Mandarin-speaking two-year-olds' comprehension of complement control

A perspective from preferential looking

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The present study investigates early acquisition of complement control by Mandarin-speaking children. We tested thirty-two Mandarin-speaking 2-month-olds in a comprehension experiment adopting the Intermodal Preferential Looking Paradigm and assessed their ability to choose the right controller of the empty subject PRO. Speech stimuli included four sentence types: subject control *xiang* 'want' sentences, covert object control *rang* 'let' sentences, overt object control *jiao* 'ask' sentences and benefactive coverb *gei* 'for' sentences. It was found that when comprehending test sentences with two potential antecedents, children's target looking was significantly above chance by looking more to the subject picture in subject control *xiang* trials and non-control *gei* trials, and that a marginal significant difference was identified for the two minimal pairs (subject control *xiang* vs. covert object control *rang*, non-control *gei* vs. overt object *jiao*). The results also point to a stronger sensitivity to subject control than to object control. These results show that Mandarin-speaking children who have just entered their second year in life are already sensitive to control, suggesting their emerging knowledge of some basic syntactic properties of complement control.

Keywords: language acquisition, early language comprehension, complement control, preferential looking

1. Introduction

Control involves the anaphoric relation between an unspoken subject, known as PRO, in the embedded clause and its antecedent. It has been one of the central concerns of theoretical as well as acquisition research in generative grammar.

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Examples in (1) are typical complement control sentences, in which PRO in the complement clause bears a co-referential relation with a matrix argument. In (1a), PRO is controlled by (or co-referential with) the matrix subject *Mary*, whereas in (1b), PRO is controlled by the matrix object *John*. Both controllers (i.e., *Mary* in (1a) and *John* in (1b)) bear two thematic roles, one assigned by the matrix control verb, and the other by the embedded verb of the complement clause.

(1) a. Mary_i wants [PRO_i to learn French].
b. Mary asks John_i [PRO_i to learn French].

The interpretation (i.e., reference assignment) of PRO reflects syntactic dependency of the embedded PRO and a matrix NP and is subject to structural constraints such as c-command and minimality. One version of the minimality constraints is the Generalized Control Rule (GCR) in (2) (Huang, 1984, 1989) (also see Rosenbaum, 1967):

(2) The Generalized Control Rule (GCR)
An empty pronoun is coindexed with the closest nominal element.[1]

Following GCR, the closest nominal controller for PRO in (1a) has to be the matrix subject NP, while the closest NP accessible for PRO in (1b) must be the matrix object NP. Yet syntactic constraints alone do not determine the interpretation of control. Verbs that take complement control exhibit different control properties. As indicated by (1), *want* is a subject control verb and *ask* is an object control verb. An exceptional case is *promise*. Like object control verbs, it takes both an object NP and a complement control clause, but it is a subject control verb. Therefore, lexical properties of verbs also play an important role in determining the controller of PRO.

To comprehend sentences like (1) successfully, it is crucial for speakers to know the co-referential relation between the controller and PRO. This means that they should be able to identify the right controller of PRO in various control structures (e.g., subject control and object control) in accordance with GCR. Also important is knowledge of lexical properties associated with control verbs. To correctly interpret (1a) and (1b), for instance, speakers should know meanings associated with *want* and *ask* (e.g., their argument structures and thematic structures), identify them as control verbs, and know that *want* differs from *ask* in that it is a subject control verb whereas *ask* is an object control verb. Since PRO is silent, and

1. The term 'closest' is defined in terms of c-command (Huang, 1984: 552–553): A is closer to B than C is if A c-commands B but C does not c-command B. Furthermore, for two nodes A and C, both of which c-command B, A is closer to B than C is if A but not C occurs within the same clause as B, or if A is separated from B by fewer clause boundaries than C is.

the interpretation of PRO "can hardly be determined inductively from observed overt phenomena" (Chomsky, 1981: 55), knowledge of PRO in young children, or to be more specific, knowledge of constraints like GCR that determine the interpretation of PRO, as part of UG, would constitute evidence for the continuity view of language acquisition, according to which children's grammar is identical to adult grammar in terms of basic categories and principles, i.e., children's grammar is constant throughout development (e.g., Pinker, 1984; Crain & Pietroski, 2002). Numerous studies have examined children's knowledge of control. The current study is a further attempt to study control in child grammar. Specifically, we will report findings from an experimental study of toddlers' comprehension of complement control in Mandarin Chinese, hoping to extend our understanding of the initial knowledge of control structures.

2. Previous studies of acquisition

Children are found to use control structures as early as age 2 in naturalistic speech (e.g., Bloom et al., 1975, 1980; Pinker, 1984; Goro, 2004; Norris, 2004; Landau & Thornton, 2011; Yang & Yang, 2015; Santos et al., 2015). Comprehension studies indicate that children attain subtle knowledge of the basic properties of control in the ambient language by age 5, including the distribution of PRO, the structural relation of c-command and minimality as well as control properties of most control verbs (e.g., English: C. Chomsky, 1969; Maratsos, 1974; Goodluck, 1981; Hsu, 1981; Hsu et al., 1985; McDaniel et al., 1990/1991; Sherman & Lust, 1986, 1993; Eisenberg & Cairns, 1994; Becker, 2006; Kirby, 2009; Sinhala: Gair et al., 1998; Greek and Spanish: Goodluck et al., 2001).[2] At the same time, children also demonstrate some non-adult-like interpretations of control under age 5. These erroneous interpretations concern how children assign the controller to PRO. For instance, 3-to-5-year-old English-speaking children may accept a sentence-external referent reading of PRO for both subject and object control (e.g., Cairns et al., 1994; Eisenberg & Cairns, 1994). In some cases, children allow the controller of PRO in object control sentences to be the matrix subject, the matrix object, or even a sentence-external referent, i.e., taking an arbitrary or free interpretation

2. In this study, we focus on children's acquisition of complement control. Other types of control, i.e., adjunct control and sentential subject control, will not be discussed here. See Goodluck (1986, 2001), Hsu et al. (1989), Broihier and Wexler (1995), Adler (2006), Gerard and Lidz (2018), Gerard et al. (2017, 2018), Janke (2016, 2018a, 2018b), Janke and Bailey (2017), Janke and Perovic (2017), etc. for studies of children's acquisition of adjunct control and sentential subject control.

of control (e.g., McDaniel et al., 1990/1991). In addition, the subject control verb *promise* is a headache for children. Though it is a subject control verb, children incorrectly interpret it as an object control verb and this incorrect interpretation may persist to school age (e.g., C. Chomsky, 1969; Hsu, 1981, Sherman & Lust, 1986).

Different analyses have been proposed to account for children's non-adult-like patterns, which bear crucially to the issue of early availability of control in children's grammar (e.g., C. Chomsky, 1969; Hsu, 1981; Hsu et al., 1985; Landau & Thornton, 2011; McDaniel et al., 1990/1991; Sherman & Lust, 1986, 1993; Wexler, 1992). One account assumes that children have access to PRO at the outset of language development (e.g., Sherman & Lust, 1986, 1993; Landau & Thornton, 2011). They are able to apply fundamental structural analyses related to control early on, i.e., to analyze complement control structures as involving subordination, with the control verb taking a complement clause the empty subject (i.e., PRO) of which is co-indexed with an antecedent in the matrix clause following the minimality constraints. In a series of production and comprehension studies on English-speaking children, Sherman and colleagues (1986, 1993) showed that 3-to-8-year-old children stick to the minimality principle in assigning the controller to PRO. In their view, children's misanalysis of subject control verb *promise* as an object control verb is consistent with the minimality analysis. The problem lies in children's delayed learning of lexical properties of the verb. This is known as the lexical-syntactic integration hypothesis, which advocates a modular view of language acquisition and assumes the involvement of both structural and lexical knowledge in interpretation of control. Children have to learn to integrate structural knowledge of control and lexical knowledge of control verbs, but these two types of knowledge develop independently of each other. While the structural properties of control may be continually available, certain aspects of lexical knowledge in the ambient language may develop gradually, resulting in non-adult-like interpretation of control (e.g. misinterpretation of 'promise' as an object control verb) (Sherman and Lust, 1993; see also Lust, 1999).

Another account contends that children may initially mis-analyze the relation between the matrix and complement clause in control sentences as clause coordination rather than subordination. This is assumed to be a source of their 'arbitrary' reading of PRO (McDaniel et al., 1990/1991; Wexler, 1992). Children will finally fix on control structures as a result of maturation of structural constraints (Wexler, 1992). This account assumes children's initial structural analysis of control. Others argue for performance strategies in children's interpretation of control (e.g., C. Chomsky, 1969; Hsu, 1981; Hsu et al., 1985). According to such accounts, children may initially use linear strategies to interpret control, i.e., choosing either the matrix subject (i.e., the first noun strategy) or the matrix object (i.e.,

the adjacency strategy) as the agent of the embedded verb. Children will go through various non-adult-like states before they attain adult-like knowledge. The strategy-based account diverges from structural accounts in assuming children's lack of structural analysis of control in the initial stage.

In spite of the extensive literature on the acquisition of control, few studies have investigated early comprehension of control. In the current study, we attempt to fill the gap by investigating how toddlers comprehend complement control in Mandarin Chinese, a language with no overt morphological marking of complement control. It would also be interesting to determine whether the proposed accounts could accommodate early Mandarin acquisition data.

3. Properties of complement control in Mandarin and acquisition issues

Similar to English, control in Mandarin Chinese may also arise in clausal complements of control verbs. The subject control verb *xiang* 'want' in (3a) and object control verb *jiao* 'ask' in (3b) have similar interpretations as their English counterparts and both sentences meet the conditions in GCR.[3, 4]

(3) a. *Zhangsan*$_i$ *xiang* [PRO$_i$ *xue fayu*].[5]
Zhangsan want PRO learn French
'Zhangsan wants to learn French.'

b. *Zhangsan*$_i$ *jiao Lisi* [PRO$_i$ *xue fayu*].
Zhangsan ask Lisi PRO learn French
'Zhangsan asks Lisi to learn French.'

In addition to the lack of overt morphological markers in control sentences, as a *pro*-drop language (Huang, 1984, 1989), Mandarin Chinese allows the existence of covert control sentences where both the subject controller and object controller may be dropped. Therefore, for the subject control sentence in (4a), the matrix subject may be null or covert as shown in (4b) (cited from Yang and Yang (2015).

3. It is still a controversial issue as to whether Mandarin exhibits a finite/nonfinite distinction. Some scholars argue that like English, Mandarin has a finite/nonfinite contrast (e.g., Huang, 1984, 1987, 1989; Li, 1985, 1990; Tang, 1990; Tsai, 2008; Zhang, 1997, 2016; Cao, 2018); others contend that the distinction does not exist in Mandarin (Xu, 1985/1986, 1986, 1994, 2003; Hu et al., 2001). In the present study, following Huang (1984, 1987, 1989), we assume that Mandarin Chinese has the finite/nonfinite distinction and that PRO only occurs in nonfinite clauses.

4. See Yang and Yang (2015) for a more detailed discussion of the distinction between control and raising in Mandarin Chinese and references cited there.

5. *Xiang* in Mandarin Chinese has various senses. In our example in (3), it is similar to *want* in English in meaning. In other cases, it can mean 'think of' or 'miss'.

In such cases, the controller of PRO is the null subject which is identified by the discourse topic in the context.

(4) a. *Ta*$_i$ *shefa [PRO*$_i$ *bang wo*].
he try PRO help me
'He tried to help me.'
b. *pro*$_i$ *shefa* [PRO$_i$ *bang wo*].
pro try PRO help me
'(Somebody) tried to help me.'

The direct object of some object control verbs can also be covert (Hu, 2010; Wang, 1999). In the case of covert object control, PRO has a covert matrix object as its controller. In (5) where the matrix object is covert (represented by *e*), the referent of which is an antecedent in the discourse context. If we lexicalize the covert object in (5), we get (6), suggesting the co-referential relation between the matrix object (overt or covert) and PRO. The syntactic representation of covert object control for Mandarin Chinese is given in (7).[6, 7]

(5) a. *Zhangsan jinzhi* *e*$_i$ [PRO$_i$ *wan youxi*].
Zhangsan prohibit e PRO play game
'Zhangsan prohibited (somebody) from playing games.'
b. *Jintian*, *wo qing* *e*$_i$ [PRO$_i$ *chi-fan*].
today I invite e PRO eat-meal
'Today, I invited (somebody) to eat a meal.'

(6) a. *Zhangsan jinzhi* *Lisi*$_i$ [PRO$_i$ *wan youxi*].
Zhangsan prohibit Lisi PRO play game
'Zhangsan prohibited Lisi from playing games.'

6. Languages differ in their tolerance of covert or implicit object control. Non-*pro*-drop languages, such as English, generally do not allow the direct object of a control verb to be omitted. In English, only the dative objects of some communication verbs such as *gesture*, *say* and *signal* are omissible (e.g., (i)) (Landau, 2000, 2013, 2015).

(i) Mary gestured/said/signaled (to John$_i$) [PRO$_i$ to follow her].

7. Note that covert object control should be differentiated from arbitrary control, in which no argument in the sentence acts as the controller of PRO (Wang, 1999; Hu, 2010; Landau, 2000, 2013, 2015). In arbitrary control such as (ii), PRO takes a generic interpretation, i.e., PRO could be anybody who smokes.

(ii) [PRO$_{arb}$ *xiyan] youhai jiankang.*
smoke harmful health
'Smoking is harmful to health.'

b. *Jintian*, *wo qing* ni_i [PRO$_i$ *chi-fan*].
today I invite you PRO eat-meal
'Today, I invited you to eat a meal.'

(7) [$_{Top}$ e_i], [$_{cp}$ … e_i [$_{cp}$ PRO$_i$ …]]

The acquisition of control in Mandarin Chinese is relatively understudied. To date, only two studies have explored acquisition of control in Mandarin Chinese. In a reference judgment experiment, Yang (2014) tested 3-to-5-year-old children's comprehension of complement control involving subject control verbs *dasuan* 'decide', *xiwang* 'hope', and *daying* 'promise', object control verbs *rang* 'let' and *guli* 'encourage'.[8] In the experiment, the child was asked to judge whether a control sentence was a true or false description of a context and three contexts were created for each control verb representing the subject-as-controller context, object-as-controller context, and external referent-as-controller context. It was found that children were able to follow the minimality constraints on control and assign the correct controller to PRO by age 5, though verbs like *daying* 'promise' posed difficulty even for 5-year-olds. Subject control verb *dasuan* 'decide' was also difficult for 3-to-4-year-olds.

Yang and Yang (2015) examined early production of both subject and object complement control structures using longitudinal production data of four Mandarin-speaking children under age 2. Through a detailed analysis of contexts in which early control sentences were used and of what children said or did not say in such contexts, the study yielded data that exhibited both universal and language-specific properties of control in early production, providing evidence for the availability of control in early Mandarin development. First, it was found that children produced control structures involving a wide variety of control verbs. Among the most frequently used control verbs were subject control verbs *yao* 'want', *xiang* 'want' and *xihuan* 'like', and object control verbs *rang* 'let' and *jiao* 'ask'. Second, the study also identified for the first time children's early distinction between control structures and serial verb constructions (SVCs), and also between control structures and coordinate constructions.[9] Due to the lack of overt morphological markers as well as the serializing nature of Mandarin Chinese, control sentences do not differ from SVCs (e.g., *wo qu lin bao* 'I go to carry the bag') or coordinations (e.g., *he shui chi mianbao* 'drink water (and) eat bread') in the surface form. The data showed that children used control with a strict order

8. Yang (2014) also examined control into adverbial and purpose clauses in the experiment.

9. Mandarin exhibits no overt inflection, so two or more verbs can appear serially without any syntactic marker. Sentences with the form of (NP) V1 (NP) (NP) V2 (NP) are traditionally considered as SVCs (Li & Thompson, 1981).

of the matrix verb and complement verb, but would switch the order of the two verbs in SVCs (e.g., *wo qu lin bao* 'I go to carry the bag' and *lin-lin bao qu* '(I) go to carry the bag') or coordinations (e.g., *he shui chi mianbao* 'drink water and eat bread' and *chi mianbao he shui* 'eat bread and drink water'). Third, control sentences with covert matrix subjects were quite common, adding evidence to the very early setting of the *pro*-drop parameter by Mandarin-speaking children (Wang et al., 1992).

Of particular relevance to the present study concerns *rang* 'let' in the two studies. Two-year-olds were found to produce typical object control sentences with *rang* as in (8a) as well as those such as (8b), where there was no NP between *rang* and the following verb. In Yang (2014)'s study, *rang* as in (8b) was analyzed as a covert object control verb with the object NP dropped, reflecting the *pro*-drop property of Mandarin Chinese. In this case, the controller of PRO should be an external referent, in accordance with the object control status of the verb. Evidence for this analysis came from Yang's findings that in comprehending sentences like (9), adults uniformly assigned an external referent to PRO. In the current study, we follow Yang (2014) in assuming that *rang* is an object control verb, whether the NP is dropped or not.

(8) a. ZTX (1;9;1)
Context: Mother was asking ZTX to decide the person to distribute the candies.
Rang mama fen.
let mom distribute
'Let mom distribute (the candies).'

b. ZTX (1;8;11)
Context: Mother asked ZTX if she could sit on his new toy car or not.
Bu rang zuo.
NEG allow sit
'(Mother) is not allowed to sit (on the toy car).'

(9) *bu-rang* 'do not allow'
Lanyangyang bu-rang chi xuegao.
Lanyangyang NEG-allow eat ice-cream
'Lanyangyang does not allow (somebody) to eat the ice cream.'

Although Mandarin-speaking children have started to produce control sentences at age 2, it still remains unclear whether they can assign the right controller to subject and object control. By extending the investigation to 2-year-olds' comprehension, we are able to get a closer look at the initial state of control in child grammar. In the current study, we employed the intermodal preferential looking paradigm (IPLP), a very child-friendly method that is suitable for children from

six months to about three years of age. This method does not require any overt action such as pointing, answering questions, or acting out on the child, but simply visual fixation which replicates children's natural responses in real settings (Hirsh-Pasek & Golinkoff, 1996, Golinkoff et al., 2013). In a typical IPLP experiment, toddlers are shown two visual stimuli side by side when only one of them matches an accompanying linguistic stimulus. The time children spend looking to the visual stimuli is measured and analyzed, different from methods such as Truth Value Judgment or Picture Selection which uses discrete measures of children's behavior (e.g., correct or incorrect responses). The paradigm builds on the rationale that, if toddlers understand the sentence, they will use it to look for the matching visual stimulus rather than the non-matching one. In this case, they will prefer looking to the image that matches the sentence more than the one that does not. Thus, the difference in time spent looking to the matching and non-matching visual stimulus is taken as a demonstration of their sensitivity to the linguistic form or structure under investigation. In the last three decades, the IPLP has been employed intensively to explore beginning linguistic competence in infants and toddlers (see references cited in Golinkoff et al., 2013; see also relevant references cited in Guasti, 2016). It has also been used widely to tap incipient syntactic knowledge such as understanding of subject and object *wh*-questions in 13-, 15-, and 18-month-olds (Sedel et al., 2003), representation of non-local dependencies in 18-month-olds (Perkins and Lidz 2021), sensitivity to aspectual distinctions between *-ed* and *-ing* forms in 26-, 30-, and 36-month-olds (Wagner et al., 2009) and also between aspect markers *le* and *zhe* in Mandarin-speaking 30-month-olds (Yang et al., 2018), as well as sensitivity to constraints on pronominal reference in 30-month-olds (Lukyanenko et al., 2014, Emond and Shi, 2025), to name just a few. As a crucial aspect of knowledge of control is to determine which nominal element is the controller of PRO, we believed that this method would be appropriate in probing 2-year-olds' selection of the controller of PRO, by measuring and analyzing their preferential looking to pictures matching or mismatching the control sentence. No study to date has yet investigated young children's comprehension of control with this methodology.

4. Methods

4.1 Subjects

Thirty-two 2-year-old children participated in the experiment (mean age: 2;1;7; age range: 2;0;11–2;2;23; 16 boys, 16 girls). Participants were recruited through online advertisements. They were acquiring Mandarin Chinese as their native lan-

guage, born and raised in Beijing and developing normally with no report of any hearing or speech disorder. They were randomly distributed across four counterbalancing groups. Four additional children were removed from analysis due to fussiness.

4.2 Test stimuli

To answer the question of how 2-year-olds interpret subject and object control, we designed four types of sentences: sentences involving control verbs *xiang* 'want', *rang* 'let', *jiao* 'ask' and coverb *gei* 'for'. *Xiang* 'want' is a typical subject control verb whereas *jiao* 'ask' and *rang* 'let' are typical object control verbs. In the design, *rang* was a covert object control verb with the object NP omitted. In addition to these three control verbs, we included coverb *gei* sentences, which do not involve control. Belonging to the class of coverbs which behave "partly like verbs and partly like prepositions" (Li & Thompson, 1981: 360), *gei* bears a benefative meaning.[10] All these verbs (and *gei*) are found in young children's production which guaranteed that our child participants were familiar with their meaning. Sample test sentences are listed in (10).

(10) a. Subject control *xiang* 'want':
Xiaotu xiang chi-fan.
little-rabbit want eat-meal
'Little Rabbit wants to have a meal.'

b. Covert object control *rang* 'let':
Xiaotu rang chi-fan.
little-rabbit let eat-meal
'Little Rabbit lets (Little Goat) have a meal.'

c. Overt object control *jiao* 'ask':
Xiaogou jiao Xiaohou kai-men.
little-dog ask little-monkey open-door
'Little Dog asks Little Monkey to open the door.'

d. Benefactive *gei* 'for':
Xiaogou gei Xiaohou kai-men.
little-dog for little-monkey open-door
'Little Dog opens the door for Little Monkey.'

Of the four sentence types, subject control *xiang* 'want' and covert object control *rang* 'let' form a minimal pair: they have the same surface form of NP V1 V2 but different underlying structures as a result of their distinct control properties,

10. Coverbs are partly verbs because they can co-occur with aspect markers *-zhe* or *-le*. Other co-verbs include *gen* 'with', *cong* 'from', *chao* 'facing', *yan* 'along', *li* 'be apart from'.

shown in (11a and b). For covert object control *rang* 'let', there is *pro* which serves as the controller of PRO with the antecedent in the discourse context. Overt object control *jiao* 'ask' and *gei* 'for' form another minimal pair with a similar surface form of NP1 V1/coverb NP2 V2 but distinct underlying structures. There is a PRO in object control *jiao* 'ask' sentence but the *gei* 'for' sentence is not a control structure. Their underlying structures are given in (11c and d).

(11) a. subject control *xiang*: $NP1_i$ $V1_{\text{-}xiang}$ PRO_i V2
b. covert object control *rang*: NP1 $V1_{\text{-}rang}$ pro_i PRO_i V2
c. overt object control *jiao*: NP1 $V1_{\text{-}jiao}$ $NP2_i$ PRO_i V2
d. *gei* 'for': NP1 *gei* NP2 V

This design enabled us to examine closely which NP children would choose as antecedent of PRO in control sentences and whether the interpretation is subject to structural knowledge or performance factors introduced earlier. If children have a correct structural analysis of control and obey constraints like GCR, they are expected to find the right antecedent for subject control and object control. Thus, NP1 in (11a) (e.g., the subject *Xiaotu* 'Little Rabbit' in (10a)) should be the controller of PRO for subject control *xiang* 'xiang', but not for covert object control *rang* 'let'. For *rang* 'let', the antecedent is not the subject but an element external to the sentence in the discourse. For overt object control *jiao* 'ask' in (11c), NP2 should be the controller of PRO, hence the agent of V2 (e.g., *Xiaohou* 'Little Monkey' in (10c)), but for *gei* 'for' in (11d), NP1 should be the agent of V (e.g., the subject *Xiaogou* 'Little Dog' as the agent of *kai-men* 'open door' in (10d)). However, if performance strategies such as the first noun strategy come into play, we should find no difference in the controller of PRO between subject control and object control, since for both structures, the first noun is the matrix subject. If children follow the adjacency strategy, they would choose the noun adjacent to the following verb for both *gei* 'for' sentences and overt object control *jiao* 'ask' sentences.

Sentences in each minimal pair contained the same nouns (i.e., animal names) and embedded verbs, but differed in the matrix verb. For example, (10a) and (10b) use the same matrix subject *Xiaotu* 'Little Rabbit' and the embedded verb *chi-fan* 'eat a meal'. For the subject control and covert object control pair, the embedded verbs were *chi-fan* 'eat-meal', *kan-shu* 'read-book' and *shua-ya* 'brush-teeth'. For the overt object control and *gei* 'for' pair, the embedded verbs included *kai-men* 'open-door', *chang-ge* 'sing-song', and *hua-hua* 'draw-picture'. In total, we created 12 test sentences (i.e., 4 sentence types × 3 tokens) (see all test sentences in Appendix A).

The speech stimuli were recorded by a native female speaker of Mandarin Chinese in a child-directed manner in a sound-proof booth. These recordings were edited and combined with the visual stimuli. We also designed several car-

rier phases for the introduction of the characters such as *Kan! Xiaotu! Kan! Xiaoyang! Wa!* 'Look, Little Rabbit! Look! Little Goat! Wow!' and wh-questions (e.g. *Shei chi-fan a?* 'Who has the meal?') about the referent in the training and test trials (cf. Table 1 and Table 2).

In deciding on what type of visual stimuli best suited our purpose, we had the following considerations. First, different from prior IPLP studies of infants' acquisition of verbs or verb-related structures which only involve simplex sentences (e.g., Legendre et al., 2010; Golinkoff et al., 1987; Naigles, 1990; Candan et al., 2002; He & Lidz, 2017; Yang et al., 2018; de Calvalho et al., 2019), control structures under investigation are complex sentences with two events (i.e., the main event and the embedded event). Second, the embedded event is unrealized. In saying 'Little Rabbit wants to eat a meal' or 'Little Rabbit asks someone to eat a meal', the event of eating-a-meal is not done yet. Third, while depicting a verb event is quite complex (for example, involving an action and one or more participants), depicting objects in pictures for word-object recognition is more straightforward. Many previous studies using object pictures in the same procedure as ours (i.e., IPLP) have successfully revealed knowledge of noun comprehension in children (e.g., Golinkoff et al., 1987; Fernald et al., 1998; Plunkett, 2005), even in one-year-old infants (e.g., Swingley & Aslin, 2002; Ballen & Plunkett, 2005). Moreover, children's noun comprehension in this procedure has shown the influence of the syntactic context of the carrier utterances, for example, successful object recognition when the carrier is grammatical (Kedar et al., 2006) or better object recognition in grammatical than ungrammatical contexts (Melançon & Shi, 2015; van Heugten & Shi, 2009). Given these considerations, we did not depict verb events in pictures. Instead, we used pictures presenting only the potential controller of PRO in the test sentence. This method avoided the potential confusions that might affect children's looking behavior and allowed us to directly test children's processing of the antecedent of PRO. Attempts were also taken to keep animals comparable in size, color, and the degree of loveliness to minimize the possibility that children might prefer to look at a particular picture. A sample visual stimulus is shown in Figure 1.

Figure 1. The visual stimulus for sentences (10a), (b)

4.3 Design

The test consisted of a training phase and a test phase. In the training phase, non-control sentences were designed to familiarize children with the experimental procedure. Six training trials fell into two types: single-NP sentences (cf. (12a)) and complex sentences with the verb *shuo* 'say', in which the agent of the embedded verb is the second noun of the sentence (cf. (12b)) (see all the training sentences in Appendix B). This would indicate to the child that either the first noun or the second noun of the sentence might be the correct answer. At the end of each training trial, the target picture (i.e., the correct answer) flashed, to inform the child of what he/she should do. See Table 1 for the layout of a sample training trial.

(12) a. Single-NP sentence:
Xiaoxiang xi-zao.
little.elephant wash-shower
'Little Elephant takes a shower.'

b. Complex *shuo* 'say' sentence:
Xiaohou shuo Xiaozhu kai-che.
little.monkey say little.pig drive-car
'Little Monkey says that Little Pig drives.

Table 1. Layout of a sample training trial

	Duration	Visual stimuli	Audio stimuli	Visual stimuli
Character introduction	5.8s		*Kan! Xiaomao!* 'Look, Little Cat!'	
			Kan! Xiaoxiang! 'Look, Little Elephant!'	
			*Wa!* 'Wow!'	
Training sentence + Question	5.1s	(Blankness)	*Xiaoxiang xizao.* 'Little Elephant takes a shower.'	(Blankness)
		(Blankness)	*Shei xizao a?* 'Who takes a shower?'	(Blankness)
	3.6s		(Silence)	

Table 1. *(continued)*

	Duration	Visual stimuli	Audio stimuli	Visual stimuli
Feedback	2.2s		*Shi Xiaoxiang xizao!* 'It's Little Elephant that takes a shower!'	 (flashing)

The test phase followed immediately. Each test trial began with an introduction of two animal characters in the test sentence using carrier phrases. The test sentence was then presented, followed by a *who*-question about the agent of the embedded verb in a blank screen interval of 5.4s. Then, two animal characters reappeared on the screen side by side for 3.6 s in silence. The side of the target picture was counterbalanced, with the target showing half time on the left and half time on the right across trials. The duration of each subject control or covert object control trial was 14.8s, and for each overt object control and *gei* 'for' trial, the duration was 15.5s. See Table 2 for the layout of a sample test trial.

Table 2. Layout of a sample test trial

	Duration	Visual stimuli	Audio stimuli	Visual stimuli
Character introduction	5.8s		*Kan! Xiaoyang!* 'Look, Little Goat!'	
			Kan! Xiaotu! 'Look, Little Rabbit!'	
			*Wa!* 'Wow!'	
Test sentence + Question	5.4s	(Blankness)	*Xiaotu xiang chi-fan.* 'Little Rabbit wants to eat a meal.'	(Blankness)
		(Blankness)	*Shei chi-fan a?* 'Who eats a meal?'	(Blankness)
	3.6s		(Silence)	

The order of the test trials was pseudo-randomized with the constraint that sentences in a minimal pair or with the same verb or coverb would not be adjacent. The position of the characters on the screen was kept constant from character familiarization to test, and the left-right position of the target animal character was counterbalanced across trials. Each child was randomly assigned to one of the four experimental orders.

4.4 Procedure

Each child came to the lab with his/her parent and was given some time to get familiar with the surroundings, entertained by an experimenter with toys. Another experimenter explained to the parent about the study and obtained parental consent. The parent was instructed not to distract the child during the experiment. The child and the parent were then led into the soundproof acoustic chamber. The visual stimuli were displayed on an LCD screen, and the audio stimuli were delivered by loud speakers on both sides of the screen. The child was seated on the parent's lap facing the screen during the experiment. The parent listened to masking music from headphones during the whole experiment. The child was videotaped during the entire experiment using a digital camera hidden under the screen. In an adjacent room, the experimenter who was blind to the stimuli observed the live video of the child on a monitor with the audio off and gave verbal instructions to the parents via headphones whenever necessary. The whole experiment lasted about 6 minutes. After the experiment, a parental report on the child's understanding of the words and structures used in the experiment was collected.

4.5 Coding and analysis

Children's looking behavior was coded off-line by a researcher frame by frame in the last 3.6 s of each test trial at 50 frames/sec. This was the period during which visual stimuli of the two characters were presented after children heard the test sentence and the *who*-question. Each frame was coded as left look, right look, or looking elsewhere. A total of 2.3% of the trials were excluded for analysis, because the child looked elsewhere over 80% of the time in these trials. Inter-coder reliability reached 96.4%.

The measure used for analysis was the proportion of looking to target (PLT) during the last 3.6s of each trial. For our purpose, the subject picture was chosen as the target for all test sentences. PLT was calculated by taking the total looking time to the subject picture by the sum of looking time to both subject and non-subject pictures.

It was predicted that, if children had knowledge of control and understood the underlying structure associated with each sentence type, that is, if they were sensitive to the structural constraints on control and the *gei* structure, they were expected to prefer looking at the target picture (i.e., look more to the subject picture) in subject control *xiang* 'want' and non-control *gei* 'for' trials, but not so in *rang* 'let' and *jiao* 'ask' trials, which were both object control sentences. For these two object control trials, they were expected to look at the non-target more (i.e. the external agent picture in *rang* trials or the object picture in *jiao* trials). A distinction in preferential looking would also be expected between the two minimal pairs (i.e., *xiang* vs. *rang* and *gei* vs. *jiao*).

5. Results

To check the reliability of the training method, we conducted a one-sample *t*-test to compare children's looking to the correct agent in training trials with the chance level 0.5. If children learned the task, they were expected to achieve above-chance performance, at least at the end of the training session. This prediction was borne out. The *t*-test results revealed that looking to the correct agent (i.e., the first noun) was significantly or marginally above chance in all single-NP training trials (Single-NP Training Trial 1: $M = .615$, $SE = .029$, $t(31) = 3.974$, $p = .000$; Single-NP Training Trial 2: $M = .565$, $SE = .035$, $t(31) = 1.864$, $p = .072$; Single-NP Training Trial 3: $M = .588$, $SE = .041$, $t(31) = 2.132$, $p = .041$). Though looking to the correct agent (i.e., the second noun) was not different from chance in the first and second complex *shuo* 'say' training trials (first: $M = .485$, $SE = .039$, $t(31) = -.378$, $p = .708$; second: $M = .484$, $SE = .047$, $t(31) = -.341$, $p = .735$), it was significantly above chance in the third one ($M = .618$, $SE = .035$, $t(31) = 3.338$, $p = .002$). These results were taken as an indication of children's successful learning of the task.

Children's proportion of looking to target (the subject picture) for different types of test trials is shown in Figura 2. We conducted two statistical analyses to test whether children understood subject and object control structures by choosing the right antecedent of PRO. The first analysis was a one-sample t-test comparing PLT of the four trial types to the 0.5 chance level. If children could tell subject control *xiang* 'want' and non-control *gei* 'for' apart from object control *rang* 'let' and *jiao* 'ask', their PLT should be significantly above chance in the former trials, but below chance in the two object control trials. The results showed that looking to target was above chance in *xiang* 'want' trials ($M = .556$, $SE = .027$, $t(31) = 2.0924$, $p = .044$) as well as *gei* 'for' trials ($M = .557$, $SE = .021$, $t(31) = 2.677$, $p = .012$), but not significantly different below chance in *rang* 'let' and *jiao* trials (*rang* 'let': $M = .485$, $SE = .029$, $t(31) = -.522$, $p = .605$; *jiao* 'ask': $M = .489$, $SE = .027$,

$t(31) = -.391$, $p = .698$). The chance-level performance of the two object control trials seems to indicate children's hesitation in the choice of the antecedent of PRO in object control structures. Nevertheless, they did not show a significant matrix subject preference like the *xiang* and *gei* sentences.

The second was a paired *t*-test that compared PLT in the two minimal pairs: subject control *xiang* 'want' vs. covert object control *rang* 'let' trials, and overt object control *jiao* 'ask' vs. *gei* 'for' trials. Note that for each minimal pair of trials, the sentences share the same surface structure but differ in the underlying structure, as a result of the control properties of the control verb. If children were able to differentiate between the two sentence types in each minimal pair, we would expect a significant difference in PLT between subject control *xiang* and covert object control *rang* trials, and also between overt object control *jiao* and non-control *gei* trials. The results revealed a tendency toward a significant difference in PLT between *xiang* and *rang* trials ($t(31) = 1.865$, $p = .071$) and also between *gei* 'for' and *jiao* 'ask' trials ($t(31) = 1.75$, $p = .09$). Thus, children tended to look more to the subject picture in *xiang* 'want' trials than in *rang* 'let' trials. In *rang* 'let' trials, children turned some of their attention to the distracter picture, i.e., external character not present in the sentence, a potential antecedent of PRO. The difference was also detected when there were two NPs in test sentences as in *gei* 'for' and *jiao* 'ask' trials: children were inclined to look more to the subject picture in *gei* 'for' trials but less so in *jiao* 'ask' trials. All statistics were two-tailed.

Taken together, the results showed that children looked more to the target in subject control *xiang* and benefactive *gei* trials while this was not the case in object control *rang* and *jiao* trials. At the same time, children marginally differentiated between subject control and covert object control, and also between overt object control and non-control *gei* sentences,. The implications of these results will be discussed in the next section.

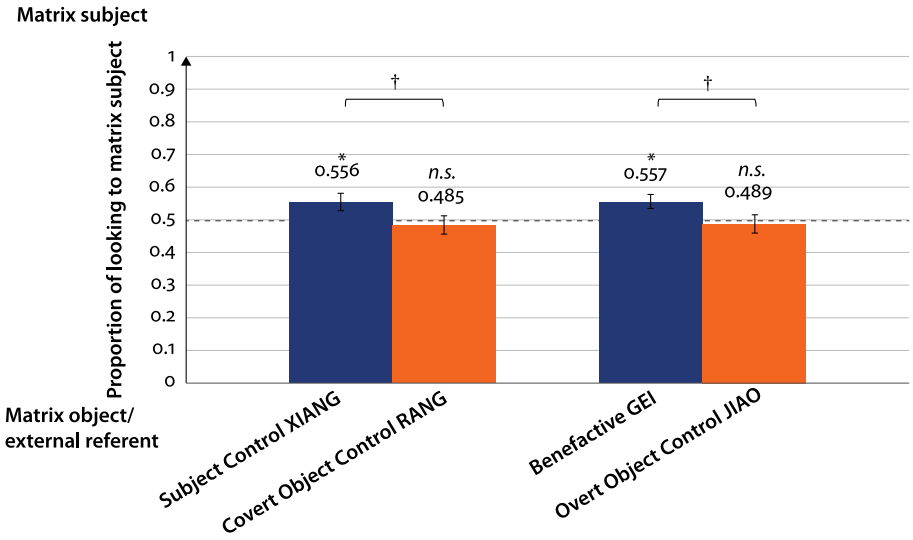

Figure 2. Mean proportion of looking to target (subject) across different trial types *(†p < .1, *p < .05)*

6. Discussion

We began the study by seeking to assess Mandarin-speaking two-year-old children's knowledge of complement control. Children' comprehension of subject and object control was investigated to determine whether they were able to choose the right antecedent of PRO in an IPLP experiment. The specific control verbs were subject control verb *xiang* 'want', object control verbs *rang* 'let' and *jiao* 'ask' in various complement control structures. We also included non-control *gei* 'for' in the minimal pair with overt control *jiao* as it shares the same surface structure as *jiao*. As predicted, we found that when comprehending test sentences with two potential antecedents, represented by the subject picture and the non-subject picture (external referent picture or the object picture) on the screen side by side, children's target looking was significantly above chance by looking more to the subject picture in subject control *xiang* trials and non-control *gei* trials, and that a marginal significant difference was identified for the two minimal pairs (subject control *xiang* vs. covert object control *rang*, non-control *gei* vs. overt object *jiao*): they were inclined to look more to the subject target picture in subject control *xiang* and non-control *gei* trials than in object control *rang* and *jiao* trials. Children's looking to target in object control *rang* and *jiao* trials was not significantly below chance, inconsistent with our prediction. These results reveal Mandarin-

speaking 2-year-olds' emerging knowledge of some basic syntactic properties of complement control. They suggest that Mandarin-speaking children who have just entered their second year in life are already sensitive to control. This sensitivity is evident in their above-chance target looking in subject control trials as well as a distinction in target looking between the two minimal pairs. The results also point to a stronger sensitivity to subject control than to object control.

Structural and performance accounts have been proposed in explicating English-speaking children's non-adult-like interpretations of control such as arbitrary interpretation or taking the subject NP as the controller of object PRO (e.g., C. Chomsky, 1969; Hsu, 1981; Hsu et al., 1985; McDaniel et al., 1990/1991; Sherman & Lust, 1986, 1993). Our early Mandarin comprehension data are obviously not consistent with the coordination account that assumes children's initial analysis of control as coordination (McDaniel et al., 1990/1991). The production data from Yang and Yang (2015) already suggest that two-year-old children make a clear distinction between control and coordinative structures. In control structures, the control verb and V2 were found to appear in a fixed word order, whereas in coordinated sentences, the order of the two verbs was relatively free, allowing for alternation. In the current study, important evidence against the coordination account is how children interpret various types of control sentences. If they analyze control sentences as coordination, they should freely take either subject or object or external character as controller of PRO in both subject and object control sentences. Then, there should be no differentiation between different types of trials. This is not the case. The results suggest that children consistently look more to the subject target in interpreting subject control sentences and there is a consistently a tendency for a looking preference distinction between subject and object control trials as well as object control and non-control sentences.

The experimental results do not provide evidence for children's adoption of the first noun strategy nor the adjacency strategy in interpreting object control sentence either. It is possible that, at the stage when children's knowledge of object control is not fully established, children may adopt performance strategies to interpret object control sentences, that is, to establish the anaphoric relation between the subject (i.e. the first noun of the sentence) or the closest NP and the empty subject of the embedded verb.[11] In both covert object control *rang* and overt control *jiao* sentences in our experiment, children's looking to target (i.e. the subject picture) was not significantly above chance level; in addition, a differentiation in looking to target between the two minimal pairs was identified, suggesting more subject selection in subject control and *gei* trials than in object control trials. Therefore, the first noun strategy does not appear to have played a decisive

11. Thanks to an anonymous reviewer for this point.

role in interpretation of object control here. As for the adjacency strategy, two test trials are relevant, i.e. overt object control *jiao* trials and non-control *gei* trials as both involve an NP in the object position (cf. 11c, d). Children's preference for the subject picture in *gei* trials as well as a looking distinction between *gei* and *jiao* trials suggests they do not adopt the adjacency strategy.

As reviewed earlier, preschoolers learning different languages have been reported to misinterpret complement control sentences. Yang (2014) also identified Mandarin-speaking 3-to-4-year-olds' difficulty with control verbs like *daying* 'promise' (similar to English-speaking children's difficulty with *promise*), and also a few other control verbs. In the current study, while 2-year-olds can successfully select the right controller of subject PRO, they seem to be less able to do so when interpreting object control *rang* and *jiao* sentences. These results do not necessarily mean that object control is not available to them. According to the lexical-syntactic integration hypothesis, the structural constraints as part of UG should be available to children early in development, yet a full understanding of control would involve an integration of both structural knowledge of control and lexical knowledge of control verbs (Sherman & Lust, 1986, 1993). While children have access to control constraints continuously, certain aspects of lexical knowledge of control verbs might develop gradually, resulting in more time taken to integrate these two types of knowledge. Development of lexical properties of different verbs may not take place at the same time, with some control verbs acquired earlier and others later. Probably, intrinsic meanings associated with object control verbs *rang* and *jiao* are not fully acquired. If lexical knowledge of specific verbs is not acquired, it will be difficult for the child to assign the correct interpretation to a control sentence. The results of the current study cannot confirm this since the verbs involved are limited, but they serve as a foundation for further research that can hopefully shed light on how different linguistic factors interact in determining young children's interpretation of complex structures.

There are other factors that need to be considered in interpreting the results. First, one anonymous reviewer asks whether it is possible for children to analyze *xiang* sentences as mono-clausal instead of a control structure. Several features of our design should help rule out this possibility. In the test, children were presented with two possible agents for the embedded verb in the *xiang* sentence, the subject and an external agent, both introduced at the beginning of the test as the background (cf. character introduction in Table 2). Right after the presentation of the test sentence, a critical question *wh*-question *Shui chifan-a* 'who-eat-rice-SFP' was asked. This ensured that the event encoded by the second verb was one different from the *xiang* event. We also checked naturalistic production of early *xiang* sentences (before age 2) in the Tong corpus (Deng and Yip, 2018) and two children's production in the BJCELA corpus and found sentences like *Xiang mai*

yi xigua 'want-buy-one-watermelon' and *Wo xiang wan-wan zhe-ge* 'I -want-play-this-CL'. Sentences like these are hard to be taken as mono-clausal. Second, not all native speakers fully accept *rang* sentences with the omission of the object and even sentences like (5a), as pointed out by an anonymous reviewer. Whether this affects young children in the present study is not clear, though similar sentences do not appear to have influenced older children's interpretation in Yang (2014). Third, covert object control *rang* might pose some difficulty for young children's interpretation as a result of pragmatic factors. Further studies should be conducted to address these speculations.

In conclusion, the present study uncovers how Mandarin-speaking 2-year-olds comprehend complement control in an IPLP experiment. The results of the experiment provide evidence for young children's emerging knowledge of properties of control, as shown by their sensitivity to subject control as well as the distinctions between subject and object control. It is hoped that the early Mandarin comprehension data can provide a different perspective for inquiries into the initial state of child grammar and the continuity issue in language acquisition.

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Appendix A. Test sentences

Subject control *xiang* 'want'

(1) *Xiaotu xiang chi-fan.*
little.rabbit want eat-meal
'Little Rabbit wants to have a meal.'

(2) *Xiaozhu xiang kan-shu.*
little.pig want read-book
'Little Pig wants to read a book.'

(3) *Xiaomao xiang shua-ya.*
little.cat want brush-tooth
'Little Cat wants to brush her teeth.'

Covert object control rang 'let'

(4) *Xiaotu rang chi-fan.*
little.rabbit let eat-meal
'Little Rabbit lets (Little Goat) have a meal.'

(5) *Xiaozhu rang kan-shu.*
little.pig let read-book
'Little Pig lets (Little Horse) read a book.'

(6) *Xiaomao rang shua-ya.*
little.cat want brush-tooth
'Little Cat wants (Little Chicken) to brush her teeth.'

Overt object control with *jiao* 'ask':

(7) *Xiaogou jiao Xiaohou kai-men.*
little.dog ask little.monkey open-door
'Little Dog asks Little Monkey to open the door.'

(8) *Xiaolu jiao Xiaoxiang chang-ge.*
little.deer ask little.elephant sing-song
'Little Dear asks Little Elephant to sing a song.'

(9) *Xiaoniu jiao Xiaoxiong hua-hua.*
little.calf ask little.bear draw-picture
'Little Calf asks Little Bear to draw a picture.'

Benefactive *gei* 'for':

(10) *Xiaogou gei Xiaohou kai-men.*
little.dog for little.monkey open-door
'Little Dog opens the door for Little Monkey.'

(11) *Xiaolu gei Xiaoxiang chang-ge.*
little.deer for little.elephant sing-song
'Little Dear sings a song for Little Elephant.'

(12) *Xiaoniu gei Xiaoxiong hua-hua.*
little.calf for little.bear draw-picture
'Little Calf draws a picture for Little Bear.'

Appendix B. Training sentences

Single-NP sentences:

(13) *Xiaoxiang xi-zao.*
little.elephant wash-shower
'Little Elephant takes a shower.'

(14) *Xiaoji tiaowu.*
little.chicken dance
'Little Chicken dances.'

(15) *Xiaoniu he-shui.*
little.calf drink-water
'Little Calf drinks water.'

Complex *shuo* 'say' sentences:

(16) *Xiaolu shuo Xiaotu xi-shou.*
little.deer say little.rabbit wash-hand
'Little Deer says that Little Rabbit washes her hands.'

(17) *Xiaohou shuo Xiaohou paobu.*
little.monkey say little.monkey run
'Little Monkey says that Little Monkey runs.'

(18) *Xiaohou shuo Xiaozhu kai-che.*
little.monkey say little.pig drive-car
'Little Monkey says that Little Pig drives.'

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