THE EFFECT OF CROSSING DEPENDENCIES ON THE ACQUISITION OF PRONOUN COMPREHENSION

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1. Introduction

In the course of language acquisition, children interpret pronouns differently from adults. In some languages and ages, children incorrectly accept "*The girl and the fairy met, and then the girl drew her*" as describing the girl drawing herself. This pattern was termed "the Delay of Principle B Effect" (i.e., DPBE), referring to Principle B of Chomsky's Binding Principles (see (1), Chomsky, 1981).

(1) *Binding Principles* [1]
A: An anaphor is bound within its governing category.
B: A pronoun is free in its governing category.

The Binding Principles define the relations between the pronominal expression and its antecedent. Roughly speaking, they determine that a reflexive element such as 'herself' must find its antecedent in the local domain, whereas a pronoun cannot find its antecedent in the local domain.

The difficulty in establishing the relation between a pronoun and its antecedent was found to be affected by various factors: the syntactic structure in which the pronoun is incorporated (ECM or not, Baauw, 2002; Philip & Coopmans, 1996; Reinhart & Reuland, 1993; Ruigendijk et al., in press); the type of the antecedent (quantified or not, Chien & Wexler, 1990); the pragmatic properties of the task and the sentence (Conroy et al., 2009; Spenader, Smits, & Hendriks, 2009); the pace the stimuli were

[1] Where α is bound by β if β c-commands α and is co-indexed with it and γ is a governing category for α if and only if γ contains α, a governor for α, and an accessible subject. Governing category can be loosely defined as *local domain*, for a precise definition see Chomsky (1986; see Reinhart & Reuland, 1993 for discussion and extension).

presented (van Rij et al., 2009); and the availability of accidental coreference in the tested language (Conroy et al., 2009).

In the current study we examine the effect of the linear locality of the antecedent by testing the comprehension of pronouns and reflexives in sentences in which the dependency between the antecedent and the pronoun crosses or does not cross another NP.

1.1. Crossing dependencies

During the early stages of language acquisition, children have difficulties understanding sentences in which one argument crosses another argument of the same kind. In other words, when a dependency is established across another potential antecedent (Friedmann, Belletti & Rizzi, 2009; Friedmann & Costa, 2010). This difficulty can explain the relatively late acquisition of Wh-movement of the object in various structures: headed object relatives, in which the a full NP object crosses the subject that is also a full NP (see 2); *Which* object questions, in which the lexically restricted object crosses a full subject (3), and of object topicalization structures (Friedmann & Lavi, 2006) (4).

Crossing dependencies can also be the source for the difficulty in Wh-movement derived sentences in children with syntactic-SLI (Friedmann & Novogrodsky, 2004, 2007, in press), and children with hearing impairment (Friedmann & Szterman, 2006; Friedmann, Szterman, & Haddad-Hanna, this volume).

(2) The elephant that the boy washed __ .

(3) Which elephant did the boy wash ___ .

(4) This elephant, the boy washed ___ .

(5) The boy washed the elephant and __ smiled.

Other syntactic dependencies of empty categories, even without wh-movement, also show sensitivity to crossing dependencies. Friedmann and Costa (2010) found that in coordination structures (example 5), when an NP is linearly closer to the empty category than its antecedent (not necessarily in a c-command configuration), children encounter difficulty in establishing the dependency. Thus, not only Wh-movement dependencies, but also other dependencies that involve empty categories, are sensitive to crossing dependencies, namely, to the existence of another NP between the antecedent and the empty category.

In the current study we tested whether children's comprehension of pronouns is also affected by crossing dependencies, or whether crossing only affects dependencies that involve empty categories. To test this question we compared children's comprehension of sentences with pronouns in which the antecedent is linearly close to the pronoun, with sentences in which another NP, an improper antecedent, appears closer to the pronoun, between the antecedent and the pronoun. If an element linearly located between the pronoun and its antecedent causes difficulty, we expect that comprehension of the pronoun in sentences such as (6) and (7) will be harder than the comprehension of the pronoun in (8). The same should hold for the comprehension of reflexives. In subject relatives (8) the reflexive should be harder to comprehend than in sentences (6) and (7), because the antecedent of the reflexive is not local, because another NP intervenes between it and the reflexive pronoun.

(6) The **boy** and the penguin met and then the penguin soaped **him**/ himself.
(7) The **boy** said that the penguin soaped **him**/ himself.
(8) The penguin that washed the **boy** soaped **him**/himself.

2. Method

2.1. Participants

The participants were 54 Hebrew-speaking children aged 2;4-6;7 (M = 4;7, SD = 1;3), 28 girls and 26 boys, in 5 age groups: 2, 3, 4, 5, and 6-year olds, as shown in Table 1.

Table 1. Ages and number of participants in each age group

	n	Age range	Mean age (SD)
2 year olds	7	2;4-2;11	2;8 (0;3)
3 year olds	12	3;0-3;9	3;5 (0;3)
4 year olds	11	4;1-4;10	4;7 (0;3)
5 year olds	14	5;0-5;10	5;5 (0;3)
6 year olds	10	6;0-6;7	6;4 (0;2)

2.2. Materials

Comprehension was tested using a picture selection task. The test included 72 sentences, randomly ordered: half included a pronoun and half a reflexive. Three types of sentences were presented: 24 were coordinated

sentences (9), 24 were subordination sentences with a sentential complement (10), and 24 were subject relatives (11). Thus, for the *pronoun condition* (in bold in examples 9-11), there were two sentence types in which the antecedent was not the closest NP linearly (the coordination and subordination conditions, examples 9 and 10), and one condition, the subject relative condition (11), in which the pronoun was linearly close to its antecedent. For the *reflexives* (marked with underline in 9-11), the conditions were reversed: the antecedent was linearly close in the coordinated and subordinated sentences, whereas the subject relative condition included an NP intervening between the antecedent and the reflexive, namely, a crossing dependency.

(9) Ha-dov ve-ha-**yeled** nifgeshu, ve-az ha-yeled sarat **oto**/et acmo
The-boy and-the-bear met and-then the-boy scratched ACC-him/himself
The boy and the bear met, and then the boy scratched him/himself.

(10) Ha-**yeled** siper she-ha-pinguin siben **oto**/et acmo
The-boy told that-the-penguin soaped ACC-him/ himself
The boy said that the penguin soaped him/himself.

(11) Ha-yalda she-pagsha et ha-**safta** cavta **ota**/et acma
The-girl that-met the-grandma pinched ACC-her/ herself
The girl that met the grandmother pinched her/herself.

Each sentence was presented together with two color pictures on one page (Fig. 1). In each page the same two figures appeared twice. In one picture a transitive action took place, with one figure acting on the other figure. In the other picture, the same action took place reflexively – the same figure acted on itself, and the other figure just stood there, watching.

Fig. 1. An example of a picture pair used

2.3. Procedure

The children were tested individually in a quiet room. The sentences were read by a native speaker of Hebrew in a neutral intonation while the two pictures were in front of the child. The child was asked to point to the picture that matched the sentence. The sentences were presented without time limitation. If the child changed her response, only the final answer was included in the calculation. A practice trial was given before the test.

3. Results

The results indicated that Hebrew speaking children show a delay in the acquisition of pronoun comprehension. They understand reflexives from age 4, but still misinterpert pronouns until the age of 6. Importantly, the results showed that the comprehension of pronouns was crucially modulated by crossing dependencies. Namely, before pronoun interpretation is fully acquired, when they do not know what the syntactically correct antecedent is, they often select the NP that is linearly closest to the pronoun as the antecedent. As a result, they select incorrect antecedents more often in cases of crossing dependencies, than when the correct antecedent is linearly closest to the pronoun.

3.1. Pronouns

Before the age of six, the children's performance on pronouns was below 80% in each of the sentence types (Fig. 2 and Table 2). Their performance on subject relatives (no crossing dependency) was significantly better than their performance on sentences with crossing dependencies, coordination sentences, $t(53) = 4.60$, $p < .001$, and better than on sentential complements, $t(53) = 3.54$, $p < .001$. It was also significantly better than both crossing dependency structures together, $t(53) = 4.71$, $p < .001$. As shown in Fig. 2 and Table 2, the children preformed better on sentences in which no NP intervened between the antecedent and the pronoun, than on sentences with crossing depndencies in each of the five age groups. This difference was significant in 4 of the 5 age groups, from age 3.

There was no significant difference between the participants' performance on the two crossing dependencies conditions (coordination and subordination), either at the whole group level, $t(53) = 0.77$, $p = .45$, or at each age group seperatly, $t < 1.43$, $p > .18$. Therefore, the two sentence types with crossing dependency (coordination and subordination) are presented together in Tables 2 and 3.

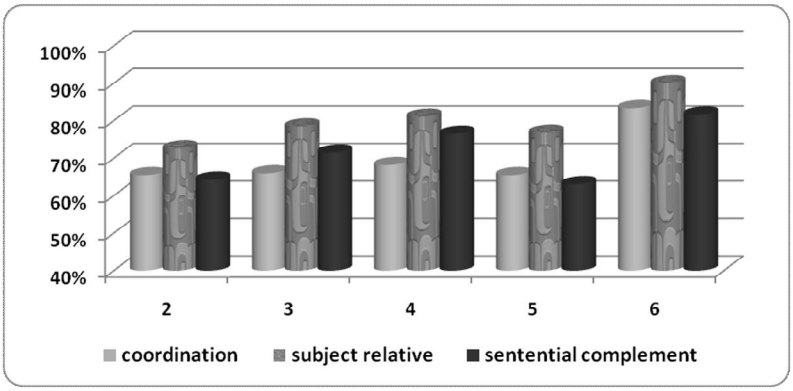

Fig. 2. Pronoun comprehension in the three sentence types tested

Table 2: Percentage of correct responces on structures with and without crossing dependencies

	Pronouns			Reflexives		
Age	Close antecedent	Crossing dependency	Comparison	Close antecedent	Crossing dependency	Comparison
2	73%	65%	$t(6)=1.16$, $p=.14$	60%	58%	$t(6)=0.11$, $p=.46$
3	79%	69%	$t(11)=1.89$, $p=.04$	75%	72%	$t(11)=0.45$, $p=.33$
4	81%	72%	$t(10)=1.82$, $p=.05$	90%	91%	$t(10)=0.27$, $p=.40$
5	77%	64%	$t(13)=3.63$, $p=.002$	87%	93%	$t(13)=2.30$, $p=.02$
6	90%	83%	$t(9)=1.78$, $p=.05$	93%	96%	$t(9)=1.34$, $p=.11$

3.2. Reflexives

The children performed above 80% correct in all three types of sentences from the age of four, as shown in Figure 3. In contrast to the pronoun findings, we did not find significant differences between the subject relatives, in which an NP intervened between the antecedent and the reflexive, and coordinated and subordinated sentences, in which the correct antecedent was the closest to the reflexive. The only significant difference between sentence types in the reflexive condition was found in the 5 year old group, who performed significantly poorer on the crossing dependency condition (subject relatives) than in the two other structures (compared seperatly and combined, p = .02). Thus, the effect of the crossing dependencies on the comprehension of reflexives is much milder than on pronouns.

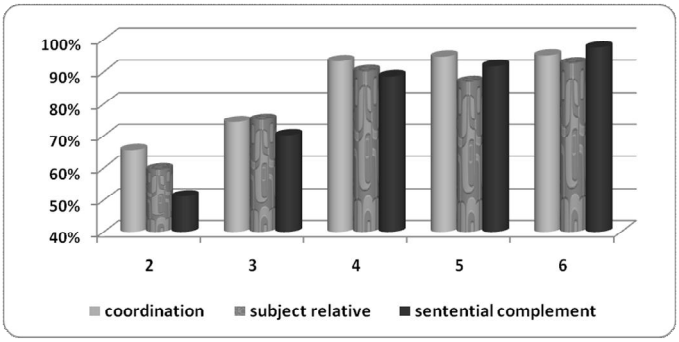

Fig. 3. The comprehension of reflexives in the three sentence types tested

The differntial effect of crossing dependencies on the interpertation of pronouns and reflexives can also be seen in the number of children who performed at chance level in the various conditions (see Table 3). When interperting reflexives, none of the children above the age of 4 performed at chance in the close antecedent condition (subject relatives). Even on the sentences with crossing dependencies, only 3/35 children performed at chance. The performance of the younger children (aged 2-3) was similar for the close condition and the crossing dependency condition (Table 3).

Completely different results were found in the pronoun conditions, where even some six years old children performed at chance level. Whereas in sentences in which there was no intervention only 12 of all the children performed at chance level, in the crossing dependency conditions 23 of the children performed at chance.

Table 3. The number of children who performed at chance level on structures with and without crossing dependencies

Age	n	Pronouns		Reflexives	
		Close antecedent	Crossing dependency	Close antecedent	Crossing dependency
2	7	2	4	4	5
3	12	2	6	4	4
4	11	2	3	0	1
5	14	5	7	0	2
6	10	1	3	0	0
Total	**54**	**12**	**23**	**8**	**12**

4. Discussion

The results show that pronoun acquisition is delayed in Hebrew, as was found in many other languages (e.g., Jakubowicz, 1984; Chien & Wexler, 1990 and Wexler & Chien, 1985 on English; Koster, 1993; Philip & Coopmans, 1996; Ruigendijk et al., 2004, in press; and Zuckerman et al., 2002 on Dutch; Sigurjónsdóttir & Hyams, 1992 on Icelandic). Children acquiring Hebrew begin to understand pronouns only when they are 6 years old. Before this age they sometimes choose an incorrect antecedent that creates a reflexive reading of the pronoun. The comprehension of reflexives is acquired by Hebrew speaking children already by age 4. Symmetrical pattern of acquisition were found also in production of pronouns and reflexives of these children, with production of pronouns in reflexive conditions (Ruigendijk, Friedmann, Novogrodsky, & Balaban, in press).

The new important finding of the current research is that before children acquire the comprehension of pronouns, they allow the NP that is linearly closer to the pronoun to act as the antecedent. Therefore, they understand better sentences in which the NP that is closest to the pronoun is its proper antecedent than sentences in which another NP is placed between the pronoun and its antecedent. Importantly, we can conclude that it is not the case that children do not use syntactic principles and select the close local antecedent in all cases. Rather, it seems they use syntactic principles as much as their language development allows them. Before the ability is fully acquired, they sometimes select an antecedent according to other considerations, among them, as we see in the current study, the linear proximity of the NP to the pronoun. Their performance on reflexives shows that once a the syntactic knowledge is acquired, the effect of crossing dependencies is reduced. (The performance at the age of five is an exception to this conclusion, as it demonstrated the effect of crossing dependency for reflexives).

Some accounts ascribe the difficulties children show in some pronoun comprehension tasks to the pragmatic properties of the sentences, and specifically, to topicality considerations (Spenader et al., 2009). The current study included two sentences with similar topicality structure (the sentential complements sentences and the subject relatives), on which the children showed different performance, and the topic was not always the referent preferred for pronominalization.

Thus, The results of this study add to the undertanding of the factors that affect pronoun interpertation in language acquisition. They show that crossing dependencies form a crucial factor in pronoun comprehension.

To summarize, we found that in Hebrew, like in several other

languages, the acquisition of pronoun comprehension is delayed and emerges two years later than reflexives. Within this developmental stage, crossing dependencies clearly affect performance, and modulate the selection of an antecedent for the pronoun. Thus, like in Wh-movement and other empty categories, the existence of a linearly intervening NP within a dependency impairs comprehension.

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