Young Chinese-speaking children's understanding of the correspondence between verb meaning and argument structure

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According to the syntactic bootstrapping theory, the sentence structure in which a verb appears is a useful cue to inferring its meaning (Gleitman, 1990), because argument structures roughly correspond to the types of verb meaning. For example, a verb that appears in a sentence with a single argument (e.g., "She came") typically describes a non-causative event, while a verb that appears in a sentence with two arguments (e.g., "She pushed him") is likely to refer to a causative event.

Previous research has reported that even young children use this knowledge about syntax-semantics correspondence to infer verb meanings. That is, young children map a verb that appears in a sentence with two arguments to a causative event as well as they map a verb in a sentence with one argument to a non-causative event (e.g., Naigles, 1990; Naigles & Lehrer, 2002; Lidz, Gleitman, & Gleitman, 2003). Is this because children are born with this abstract knowledge? Or do children acquire this knowledge by observing that verbs with similar meanings are likely to appear in similar constructions?

It is difficult to determine which is the case if we consider only data from English-speaking children. Because English does not allow argument-dropping, children learning English observe that a verb that appears in a sentence with one argument usually denotes a non-causative event and that a verb that appears in a sentence with two arguments typically describes a causative event. Thus, even if English-speaking children are sensitive to the correspondence between verb meaning and argument structure from very early on, we cannot tell whether they are born with such knowledge or they have learned it by observing the language input.

These two possibilities may be better investigated by examining whether Chinese-speaking children understand this syntax-semantic correspondence. Chinese allows argument-dropping: Subjects or objects, or even both, are frequently dropped in utterances. In describing the causative event in which a boy pushes a girl, for example, it is equally grammatical to say "The boy pushed" (dropping the object), "Pushed the girl" (dropping the subject), or "Pushed" (dropping the both) in Chinese. This pervasive ellipsis of arguments in Chinese would make it difficult for children to learn the

correspondence between verb meaning and argument structure from the input. Therefore, if Chinese children exhibit knowledge about the syntax-semantics correspondence from very early on, this would support the idea that such knowledge is universal and innate.

Lee and Naigles (2008) investigated whether Chinese-speaking children could infer verb meanings based on the structure of the sentence in which the verb appeared, using an act-out task. In their study, Chinese-speaking 2-year-olds in Singapore were presented with familiar verbs embedded in either transitive (NVN) or intransitive (NV) constructions, and were asked to enact the given sentence using a set of toy animals. The children were likely to manipulate one animal when they heard the verb in a sentence with one argument, while they were likely to manipulate two animals interactively when they heard the verb in a sentence with two arguments. It was striking that the children enacted the given sentences according to the number of arguments even when the sentence was ungrammatical. That is, when children heard a familiar intransitive verb in a sentence with two arguments like "Xiao3zhu1 qu4 shi1zi" ("The pig goes the lion"), they manipulated the two animals. Based on these findings, Lee and Naigles (2008) argued that the ability to use the number of arguments to infer verb meanings may be innate, rather than learned from the input.

There are three reasons, however, to be cautious in concluding from these results that Chinese-speaking children know the correspondence between the number of arguments and verb meanings from early on. First, in Lee and Naigles's (2008) study, all of the participants were Chinese-speaking children who lived in Singapore. It is well known that, in this country, English is recognized as an official language, as well as Malay, Chinese, and Tamil, and many citizens are bilingual or even trilingual. The participants tested by Lee and Naigles (2008) might already have had much exposure to English, even though they were from households in which Mandarin Chinese was mainly used. Such exposure to English might have led the children to easily learn the correspondence between the number of arguments and causativity of the described events.

Second, the act-out task might have overestimated Chinese-speaking children's knowledge, as pointed out by Goldberg (2004). In Lee and Naigles's task, if a child manipulated two animals, the response was likely to be coded as "causative." However, in actuality, a child who heard a familiar intransitive verb in a transitive sentence like "The pig goes the lion" might have simply picked up the two animals denoted in the sentence without knowing whether or not those two animals should interact.

Finally, the sentences used in Lee and Naigles (2008) contained the same

number of arguments as the number of nouns. For example, in an intransitive sentence such as "The pig goes," the number of arguments that appeared in the sentence is one (the pig), which is the same as the number of nouns that appear in the sentence. In a transitive sentence like "The pig goes the lion," there are two arguments (the pig, the lion) and two nouns (pig, lion). Even when children enacted a sentence with two arguments by manipulating two animals, it is not known whether they successfully mapped a sentence with two arguments to a causative event or they just picked up the animals that were referred to in the sentence.

The goal of the present study is to re-examine Chinese children's understanding of argument structures. We tested children who lived in China and heard only Chinese in their daily lives. We presented them with a novel verb in a transitive or intransitive construction, and asked them to select, from two test videos, the one that matched the given sentence. Both transitive and intransitive sentences contained the same number of nouns, for example, "The woman and the man are X-ing (a novel verb)" as an intransitive sentence versus "The woman is X-ing the man" as a transitive sentence. It is difficult to learn from Chinese input that a verb appearing in a sentence with a single argument denotes a non-causative event. Therefore, if the children are able to map a novel verb in an intransitive construction to a non-causative event as successfully as they map a novel verb in a transitive construction to a causative event, this is evidence that abstract knowledge about syntax-semantics correspondence is innate.

Method

Participants

Forty 2-year-olds (mean age = 30.1 months, range = 24-35 months, 18 boys and 22 girls), forty 3-year-olds (mean age = 41.5 months, range = 36-47 months, 22 boys and 18 girls) and forty 4-year-olds (mean age = 52.6 months, range = 48-59 months, 22 boys and 18 girls) participated in the study. All were native Chinese speakers and were from two kindergartens in Haiyan, Zhejiang Province, China. Within each age group, half of the children were assigned to the intransitive condition and the other half to the transitive condition. An additional 17 children were also tested, but were excluded from the final analyses due to position bias (14) or failure to complete the task (3).

Materials

Six sets of videos were used (Table 1). Each set consisted of two videos, one showing a non-causative event and the other showing a causative one. In the non-causative events,

a young woman and a young man performed the same repetitive action separately, side by side. In half of the six causative videos, a young woman made a man perform some action; while a man worked on a young woman in the other half (see Figure 1 for an example). Six monosyllabic nonsense words, "xia3," "kao2," "pa3," "de4," "mu1," and "tie2," were used as novel verbs. Ten college students agreed that all these words were meaningless in Mandarin Chinese.

Table 1 Stimulus materials used in the study.

| Set	Non-causative events	Causative events	Novel Verb
1	A woman and a man are swaying from side to side.	A woman is tugging at a man's hand.	xia3
2	A man and a woman are moving down and up by bending their knees.	A man is shaking a woman by the shoulder.	kao2
3	A man and a woman are twisting their torsos from side to side.	A man is making a woman bend down by holding her shoulders.	pa3
4	A woman and a man are bowing repeatedly.	A woman is patting a man on the shoulder.	de4
5	A woman and a man are swinging both of their arms up and down together.	A woman is turning a man's body in a circle.	mu1
6	A man and a woman are stamping their feet.	A man is making a woman wave her hand by taking her hand.	tie2
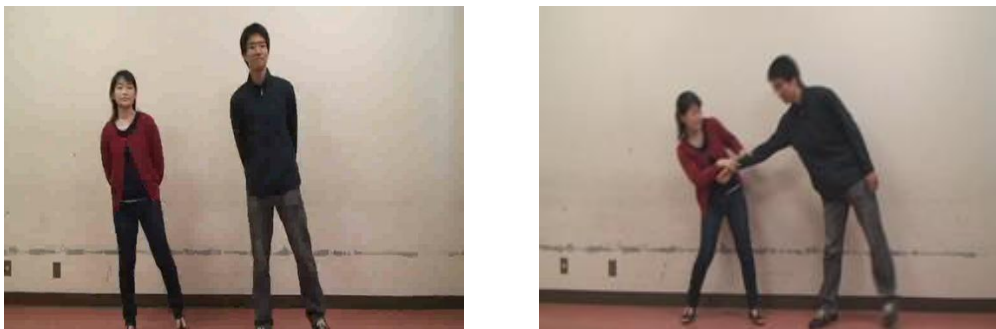
Figure1 A sample set of video events used in the study (Set 1)

Procedure

Children were tested individually in a room in the kindergartens they attended. The video stimuli were presented on a notebook computer using PowerPoint, and the linguistic stimuli were read aloud by the experimenter. Before beginning the test, the child received two warm-up trials in a fixed order.

After the warm-up trials, the child received six test trials. At the beginning of the test trials, the child was shown photographs of the young woman and man who would appear in all the video stimuli and was asked to call the woman "A1yi2" ("Auntie") and the man "Shu1shu" ("Uncle"). After it was confirmed that the child could name the woman and the man appropriately, the test trials began. In each trial, the child was shown two videos, one causative and the other non-causative, side-by-side, and was asked to point to the video that matched the presented sentence. Children in the intransitive condition heard a novel verb in a sentence with one argument such as "A1yi2 he2 shu1shu zai4 X" ("The woman and the man are X-ing"), while children in the transitive condition were presented with a novel verb in a sentence with two arguments such as "A1yi2 zai4 X shu1shu" ("The woman is X-ing the man"). In half of the six trials, children heard the noun *woman* first, as in the sentence "The woman and the man are X-ing" or "The woman is X-ing the man," while in the other three trials, they heard the word *man* first in the presented sentences. In three trials, the woman appeared to the left of the man in both videos, while in the other three trials she appeared to the right of the man.

Results

The selection of a causative event was scored as a causative response, The mean proportion of causative responses was calculated for each condition and each age group, as is shown in Figure 2.
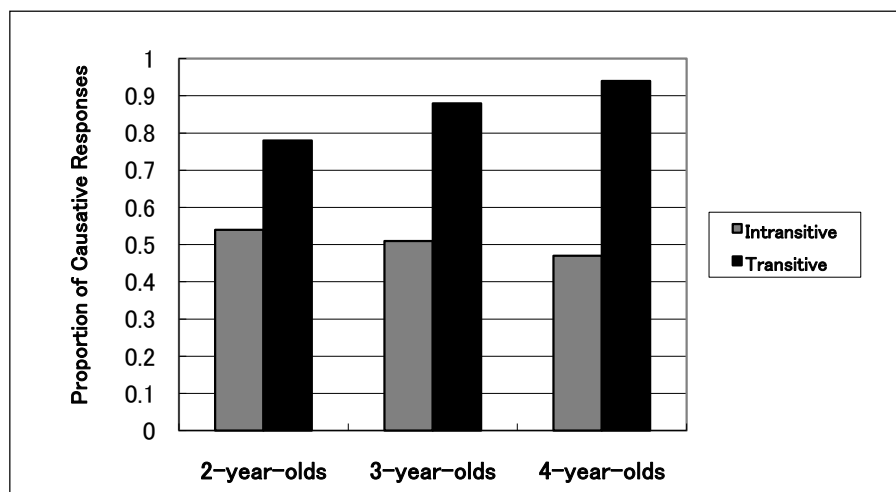

Figure 2 Mean proportions of causative responses

In order to examine whether the proportion of causative responses differed across condition and age group, a 2 (condition: intransitive or transitive) × 3 (age: 2-, 3-, or 4-year-old) ANOVA was conducted on proportion of causative responses. A reliable main effect was found for condition, $F(1,114) = 95.42$, $p < .01$, while the main effect of age was not significant, $F(2,114) = .47$, $p > .05$. The interaction between age and condition was also significant, $F(2,114) = 3.29$, $p < .05$. Post-hoc analyses revealed that the difference between the two conditions was significant for all the age groups (2-year-olds: $F(1,114) = 14.03$; 3-year-olds: $F(1,114) = 33.78$; 4-year-olds: $F(1,114) = 54.20$, all ps <.01). Thus, in all age groups, children selected causative events more frequently in the transitive condition than in the intransitive condition.

Next, we examined whether children in each condition chose causative events more often than expected by chance. In the transitive condition, the 2-, 3-, and 4-year-olds selected causative events 78%, 88%, and 94% of the time, respectively. Three t tests revealed that children of all age groups chose the causative event significantly more often than expected by chance ($t = 5.67$, $t = 11.14$, and $t = 17.67$, all ps < .001). In contrast, the 2-, 3-, and 4-year-old children in the intransitive condition chose causative events 54%, 51%, and 47% of the time, none of which differed from chance ($t = .84$, .17, and .59, respectively, all ps > .10).

Discussion

The results showed that Chinese-speaking children, even at the age of two, could map a novel verb that appeared in a sentence with two arguments to a causative event. In contrast, they were not willing to map a novel verb that appeared in a sentence with one argument to a non-causative event. These results seem to be consistent with the prediction that children learn the correspondence between verb meaning and argument structure from the input.

Chinese allows argument-dropping. A verb that appears in a sentence with a single argument does not always refer to a non-causative event, since the object may be dropped from an originally transitive sentence. Under such circumstances, children should have difficulty learning that a verb that appears in a sentence with one argument describes a non-causative event, and they should not be able to use such knowledge to infer the meaning of a novel verb. In contrast, when a verb appears in a sentence with two arguments, the verb is highly likely to describe a causative event. Through observation of the language input, Chinese-speaking children may have learned that a verb that appears with two arguments usually describes a causative

event, whereas they cannot tell whether a verb that appears in a sentence with only one argument describes a causative event or a non-causative event.

However, there is another possibility that should be considered before we conclude that knowledge about the correspondence between verb meanings and argument structure is learned from the input and is not innate. Children indeed may be born with abstract knowledge about the correspondence between verb meaning and argument structure, but experience with a particular language that permits argument-dropping may lead them to think that verbs appearing in a sentence with one argument should not always be mapped to a non-causative event. That is, children are born with abstract knowledge of argument structure. But, by the age of 2, Chinese children come to know that in Chinese a sentence with one argument does not always describe a non-causative event. In order to determine which possibility is the case, further research with younger Chinese children is needed.

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