

Effect of Indefiniteness on Mandarin-Speaking Children's Comprehension of the Double-Object Construction

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1. Introduction

In learning verbs, children must learn the correspondence between the event participants in the world and the verb arguments in sentences. This study examined a possible learning mechanism for mapping the thematic structure to the argument structure by testing children's comprehension of the double-object construction. Double-object sentences usually convey the meaning of transfer. Cross-linguistically, the order of the recipient and the theme in the double-object construction varies, and it is not entailed by the order of VO/OV in the language (Haspelmath, 2015), such as the recipient-theme order in English and Mandarin, and the theme-recipient order in Cantonese. Children need to learn how to correctly map the recipient and theme to the two object argument positions in their native language.

English-speaking children begin to produce double-object constructions spontaneously before the age of 3 years (Campbell & Tomasello, 2001), but it has been found that 3- to 4-year-old children struggle with double-object sentences in experimental settings: in the act-out or video-selection experiments, children often assigned incorrect thematic roles to the indirect and direct objects (Osgood & Zehler, 1981; Rowland, Noble & Chan, 2014; Arunachalam, 2017; Conwell, 2019). Similarly, Cantonese-speaking 3-year-olds failed to assign the recipient and theme roles correctly in the double-object construction (Rowland, Noble & Chan, 2014).

One possible explanation is that 3- to 4-year-old children have lexically specific representations of the double-object construction. Conwell, O'Donnell and Snedeker (2011) found that 79% of indirect objects in the English double-object construction in the adult input were pronominal. They suggested that children's early spontaneous production of the double-object construction

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relies on the high-frequency and routinized item-based structures, such as ‘*give me X*’ or ‘*show me X*’. In line with this explanation, 3- to 4-year-old children exhibited conservative behaviors in the elicited production task after learning novel verbs: they were reluctant to produce double-object sentences with the novel verbs that were learned in the dative prepositional construction (Conwell & Demuth, 2007).

However, other studies did not support this explanation. Syntactic priming effects of the double-object construction have been found in 3- to 4-year-olds in both comprehension and production. In comprehension, Thothathiri and Snedeker (2008) found that children who had heard the double-object sentences before were more likely to interpret the first post-verbal NP as the recipient in their online processing, as measured by eye movements. In production, 3- to 4-year-old children produced more double-object sentences after hearing the double-object priming sentences, even when there was no lexical overlap between the priming sentences and the target sentences (Rowland et al., 2012). These results suggest that 3- to 4-year-olds have abstract syntactic representations of the double-object construction that are not tied to the verb-specific frames.

Another possibility is that double-object sentences in which the indirect and direct objects are both animate and definite NPs (as in (1a)) are extremely rare in the ambient language to which children are exposed, and thus might obscure children’s knowledge of the double-object construction. In fact, the double-object construction tends to have pronominal, animate, definite, and discourse-given indirect objects, and non-pronominal, inanimate, indefinite, and discourse-new direct objects (Collins, 1995; Bresnan et al., 2007), as indicated in (1b). This pattern of indirect and direct objects has also been found in adult child-directed speech (Snyder, 2003; de Marneffe et al., 2012). In line with this explanation, although 3-year-olds often struggle with comprehending sentences like (1a), their performance is crucially facilitated when the direct objects are inanimate (Osgood & Zehler, 1981), or when the indirect objects are pronouns (Conwell, 2019) or proper names (Rowland & Noble, 2011).

- (1) a. The lion gives the cat the puppy.
- b. The lion gives him a puppy.

These semantic and pragmatic properties might guide the mapping between the thematic structure and the argument structure, as proposed by the learning theory of semantic bootstrapping (Grimshaw, 1981; Pinker, 1984; Becker, 2014; Lidz & Gagliardi, 2015). The semantic bootstrapping hypothesis presupposes that systematic correlations exist between thematic structure and argument structure. Similarly, Marantz (1984) proposes that argument structure and thematic structure are related across human languages, while Dowty (1991) further suggests that these correspondences are based on the hierarchy of proto-agentivity. Given these correlations, children may track the semantic and pragmatic properties in their ambient language to identify syntactic arguments

such as the subject (Pinker, 1984). The same learning mechanism can extend to the acquisition of double-object construction. Cross-linguistically, indirect objects are more likely than direct objects to be animate, definite, discourse-given, and pronominal (Haspelmath, 2015). At the level of thematic structure, the recipient in a transfer event is more agent-like in the hierarchy of agentivity, for instance, recipients but not themes typically display ‘volitional involvement’, a property of the proto-agent (Dowty, 1991). Consequently, children may track these semantic and pragmatic cues to map the recipient role onto the indirect object, and map the theme role onto the direct object.

Our analysis of the Mandarin child-directed input suggests that the indirect object and direct object are distinct in animacy, pronominality, discourse-givenness, and definiteness (Wu & Yang, 2024). This study explores whether one of these semantic properties, the indefiniteness, associated with objects can influence children’s comprehension of the double-object sentences, thereby exploring children’s sensitivity to these semantic properties.

2. Mandarin double-object construction

2.1. Syntactic configurations and properties associated with objects

The double-object construction in Mandarin features a recipient-theme order, as shown in (2a). There is a ditransitive verbal suffix *-gei* (Huang & Ahrens, 1999), which can attach to the main verb, as shown in (2b). The suffix *-gei* is sometimes optional, as in (2a) and (2b), but sometimes it is obligatory, as shown by the contrast of grammaticality in (2c) and (2d). Whether the suffix *-gei* is optional or obligatory depends on the verb types. Thus, there are two kinds of ditransitive verbs in Mandarin: the *gei*-optional verbs, and the *gei*-obligatory verbs¹ (Li & Thompson, 1981, p. 374-377). This classification can be largely explained by the verb semantic subclasses, despite some idiosyncratic exceptions. For instance, most verbs of giving are *gei*-optional, such as *song* ‘give’ in (2a) and (2b), while most verbs of motion and most verbs of creation are *gei*-obligatory, such as *reng* ‘throw’ in (2c) and (2d) (Chung & Gordon, 1998, p. 116).

- (2) a. Wo song ta [yi-ping jiu]
 I give him/her one-Classifier wine
 ‘I give him/her a bottle of wine.’
- b. Wo song-gei ta [yi-ping jiu]
 I give-gei him/her one-Classifier wine
 ‘I give him/her a bottle of wine.’

¹ Some ditransitive verbs in Mandarin disallow the suffix *-gei* (Li & Thompson, 1981). Double-object constructions with such verbs typically express non-recipient-thematic relations (e.g., loser-theme or affectee-theme; Tsai, 2018). The present study focuses only on the recipient-theme double-object construction, which is cross-linguistically considered the most prototypical type (Haspelmath, 2015).

- c. Wo throw-gei ta [yi-ping jiu]
 I throw-gei him/her one-Classifier wine
 'I throw him/her a bottle of wine.'
- d. *Wo throw ta [yi-ping jiu]
 I throw him/her one-Classifier wine
 Intended meaning: 'I throw him/her a bottle of wine.'

As in English, the indirect object is often animate, pronominal, and discourse-given, while the direct object is usually inanimate, non-pronominal, and discourse-new (Zhu, 1979; Xu, 2004; Zhang & Xu, 2024). In addition, the direct objects are usually in the form of the Numeral-Classifier phrase (henceforth NumCl; Zhu, 1979; Lu, 2002). The grammatical form of NumCl is a reliable indicator of the indefiniteness, compared with other nominal forms. Bare nouns can be either definite, indefinite, or generic, while NumCls can only be indefinite (Chen, 1987).

2.2. Acquisition studies

Previous corpus studies have found that Mandarin-speaking children begin to produce double-object utterances spontaneously around their second birthday (Zhou, 1997; Zou, 2012; Zhang, Gao & Wang, 2018; Wu & Yang, 2024), and the ditransitive suffix *-gei* emerges in the double-object construction in children's spontaneous production as early as 2.5 years of age (Zhou, 1997). In the adult input, it has been found that the double-object sentences are comparatively rare, since the object-dropping (e.g., 'V-recipient' or 'V-theme') and the object-topicalization (e.g., 'theme-agent-V-recipient') are very frequent in Mandarin (Zhang, Gao & Wang, 2018). Meanwhile, the distinct semantic and pragmatic properties between the indirect and direct objects are highly robust in the adult input: indirect objects tend to be animate, discourse-given pronouns, and the direct objects tend to be inanimate, discourse-new NumCls (Wu & Yang, 2024).

In addition to an early study that examined Mandarin preschoolers' judgements on the grammaticality of the double-object sentences with different verbs (Chung & Gordon, 1998), more recently, Wang (2017) adopted the video-verification task to test children's thematic assignment in comprehending the recipient-theme double-object sentences. It was found that 3- to 6-year-old children can interpret the direction of transfer correctly. For instance, children refused sentences like '*the girl gives the boy a banana*' when the scene was that the banana was transferred from the boy to the girl. However, 3- to 6-year-old children have difficulty refusing the ungrammatical agent-V-theme-recipient sentences like '**The brother gives a banana the sister*', indicating that children have difficulty in identifying the positions of the recipient and theme arguments. Nevertheless, the video-verification task requires children to judge whether the test sentences match the scenes, but it might be hard to establish any truth value conditions from ungrammatical sentences; as a result, it is hard to judge whether

an ungrammatical sentence matched a scene or not. In the present study, we adapt a binary picture-selection task, in which both indirect and direct objects in the test sentences are animate and thus are potential recipients, to directly investigate children's mapping of the recipient and theme roles.

3. The experiment

3.1. Participants

Seventy-two 3-year-olds and seventy-three 4-year-olds participated in the experiment (3-year-olds: $M = 3;8$, range: 3;1 to 4;1, $SD = 96$ days; 39 girls; 4-year-olds: $M = 4;9$, range: 4;1 to 5;1, $SD = 110$ days; 27 girls). An additional eighteen participants were removed because they did not finish the entire test phase (8 participants), refused to continue after the practice phase (3 participants), or made incorrect selections on more than 25% of mono-transitive and intransitive fillers (four or more out of twelve fillers; 7 participants).

3.2. Design

This study used a forced-choice paradigm in which two pictures in a pair were presented to children simultaneously, and only one picture was described by the test sentence. Children were asked to identify the picture that was described by pointing to the picture on the screen with their fingers.

The study adopted a 3×4 mixed design. The first factor was the Object Definiteness at three levels: the No NumCl condition with the bare noun indirect objects (IOs) and direct objects (DOs); the NumCl DO condition with the bare noun IOs and NumCl DOs; and the NumCl IO condition with the NumCl IOs and the bare noun DOs. The between-subjects design was adopted for the Object Definiteness to avoid the potential carry-over effects. The second factor was the Verb Type. We included two verbs of giving (*song* 'give' and *fā* 'distribute'), and two verbs of motion (*reng* 'throw' and *tui* 'push'). Previous studies show that in the adult input, verbs of motion are seldom found in the double-object construction, but verbs of giving are frequently used in the double-object construction (Zhang, Gao & Wang, 2018; Wu & Yang, 2024). We thus included the two semantic subclasses of verbs to explore whether children exhibit better performance with high-frequency verb items. Each verb appeared twice, leading to eight test sentences. The Verb Type was a within-subjects factor, so that all participants were tested with the same set of verbs.

The position of the target pictures (left or right) and the presentation order of the test sentences were pseudo-randomized and counterbalanced. Participants were randomly assigned to one of four counterbalancing groups.

3.3. Stimuli

The visual stimuli for this study consisted of picture pairs depicting cartoon animals engaged in transfer events. In all pictures, the agent was a rabbit

transferring one animal to another; in both pictures of a pair, the rabbit and the recipient animal were of the same size, while the theme animal was smaller. Each picture pair depicted the same transfer event with identical participants, differing only in that the theme and recipient roles were reversed across the two pictures, as illustrated in Figure 1. Additional practice trials and fillers used pictures depicting intransitive actions and mono-transitive actions.

The verbal stimuli were pre-recorded by a female native speaker of Mandarin, consisting of double-object sentences describing the scene. All test sentences contained the verbal suffix *-gei* to ensure that both the verbs of giving (*gei*-optional) and the verbs of motion (*gei*-obligatory) could be licensed. The subject was always in the form of the first-person pronoun *wo* 'I', and the indirect and direct objects varied across the conditions of Object Definiteness. Examples of verbal stimuli in the three conditions are listed in (3a), (3b), and (3c), and all correspond to the picture pair in Figure 1.

(3) Example of verbal stimuli

a. No NumCI condition

Wo	reng-gei	[huli] _{IO}	[xiao ³ zhu] _{DO}
I	throw-GEI	fox	pig
'I throw the fox the pig.'			

b. NumCI DO condition

Wo	reng-gei	[huli] _{IO}	[yi-zhi xiao ³ zhu] _{DO}
I	throw-GEI	fox	[one-Classifier pig]
'I throw the fox a pig.'			

c. NumCI IO condition

Wo	reng-gei	[yi-zhi huli] _{IO}	[xiao ³ zhu] _{DO}
I	throw-GEI	[one-Classifier fox]	pig
'I throw a fox the pig.'			

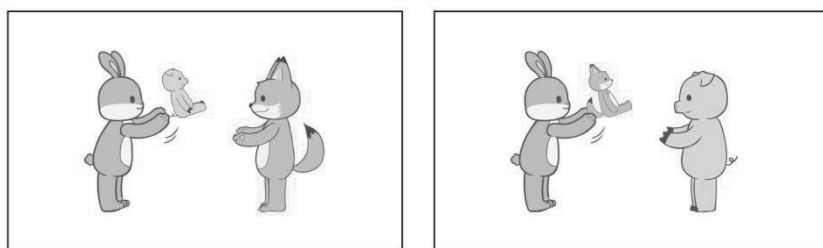


Figure 1. Sample picture pairs used in the experiment

3.4. Procedure

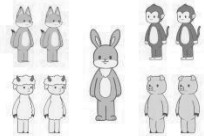
Child participants, along with their caretakers, were invited to a quiet room. After their caretakers signed the consent form, the experimenter invited children

to play a game on the laptop. Caretakers usually waited in another room, but for children who did not want their caretakers to leave the room, only one caretaker was invited to sit behind the child and was asked to avoid offering any instructions during the experiment.

The experimenter sat beside the child and played the stimuli using PowerPoint on a 14-inch laptop. Before the test, children went through a warm-up character identification, and practice, as exemplified in Table 1.

After the warm-up session where the rabbit on the screen invited children to play a game with her, there was a character identification session in which all animal characters showed up. Children were encouraged to say the names of all animal characters. The purpose of adding this phase was threefold: first, to ensure that children were familiar with the names of characters; second, to make all characters discourse-given, thereby ruling out the influence of discourse-givenness; and third, to provide the felicitous context for both definite and indefinite readings of object arguments, given that there were two individuals for each kind of animal. For the following four intransitive and mono-transitive practice sentences, the experimenter offered corrections if children failed to point to the target picture, to ensure that they understood the task. After the practice, the rabbit asked children whether they wanted to go on. If children said yes, they moved on to the test, which included eight double-object sentences and twelve mono-transitive or intransitive fillers. The experimenter only provided general encouragement during the test and no feedback. The experiment usually lasted six to eight minutes per participant.

Table 1. Overview of the pre-test procedure

	Visual stimuli	Audio stimuli (translations)
Warm-up		‘Hello! Do you want to play a game with me?’
Character identification		‘Look! These are all my friends. Do you know their names?’
Practice (4 sentences)		‘I’m running.’

3.5. Predictions

Our first prediction is that if children know the thematic-role assignment in the double-object construction, their accuracy in pointing to the target picture should be significantly higher than the chance level in the No NumCl condition. The second prediction is that if indefiniteness influences the comprehension of the double-object sentences, we should witness more target selections in the NumCl DO condition and fewer target selections in the NumCl IO condition, compared with the No NumCl condition. Finally, if children's knowledge of the double-object construction is tied to high-frequency verb items in the adult input, they should show more target selections for verbs of giving (e.g. *song* 'give' and *fa* 'distribute') than for the verbs of motion (e.g. *reng* 'throw' and *tui* 'push').

3.6. Results

The results in each condition are shown in Figure 2. Overall, 4-year-olds performed better than 3-year-olds. Descriptive analyses show that children performed best in the NumCl DO condition, followed by the No NumCl condition, and worst in the NumCl IO condition.

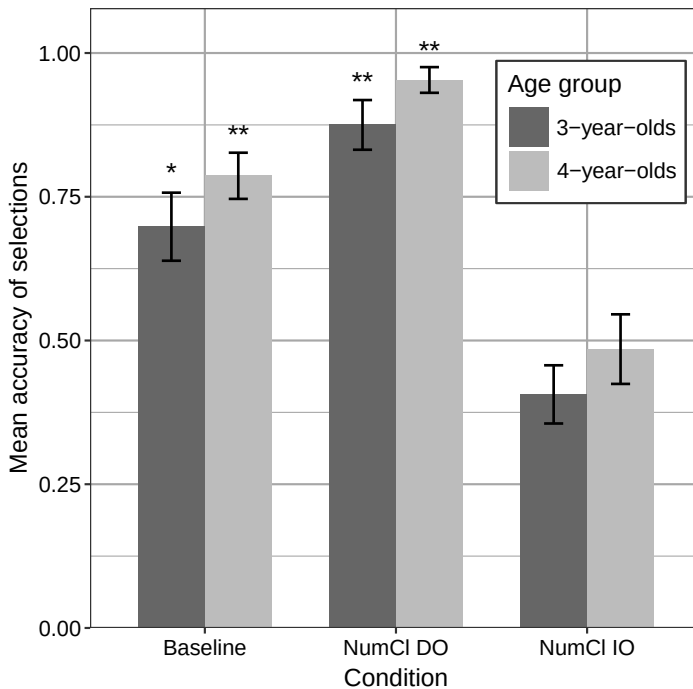


Figure 2. Mean accuracy and results of Wilcoxon signed-rank tests against chance level (error bars indicate SD; '*' for $p < 0.05$; '**' for $p < 0.001$)

To examine whether children could correctly interpret the double-object sentences in each condition, we compared the performance of each group with the chance level by using Wilcoxon signed-rank tests. The chance level was 50% since children made binary selections. Both 3- and 4-year-olds performed significantly above the chance level in the No NumCl condition (for 3-year-olds, $z=-2.087$, $p=0.037$; for 4-year-olds, $z=-3.968$, $p<0.001$), and both age groups in the NumCl DO condition (for 3-year-olds, $z=-4.085$, $p<0.001$; for 4-year-olds, $z=-4.400$, $p<0.001$). However, both 3- and 4-year-old children in the NumCl IO condition performed at chance level (for 3-year-olds, $z=-1.670$, $p=0.095$; for 4-year-olds, $z=-0.360$, $p=0.719$).

Then, the data were fitted to a generalized linear mixed model using the lme4 package in R. The fixed effects included Age (in days, standardized and centered), Verb Type (sum coding), Definiteness (sum coding), and all two- and three-way interactions. The random intercept of Participant was included as the only random effect. Other random effects such as the random intercept of Trial, the random slope of Participant, and the random slope of Trial were all removed because the model failed to converge or showed singular fits. Type III Wald chi-square tests associated with the final model revealed a main effect of Definiteness ($\chi^2(2)=75.646$, $p<0.001$), a main effect of Age ($\chi^2(1)=6.992$, $p=0.008$), but no other main or interaction effects were found ($p>0.05$ for all interaction effects; see Table 2). For Definiteness, post hoc comparisons (Tukey HSD, comparing estimated marginal means) revealed that accuracy differed significantly across all three conditions (No NumCl vs. NumCl DO: Estimate=-1.77, $SE=0.419$, $z=-4.232$, $p<0.001$; No NumCl vs. NumCl IO: Estimate=1.83, $SE=0.345$, $z=5.321$, $p<0.001$; NumCl DO vs. NumCl IO: Estimate=3.61, $SE=0.425$, $z=8.483$, $p<0.001$). Thus, differences across conditions reached statistical significance.

Table 2. Results of Type III Wald chi-square tests for fixed effects in the GLMM (indicates $p<0.05$)**

Fixed effect	χ^2	df	p -value
(Intercept)	80.068	1	<0.001*
Age	6.992	1	0.008*
Definiteness	75.646	2	<0.001*
Verb type	5.631	3	0.131
Age:Definiteness	0.921	2	0.631
Age:Verb type	4.108	3	0.250
Definiteness:Verb type	5.636	6	0.465
Age:Definiteness:Verb type	3.500	6	0.744

These findings confirmed our first prediction: children pointed significantly more to the target picture in the No NumCl condition. The second prediction was also confirmed: more on-target pointings were found in the NumCl DO condition, and less on-target pointings were found in the NumCl IO condition, compared with the No NumCl condition. However, our third prediction was not confirmed: we did not find more on-target pointings for the verbs of giving, compared with the verbs of motion.

4. Discussion

To fully acquire knowledge of double-object argument structure, children must establish the correct thematic-syntactic mapping of recipient and theme roles. This study examined Mandarin-speaking 3- to 4-year-old children's thematic assignment of the recipient and theme roles in comprehending double-object sentences. There were three important findings. First, the children correctly interpreted the double-object construction in the No NumCl condition. Second, the indefiniteness indicated by the NumCl form significantly influenced children's comprehension accuracy: their performance was facilitated when the direct object was marked by NumCl, while they performed worse when the indirect object was marked by NumCl. Third, children's performance was equally good for verbs of motion and verbs of giving, despite their different input frequencies.

Our findings suggest that Mandarin-speaking children have fully mastered the syntactic position of indirect and direct objects by the age of 3. Although previous studies using the video-verification task find that 3- to 6-year-olds have problems with the position of objects (Wang, 2017), findings from the current study adopting the picture-selection task indicate that 3-year-old children can correctly map the recipient and theme roles relying solely on syntactic positions in the No NumCl condition, where the indirect and direct objects share the same grammatical form and manifest similar semantic and pragmatic properties.

The results do not support the hypothesis that children's early knowledge of the double-object construction relies on the high-frequency, routinized lexical chunks. The first piece of evidence is that the test sentences in this study did not contain any pronominal items, which is usually considered part of item-specific structures, like *song(-gei) wo X* 'give me X', yet children could correctly comprehend the double-object sentences in the No NumCl condition in which both the indirect and direct objects were in the form of bare nouns. Over 80% of the indirect objects in the adult input are pronominal (Wu & Yang, 2024), but the indirect object in the form of bare nouns does not introduce difficulties in comprehension. In addition, there seems to be no input-frequency effect of verbs. As indicated earlier, adults seldom use the verbs of motion in the double-object frame (Wu & Yang, 2024), and children rarely spontaneously produce the double-object sentences with the verbs of motion (Zhang, Gao & Wang, 2018). Nevertheless, in our study, children's comprehension accuracy did not differ across the verb types. Together, such evidence suggests that 3-year-old children

have a general representation of the double-object construction that is not tied to specific lexical items.

The indefiniteness of object arguments significantly influenced our children's comprehension of the double-object construction. Their performance was significantly enhanced when the direct object took the indefinite NumCl form, while their comprehension accuracy was significantly reduced when the indirect object was marked by the NumCl. Before drawing the conclusion that children are sensitive to the indefiniteness associated with object arguments, we must rule out another theoretically possible explanation: children develop some task-specific strategies that are unrelated to syntactic structure. For instance, they may observe that in the adult input, NumCl-marked objects are more likely to refer to themes, and therefore assign the theme role to the character who was referred to by NumCl, regardless of the syntactic positions of objects. This explanation predicts that children should strongly prefer the non-target picture in the NumCl DO condition, where the indirect object was marked by NumCl. However, this prediction was not borne out. Children's selections in the NumCl IO condition were at chance level, supporting the interpretation that non-canonical semantic cues of indefiniteness obscure children's knowledge of the double-object construction. Thus, in line with findings from the experimental studies in English (Osgood & Zehler, 1981; Rowland & Noble, 2011; Conwell, 2019), our findings suggest that children are sensitive to the semantic and pragmatic properties associated with arguments. Our study thus further supports the view that the semantic and pragmatic cues can guide the learning of verb argument structure (Pinker, 1984; Becker, 2014; Lidz & Gagliardi, 2015).

5. Conclusion

The acquisition of the double-object construction requires children to map thematic roles to syntactic positions. The present study has investigated whether indefiniteness guides Mandarin-speaking children's interpretation of double-object sentences. Children interpret double-object sentences most accurately when the direct object is indefinite, and perform at chance when the indirect object is indefinite. These findings show that children are able to assign thematic roles based on indefiniteness, one of the semantic cues associated with arguments, and the non-canonical distribution of this cue obscures their interpretation. The pattern is the same across 3- and 4-year-olds, and across verb items, suggesting a robust mapping mechanism in young children. The study thus provides evidence that children's acquisition of argument structure is guided by language-universal semantic cues.

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