The syntax and acquisition of Mandarin *bei*-passives (Chapters 5 & 6)

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5. Corpus study: Production of *bei*-Passives in Child Mandarin

5.1. Previous studies on child production of passives

In child English, spontaneous production of long passives is much less frequent than that of short passives.[1] Horgan (1978) showed that English-speaking children aged 2 to 13 (N = 234) produced far more short passives ('truncated passives') than long passives ('full passives') in picture description tasks.[2] The scarcity of long passives in English child speech was also observed by Gordon & Chafetz (1990) in their corpus study.

A similar short > long passive asymmetry in children's production is observed in other languages, even those in which early acquisition of passives is observed. For example, Sesotho-speaking children acquire passives relatively early (Demuth 1989, Demuth et al. 2010, Kline & Demuth 2010; cf. Crawford 2005). A longitudinal study of the spontaneous production of four Sesotho-speaking children aged 2;1-4;2 showed that long passives are less frequent than the short ones in all age intervals; overall only 21% of the children's passives are long (Demuth 1989; Kline

[1]Nonetheless, this short > long passive asymmetry in children's production has not been observed in subsequent comprehension experiments in child English. Although most of these studies have found slightly better performance on short passives than long passives, none of these differences in children's comprehension were statistically significant (Gordon & Chafetz 1990, Hirsch & Wexler 2006a,b, O'Brien et al. 2006, Orfitelli 2012).

[2]In Horgan's study, children's 'full passives' included not only long passives with *by*-phrases but also those with prepositional phrases headed by *with, from, for*, and *of* (e.g., **The lamp was broken of the ball*). Short passives were more frequent in child speech than all of these full passive constructions combined.

and Demuth 2010; see also Pye and Poz 1988 on Kiché; Allen and Crago 1996 on Inuktitut).

Nonetheless, in the current study, which is the first large-scale corpus study on child Mandarin passive production, we find the opposite results. As will be shown in section 5.3, long *bei*-passives are much more frequent than short *bei*-passives in 2- to 6-year-olds' spontaneous production of Mandarin.

Previous studies of child Mandarin have seldom looked into the production of passives. One longitudinal study by Hu (2013) investigated two Mandarin-speaking children (aged 1;0-5;4 and 0;10-5;7, respectively). Her data suggest that both long and short *bei*-passives occur very early in child language, as exemplified in (1) and (2) respectively. In total, Child 1 produced 17 long *bei*-passives and 5 short ones, and Child 2 produced 9 long bei-passives and 7 short ones in the study periods.[3]

(1) First occurrences of long passives in Hu's records:

a. bei *na-ge* *mao* yao-diao le (Child 1, age 2;6)
BEI that-CLF cat bite-off PRF
'[*e*] was bitten off by that cat.' ([*e*] stands for a dropped subject/topic)

b. bei *wo* chi-le (Child 2, age 2;11)
BEI I eat-PRF
'[*e*] was eaten by me.'

(2) First occurrences of short passives in Hu's study:

a. ta jiu bei bing zai binggui shangmian (Child 1, age 3;6)
3SG just BEI freeze at freezer top
'She/He/It was just frozen on top of the freezer.'

b. bei yao-le (Child 2, age 1;11)
BEI bite-PRF
'[*e*] was bitten.'

[3]Hu (2013) analyzed children's production of *bei*-passives, as reported here, and also other types of non-canonical passives (and non-passive unaccusative constructions) which we do not discuss here. She provided a list of child passives collected in her study, but did not annotate nor analyze any other data, such as children's total number of utterances or child-directed speech.

On its face, Hu's (2013) observation that long *bei*-passives are produced early in child Mandarin conflicts with findings from other languages, as well as with the experimental studies of child Mandarin which have shown a delay in the comprehension of long passives. Recall from our previous discussion of the a two-choice picture selection test by Xu and Yang (2008) with 48 Mandarin-speaking children aged 3 to 5, that with bare actional verbs, long *bei*-passives pose significantly more difficulty for children than short *bei*-passives, which, recall, have no implicit EA in Mandarin. The oldest group tested in their study (age 5) showed adult-like comprehension on short actional passives, with 95.8% correct responses, but even this age group did not perform well with long actional passives, with only 60.4% correct. We will come back to this puzzling production-comprehension asymmetry in section 5.5, where we propose that children's comprehension difficulty with long passives in Xu and Yang's (2008) experiments came from a specific source: intervention by overlapping morpho-syntactic features.

5.2. Data collection

For the current study we analyzed data from the Mandarin corpora on CHILDES (CHIld Language Data Exchange System, MacWhinney 2000), listed in Table 1, which contain the spontaneous productions of 1,182 monolingual Mandarin-speaking children ages 2 to 6, as well as their language input (Child-Directed Speech, CDS) during the recorded sessions, both transcribed in the standard CHAT format (Codes for the Human Analysis of Transcripts, MacWhinney & Snow 1990).

The KWAL command was used in the Computerized Language Analysis (CLAN; MacWhinney 2000) software to extract all child and adult utterances containing the Mandarin passive marker *bei*, as well as the two lines before and two after the target utterances. After excluding 19 incomplete sentences, three indistinguishable utterances (i.e., those marked with '*xxx*' in the transcripts), and two immediate repetitions, we found a total of 396 *bei*-passive utterances in the child speech. Among children's production of *bei*-passives, 38 were ungrammatical constructions (including transitivity errors, word order errors, uninterpretable sentences, and other types of errors) and 358

Table 1: Mandarin corpora investigated in the current study

Corpus Name	**Age**	**Number**	**Notes**
Chang2	3;4–4;4	16	Spontaneous production in longitudinal studies
ChangPlay	3–6	21	
Erbaugh	2;0–3;9	4	
TCCM (part)	2;0–3;4	10	
Tong (part)	2;0–3;5	1	
Zhou3 (part)	2;0–4;5	1	
Chang1	3;6–4;5, 5;7–6;5	24	Spontaneous production during toy play sessions or other home activities
ChangPN (part)	3–6	72	
LiZhou	3–6	80	
Zhou1 (part)	2, 4	15	
Zhou2	3–6	15	
ZhouDinner	4–5	80	
AcadLang	3–6	15	Spontaneous production during picture description tasks
Xinjiang (part; No CDS)	4–6	60	
ZhouAssessment	3–6	334	
LiReading	3–6	214	Spontaneous mother-child conversations initiated by picture-book reading activities
TCCM-Reading	2	20	
ZhouNarratives	3–6	200	
Total		**1,182**	

were grammatical. In the CDS, there were 1,005 *bei*-passives. No adult data were excluded and all were grammatical.

5.3. Analysis 1: Long vs. short *bei*-passives in child production and CDS

Our first question is whether child Mandarin shows the short > long passive asymmetry that has been observed in L1 production in other languages. Each grammatical *bei*-passive utterance was annotated as either long or short, the criterion being whether there is an overt EA phrase after *bei*.

Our results confirmed Hu's (2013) previous observation of early passive production that she found in her longitudinal study. Our corpus data show that Mandarin-speaking children already use a range of different verbs (see the list in Appendix +++REF+++) in both long and short passives by the age of 2 to 3. Some early examples are shown in (3) and (4).

(3) Early long *bei*-passives:

a. bei *mama* na-zou le (2;01)
BEI mom take-away PRF
'[*e*] was taken away by mom.'

b. Guaiguai tongtong bei *xiongxiong* chi-guang (2;06)
Guaiguai all BEI bear eat-up
'Guaiguai is all eaten up by the bear.'

c. maobi huai le. bei *wo* nong-huai le (2;07)
brush_pen break PRF BEI I make-break PRF
'The brush pen is broken. [The brush pen] was broken by me

(4) Early short *bei*-passives:

a. ta bei zhe-yangzi zhuan zhuan zhuan zhuan... (2;08)
3SG BEI this-way spin spin spin spin
'S/he was spun and spun in this way.'

b. ni ganggang you-mei-you bei ya-bian? (3;02)
you just_now have-not-have BEI press-flat
'Have you been pressed flat just now?'

c. da-jiujiu yeshi bei pen-shang (3;04)
eldest-uncle also BEI spray-on
'Eldest uncle was also sprayed on.'

As shown in Figure 1, among the 358 grammatical *bei*-passives produced by 2- to 6-year-olds, long passives (61.2%) were significantly more frequent than short passives (38.8%) ($p < .001$, binomial test). This is contrary to previous studies in other languages showing a higher percentage of short passives in children's spontaneous production (e.g., Horgan 1978 on English, Pye & Poz 1988 on Kiché, and Kline & Demuth 2010 on Sesotho).

Our results also show a similarly high frequency (58.5%) of long passives in the 2- to 6-year-olds' input data (CDS) as in Figure 2 (cf. a corpus study by Gordon & Chafetz 1990 showing that only 4% passives in child-directed English are long passives). Since the high propotion of long *bei*-constructions in the CDS is not significantly different from that of the child data ($X^2(1) = 0.78, p = .38$), we propose that the higher rate of long *bei*-passives in child Mandarin can be

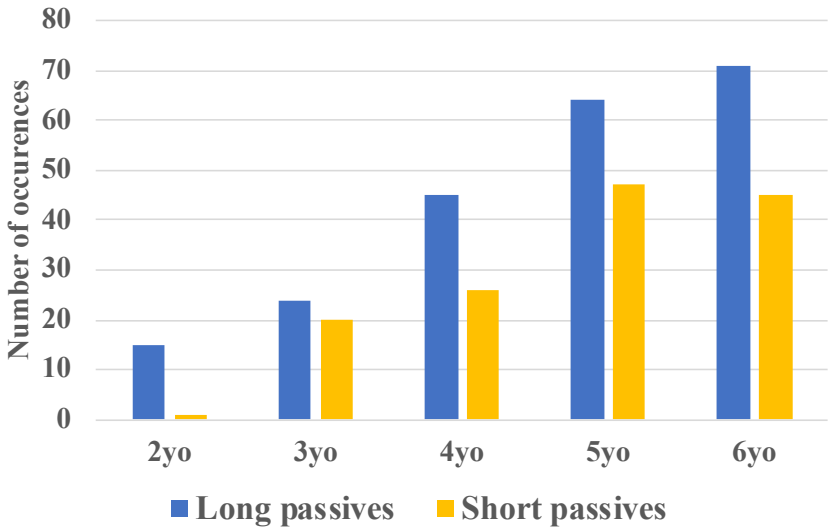

Figure 1: Numbers of *bei*-passives produced by 2- to 6-year-olds

attributed to the higher frequency of such constructions in children's input, compared to the short ones.

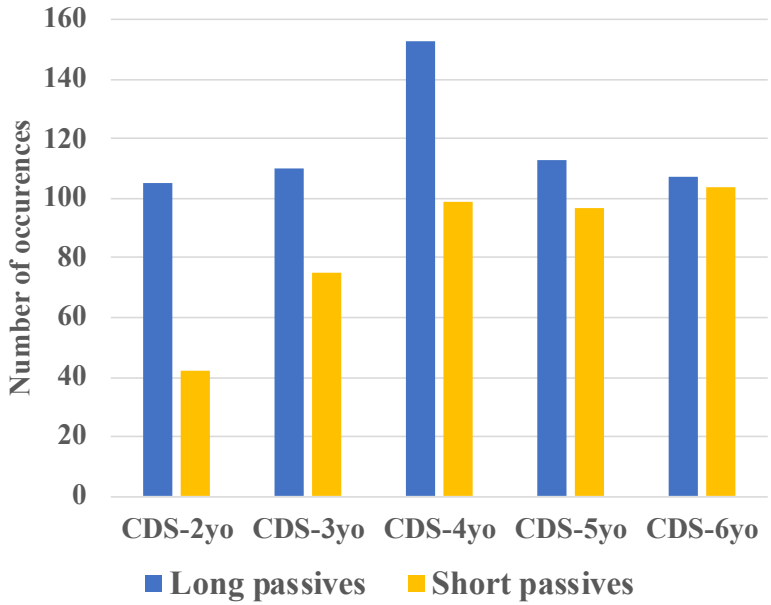

Figure 2: Numbers of *bei*-passives in 2- to 6-year-olds' input

Of course this begs the question of why Mandarin long passives are more frequent than the short ones in the adult speech to children. Possibly this is due to pragmatic or other (maybe

Mandarin-specific) factors that influence *both* children and adults alike.[4] The interesting question, which we turn to shortly in the next section, is why children – who are known to adhere to a strict version of intervention – are able to produce long passives at all.

5.4. Analysis 2: Animacy conditions in long *bei*-passive production

Recall from our discussion of the syntactic derivation of long *bei*-passives in Chapter 2 and our discussion of intervention effects in section ++REF++, that in long passives (5) the EA (e.g., *houzi* 'monkey') structurally intervenes between the IA and its gap, whereas in short passives (6), there is no such intervention. According to the Intervention Hypothesis, based on fRM, the A′-dependency between the IA *huli* 'fox' and its gap in (5b) should be harder for children to understand than (6b), and the more the two arguments in (5a) overlap in their morpho-syntactic features, the more difficult the dependency in (5b) is.

(5) a. huli bei houzi da le
fox BEI monkey hit PRF
'The fox was hit by the monkey.'

b. Intervention in long passives:

fox_i BEI [$_{IP}$ ~~fox~~$_i$ monkey hit $\_\_\_{}_i$]
predication; A′-movement

(6) a. huli bei da le
fox BEI hit PRF
'The fox was hit .'

b. Lack of intervention in short passives:

fox_i BEI [$_{VP}$ ~~fox~~$_i$ hit $\_\_\_{}_i$]
control; A-mvmt

Despite the similarity in child and adult production in terms of the prevalence of long passives over short passives, the question still remains why these children can produce long passives in

[4]Pragmatics plays an important role in the usage of long passives. For example, for English-speaking children, both comprehension and production of long passives both improve when there is a third character (in addition to the Agent and the Theme) forming a contrastive set with the Agent (Crain & Fodor 1989, O'Brien et al. 2006, Crain et al. 2009). However, pragmatics-wise it is not clear why there should be any difference between Mandarin and the other languages in which long passives are rare in (both child and adult) spontaneous speech (see references in section +++REF+++).

To better understand this cross-linguistic difference, a Mandarin-specific factor cannot be ignored. That is, Mandarin long passives show A′-properties (see section +++REF+++) that are not observed in Mandarin short passives nor passives in the other languages mentioned above. Do the A′-properties contribute to the more frequent use of long passives by Mandarin-speaking children and adult (compared to other languages)? This question is beyond the scope of the current study.

the first place, given the intervention restriction in their grammar. Do children *not* find producing long passives difficult? Our hypothesis is that the long passives produced by these children are most likely to contain two arguments with *mismatched* morpho-syntactic features, as opposed to matched ones, such that the difficulty introduced by structural intervention in long passives is thereby circumvented. To examine this hypothesis, the second part of our study investigates the feature content – more specifically, the *animacy* feature – of the IA and the EA in children's and adults' production of long *bei*-passives.

5.4.1. Animacy as a morpho-syntactic feature in Mandarin

As discussed in section ++++REF+++, Relativized Minimality (Rizzi 1990, 2004) predicts that only morpho-syntactic features, and not phonological or purely lexico-semantic features trigger intervention effects.

Some features that have been previously discussed in the intervention literature, for example, grammatical gender and number, (e.g., Adani et al. 2010, Belletti et al. 2012, Adani et al. 2014, Cilibrasi et al. 2022) are not ideal for our corpus study. First, grammatical gender is absent in Mandarin morpho-syntax. Second, grammatical number seldom occurs in our spontaneous data because in Mandarin it is encoded on the classifiers (e.g., Cheng & Sybesma 1999, 2012) and classifiers only occur when there is a numeral phrase (7a), or a demonstrative phrase if the numeral is *one* and is phonologically omitted, such as (7b).

(7) a. *(wu)-ge pingguo
five-CLF apple
'five apples'

b. *(zhe (yi))-ge pingguo
this one-CLF apple
'this (one) apple'

In our corpus study, only 2 of the child long passive utterances contained classifiers in both the IA and the EA. Therefore, the spontaneous production data are very limited in terms of examining the match/mismatch of grammatical number on classifiers. While not good for a corpus study, the effects of number in children's comprehension of passives can be explored experimentally, with

careful manipulations of the classifiers in the arguments, which I do later in Exp 2 (to be discussed in section **??**).

Another potential morpho-syntactic feature that has been shown to mitigate intervention effects in other languages is animacy. For example in English, animacy is a morpho-syntactic feature that affects its pronomial forms (e.g., *s/he* vs. *it*; *who* vs. *what*), as well as syntactic constructions such as genitives (e.g., *the boy's hands* vs. *??the clock's hands*) and double object constructions (e.g., *I sent Lisa a book* vs. *I sent Los Angeles a book*). Mateu & Hyams (2021) found that animacy mismatch faciliated English-speaking children's comprehension of object sluicing constructions (in which the object *wh*-phrases move across an existing subject, triggering intervention), but not of subject sluicing constructions where there was no intervention.

There is reason to consider animacy an active morphosyntactic feature in Mandarin: the plural/collective suffix *-men* may only attach to animate nominals, including personal pronouns (8a) and human-denoting NPs (8b), but not inanimate NPs (8c). In other words, the suffix *-men* syntactically selects for animate NPs, which entails that animacy features are employed in the grammar.

(8) a. Personal pronouns: *wo* 'I' *wo-men* 'we'

b. Human NPs: *xiaohai* 'child' *xiaohai(-men)* 'children'

c. Inanimate NPs: *pingguo* 'apple' *pingguo(*-men)* 'apples'

Child Mandarin adheres to these rules, except that *-men* can sometimes attach to non-human plural NPs when they are personified – for example to NPs referring to animals, such as *xiao niao* 'little bird' in (9). In much rarer cases, inanimate NPs – when personified – can be treated as human NPs in child speech and be suffixed by *-men* as well. For example, in (10), this suffix is associated with an inanimate NP *xiao-cao* 'grass' when the sentence describes the grass's feelings.

(9) xiao-niao-men dou pao-le (6;01)
little-bird-PL all run-PRF
'All the little birds ran away.'

(10) haoduo xiao-cao-men hui hen teng (4;02)
many little-grass-PL will very hurt
'Many grass will hurt.'

In our search for the suffix *-men* produced by children in the corpora listed in Table 1, we found 402 occurrences of *-men*, among which 142 were found on personal pronouns, 257 on nouns, and 3 were ungrammatical. We then looked into the animacy levels of those 257 noun bases for this suffix. Only 2 (0.78%) of them were personified inanimate entities and the other ones were all animate, including 142 (55.25%) human NPs and 113 (43.96%) personified non-human animate NPs (e.g., animals, monsters, and dwarfs). This result shows that Mandarin-speaking children adhere to the animate-inanimate distinction when it comes to the animacy requirements of suffix *-men*, suggesting that animacy is a morpho-syntactic feature not only in adult Mandarin, but also in child Mandarin grammar.

5.4.2. Corpus analysis of animacy conditions

In our corpus analysis, the animacy level of each NP was annotated based on the contexts provided by the two utterances preceding and following the *bei*-passives as well as on our world knowledge. The distinction was binary, i.e., animate vs. inanimate, with human beings and animals considered as equally animate. Dolls and stuffed animals might also be considered animate by children. However, there were no such references in the data. Cartoon characters such as *dahuilang* 'Big Bad Wolf' were all considered animate.

Previous studies have shown that the difference between the phrase type of the moved element and that of the intervener also affects intervention. For instance, Choe (2012) found that English-speaking children comprehend raising sentences with a pronominal experiencer (e.g., *Donald$_i$ seems to him ___$_i$ to be short*) significantly better than those with a full NP experiencer (e.g., *Donald$_i$ seems to Mickey ___$_i$ to be short*), in which the experiencer phrase intervenes between the full NP subject and its gap in the embedded TP. Moreover, Bentea et al. (2016) showed that in object *wh*-questions and object resultative clauses in child French, an animacy mismatch only has

a facilitating effect if this feature is on a [+NP] phrase (e.g., animate *quelle dame* 'which lady' and inanimate *quelle balle* 'which ball'), but not on a [−NP] phrase (e.g., animate *qui* 'who' and inanimate *qu(e)'* 'what').

In order to control for this factor, our study only examined long passives in which *both* arguments are of the same NP type. We identified four types of NP in our data, including (i) full NPs (*xiongmao* 'panda', *zhe-ge daxiang* 'this elephant', etc.), (ii) personal and demonstrative pronouns (PRON) (*wo* 'I', *zhe-ge* 'this', etc.), (iii) proper names, and (iv) *wh*-phrases (*shei* 'who', *shenme* 'what', etc.). However, the long passives with two PRONs, two proper names, or two *wh*-arguments had very small sample sizes: There were only three long passives with two PRON arguments, one with two proper names, and none with two *wh*-arguments. Therefore, these types of long passives were excluded and only the long passives with two full NP arguments were included, such as (11). In what follows, 'long passive' refers to long passives with two full NP arguments.[5]

(11) daxiang bei da juren cai-si (3;10)
elephant BEI big giant trample-dead
'The elephant was trampled to death by the big giant.'

In total there were 35 such long passives in child speech and 52 in the CDS (the majority of long passives in both child speech and CDS had two arguments that were mismatched in NP type). As shown in Figure 3, children's production did not match their input with respect to animacy properties. More specifically, in the child data 77.1% of the long passives contained animacy-*mismatched* arguments, while the adult data showed the opposite – 76.9% of the passives contained animacy-*matched* arguments ($X^2(1) = 24.7, p < .001$).

Thus, the prevalence in child Mandarin of passives whose NPs mismatched in animacy cannot be explained as an effect of input; instead, it demonstrates an important distinction between child and adult grammars, that is, children are subject to intervention restriction in long passives but

[5]In our comprehension experiments to be discussed in sections 6 and **??**, all long passives contained two full NP arguments.

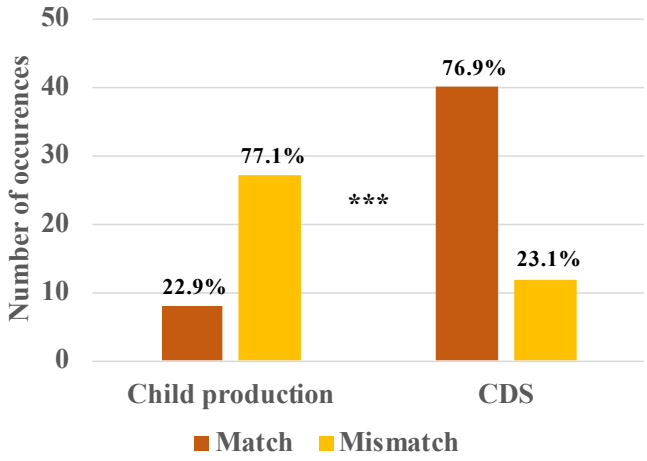

Figure 3: Animacy match/mismatch in long *bei*-passives with two full-NPs

adults are not. Because producing long passives with arguments matched in animacy is too difficult for children, they avoid producing those, possibly resorting to other alternative constructions, such as actives or short passives. However, when arguments are mismatched in animacy, the intervention difficulties are mitigated, hence the higher proportional production of animacy-mismatched long passives over matched ones compared to their input, in which the passives are not grammatically constrained by intervention in this way.

5.5. Summary and discussion

Our corpus studies have demonstrated a significant long > short passive asymmetry in child Mandarin, not previously observed in other languages. The prevalence of long passives in child Mandarin reflects the higher frequency of long passives in their input. Or alternatively children produce a higher frequency of long passives for the same reasons adult do – though we do not know at this point what factors are responsible for this. In this respect, children's language does not differ significantly from that of their care-takers.

However, a closer look at the data suggests that child passives differ from the input in a crucial way: children – but not adults – overwhelmingly produce long passives with two arguments that mismatch in animacy features, arguably because that configuration is easier to compute. This

distinction suggests that children are subject to a stricter grammatical constraint than adults, in that the intervention of the EA in long passives does not cause difficulty in adult language as it does in child language.

Our hypothesis predicts that if the features (such as animacy and NP type) of the IA and the EA match, children will find long *bei*-passives difficult to comprehend and/or produce. In this regard, let us recall the apparent conflicting comprehension-production results in previous Mandarin studies: Mandarin-speaking children produce grammatical long *bei*-passives as early as the age of 3 but seem to have delayed comprehension of long (but not short) actional passives. In Xu and Yang's (2008) picture-selection task with images depicting two animals acting out two verbs with reversed theta-role assignments (e.g., *The cat was hit by the dog* vs. *The dog was hit by the cat*), children aged 3-5 generally performed worse on long passives (average 57.3% correct) than the short ones (average 88.6%). By the age of 5, children already show near-ceiling performance on short actional passives but their comprehension of long actional passives is significantly worse. We can now explain these comprehension results by considering the NPs used in Xu and Yang's (2008) study: all the long passives tested in their experiment contained two animacy-*matched* full-NP arguments such as 'the cat' and 'the dog', which – by our hypothesis – should trigger an intervention effect and hence produce poor performance. Thus, the bad performance on long passives in their study might be an artifact of not controlling for animacy; it does not necessarily demonstrate delayed acquisition of the long passives.

We therefore predict that children's comprehension of Mandarin long passives will improve with two arguments that have mismatched morpho-syntactic features (and also other languages). As will be shown in sections 6 and **??**, this prediction is borne out in our two experiments with Mandarin-speaking 3- to 6-year-olds.

6. Experiment 1: Animacy and Intervention Effects in Mandarin Passives

Although in our corpus study, 2- to 6-year-old Mandarin-speakers produced more long passives than the short ones – presumably due to the higher frequency of long passives in their input – we still observed an effect of the structural intervention in children's long passives. That is, children's long passives were more restricted than in the adult input, as most of the long passives they produced contained NP arguments with mismatched animacy features (despite the opposite trend in their input). This arguably shows that children circumvented intervention by featural-mismatch.

In the experiment to be discussed below, we will further examine the effects of animacy match/mismatch in children's comprehension of full-NP long passives. Because animacy has a morpho-syntactic consequence in Mandarin (see discussion in section 5.4.1), we consider it a morpho-syntactic feature that is relevant to our Intervention Hypothesis. Based on the syntactic properties of Mandarin passives and featural Relativized Minimality, we predict in this experiment that (i) Mandarin-speaking children will perform worse on long passives than short passives and actives; and (ii) children's performance of long passives, but not actives, will be improved when the animacy of the IA and the EA are mismatched.[6]

6.1. Design and materials

Previous studies have shown that children's performance with passives is affected by the types of verbs in the sentences. For instance, Previous studies across different languages have shown that passives with actional verbs are much easier for children to acquire than those with non-actional verbs (e.g., Maratsos et al. 1985, Gordon & Chafetz 1990, Hirsch & Wexler 2006b, Volpato, Verin, & Cardinaletti, 2016, Oliva & Wexler 2018, Agostinho 2020).

Our purpose of the experiment is not to test the verb type effects, but to examine the difference between children's comprehension of long passives vs. short passives and actives, and the potential

[6]Mandarin short passives only have one argument, namely the IA (there is no implicit EA, see discussion in Chapter 2) and therefore are excluded in our analysis of featural match vs. mismatch between the IA and the EA.

effects of the intervention constraints in child grammar. Therefore, we intend the test verbs in our experiments to be as easy as possible for children, to eliminate any difficulty caused by the verb.

For this purpose, all the test verbs in our experiments are actional and we used resultative verb compounds (RVCs) as opposed to bare verbs. Descriptively, Mandarin RVCs can be decomposed into two verbal components: The second component denotes some 'result' of the action or process conveyed by the first one, hence the name (Li & Thompson 1989). RVCs are a highly frequent type of predicates in Mandarin that occur in child speech as early as around the age of one and a half (e.g., Yang 2006, Deng 2019). RVCs are also highly frequent in child passives: In our corpus study (section 5), most (73.42%) of the main verbs in children's passives were RVCs. As for their comprehension of RVC passives, Xu and Yang's (2008) results showed that Mandarin-speaking 3- to 5-year-olds generally performed slightly better with passives of actional RVCs (ave. 75.00%) than passives of bare actional verbs (ave. 70.83%).

That is to say, the actional RVCs tested in our experiment ought to be the easiest verb condition for children, compared to the non-actional or bare verbs, and any difficulty in their comprehension of passives – especially long passives – cannot be contributed to the inherent difficulty of the verb forms. If intervention – which is absent in the derivation of short passives – is the only source of the difficulty in children's comprehension of long passives (as opposed to potential difficulties caused by the verbs, the *bei* morphology, or the promotion of internal argument), then short passives should be as good as the active sentences (control trials).

The current experiment is a two-choice sentence-picture matching task with a 3 $\times$ 2 design, crossing three Sentence Types (actives, long passives, and short passives) and two Feature Combinations (match vs. mismatch). In total, there are 36 trials, six per condition. These trials vary among 4 verbs: *zhuang-dao* 'bump into', *lan-zhu* 'block (the way of)', *ya-dao* 'pin down', and *la-zhu* 'pull'.

A complete list of the trials in Exp 1 can be found in Appendix +++REF+++. Table 2 lays out our animacy manipulation in this experiment.

Table 2: Manipulation of animacy in Exp 1

Sentence type	**Feature**	**Test sentence** (IA/Theme Subject)		(EA/Agent)		(IA/Theme Object)
Actives	Match			[+ani]	V	[+ani]
	Mismatch			[+ani]	V	[−ani]
Long passives	Match	[+ani]	BEI	[+ani]	V	
	Mismatch	[−ani]	BEI	[+ani]	V	
Short passives	*(N/A)*	[+ani]	BEI		V	
		[−ani]	BEI		V	

In actives and long passives, the *match* conditions contain sentences with two animate NPs, such as (12a) and (13a), whereas the *mismatch* conditions are sentences in which the EA/Agent is animate and the IA/Theme is inanimate. For example, the active sentence (12b) has an animate EA/Agent as the surface subject and the long passive (13b) has an animate EA/Agent as the embedded subject under *bei*.

(12) a. Active; Match (trial 13)

houzi la-zhu le xiao-mao
monkey pull-hold PRF little-cat
'The monkey pulled the cat.'

b. Active; Mismatch (trial 7)

xiao-zhu la-zhu le gongjiaoche
little-pig pull-hold PRF bus
'The pig pulled the bus.'

(13) a. Long passive; Match (trial 27)

xiao-niu bei daxiang la-zhu le
little-cow BEI elephant pull-hold PRF
'The cow was pulled by the elephant.'

b. Long passive; Mismatch (trial 35)

xiao-qiche bei xiao-zhu la-zhu le
little-car BEI little-pig pull-hold PRF
'The car was pulled by the pig.'

In short passives, there is only one NP – the IA/surface subject – and hence the featural match vs. mismatch manipulation is not applicable. The IA/surface subject is animate in half of the trials such as (14a), and inanimate in the other half (14b). The EA of the event – structurally absent in the short passives – is always animate and is illustrated in the test pictures the same way as in the other two types of sentences.

(14) a. Short passive; [+ani] subject (trial 2)

huli bei la-zhu le
fox BEI pull-hold PRF
'The fox was pulled.'

b. Short passive; [−ani] subject (trial 9)

xiao-qiche bei la-zhu le
little-car BEI pull-hold PRF
'The car was pulled.'

Note that we have controlled for the animacy of the EA/Agent across all sentence types (active, long passives, or short passives). The EA/Agent is always animate; It is the animacy of the IA/Theme (i.e., object in active sentences and subject in passives) that varies across different Feature Combinations, as can be seen in Table 2. Admittedly, it is logically possible to manipulate featural match vs. mismatch with an *inanimate* "Agent" as well – *match* trials would have inanimate Themes and *mismatch*, animate Themes.[7] However, an inanimate "Agent" independently causes difficulty in children's comprehension as it represents a non-prototypical event (e.g., Slobin 1982, Childers & Echols 2004) and thus is excluded from our experiment.

Our hypothesis makes the following predictions. First, long passives in general will be more difficult for children to understand than actives and short passives. Second, animacy-mismatched long passives (13b) will be easier than the matched ones (13a). Lastly, such an improvement in children's performance with animacy-mismatched items will not be observed in active trials, i.e., (12b) will *not* be easier than (12a).

6.2. Procedure

In the pre-test training session, the child was asked to identify all the animal characters in Figure 4 and the inanimate objects in Figure 5. The NPs tested in this experiment are all familiar to young children. In the rare cases when the child was unfamiliar with any animal/item, the experimenter would tell the child its name.

The child was also familiarized with the sentence-picture matching task before the test. They were instructed that their task was to indicate which picture out of the two best matches the sen-

[7]The quoted term "Agent" is conveniently used here to refer to both the subjects in active sentences and the embedded subjects in long *bei*-passives, but not Agent the thematic role, which is inherently animate.

Figure 4: Picture of the animal characters in the training session of Exp 1 and Exp 2

Figure 5: Picture of the inanimate items in the training session of Exp 1

tence they heard. In the familiarization session, they completed two training trials with intransitive sentences. No participant was unable to finish the training or failed these two training trials.

The 36 trials in the main session were arranged in a semi-random order so that the same sentence types or the same verbs were never adjacent. For each trial, the tested child was presented with two pictures on a computer screen while they hear a pre-recorded test sentence. These two pictures showed the same verb but with opposite theta-role assignments such as Figure 6. For half of the trials, the test sentence matched the picture on the left and for the other half, picture on the right. The side of the correct choice was also semi-randomized across trials in a way that the correct choices were never on the same side for more than three consecutive trials.

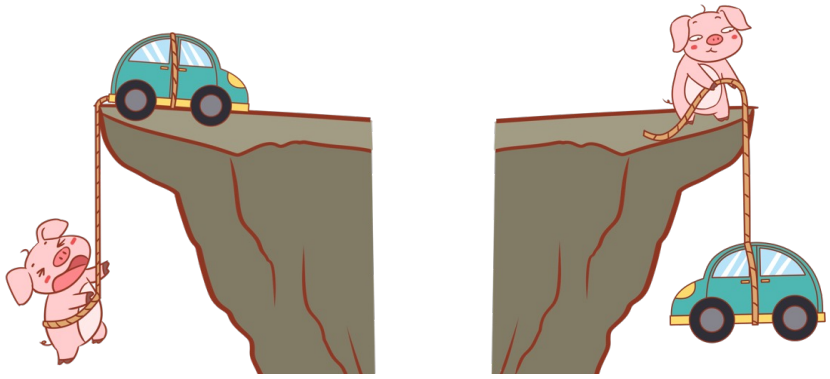

Figure 6: Example trial in Exp 1 for sentence (13b) '*The car was pulled by the pig.*'

Due to the COVID-19 pandemic, the experiment was conducted online via a video call, with the child and their caretaker/teacher on the one end and the experimenter on the other end. The experimenter shared her screen on which the materials were played in a PowerPoint slide show. During the test, the child indicated their answers by pointing to the pictures of their choice, and their caretaker/teacher verbally reported which side of the screen was pointed at. The test only proceeded when the previous trial was answered. If a child could not decide which picture to choose, the experimenter repeated or replayed the recorded sentence only once again and encouraged them to try their best. The adult accompanying the child during the test is specifically told that the test results are anonymously stored and do not reflect any aspect of the child's cognitive capability and/or intelligence, and that they should always be truthful when reporting the child's responses. The child's choices (left vs. right) were then recorded by writing and later coded by the experimenter.

6.3. Subjects

The final sample included data from 80 monolingual Mandarin-speaking 3- to 6-year-olds. Subject data is given in Table 3. An additional seven children were tested but excluded due to their chance or below-chance performances on the control trials: five or more errors in the 12 active sentences. All of the children were recruited from the city of Changsha, Hunan Province, China, and its surrounding areas. None of the subjects had a history of language or cognitive impairment.

Table 3: Age information of subjects in Exp 1

Age Group	Age Range	Mean	Number
3-year-olds	3;01-3;11	3;08	19
4-year-olds	4;01-4;11	4;05	23
5-year-olds	5;00-5;11	5;05	19
6-year-olds	6;00-6;08	6;04	19
All subjects	**3;01-6;08**	**4;11**	**80**

6.4. Data analysis

Because our dependent variable is binary (i.e., correct vs. incorrect responses), we use mixed-effects logistic regression model to analyze our data in R (R Core Team 2013). The full model includes **Sentence Type** (actives, long passives, and short passives), **Featural Condition** (match/mismatch for long passives and actives; not applicable to short passives), and **Age Group** (3, 4, 5, and 6), as well as all their interactions. Additionally, the model includes random intercepts for participants and verbs, to allow for individual differences across children and tested verbs. The significance of each fixed and random effect is tested with step-wise model comparisons using the *anova()* function in R.

Unexpectedly, the random effect of verb turns out to be significant in our full model ($X^2(1) = 62.26, p < .001$). Table 4 shows the breakdown of the results by verb. Among the four verbs, the verb *ya-dao* 'pin down' is particularly difficult for children to understand as it is the only verb whose correct rate is less than 90% in the control trials (i.e., active sentences).

Table 4: Correctness of the four verbs in the control trials of Exp 1

		Animacy-match, active sentences	Animacy-mismatch, active sentences	All actives
zhuang-dao	**'bump into'**	96.25%	87.50%	93.33%
lan-zhu	**'block'**	91.25%	98.75%	93.75%
ya-dao	**'pin down'**	97.50%	81.88%	87.08%
la-zhu	**'pull'**	91.25%	92.50%	92.08%
Average		93.96%	89.17%	91.56%

Table 5: Correctness of the four verbs in all Match/Mismatch conditions in Exp 1

		Match	Mismatch	Average
zhuang-dao	**'bump into'**	86.00%	81.56%	84.03%
lan-zhu	**'block'**	85.75%	95.63%	90.14%
ya-dao	**'pin down'**	92.19%	63.75%	76.39%
la-zhu	**'pull'**	88.44%	91.00%	89.86%
Average		87.85%	82.36%	85.10%

(a) 'Pin down' in animacy-matched scenarios

(b) 'Pin down' in animacy-mismatched scenarios

Figure 7: Example pictures for the verb 'pin down'

More specifically, as shown in Table 5, children behaved disproportionately better with this verb when it was tested in the animacy-matched scenarios (Figure 7a) than in the mismatched ones (Figure 7b), with a 92.19% average correct rate across *all* sentence types in the former and only 63.75% in the latter, even in the active control trials (97.5% vs. 81.88%). It is unclear why children had difficulties with sentences that contained this verb with an inanimate theme (see Figure 7b). However, we are excluding the trials with this verb from our analysis. After the exclusion, we re-ran the model and the results are discussed below.

6.5. Results and discussion

Table 6 demonstrates the correct rates of the 3- to 6-year-olds' responses in each condition, after the exclusion of the verb *ya-dao* 'pin down'.

Table 6: Exp 1 results (excluding the verb 'pin down')

Age Group	Actives			Long Passives			Short Passives	Ave.
	Match	Mismatch	Ave.	Match	Mismatch	Ave.		
3	91.6%	92.1%	91.8%	73.7%	85.5%	78.9%	88.3%	**86.4%**
4	94.8%	95.7%	95.2%	75.7%	72.8%	74.4%	89.4%	**86.3%**
5	90.5%	86.8%	88.9%	73.7%	92.1%	81.9%	93.0%	**87.9%**
6	95.8%	96.1%	95.9%	78.9%	92.1%	84.8%	94.7%	**91.8%**
Ave.	**93.3%**	**92.8%**	**93.1%**	**75.5%**	**85.0%**	**79.7%**	**91.3%**	**88.0%**

Step-wise model comparison against the above-mentioned full model shows that Age Group ($X^2(15) = 26.196, p = .036$), Sentence Type ($X^2(8) = 82.366, p < .001$) and Featural Condition ($X^2(8) = 21.186, p = .007$) are all significant predictors for children's performance. More specifically, children perform worse with long passives than actives (z-value $= -4.038, p < .001$), while their performance with short passives and actives are not significantly different (z-value $= -0.256, p = .798$). Crucially, the interaction between Sentence Type and Featural Condition is also significant ($X^2(4) = 10.73, p = .030$). The difference between the animacy-matched vs. mismatched trials is only significant in long passives ($X^2(4) = 17.583, p = .001$) – with animacy-mismatched trials better than the matched ones (z-value $= 2.559, p = .011$) – but not in actives ($X^2(4) = 0.6842, p = .953$), as shown in Figure 9.

To sum up, our results show that Mandarin-speaking 3- to 6-year-olds have more difficulty comprehending long passives than actives and that short passives are no more difficult than actives, consistent with the first prediction of the Intervention Hypothesis. That is, children find it difficult to establish the dependency between the surface subject and the gap of the IA when it crosses the intervening EA in Mandarin long passives. Second, the manipulation of the animacy feature in our experiment only affected children's performance on long passives, not actives. More specifically,

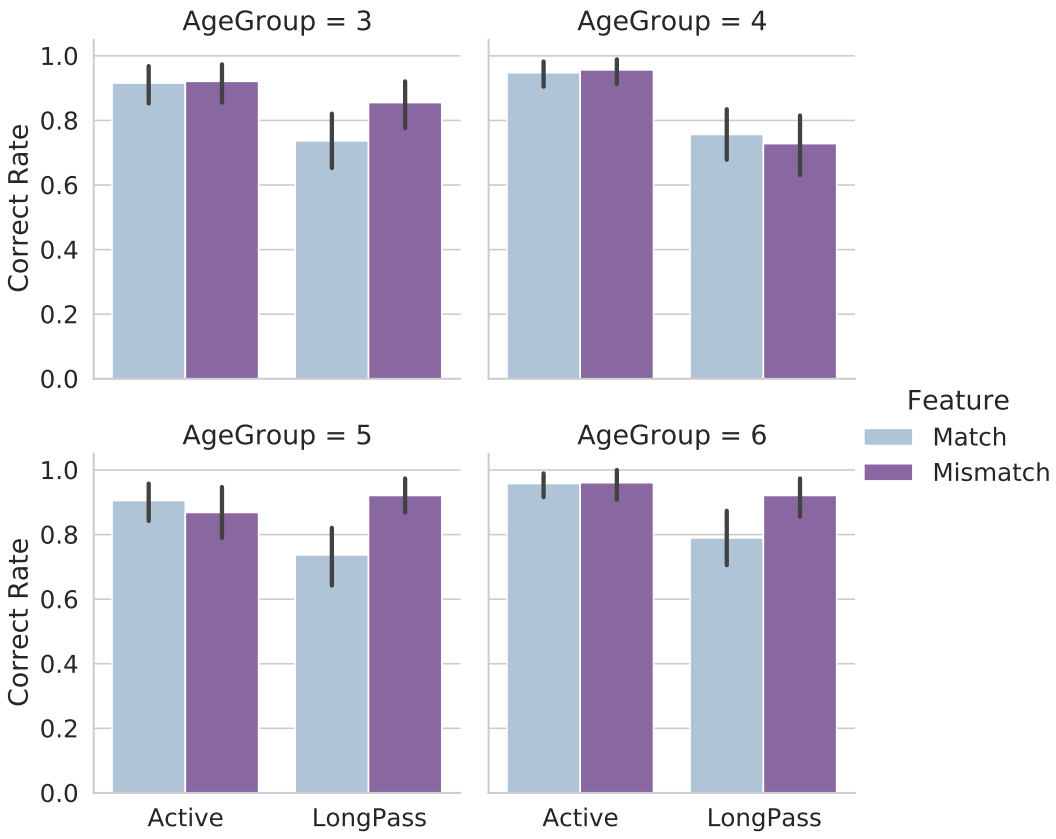

Figure 8: Animacy match vs. mismatch in children's actives and long passives

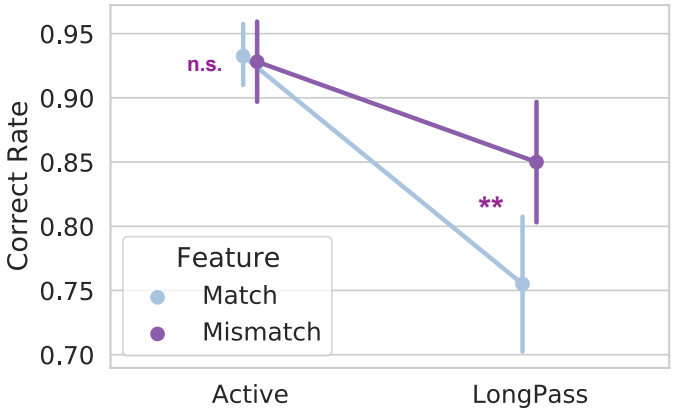

Figure 9: Interaction between sentence types and feature conditions in Exp 1

the mismatch in the animacy of the IA and the EA improved comprehension in long passives but not actives. This interaction between Sentence Type and Featural Condition is also predicted by the Intervention Hypothesis because the mismatch in the animacy of the two arguments – a morpho-syntactic feature in Mandarin – mitigates the difficulty caused by structural intervention and structural intervention only exists in long passives.[8]

In our experiment the short passives were understood as easily as their active counterparts. Considering the delayed acquisition of passives in many (but not all) languages, the good performance (even for the youngest group tested) of Mandarin short passives might be surprising, especially given that there is no adjectival strategy in Mandarin (i.e., short passives are not homophonous to adjectival passives; see section +++REF+++). However, it is expected under the Intervention Hypothesis given the structure of short *bei*-passives in Mandarin (see discussion in section ++REF+++): In contrast to languages such as English, in Mandarin short passives the EA is *not* syntactically projected, as opposed to being an implicit argument that is present in the structure and merely phonologically null. That is to say, there is no argument intervening the syntactic movement of the IA in short passives, therefore short passives in Mandarin are not predicted to be especially difficulty for children.[9]

[8]For consideration of the naturalness of our test sentences, the mismatch conditions in this experiment only had animate Agents and inanimate Themes (or in the cases of short passives, only inanimate Themes), but not the other way around. One can argue that such a design is comparing children's comprehension of sentencecs with an animate vs. inanimate Theme given that the Agent is animate, which is not quite the same as comparing the effects of featural match vs. mismatch. However, if that is true, we should have observed the same facilitation effect in children's performance with active sentences as well, which is not what the results have shown.

Regardless of the unnaturalness of sentences with inanimate EA/Agents, our hypothesis predicts for future studies that mismatched long passives will still be easier for children than the matched ones even when the former condition contains with inanimate EAs and animate IAs while the latter contains two inanimate arguments.

[9]In languages where the EA is realized as an implicit argument (but not an adjunct) in short passives, the Intervention Hypothesis predicts that the short passives should be equally difficult for children as the long passives, due to the Intervention Effects. For example, Orfitelli (2012) argued that English-speaking children are subject to the intervention difficulties in both long and short passives because there is an implicit EA in the latter.

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