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Comprehension and production of non-canonical word orders in Mandarin-speaking Child Heritage Speakers

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Across languages, structures with non-canonical word order have been shown to be problematic for both child and adult heritage speakers. To investigate the linguistic and child-level factors that modulate heritage speakers' difficulties with non-canonical word orders, we examined the comprehension and production of three Mandarin non-canonical structures in 5- to 9-year-old Mandarin-English heritage children and compared them to age-matched Mandarin-speaking monolingual children and adults. Specifically, we examined how linguistic properties, such as linear word order, presence or absence of morphosyntactic cues, and surface structural overlap between languages, as well as child-level factors, such as chronological age and current home language use affect the acquisition of non-canonical structures in heritage children and their monolingual peers. Results showed that although heritage children could use morphosyntactic cues, they did not show monolingual-level sensitivity to passive-related morphology. Additionally, children produced more canonical SVO word order, which is shared between English and Mandarin, and preferred the reverse interpretations of non-canonical structures in comprehension. These responses were taken as evidence for cross-linguistic influence from the majority to the minority language. Finally, although non-canonical structures caused difficulties for child heritage speakers, their performance was modulated by structure and improved with age, over and above heritage language use.

Keywords: child heritage speaker, Mandarin non-canonical word order, age effect, cross-linguistic influence, morphosyntactic cue.

1. Introduction

Growing up in a bilingual environment, *heritage speakers* (HSs) are exposed to the minority *heritage language* (HL) and the societal *majority language* (ML) either at the same time from birth, or to the HL from birth as their home and/or community language, and to the ML later through education. Although HSs' individual language experience may vary, HSs are usually dominant in their ML, especially when it is also the language of schooling, and weaker in their HL (Montrul, 2008). Despite acquiring their HL in naturalistic contexts with exposure to native

or near-native input from birth, they still have different acquisition conditions compared to their monolingual peers. Given their distinct bilingual environment and highly varied linguistic experience to both languages, HSs may show different language profiles from their monolingual peers and varied HL abilities across HSs (Montrul, 2016).

Within the domain of syntax, non-canonical word orders have been reported to cause difficulties for both child heritage speakers (CHSs) (Chondrogianni & Schwartz, 2020) and adult heritage speakers (AHSs) (Polinsky, 2008). These non-canonical structures are often characterised as complex because they involve displacement of constituents from the original position, where sentential arguments are interpreted. For example, in English passives, as in “The dog was kicked by the giraffe”, *the dog* is the notional patient of the verb *kick* that occupies the syntactic subject, whereas the notional agent *the giraffe* is within a by-phrase. Non-canonical structures may also be complex due to their low frequency compared to the canonical structures (Brooks & Tomasello, 1999). The combination of low frequency with syntactic complexity may modulate the acquisition of these structures and lead to protracted developmental patterns in monolingual and bilingual children (e.g., Aizu, 2016; Huang, Zheng, Meng & Snedeker, 2013).

Many factors have been argued to cause HSs’ difficulties with non-canonical word orders. Among other things, these factors may be linguistic, related to the target language itself, such as the presence and absence or the transparency of the morphosyntactic cues within the structures (Chondrogianni & Schwartz, 2020); or, to language contact and cross-linguistic influence from the ML to the HL, normally leading to developmental patterns or rates different from monolingual baseline (Chondrogianni & Schwartz, 2020; Mai, Kwan & Yip, 2018). They may also be child-specific, such as children’s chronological age when tested, or how much the HL/ML is used on a daily basis over a period of time (Flores, Santos, Jesus & Marques, 2017).

In both Mandarin and English, the subject-verb-object (SVO) word order is considered the canonical word order. Mandarin, a language with more sparse, compared to English, or even no inflectional morphology (Huang, Li & Li, 2009), uses a combination of (non-)canonical word orders and free morphosyntactic cues to form various sentence types, including actives and passives. In this study, we focused on two relatively common Mandarin non-canonical word orders, SOV and OSV. SOV structures carry the morphosyntactic cue *ba* associated with active structures, whereas OSV structures may carry the *bei* cue and be associated with passives, or no cue at all, but still foreground the object to the sentence-initial position. We focused on how CHSs comprehend and produce these structures, as an HL context where Mandarin is acquired under pressure from the dominant language, English in this case, may lead Mandarin-English CHSs to disregard the free-standing morphological cues in Mandarin and rely on the canonical (SVO) word order strategy that is shared between the two languages. This over-reliance on canonical word order could be taken as evidence for CLI from the ML to the HL. In the present study, we investigated how the acquisition of Mandarin non-canonical structures by 5- to 9-year-old Mandarin-English CHSs is modulated by linguistic and child-level factors.

2. Background

2.1 *Non-canonical word orders in Mandarin and English*

Like English, sentences in Mandarin are canonically realised in the sequence of SVO (in the phrasal level: Noun-Verb-Noun, NVN henceforth), as in (1).

(1) Canonical word order.

e.g., Laoshi-AGENT biaoyang-le xuesheng-PATIENT.

Teacher praise-PERF student

‘The teacher praised the student.’

Other word order permutations, such as SOV, OSV, VOS and OVS are also observed in spoken language. In traditional studies of Mandarin syntax, the canonical word order is seen as the unmarked, neutral form in meaning, while pragmatic reasons motivate the use of non-canonical word orders. For instance, the most used non-canonical word order variations, i.e., SOV and OSV, emphasise the object. In this study, we will focus on these particular variations, SOV and OSV. Although these two variations contrast with each other in that the agent is realised before the patient in SOV and after in OSV, they share the same phrasal order, i.e., N(oun)-N(oun)-V(erb). Additionally, these non-canonical word orders are typically marked with morphosyntactic cues in-between the two Noun Phrases (NPs), e.g., *ba* for SOV, *bei* for OSV. In SOV marked with *ba*, the first NP (NP1) is the agent and the second NP (NP2) the patient, as in (2). Conversely, when the two NPs are separated by *bei* in OSV structures, these structures are considered passives with NP1 denoting the patient and NP2 the agent, as in (3). This contrasts with English, where the linear phrasal order of passives is still NV(-by N) with the two thematic roles separated by the verb, whereas in Mandarin, both NPs are presented linearly before the VP.

(2) *ba* intervenes between two NPs making NP1 the agent and NP2 the patient.

e.g., Laoshi-AGENT *ba* xuesheng-PATIENT biaoyang-le.

Teacher BA student praise- PERF

‘The teacher praised the student.’

3) *bei* distinguishes NP1 as the patient and NP2 as the agent.

e.g., Xuesheng-PATIENT *bei* laoshi-AGENT biaoyang-le.

Student BEI teacher praise- PERF

‘The student was praised by the teacher.’

However, it is not always necessary to have a morphosyntactic cue, like *ba* or *bei*, between the two NPs, and NNV structures without morphosyntactic cues are common in Mandarin. Importantly, Mandarin speakers predominantly interpret these NNV structures without morphosyntactic cues as structures demoting the agent while promoting the patient similarly to passives (Li, Bates, Liu & MacWhinney, 1992). Therefore, sentences like (4) are comparable to passives as they share the same patient-agent order¹. Note that although a comma is sometimes presented after NP1 in the written modality, a pause or intonation change at this position is not obligatory in production. Hence, these structures are not equivalent to an English object topicalisation structure, whose frequency is extremely rare, especially in children’s input (Slabakova, 2015).

(4) Xuesheng- PATIENT, laoshi-AGENT biaoyang-le.

Student teacher praise- PERF

‘The student was praised by the teacher.’

In the current study, we term the SOV structures with *ba* as “the BA”, OSV structure with *bei* as “the BEI”, and the NNV structure without morphosyntactic cue as “the simple OSV”².

¹ A structure of this kind, however, is treated as a separate syntactic structure from passives, while what the structure is and how it is formed remain contentious issues among researchers.

² The analysis of these structures is controversial. We refer the readers to Huang et al., (2009) among others for a detailed discussion.

2.2 Non-canonical word orders in typically-developing Mandarin children

In typically-developing monolingual children, difficulties in comprehending and producing non-canonical word orders are attributed to children's inability to use morphosyntactic cues at a young age (Chan et al., 2009), coupled with their over-reliance on the agent-first strategy (Dittmar et al., 2008). The agent-first strategy refers to the tendency observed in very young children across different languages to interpret the first NP they encounter in the sentence as the agent. In non-canonical structures, this strategy may lead to misanalysing NP1 as the agent instead of the patient, which is the correct interpretation. This initial erroneous interpretation would need to be later reanalysed, a reanalysis that can be facilitated by the presence of morphosyntactic cue(s). The ability to reanalyse complex syntactic structures has been shown to be a function of age, with children older than five years generally recovering from initial erroneous interpretations (Abbot-Smith, Chang, Rowland, Ferguson, Pine & Paterson, 2017; Demuth, 1989).

The acquisition of the BA and BEI has been examined in Mandarin-speaking preschool children either using longitudinal, naturalistic production data (Deng, Mai & Yip, 2018) or sophisticated online paradigms such as eye-tracking (Huang, Zheng, Meng & Snedeker, 2013; Zhou & Ma, 2018). Despite the undisputed contributions of these studies, they give rise to contradicting results regarding if the production or processing of one structure precedes that of the other, and hence, their exact developmental pattern is less clear. Starting with the production of the BA and the BEI, Deng, Mai, and Yip (2018) conducted an analysis of naturalistic child corpus coupled with a diary analysis, showing an early production of the BEI and the BA around the age of two in naturalistic contexts. Interestingly, they observed that the BEI (0.02%) was produced two months earlier than the BA (1.27%), even though the input frequency of the BA (2.62%) was significantly higher than the BEI (0.13%). And despite the low production frequency of these structures, the sentences produced by children followed the

same constraints as adults did. This was taken to suggest an early acquisition of these structures, although with very low occurrence in child corpora.

Turning to comprehension, Huang et al. (2013) used the visual-world eye-tracking paradigm to compare five-year-old children's and adults' processing of the BEI compared to the BA. Overall, adults performed better than children on interpreting the BEI regardless of whether NP1 was lexical (e.g., *shayu* 'shark') or a pronoun (e.g., *ta* 'it/she/he). However, both adults and children showed similar processing patterns in the two conditions and had more difficulties in the pronoun condition, where the presence of *bei* triggered the revision of an initially assigned interpretation. The authors concluded that children used the same processing mechanism as adults, and the difference exhibited in accuracy between groups was quantitative rather than qualitative. Importantly, overall worse performance on the BEI was observed compared with the BA in this study, indicating a BA advantage for monolingual children.

Contrary to Huang et al. (2013), Zhou and Ma (2018) did not find a BA advantage in children as young as three-year-old. Using the same eye-tracking paradigm, they tested whether children fixed their eye-gaze on the target picture depicting the patient (in the BA) or the agent (in the BEI) immediately after hearing either *ba* or *bei* cue. They found that three-year-olds could correctly use these morphosyntactic cues in real-time to assign the target thematic roles and only differed from adults in overall processing time, whereas five-year-olds were indistinguishable from adults.

All the above studies suggest that the BA and the BEI emerge early in children's naturalistic production, and that children as young as three years old can use *ba* and, to a certain extent, *bei* cues in comprehension. However, results from previous studies are mixed as to whether these structures are comprehended and produced at the same time in monolingual children, which might be due to the different child samples and methods deployed. In the present study, to establish whether monolingual children had knowledge of the BA and the BEI

and potentially differential performance on these two structures, we tested the same children on both a production and an offline comprehension task. We also targeted the comprehension of the simple OSV in monolingual Mandarin-speaking children, not examined in previous studies, to investigate whether the presence of a morphosyntactic cue modulates performance in the monolingual and the heritage children. This would also allow us to gauge HS's performance as compared to their monolingual counterparts.

2.3 Non-canonical word orders in heritage grammar

2.3.1 The acquisition of non-canonical word order and morphosyntactic cues. The difficulties in HSs' comprehension and production of non-canonical word orders have partially been attributed to their reliance on canonical word order over morphosyntactic cues, especially when there is surface overlap between the HL and the ML, ([Chondrogianni & Schwartz, 2020](#); [Janssen, 2016](#); [Kim et al., 2018](#)).

For example, Kim et al. (2018) tested Korean-English CHSs' comprehension and production of Korean case cues in canonical (SOV) and non-canonical (OSV) structures. The results showed that CHSs' comprehension of the non-canonical but not the canonical structure was problematic, because of the non-transparent Korean case marking system that does not facilitate the disambiguation of syntactic roles. This was despite having high accuracy on case production. Similarly, Janssen (2016) observed that CHSs' performance on non-canonical OVS structures in heritage Russian and Polish was significantly worse than their performance on canonical structures when they showed high accuracy of case production.

Turning to Mandarin, the cues *ba* and *bei* indicate whether a non-canonical structure is an active or a passive, respectively. To our knowledge, studies investigating non-canonical structures in Chinese as an HL have only targeted the BA (or its equivalents in other Chinese languages). For instance, Polinsky et al.'s (2010) case study illustrated poor production of the

BA in Mandarin-English heritage adults. Similarly, Mai et al. (2018) found that Cantonese-English heritage adults were less likely to produce the ZOENG-construction, the Cantonese counterpart of the BA. In both studies, participants produced significantly more canonical structures with shared word order (SVO) in both the HL and the ML.

To our knowledge, no study to date has examined both the comprehension and production of non-canonical word orders and, importantly, compare the potentially differential development of different non-canonical word orders in CHSs. This is one of the contributions of the present study.

2.3.2 Cross-linguistic influence and non-canonical word order acquisition. In the context of bilingual development, HSs' difficulties with non-canonical structures and preference for canonical word orders over morphosyntactic cues may also be boosted by the preferred canonical word order in the ML, especially when that word order overlaps with the HL canonical word order. This influence of the ML on the HL for structures that overlap on the surface between the two languages has been coined as cross-linguistic influence (CLI). CLI has been shown to take place when HSs prefer the HL structure that is shared between the HL and the ML, and when the HL allows more than one structures (Müller & Hulk, 2001; Serratrice, 2016). Several empirical studies using single language pairs (e.g., Greek-English or Italian-English; Argyri & Sorace, 2007; Serratrice, Sorace & Paoli, 2004) have reported CLI in production, where CLI emerges when the target language-specific structure is avoided using the structure that overlaps between the two languages. Additionally, CLI has also been reported in comprehension, where bilinguals opt for the shared structure when interpreting the structure not available in the other language (Chondrogianni & Schwartz, 2020; Janssen, 2016; Kim et al., 2018).

Regarding Chinese-English bilinguals, both Mai et al. (2018) and Polinsky et al. (2010) regarded the production of SVO in Cantonese and Mandarin in contexts where SOV was required as manifestations of CLI from English. In comprehension, Kidd, Chan & Chiu (2015) found that the shared canonical word order between Cantonese and English, i.e., SVO, led bilingual children to incorrectly choose the first NP in Cantonese object relative clauses as the head even though they were able to assign correct thematic roles within object relative clauses most of the time. For example, when comprehending Cantonese object relative clauses where the head is placed to the right of the relativiser instead of to the left, as in English, e.g., *[[chicken feeding that_{RC}] lion is where_{CP}]* (English gloss) “where is the lion that the chicken is feeding?”, Cantonese-English bilingual children incorrectly chose *chicken* instead of *lion* as the head. This was interpreted by the authors as a manifestation of CLI in comprehension. In the present study, we extend the investigation of CLI to CHSs by examining their production and comprehension of not only SOV but also of OSV with and without a morphosyntactic cue. This will allow us to investigate the interaction between the presence or absence of morphosyntactic cues and canonicity, and whether CHSs will avoid the target non-canonical structures by opting for the shared word order in both languages in production and comprehension, a proxy for CLI.

2.3.3 Age and language use in HL development. HL development has been shown to be highly variable and to be modulated by child-related factors, e.g., children’s chronological age and current language use (input and output). Nonetheless, if and how these individual factors separately and jointly modulate HL development has yet to receive empirical consensus.

For example, whether vulnerable HL properties develop with age (e.g., Flores & Barbosa, 2014; Jia & Paradis, 2018) or not (e.g., Chondrogianni & Schwartz, 2020; Janssen, 2016) has received mixed results. In most studies, children’s increasing age has been interpreted as an index of increasing, cumulative HL input coupled with improved cognitive

skills. In this sense, certain studies have reported that initial differences between CHSs and monolingual children disappeared with age and continuous exposure to HL input (Gagarina & Klassert, 2018), and that the acquisition of HL properties followed the same developmental stages as monolinguals (Flores & Barbosa, 2014; Jia & Paradis, 2018).

Other studies, on the other hand, reported that current use of the ML/HL strongly and differentially modulates HL development. Specifically, Daskalaki, Chondrogianni, Blom, Argyri & Paradis (2019) found that current HL use predicted the development of subject placement in Greek in conditions regulated by discourse. Yet, postverbal subject pronoun placement under purely syntactic conditions was immune to such an effect. Similarly, Gagarina & Klassert (2018) observed an effect of current HL use on subject-verb agreement but not on case marking in heritage Russian.

In the present study, we examined the effect of chronological age and current home language use (and their interaction, if any) on the development of non-canonical structures in Mandarin-English CHSs. To do so, we focused on a group of CHSs with varied age of testing and current language use at home.

3. Present Study

Overall, little is known about whether non-canonical structures are vulnerable in Mandarin CHSs, and what linguistic and child-level factors modulate their development of non-canonical structures. In addition, it is unclear whether CHSs can use morphosyntactic cues, in this case *ba* and *bei*, to assist non-canonical structure interpretation and production. Therefore, we compared 5-to 9-year-old Mandarin-English CHSs living in Edinburgh (the CHS) to their age-matched monolingual Mandarin-speaking children living in Northwest China (the MC) with a comprehension and a production task. Specifically, we addressed the following research questions:

1. Do the CHS differ from the MC on the comprehension and production of Mandarin non-canonical structures? If so, are the differences also influenced by structure type?
2. How do Age and HL use individually and/or jointly modulate the CHS's comprehension and production of non-canonical structures? Is the acquisition of these structures modulated by Age in the MC?
3. Will the CHS resort more to canonical word order when comprehending and producing non-canonical structures compared to MC, thus, indicating CLI?

To answer these research questions, we constructed a picture selection comprehension task and an oral priming production task modelled on Zhou and Ma (2018) and Messenger, Branigan, McLean & Sorace (2012), respectively. For the production, we employed comprehension-to-production priming to facilitate the production of these otherwise infrequent structures. Additionally, since priming taps into the abstract syntactic knowledge of these constructions (Song & Lai, 2021), the presence and magnitude of the priming effect would inform us about whether children have abstract representations of these structures (Branigan & Pickering, 2017). The monolingual-bilingual comparison would further inform us whether monolingual and heritage children differ in this respect.

3.1 Predictions

Starting with research question 1, we expected the MC to show adult-like performance for at least the BA and BEI (cf., Zhou & Ma., 2018). Given that the simple OSV has not been previously tested in Mandarin-speaking monolingual children, their performance on this structure is an empirical contribution of the present study. Provisionally, we can note here that if the MC rely on morphosyntactic cues over word order to interpret sentences, performance

on the simple OSV structure may be reduced compared to the BEI, as the latter contains an early acquired morphosyntactic cue.

For the CHS, we predicted that non-canonical structures would cause comprehension difficulties, especially if the CHS do not have the morphosyntactic cues as part of their linguistic repertoire. However, performance across the three structures might be differential. In the comprehension task, we expected their performance on the BA to be better than the BEI or simple OSV because of general sentence-interpretation strategies, i.e., NP1 as the agent (Dittmar et al., 2008; Huang et al., 2013; Omaki et al., 2014). In the case of the simple OSV, however, the CHS should have more difficulties compared with the BEI as no overt morphosyntactic cue is available to assist the interpretation of these structure. Furthermore, the CHS might also be more likely to choose the reversed interpretation when comprehending the BEI and the simple OSV compared with the MC, indicating a preference for the shared comprehension strategy between languages (NP1 as the agent), which could be interpreted as evidence for CLI (see also Kidd et al. 2015).

In production, we expected children to produce the target structure after the relevant prime, e.g., more BEI structures after BEI primes. This would indicate that these structures are part of their linguistic repertoire and can be used when primed. However, this might again be modulated by structure type. Studies with monolingual children are inconclusive as to which of the two cues, *ba* or *bei*, is acquired first. In our study, however, children might perform better on the BA than the BEI or simple OSV because the thematic ordering of agent-patient is canonical despite the word order being non-canonical, whereas the BEI and simple OSV involve non-canonical ordering of the patient/theme-agent thematic roles, which may, in turn, lead to reduced performance. Given the low prevalence of these structures in naturalistic production data, our study would reveal the production rates of these structures in the MC when primed, and whether age is still a factor for these children. Additionally, similarly to previous

studies with AHSs, it might be the case that the CHS resort to the canonical SVO instead of the BA, BEI or simple OSV (cf., Polinsky et al., 2010), when not producing the primed structures. This means that they might produce more canonical SVO, coined as canonical actives (CA) in this study, as an avoidance strategy where non-canonical structures are primed. Therefore, we expected the non-primed CA to emerge as an avoidance strategy in our study in place of the primed non-canonical structures. In the present study, we take the overproduction of the CA as an indication of CLI (Mai et al., 2018).

In sum, we proposed that CLI might emerge in comprehension as preference for the reverse than the target picture in the BEI and the OSV conditions; that is the CHS may interpret these non-canonical structures as canonical. CLI might emerge in the priming task as (over-)production of the CA in place of other non-canonical structures. Interestingly, in the study by Mai et al. (2018), when Cantonese-English AHSs were not producing the ZOENG-construction, they frequently used topicalisations in Cantonese, which are similar to the Mandarin simple OSV. The authors interpreted this overuse of topicalisations as CLI from English. However, we did not expect this to be the case for the CHS in our sample, given their low occurrence in data from English-speaking children and overall low frequency in English (Slabakova, 2015).

Finally, given the mixed results in the literature concerning the contribution of age and language use to HL development, we expected them to individually or jointly modulate the CHS's performance, so that older children and/or children with more HL use perform better than younger children and/or children with less HL use.

4. Method

4.1 Participants

In total, 40 children and ten adults participated in the study; twenty 5-to 9-year-old Mandarin-English CHSs living in Edinburgh, twenty age-matched Mandarin monolingual children living in China, and ten Mandarin-dominant adults residing in Edinburgh with less than eight months of naturalistic exposure to English (serving as the adult baseline; ADT) who had a mean age of 25 ($SD = 2.99$, $Range = 23 - 34$).

We administered the Alberta Language Environment Questionnaire adapted to heritage speakers (Daskalaki et al., 2019) to include and exclude participants and to capture their status of language use. We included in the CHS, children who were born in the UK (twelve out of twenty children) or had immigrated to the UK before the age of three (eight out of twenty children). All the CHS attended two-hour Mandarin Saturday schools every week during term time. Children were excluded from the study if they spoke languages other than Mandarin and English (one was excluded), or if they were extensively exposed to Mandarin for more than three months (e.g., went back to China) before they participated in the study (one was excluded). In terms of their parental information, ten of them had both Mandarin-speaking parents, while the remaining eight had a Mandarin-speaking parent and another English-speaking parent. All participants (48) included finished the experimental battery and had no reported history of hearing, speech, or language disorders. The two child groups were matched on age ($t(38) = .44$, $p = .67$) and socioeconomic status (SES) ($t(38) = .80$, $p = .43$), Table 1 presents detailed information about the final sample.

4.2 Materials

4.2.1 Language background and proficiency. We used the Alberta Language Environment Questionnaire adapted to heritage speakers (Daskalaki et al., 2019) to collect information about the CHS's experience with the two languages. To measure children's current home language

use (HLU), we asked questions about both their input and output of Mandarin and English and calculated HLU as the mean proportion of Mandarin input and output of the child. Specifically, parents were asked to rate on a scale from 0 (Mandarin almost never / English almost always) to 4 (Mandarin almost always / English almost never) on the questions of how frequently the child was spoken to in Mandarin by their parents, guardians (caregivers, grandparents, etc.) and siblings (input) and of how frequently the child directed to these family members in Mandarin (output). Furthermore, we also collected information about the socioeconomic status (SES) of the family by measuring the maternal education level.

As there is no standardised test for Mandarin proficiency for children of this age and the duration of the experiment was already demanding, we asked parents and teachers to assess the English and Mandarin language proficiency of the CHS. All CHS were assessed to have monolingual levels of performance in English based on their performance in local English mainstream schools. Concerning their Mandarin proficiency, teachers at the Chinese schools rated them as far below monolingual norms in general because the formal language instruction at the Chinese schools takes place two hours a week, and the teaching materials for Mandarin classes at the Chinese schools are initially intended for younger monolingual children.

Table 1. Mean age, SES, and current language use in the CHS and the MC.

Variables		CHS (n = 18)	MC (n = 20)
Age (in months)	Mean	81.39	83.6
	Range	60-110	60-109
	SD	15.82	15.41
HLU (proportion)	Mean	0.5	
	Range	0.25-0.83	
	SD	0.21	
Maternal education (in years)	Mean	15.9	15.4
	Range	12-20	12-20
	SD	2.1	2.44

Notes. HLU= current home language use (the higher the score, the more of a shift to English use at home); SES = socioeconomic status (maternal education level).

4.2.2 Experimental tasks

a Comprehension task. To gauge how participants interpret the three Mandarin non-canonical structures, we implemented a picture-selection task. In this experiment, each participant was shown a set of pictures on a computer screen. Each set contained two pictures, one on the left and one on the right. The two pictures depicted the same two animals or human participants performing the same action, but the thematic roles were reversed on each picture (Fig. 1). Children were then asked to point to the picture matching the sentence uttered by the experimenter. To ensure consistency across participants, each sentence was only produced once by the experimenter with the same intonation, pause, etc.

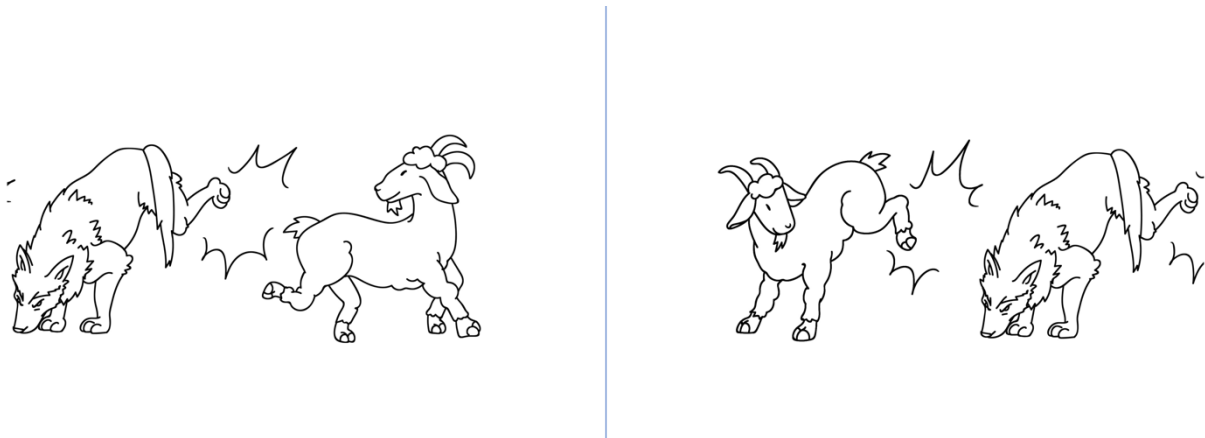


Figure 1. Example of experimental picture sets in the comprehension task.

This task comprised three experimental conditions: the BA condition (6), the BEI condition (7), the simple OSV condition (8). There were six sentences per condition resulting in 18 experimental items in total.

(6)	laolang-AGENT	<i>ba</i>	shanyang-PATIENT	qingqingde ti-le	yixia.
	wolf	BA	sheep	gently kick-PERF	once

‘The wolf gently kicked the sheep.’

- (7) shanyang- PATIENT *bei* laolang-AGENT qingqingde ti-le yixia.
sheep BEI wolf gently kick-PERF once
‘The sheep was gently kicked by the wolf.’

- (8) shanyang-PATIENT, laolang-AGENT qingqingde ti-le yixia.
sheep wolf gently kick-PERF once
‘The sheep was gently kicked by the wolf.’

All experimental sentences shared the same structure: NP + morphosyntactic cue *ba* or *bei*/without *bei* + NP + Adverb + VP. The NPs in all sentences were disyllabic and were presented in their bare form to encourage a definite reading so that consistency in the discourse level was maintained. The adverbs were *qingqingde* ‘gently’, *kaixinde* ‘happily’, and *henhende* ‘heavily’. Each of the three adverbs was used twice in each condition. Six verbs were selected to be used only once in each condition and all were ensured to appear in each condition. The verbs were *tui* ‘push’, *zhui* ‘chase’, *yao* ‘bite’, *ti* ‘kick’, *qin* ‘kiss’, and *hua* ‘paint’. All verbs were followed by a perfective aspect marker, *le*. In addition, to level out animacy effect and plausibility effect based on world knowledge, both NPs in every trial were animate, and the sizes of each pair of animals were matched. Furthermore, all the NPs, Adverbs and VPs were approved by the teachers at the Edinburgh Chinese schools that all participants should have been familiar with them.

The task also comprised 12 fillers which had two animals performing an intransitive action (e.g., *yuedu* ‘reading’, *shuxie* ‘writing’, *paobu* ‘running’, *kaixin* ‘being happy’ and *tiaoyue* ‘jumping’), as in (9) (Fig. 2).

- (9) zhizhu kaixinde kanshu, zhizhu kaixinde xiexin.
 spider happily read spider happily write
 ‘A spider is happily reading; a spider is happily writing.’

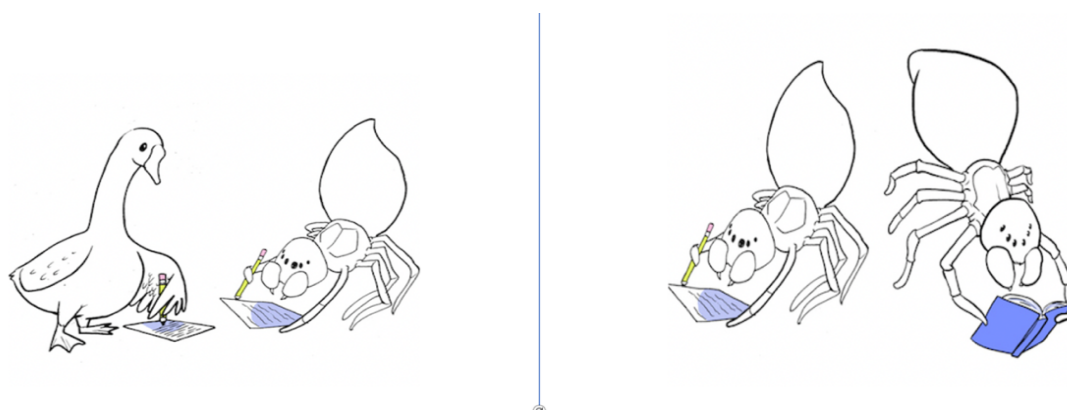


Figure 2. Example of filler picture sets in the comprehension task.

Three separate lists of experimental items were made to avoid picture order or verb biases. Specifically, the BA, the BEI and the simple OSV were all used to describe the left picture in Figure 1, and they were assigned respectively to list A, B and C, (BA (6) in list A, BEI (7) in B, and simple OSV (8) in C; for detailed and complete lists, see Appendix A). Participants were pseudorandomly assigned to different lists and were presented with a full list in a within-subject design. The relative position of the correct picture was counterbalanced so that the half trials had correct answers on the left and half on the right. In each list, 12 fillers and 18 experimental trials were arranged in a pseudorandom order.

b Production task. To investigate participants production of these structures, we adopted comprehension-to-production priming. In this task, participants were presented with a set of two pictures on a laptop screen and were asked to cooperate with the experimenter to take turns to describe the pictures. The experimenter described one of the pictures first (the

prime) and asked the participant whether they understood the sentence. Then the experimenter showed the next picture to the participant for them to describe. The primes targeted three conditions (BA, BEI, and simple OSV). The pictures used in the production task were different from the comprehension task, but the primes shared the same structures as the sentences in the comprehension task. Five verbs (*tui* ‘push’, *wei* ‘feed’, *shu* ‘comb’, *xi* ‘clean’, and *pen* ‘spray’) were selected, with each verb used once per condition. To reduce the reliance on non-syntactic cues and to level out item-based priming effects, the lexical items used in primes were different from the targets (Tomasello, 2000). Each condition consisted of five trials (a total of 15 target primes).

Similarly, three lists were made to ensure that every prime picture had a BA prime, a BEI prime and a simple OSV prime. For example, (10), (11), (12) are BA, BEI and simple OSV primes for the prime picture in Figure 3, and they were divided into list A, B, C respectively (for the full list, see Appendix B).

(10) gongniu-AGENT *ba* konglong-PATIENT qingqingde tui-le yixia.
 bull BA dragon gently push- PERF once
 ‘The bull gently pushed the dragon.’

(11) konglong-PATIENT *bei* gongniu-AGENT qingqingde tui-le yixia.
 dragon BEI bull gently push- PERF once
 ‘The dragon was gently pushed by the bull.’

(12) konglong-PATIENT, gongniu-AGENT qingqingde tui-le yixia.
 dragon bull gently push- PERF once
 ‘The dragon was gently pushed by the bull.’



Figure 3. Example of a prime picture (on the left) and an accompanying target picture (on the right).

There were also ten fillers, with four of them adapted from the fillers in the comprehension task, and six being different pictures. The presentations of primes and fillers were pseudorandomised across the three lists. The pictures used in both tasks were mainly adapted from Chondrogianni and Schwartz (2020), while some were drawn by the authors.

4.3 Procedure

The CHS were tested either at the Edinburgh Chinese schools or at the Wee Science Lab at the University of Edinburgh. The ADT were tested in the Admiral Lab at the University of Edinburgh. The MC were tested in their schools. Each participant participated in all the experimental tasks which lasted approximately 30 minutes. The presentation of the tasks was counterbalanced to cancel out potential carry-over effects that the comprehension task was administered first to a random half of the participants and the rest were firstly tested with the production task. Parents/caregivers completed the questionnaire either on their own or through

a face-to-face interview. The whole process of the experiment for each participant was audio-recorded. All the responses were later transcribed and scored by the first author of this paper.

4.4 Coding and Scoring

In the comprehension task, if the participant correctly selected the target picture either verbally or by pointing, the response was scored “1” and “0” otherwise. No responses and “I don’t know” responses were excluded from further calculation (two items excluded from both the CHS and the MC). Accuracy for the fillers was calculated and checked against chance-level (50%). This resulted in one six-year-old monolingual child being excluded (33% accuracy). All other participants showed above-chance accuracy ($M = .97$, $SD = .11$ $Range = 0.33 - 1$), and were, therefore, included in the analysis.

In the production task, participants’ utterances were coded as BA, BEI, simple OSV, and canonical SVO (canonical active; CA) if their utterances encoded correct thematic roles and were complete. Incomplete utterances, utterances with reversed thematic roles, English responses and responses with code-switching were coded as “others” and were excluded from further analysis (37 out of 270 for the CHS, 10 out of 300 for the MC, and two out of 150 for the ADT).

5. Results

Statistical analyses were carried out with the *lme4* package, *mlogit* package for multinomial regressions and the *psych* package in R (R Core Team, 2018). We visualised the results using the *ggplot2* package. Models were built up incrementally from the null model to the model with the interaction terms. We entered the maximal random effects, by-subject and by-item intercepts and slopes where possible (Barr et al., 2013). To identify the optimal model,

likelihood ratio tests were run. After determining the optimal models, we calculated C-index and Somers' D_{xy} rank correlation to justify the model fit. A value over 0.7 indicates a good fit of the model to the data.

5.1 Comprehension Task

Figure 4 presents the overall accuracy of each group across conditions. All groups reached the ceiling for the BA condition. The MC and the ADT performed at ceiling in the BEI and simple OSV conditions as well, although there were some individual differences, especially for the MC in the simple OSV condition. Inferential statistics confirmed that no group difference was observed between the ADT and the MC groups.

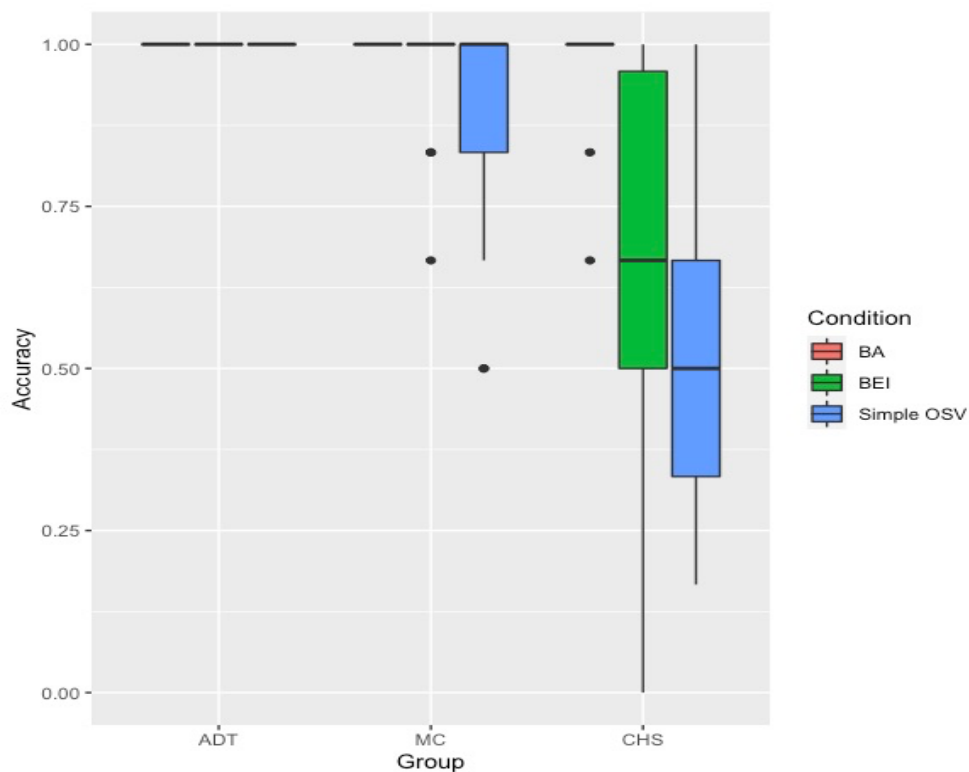


Figure 4. Comprehension accuracy of each condition for the monolingual adults (ADT), monolingual children (MC) and the heritage children (CHS). *Notes.* Line range = range of the data without the outliers, dots = outliers, upper and lower ends of the boxes = first and third quartile, lines in the centre of boxes = median.

Given that the ADT performed at ceiling across structures without individual variations, we excluded the ADT from further analysis. To understand the two child groups' comprehension of non-canonical word orders and how their performance was modulated by Group, Structure (research question 1), and Age (research question 2), we performed a generalised logistic linear mixed-effects analysis (GLLM), as the dependent variable (Accuracy; correct vs. incorrect) is binomial. As fixed effects, Group (**MC**³ and CHS), Condition (BA, **BEI** and simple OSV) and Age (scaled) were entered in the model. We included the BEI condition in the intercept to respectively contrast between the BA and the BEI as well as between the BEI and the simple OSV.

Table 2. Optimal model with Group, Condition (with their interaction) and Age as fixed effects for the comprehension data of the MC and the CHS.

	Estimate	Standard Error	<i>t</i>	<i>p</i>
(Intercept)	3.72	0.59	6.34***	<.001
Age (scaled)	0.36	0.20	2.28*	.02
<i>Group</i>				
CHS	-2.96	0.64	-4.59***	<.001
<i>Condition</i>				
BA	0.33	0.78	0.42	.11
Simple OSV	-1.01	0.62	-1.61	.11
<i>Group:Condition</i>				
CHS:BA	2.93	1.02	2.88**	<.01
CHS:Simple OSV	0.44	0.64	2.44**	<.01

³ Unless specified, the level in bold was the reference level throughout the analysis.

Notes. * $p < .05$, ** $p < .01$, *** $p < .001$

The optimal model included an interaction between Condition and Group (Table 2) and provided a good fit to the data ($C = .79$, $D_{xy} = .58$). To disentangle the interaction terms, we conducted post hoc analysis with Bonferroni pairwise comparisons. Together with the optimal model, the results showed that the CHS performed significantly worse than the MC in the BEI and simple OSV conditions (all $ps < .01$) but not in the BA condition. Additionally, while the accuracy across structures did not differ for the MC, the accuracy of the BA was the highest and the simple OSV was the lowest for the CHS. As for the effect of Age, it was observed for both groups across structures.

To examine the relative contribution of Age and (current) home language use (HLU) to CHS’s non-canonical structure comprehension, we ran another GLLM only for the CHS. In building up the model, HLU was not significant while Age was included in the final model. See figure 5 for the visual representations on the relationships between accuracy and non-linguistic factors across structures.

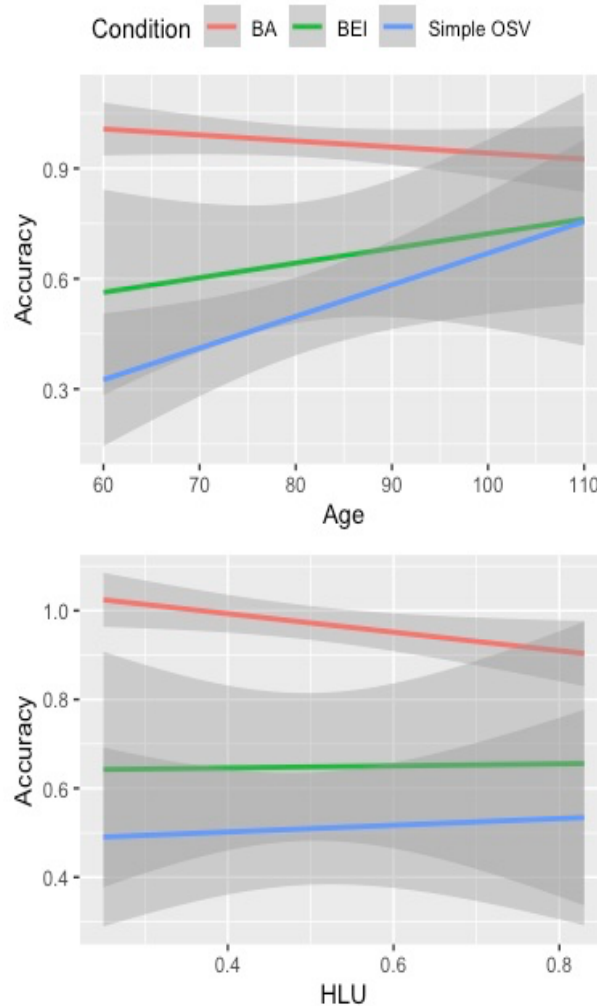


Figure 5. The relationship between the CHS’s comprehension accuracy and Age (top) and HLU (bottom) across structures.

Additionally, to examine more closely what gave rise to the CHS’s chance performance overall in comprehending the simple OSV, we looked at the individual data. This showed that the individual accuracy manifested a binomial distribution. Specifically, only a few showed at

chance performance while others either scored above or below chance level with some even showing 100% accuracy and some 0%.

5.2 Production Task

In the production task, the ADT produced 148 responses (98% of the target items). Out of these, 48 (33%) were BA responses, 56 were BEI (38%), 35 simple OSV (23%) and 9 CA (6%) responses. The MC totally produced 290 responses (97% of the target items), with 107 BA (33%), 101 BEI (35%), 75 simple OSV (26%) and 7 CA (2%) responses. For the CHS, 233 responses (85% of the target items) were used in the analysis, with 105 BA (45%), 62 BEI (27%), 15 simple OSV (6%) and 51 CA (22%) responses. As the numbers of total responses varied across groups, we converted the token of each response structure under each priming condition into proportions, i.e., token of a response type divided by the number of items in one condition (Figure 6). For the statistical analyses, we ran multinomial logistic regressions. This type of analysis allowed us to measure the conventional priming effect of one structure, e.g., the BEI after BEI primes as opposed after BA primes, by comparing the log odds of producing a particular structure versus producing the structure at the reference level (dependent variable) when changing from the prime structure at the reference level (independent variable) to other prime types. It also allowed us to measure the proportion to which a particular structure was produced after a particular prime, e.g., the BEI after a BEI prime and the BA after a BA prime, for each group separately, and thus carry out group comparisons by examining the intercepts and interactions (e.g., a significant intercept suggests that under the reference level of all independent variables, if the likelihood of producing a structure at the reference level in the dependent variable is larger or smaller than producing the other structures).

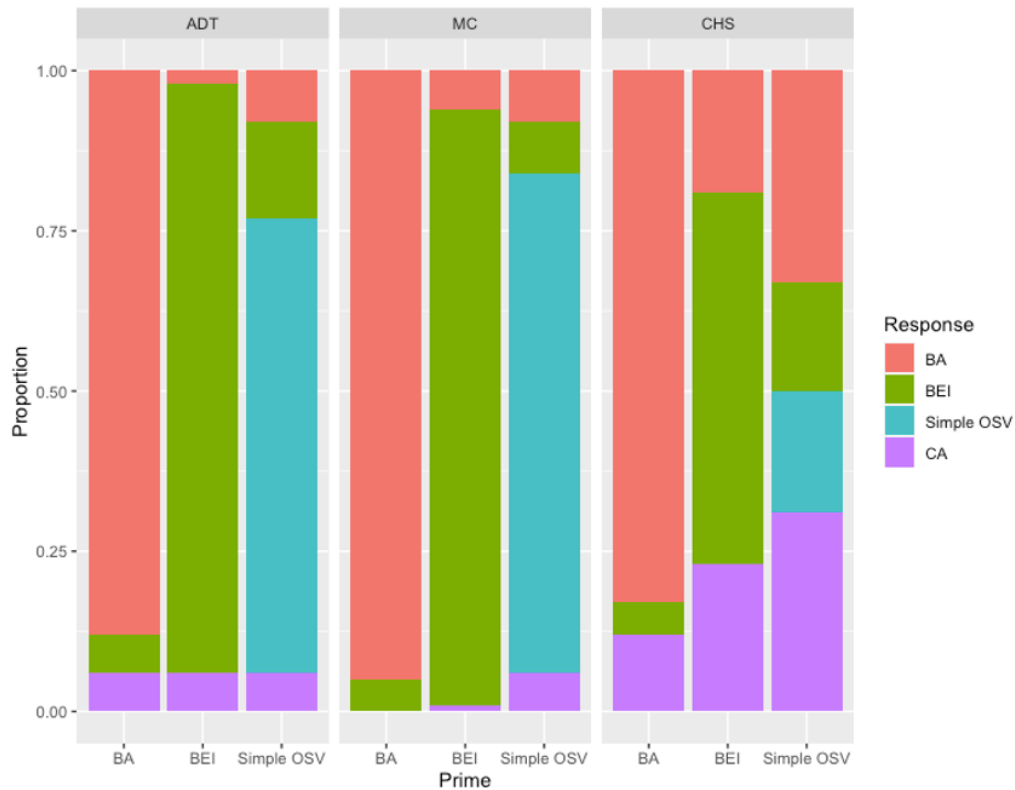


Figure 6. Proportion of response types (the BA, BEI, simple OSV and the canonical SVO; CA) following different prime types in the monolingual adults, children, and the heritage children.

Similar to the comprehension data analysis, we excluded the ADT whose performance was indistinguishable from the MC across prime types (all $ps > .05$) and ran a multinomial logistic regression with a three-level dependent variable (BA, BEI and simple OSV response types) and Group (MC and CHS), Prime Type (BA, BEI and simple OSV) and Age (scaled) as fixed effects to examine group differences between the MC and the CHS (research question 1) and the effect of age on both child groups (research question 2). The optimal model included the interaction between Group and Prime Type (Table 3).

Table 3. Optimal model with Group, Prime Type (with their interaction) and Age as fixed effects for the production data of the monolingual children and the heritage children.

Independent Variable	Estimate	Standard Error	<i>t</i>	<i>p</i>
<i>Production Structure: BEI vs BA log-odds</i>				
Intercept	-1.92	1.06	-2.79**	<.01
Age	-0.75	0.17	-4.44***	<.001
<i>Prime Type</i>				
BEI vs BA	6.19	0.68	9.11***	<.001
BEI vs simple OSV	2.36	0.68	3.42***	<.001
<i>Group</i>				
MC vs CHS	1.73	0.54	3.23***	<.001
<i>Group:Prime Type</i>				
CHS:BA	-2.01	0.88	-2.27*	<.05
CHS:simple OSV	-0.57	0.83	-0.68	.49
<i>Production Structure: BEI vs simple OSV log-odds</i>				
Intercept	-6.87	3.75	-2.17*	<.05
Age	-0.43	0.24	-1.83***	<.001
<i>Prime Type</i>				
BEI vs BA	4.47	1.90	0.11	.91
BEI vs simple OSV	6.30	3.72	0.48	.62
<i>Group</i>				
MC vs CHS	2.52	3.56	0.08	.94
<i>Group:Prime Type</i>				
CHS:BA	-4.03	9.40	-0.05	.96

CHS:simple OSV	-4.82	3.56	-0.14	.88
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Notes. * $p < .05$, ** $p < .01$, *** $p < .001$

Firstly, as an interaction between Group and Prime Type was included in the optimal model, we exhausted all possible combinations of reference levels of both dependent and independent variables, which was further supplemented by post hoc models run separately for each group. The results suggested that there was a significant effect of Prime Type across groups, i.e., participants were more likely to produce a specific structure, e.g., the BA, when the structure was the prime, i.e., the BA, compared with when the prime was not the same structure, i.e., the BEI/simple OSV. On the other hand, the proportion to which a particular structure was produced after a particular prime differed between groups, which was modulated by Prime Type. Specifically, the priming effect was the same between groups and the production pattern was comparable between groups in the BA. However, the CHS was more likely to produce a BA response when primed by BEI or simple OSV compared with the MC. Additionally, the simple OSV was not the preferred structure for the CHS even when it was primed by simple OSV. Secondly, the effect of Age was found across Prime Type and Group.

To see the effect of age and HLU within the CHS (research question 2) and how it was modulated by Prime Type, we included only the CHS in another multinomial logistic regression with response structure as dependent variable (BA, **BEI** and simple OSV), Prime Type (BA, **BEI** and simple OSV), Age (scaled) and HLU (scaled) as independent variables. Again, Age won over HLU which was not significant and was included in the optimal model.

Finally, we examined whether the CHS were more likely to use CA (SVO) than the other two groups (research question 3). We gave CA responses a value of “1” and all other valid responses a value of “0” (dependent variable). GLLM analyses with Group (**MC**, ADT

and CHS) and Prime Type (**BA**, BEI and simple OSV) as fixed effects were run. The optimal model ($C = .73$, $D_{xy} = .46$) without interaction term was selected (Table 4).

Table 4. Optimal model for the relationship between Group and Prime Type and the number of canonical active produced by the monolingual adults, children, and the heritage children.

	Estimate	Standard Error	<i>t</i>	<i>p</i>
(Intercept)	-5.71	1.13	-5.07***	<.001
<i>Group</i>				
ADT	0.18	1.88	0.10	.92
CHS	2.99	1.19	2.51**	<.01
<i>Prime Type</i>				
BEI	0.92	0.48	1.90*	<.05
simple OSV	1.49	0.48	3.10**	<.01

Notes. * $p < .05$, ** $p < .01$, *** $p < .001$

Across all three Prime Types, CHS were significantly more likely to resort to CA compared to the ADT and the MC (no significant difference between these two groups). In addition, for the CHS, the tendency of producing CA responses significantly increased following BA, then BEI and finally, simple OSV primes.

6. Discussion and conclusion

The aim of this study was to examine the acquisition of non-canonical structures in Mandarin-English child heritage speakers (the CHS) compared to Mandarin-speaking monolingual children (the MC). Specifically, we examined how the comprehension and production of non-

canonical structures, in both the CHS and the MC, were modulated by structure type and age, and also current home language use for the CHS. We wanted to find out whether the CHS would produce more canonical SVO structures instead of non-canonical structures, and whether they were more likely to choose the picture depicting the reverse action in comprehension compared with the MC. Note that canonical SVO structures are shared between Mandarin and English, and preference for these structures in production and/or comprehension would constitute evidence for cross-linguistic influence.

Given the mixed results and the limited structures tested in previous studies with monolingual children, we discuss the results for the MC first. Firstly, the MC performed as well as the ADT across structures in both comprehension and production, as predicted. The predictions that (1) the BA will be the most accurate in comprehension and easiest to produce in production and (2) the simple OSV should be the least accurate for the MC because the MC at a young age still rely more on the agent-first strategy (favouring the BA) relative to morphosyntactic cues (disfavouring the simple OSV) were not borne out in the present study, although we did observe a numerical disadvantage for the simple OSV in both the comprehension and production tasks. This finding also contrasts with previous studies showing a BA advantage in comprehension in the monolingual children at the age of five (cf., Huang et al., 2013), which might be caused by task differences. Finally, the MC's ability to use morphosyntactic cues for sentence interpretation and production improved with age, as reported in previous studies (Omaki et al., 2014).

Turning to the CHS, we hypothesised that the three structures should cause difficulties for them (see also Chondrogianni & Schwartz, 2020; Janssen, 2016; Kim et al., 2018) but to different degrees. Firstly, comparing the BA to the BEI and the simple OSV, we postulated that the BA should be easier to comprehend and produce because of the availability of the agent-first sentence-interpretation strategy (Dittmar et al., 2008; Omaki et al., 2014) regardless

of the use of the BA cue. The results supported the prediction. Secondly, comparing the BEI with the simple OSV, we found that the CHS had more difficulties comprehending and producing the simple OSV. We consider this to be caused by the lack of overt morphosyntactic cue assisting interpretation and production in the BEI. Note that the overall chance performance at the group-level in the comprehension task might have masked individual-level performance, which we discuss in the next section. In sum, we attributed the observed comprehension accuracy and production ease of the three structures to the fact that in the BA, the linear order of NPs (NP1_S-NP2_O) matches the canonical agent-patient order, while in OSV constructions NPs carry reversed thematic roles (patient-agent) to the linear order. This coupled with the absence of an overt morphosyntactic cue to assist the comprehension and production of the simple OSV may lead to its reduced accuracy. Additionally, as observed in other studies (Chondrogianni & Schwartz, 2020; Janssen, 2016; Kim et al., 2018), the CHS's reliance on the agent-first strategy might be fostered by the fact that it is also the dominant strategy in the ML English.

6.2 Child-level factors and non-canonical word orders in HL

Overall, the CHS did not show monolingual-level performance in either the comprehension or the production of the two OSV structures. Additionally, individual variability within the CHS sample in comprehending the simple OSV surfaced in the form of a binomial distribution, with children clustering either close to ceiling or to floor performance (see also Chondrogianni & Schwartz, 2020). This reinforced the importance of investigating the non-linguistic factors that affected the development of non-canonical word orders in the CHS. For that reason, we examined the role of chronological age and home language use (HLU). The results suggested that age (see also Armon-Lotem et al., 2011; Gagarina & Klassert, 2018) was a more significant predictor than HLU. The lack of HLU might reflect the nature of the heritage sample in our

study, i.e., more first-generation children compared to previous studies (e.g., Daskalaki et al., 2019) or the differential interaction between HLU and the structures tested in the present study (Daskalaki et al., 2019; Gagarina & Klassert, 2018). We are currently collecting data from more second-generation children as well as proficiency data to gauge the interplay between heritage generation and proficiency, on the one hand, and age on the other.

6.3 Cross-linguistic Influence

Following previous research (e.g., Chondrogianni & Schwartz, 2020; Polinsky et al., 2010; among others), we hypothesised that the CHS might resort to more canonical SVO (what we termed as canonical actives; CAs), leading to a higher preference of the reversed than the target picture when comprehending the BEI, and the simple OSV or to an avoidance strategy in production when the BA, BEI or simple OSV were preferred. This is indeed what we observed. In line with previous studies, we took the preference/overproduction of the shared surface structure between Mandarin and English, e.g., CA, as an effect of cross-linguistic influence (CLI) (Chondrogianni & Schwartz, 2020; Kidd et al., 2015 for comprehension and Polinsky et al., 2010; Mai et al., 2018 for production).

One could argue, however, that the CHS's overreliance on CA might reflect a more general cognitive strategy for Agent-Patient constructions, enhanced by their limited exposure to the HL. To be able to disentangle CLI from more general cognitive biases towards canonicity, one would need to have two different L1s with opposing properties to that in the ML. However, most studies reporting CLI have adopted a single language pair design (e.g., Argyri & Sorace, 2008; Bosch & Unsworth, 2020; Chondrogianni & Schwartz, 2020; Serratrice et al., 2004), and for these studies surface overlap between two languages seems to be what determines CLI. Future studies may also want to compare speakers of the same HL acquiring MLs with different word orders. For example, if Chinese heritage speakers with Truku Seediq (a VOS language

spoken in Taiwan) as their ML do not over-rely on CA but do when English is the ML, as in the present study, one could more confidently argue for CLI in the latter context.

Additionally, the CHS's performance in the BA contrasted sharply with that in the BEI/simple OSV. Specifically, heritage children did not differ from their monolingual peers in the comprehension of the BA, and the BA was primed to an equal extent as in the monolingual groups. Furthermore, when they produced CAs after BA primes, this was done to a much lesser extent than after BEI or simple OSV primes. This suggests that CLI may selectively affect non-canonical structures, especially the ones that require thematic role reversal, e.g., the BEI and the simple OSV. CHS may be performing better on the comprehension of the BA and produce fewer instances of CAs in this condition because the general heuristics that NP1 is the agent and NP2 is the patient is the same in the BA in Mandarin and in actives in English, but not in the two OSV structures.

To conclude, the Mandarin-English Child Heritage Speakers tested in the study lagged behind their age-matched Mandarin-speaking monolingual children in both the comprehension and production of non-canonical structures. Importantly, the findings suggest that the relative difficulty for the CHS to comprehend and produce different word orders was modulated by the linear word order and the presence or absence of morphosyntactic cues in these structures. Specifically, for the CHS, when morphosyntactic cues are present and the linear word order in the HL aligns with the canonical word order strategy (agent-first), performance increases. Additionally, CLI from the ML to the HL emerged in the form of overproduction of canonical actives as an avoidance strategy and as preference for agent-first interpretations in comprehension, highlighting the role of cross-linguistic structural overlap. Finally, in this sample of primarily first-generation heritage children, performance on these otherwise difficult non-canonical structures improved with age, over and above heritage language use.

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Appendix A Experimental sentences for the comprehension task

Table 5. List A for comprehension task.

Num	Condition	Agent	Action	Patient	corr.ans	target sentence
1	Simple OSV	小猫 cat	追 chase	老鼠 mouse	left	老鼠小猫开心地追了一会。
2	BA	狮子 lion	追 chase	马儿 horse	right	狮子把马儿开心地追了一会。
3	Simple OSV	马儿 horse	咬 bite	老狼 wolf	right	老狼马儿狠狠地咬了一下。
4	Simple OSV	男孩 boy	推 push	女孩 girl	left	女孩男孩子轻轻地推了一下。
5	BEI	公牛 bull	推 push	恐龙 dragon	right	恐龙被公牛轻轻地推了一下。
6	BEI	马儿 horse	踢 kick	犀牛 hippo	left	犀牛被马儿狠狠地踢了一下。
7	BA	小羊 sheep	踢 kick	老狼 wolf	right	小羊把老狼狠狠地踢了一下。
8	BEI	小猫 cat	追 chase	小狗 dog	left	小猫被小狗开心地追了一会。
9	BEI	男孩 boy	亲 kiss	女孩 girl	right	女孩被男孩轻轻地亲了一下。
10	BA	母鸡 chicken	亲 kiss	鹦鹉 parrot	left	母鸡把鹦鹉轻轻地亲了一下。
11	Simple OSV	小猪 pig	画 paint	鹦鹉 parrot	right	鹦鹉小猪开心地画了一下。
12	BEI	毒蛇 snake	咬 bite	老鼠 mouse	right	老鼠被毒蛇狠狠地咬了一下。
13	Simple OSV	狮子 lion	踢 kick	恐龙 dinosaur	left	恐龙狮子儿狠狠地踢了一下。
14	BA	鳄鱼 crocodile	咬 bite	毒蛇 snake	left	鳄鱼把毒蛇狠狠地咬了一下。
15	BA	小熊 bear	推 push	企鹅 penguin	left	小熊把企鹅轻轻地推了一下。

16	Simple OSV	海豚 dolphin	亲 kiss	鲨鱼 shark	right	鲨鱼海豚儿轻轻地亲了一下。
17	BA	鳄鱼 crocodile	画 paint	海豚 dolphin	right	鳄鱼把海豚开心地画了一下。
18	BEI	母鸡 chicken	画 paint	天鹅 swan	left	天鹅被母鸡开心地画了一下。

Note:

BEI and BA conditions in List B and C were respectively converted from simple OSV in list A.

simple OSV and BEI conditions in List B and C were respectively converted from BA in list A.

BA and simple OSV conditions in List B and C were respectively converted from BEI in list A.

Appendix B Experimental sentences for the production task

Table 6. Experimental sentences for the production task

Num	Condition	Action	Agent	Patient	Sentence
1	Simple OSV	推 push	企鹅 penguin	小熊 bear	小熊企鹅轻轻地推了一下。
2	BA	洗 clean	老鼠 mouse	鸡 chicken	老鼠把鸡开心地洗了一下。
3	Simple OSV	喷 water	鳄鱼 crocodile	海豚 dolphin	小海豚鳄鱼重重地喷了一下。
4	Simple OSV	洗 clean	小猪 pig	犀牛 hippo	犀牛小猪开心地洗了一下。
5	BEI	洗 clean	犀牛 hippo	小猪 pig	猪被犀牛开心地洗了一下。
6	BEI	喂 feed	小鹿 deer	恐龙 dinosaur	恐龙被鹿温柔地喂了一口。
7	BA	喂 feed	小猪 pig	老鼠 mouse	猪把老鼠温柔地喂了一口。

8	BA	推 push	男孩 boy	女孩 girl	男孩把女孩轻轻地推了一下。
9	BEI	推 push	小熊 beer	企鹅 penguin	企鹅被熊轻轻地推了一下。
10	BEI	梳 comb	小鹿 deer	老狼 wolf	狼被鹿轻轻地梳了一下。
11	BA	梳 comb	小鹿 deer	小羊 sheep	鹿把羊轻轻地梳了一下。
12	Simple OSV	梳 comb	老狼 wolf	小鹿 deer	小鹿狼轻轻地梳了一下。
13	BEI	喷 water	海豚 dolphin	鳄鱼 crocodile	鳄鱼被海豚重重地喷了一下。
14	Simple OSV	喂 feed	恐龙 dinosaur	小鹿 deer	小鹿恐龙温柔地喂了一口。
15	BA	喷 water	毒蛇 snake	鳄鱼 crocodile	蛇把鳄鱼重重地喷了一下。

Note:

BEI and BA conditions in List B and C were respectively converted from simple OSV in list A.

simple OSV and BEI conditions in List B and C were respectively converted from BA in list A.

BA and simple OSV conditions in List B and C were respectively converted from BEI in list A.

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