YTD peers produced subject (A-RCs) and object (P-RCs) with comparable ease; whereas a significant A > P-RCs advantage was observed only in the older, age-matched TD children. Thus, our data does not show an across-the-board subject-over-object advantage or an object disadvantage. The lack of a robust P-RCs disadvantage in Cantonese is also unlike the developmental trajectory of RCs in English and other European languages, where a robust subject RC advantage in acquisition studies was reported when factors such as animacy contrast and the discourse status of the NP were controlled (e.g. Diessel & Tomasello, 2005 in English and German; Friedmann, Belletti & Rizzi, 2009 in Hebrew; Contemori & Belletti, 2014 in Italian; see *meta*-analysis in Tanaka et al., 2024), and also unlike the broad consensus of a difficulty with P-ORCs as a characteristic feature of DLD in the literature (e.g. Adani et al., 2014, Frizelle & Fletcher, 2014a in English; Stavrakaki 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). 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.

4.2. 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 performed consistently across the two subtypes (i.e. finding OBL-RCs (subtypes Help and With alike) significantly easier than IO-RCs), children with DLD's accuracy in repeating oblique RCs declined notably in subtype OBLWith, resulting in a lack of significant difference between OBLWith and IO-RCs. Subtype OBLWith was predicted to be

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

[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.

slightly disadvantaged, because semantically it is relatively more distant and therefore may not receive as much support as OBLHelp from the simple, frequently occurring serial verb main clause constructions. While the TD children's stable performance with OBL-RCs (OBLHelp and OBLWith alike) in our study may reflect their abilities to generalize across exemplars and identify the constructional relationship between the subtypes, DLD's differential performance with the two subtypes of OBL-RCs is consistent with the literature's observation that DLD children are worse than their TD peers in generalizing across exemplars (e.g. Stokes & Fletcher, 2000; Fletcher et al., 2005 on Cantonese aspect marker; Riches, Faragher & Conti-Ramsden, 2006 on English verb schema use; see Hsu & Bishop (2010) for a summary of more cross-linguistic evidence).

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

4.3. 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 morpho-syntactic 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, Chan & Matthews, 2023; Lai, Chan & Kidd, 2023).

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.

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

CRediT authorship contribution statement

Jane Lai: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Angel Chan:** Writing – review & editing, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Evan Kidd:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Conceptualization.

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.

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 are included in the supplementary materials.

Acknowledgment

This research was supported by the Hong Kong PhD Fellowship Scheme (HKPFS), awarded by the Research Grants Council, Hong Kong, to the first author, and a research grant titled "Asymmetries in Cantonese Children's Comprehension and Production of Relative Clauses: Structure, Typology and Processing" (PolyU 156072/17H; PI: Chan), awarded by the Research Grants Council General Research Fund, Hong Kong, and a research grant titled "Relative Clause Processing in Cantonese-Speaking Children with Specific Language Impairment: A Pilot Study" (P0001890, 4-ZZHF; PI: Chan), awarded by the Hong Kong Polytechnic University (http://www.polyu.edu.hk/rio/) to the second author. The funders had no role in study design, the collection, analysis and interpretation of data, the writing of the report or the decision to submit the article for publication. We thank Dr Franklin Chang for advice on statistical analyses in the early phases of this study, Dr Anita Wong for advice on group matching designs for DLD/SLI studies at the outset of this study, Ms Louise Hui and colleagues at the Speech and Hearing Services Section of the Hong Kong Education Bureau and Dr Cecilia Au for their support in participant recruitment, and all the children and schools who took part in this study.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bandl.2024.105425.

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