Acquisition of Constraints on Forward Coreference

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1 Introduction: Models of Condition C Acquisition

Binding Theory, which handles the interpretation of NPs under various locality conditions, represents a major segment of our adult knowledge of language. In particular, Binding Condition C, given in (1), is generally taken to entail that an *R-expression* (referring expression, or full NP) cannot be *bound* by (c-commanded by and coindexed with) a pronoun, where c-command can be defined as in (2).

(1) An R-expression is free (Chomsky 1986).
(2) *C-command*: Node A c-commands node B iff the first branching node above A dominates B and neither A nor B dominates the other (Reinhart 1976).

Condition C yields the contrast in (3).

(3) a. Max$_i$ said that he$_i$ loved Paris.
    b. *He$_i$ said that Max$_i$ loved Paris.
    c. Before he$_i$ went to Rome, Max$_i$ visited Paris.

It has been noted (Carden 1986, Ingram 1989, O'Grady 1997, Taylor-Browne 1983) that full development of Condition C may unfold over the course of a number of years. Carol Chomsky (1969) detailed an acquisition sequence for Condition C that included a first stage in which no syntactic constraint was observed, with the child permitting any full NP to serve as antecedent to a pronoun in the same sentence. At about 3 or 4 years of age, the child showed a linear order sensitivity, such that a pronoun could not precede its antecedent. A third stage appeared at about 5 or 6 years: A pronoun now could not precede its antecedent unless it occupied a syntactically subordinate position, yielding the contrast between good backward coreference examples like (3c) and blocked backward examples like (3b). At this third stage, a pronoun could always follow its antecedent, so that the forward coreference in (3a) would always be possible. Achievement of this third developmental stage in the acquisition of Condition C reflected a sensitivity to the structural relation of c-command and permitted the child to produce adultlike judgments on sentences like (3a–c).

The full adult system, however, does not appear until later; in particular, constraints on forward coreference are relatively slow to emerge. Thus, although the backward coreference in an example like (4a) is generally accepted at the third developmental stage, the forward coreference in (4b) is not blocked until age 8 or later (cf. Taylor-Browne 1983).

(4) a. Near him$_i$, Max$_i$ saw a guitar.
b. *Near Max$_i$, he$_i$ saw a guitar.

What triggers the rejection of an apparent precedence constraint (forward coreference is always good) in favor of an order-neutral structural constraint (a pronoun cannot be structurally superior to its antecedent, even if it follows that antecedent within a sentence)? Under a stage-based model like that of Carol Chomsky, the child simply abandons his precedence principle, so that Condition C structures are now limited only by the c-command constraint; the adult system follows from this adjustment to the third stage of the child's grammar. Others (e.g., Crain and McKee 1986; Lust, Eisele, and Mazuka 1992) have observed continuity in development, with earlier sensitivity to a surface-level c-command constraint than had been observed by Chomsky. Carden (1986), however, approached continuity from a different perspective, proposing that the adult analyses of (4a) and (4b) refer to hierarchical relations within a clause at an abstract (reconstructed) level, as illustrated in (5).

(5) a. [PP Near him$_i$]$_j$, Max$_i$ saw a guitar t_j. → Max$_i$ saw a guitar near him$_i$.
b. *[PP Near Max$_i$]$_j$, he$_i$ saw a guitar t_j. → *He$_i$ saw a guitar near Max$_i$.

Under Carden's proposal, it is the gradual schedule of developing capacity to manage multiple levels of representation in the calculation of NP reference that constrains acquisition of blocked forward coreference.

Although the stage-based model and the early acquisition model differ implicationally with respect to continuity in development, they share the assumption that the adult constraint on pronominal reference involves a surface application of c-command. Here Carden drew on developmental facts (earlier acquisition of the good-blocked backward contrast, substantially later acquisition of the good-blocked forward contrast) to argue that the adult grammar consults a more abstract syntactic level in pronoun interpretation.

How can we distinguish between the various proposals: Does a directionality constraint delay the acquisition of blocked forward type (4b), or is acquisition of the good-blocked forward contrast inhibited by the more ad-

vanced processing demands of an example like (4b)? We can test for the presence of an independent precedence constraint via another blocked forward coreference structure, that of the control example (6a), structured as in (6b):

(6) a. *Discovering that Max$_i$ could play the harmonica pleased him$_i$.
b. *[$_{IP}$ PRO$_i$ discovering that [$_{IP}$ Max$_i$ could play the harmonica] pleased him$_i$].

Forward coreference in (6) is blocked in the adult grammar under Condition C: Although the pronoun *him* does not c-command coindexed *Max*, the PRO subject of *discovering* binds *Max*, so that the latter R-expression is not free. Developmental abandonment of a precedence principle in favor of a c-command constraint applied at S-structure should result in contemporaneous recognition of the blocked forward coreference in (4b) and that in (6). If, on the other hand, mastery of the constraint on forward coreference in (4b) depends on ability to handle multiple representational levels in NP interpretation, there is no necessary simultaneity in the emergence of blocked coreference in that example and in (6) (where interpretation depends on access to complex but different grammar principles). Note a crucial difference between (4b) and (6): A c-command constraint applied at S-structure can (under an appropriate attachment of the preposed PP) yield the adult judgment for (4b), without reference to an abstract structure. But attention only to the surface relationship between *Max* and *him* in (6), without consideration of control facts, will yield the wrong coreference interpretation.

2 The Study

In this study, twenty 9- to 14-year-olds were tested on good and blocked backward and forward coreference structures. Each participant judged two blocked backward, two blocked forward, two good backward, and two good forward coreference structures. In addition, participants were given a non-preposed-PP example and a control example. An interview technique was utilized: A brief passage introduced two characters, with text controlled for topicality. After presentation of a target sentence containing a pronoun, a text-based question invited the participant to select all possible antecedents. Texts were read with participants, who were instructed to answer each question in as many ways as possible. Each stimulus sentence presented to a participant was based on a different text. (7) gives a sample text; (8) illustrates ten target structures.

(7) Jill and Paula turned the rusty door knob. Paula told Jill that the house was spooky.

(8) a. *Blocked Backward 1* (BB1)
She saw that Jill had gone too far.
- Who saw it? (Paula, Jill, someone else)

b. *Blocked Backward 2* (BB2)
She stood back after Jill pushed open the creaking door.
- Who stood back? (Paula, Jill, someone else)

c. *Blocked Forward 1* (BF1)
Near Jill, she saw a long spider web.
- Who saw a long spider web? (Paula, Jill, someone else)

d. *Blocked Forward 2* (BF2)
Realizing that Jill had stepped into a haunted house scared her.
- Scared who? (Paula, Jill, someone else)

e. *Good Backward 1* (GB1)
Near her, Jill saw a long spider web.
- Near who? (Paula, Jill, someone else)

f. *Good Backward 2* (GB2)
Realizing that she had stepped into a haunted house scared Jill.
- Realizing that who had stepped into a haunted house?
(Paula, Jill, someone else)

g. *Good Forward 1* (GF1)
Jill saw that she had gone too far.
- Who had gone too far? (Paula, Jill, someone else)

h. *Good Forward 2* (GF2)
After Jill pushed open the creaking door, she stood back.
- Who stood back? (Paula, Jill, someone else)

i. *Good Forward: Nonpreposed PP*
Jill saw a long spider web near her.
- Near who? (Paula, Jill, someone else)

j. *Control Structure*
Realizing that Paula had stepped into a haunted house scared Jill.
- Who realized it? (Paula, Jill, someone else)

3 Results

Results are given for the full group and for two age subgroups: 9 years to 11 years, and 12 years to 14 years. Table 1 displays percent coreferent responses on two blocked backward, two blocked forward, two good backward, and two good forward coreference structures.

Group	BB1	BB2	BF1	BF2	GB1	GB2	GF1	GF2
9-14 n=20	5	20	35	65	80	95	100	95
9-11 n=14	7.1	21.4	35.7	71.4	71.4	100	100	100
12-14 n=6	0	16.7	33.3	50	100	83.3	100	83.3

Table 1. Percent coreferent responses

The results displayed in Table 1 are consistent with results on good and blocked coreference structures reported for this age group in the literature (e.g., Taylor-Browne 1983): good forward coreference structures elicited a high percentage of possible coreference judgments, and good backward structures lagged only slightly behind. Coreferent responses on blocked backward structures like (8a) and (8b) (BB1 and BB2) were reduced, particularly on BB1 and in the older (12–14 years) group. Consistent as well with other results was the elevation in coreferent responses on the preposed-PP blocked forward structure (BF1). As in other studies, the contrast in coreferent responses on good and blocked structures was greater in backward than in forward anaphora, due to the incomplete mastery of blocked forward coreference (cf. Carden 1986).

Untested in previous studies was the control-type blocked forward structure (BF2). Coreferent responses on this structure were, at 65%, at a substantially higher level than on the preposed-PP blocked forward structure.

4 Discussion

Results in this study show a delay in the acquisition of blocked forward coreference in the preposed-PP structure (BF1). The observation that the coreferent response level was even higher on the control-type blocked forward structure (BF2) might, prima facie, be construed as support for a persistent precedence constraint inhibiting the acquisition of blocked forward coreference. Closer inspection of within-subject responses, however, reveals that few individuals followed a *forwards-is-always-good* rule. Of those participants who did not display target grammar judgments of blocked coreference on BF1 and BF2, six permitted a coreferent interpretation on both types of blocked forward, but eight permitted coreference on only one.

Consider now the control structures (8d) and (8f), repeated as (9a–b):

(9) a. *[$_{IP}$ PRO$_i$ realizing that [$_{IP}$ Jill$_i$ had stepped into a haunted house] scared her$_i$].

b. [$_{IP}$ PRO$_i$ realizing that [$_{IP}$ she$_i$ had stepped into a haunted house] scared Jill$_i$].

Apprehension of control facts in (9a) (cf. (8d)) is necessary to a blocked forward coreference judgment: it is not the pronoun *her* in that example but PRO, controlled by and coindexed with *her*, that c-commands coindexed *Jill*, in violation of Condition C. Interpretation motivated simply by the S-structure relationship between the pronoun and the full NP *Jill* gives the wrong results. Acknowledgment of control might play a different role, however, in the assessment of good backward (9b) (cf. (8f)): In this case, the absence of S-structure c-command of *Jill* by *she* yields the target judgment of possible coreference.

Consider next the preposed-PP types (8c) and (8e), repeated as (10a–b):

(10) a. *[$_{PP}$ Near Jill$_i$]$_j$, she$_i$ saw a long spider web t_j.

b. [$_{PP}$ Near her$_i$]$_j$, Jill$_i$ saw a long spider web t_j.

As in the case of good backward (9b), the coreference in good backward (10b) might be accepted on the basis of surface syntax: the pronoun does not c-command the coindexed R-expression at S-structure. An assessment considering only the S-structure relationship between the pronoun and *Jill* could also yield correct results on blocked forward (10a) (given appropriate attachment of the preposed PP), but we saw that it would yield incorrect results on blocked forward (9a) if control facts were not registered. How did individual participants behave? Table 2 displays four response patterns on blocked forward coreference structures BF1 and BF2:

	BF1 (preposed PP)	BF2 (control structure)
Group 1 (n=6)	noncoreferent	noncoreferent
Group 2 (n=6)	coreferent	coreferent
Group 3 (n=7)	noncoreferent	coreferent
Group 4 (n=1)	coreferent	noncoreferent

Table 2: Response patterns on blocked forward structures

As noted by Carden (1986), the thorough mastery at an earlier point of the good-blocked backward anaphora contrast would not be predicted if a persistent preference for forward anaphora delayed the acquisition of blocked forward coreference: We would not expect good backward coreference to be

recognized. Existence of a general precedence constraint on the part of participants is unsupported, moreover, by the present data; participants who had not acquired the target adult grammar permitted forward coreference in both BF1 and BF2 in less than 50% of cases (Group 2). How did the other participants behave? We see that 50% (7 individuals) of those participants who did not show the target grammar judgments of noncoreference on both blocked forward types were noncoreferent on the preposed-PP type but coreferent on the control type, a response pattern that, we saw, might be arrived at via S-structure application of a c-command constraint in both cases, without attention to control facts in assessing BF2.

It might be asked at this point why one might not propose a developmental sequence based on the response distribution for BF1 and BF2 displayed in Table 2, with Group 2 representing a *forwards-is-always-good* stage, Group 3 representing the stage at which a c-command constraint on backward and forward coreference has been acquired but control facts are not integrated in interpretation, and Group 1 representing the target adult stage, with control facts accounted for in the interpretation of nominal reference. Such a proposal is undermined by the following considerations: First, there is no developmental evidence in these data for a *forwards-is-always-good* principle, insofar as 29% of the younger participants but 33% of the older group showed this response pattern. Second, we continue in the present results to see an apparent S-structure c-command constraint applied to backward coreference before it is applied to forward cases. Insofar as there is no evidence for a consistent directionality preference, we would expect an S-structure c-command constraint, once acquired, to show order-neutral application. Third, results on stimuli like (8j) showed 80% of the participants displaying target grammar control assignment. The discrepancy between target grammar response level on structure type (8j) and that on structure type (8d), where control facts needed to be integrated with Binding Theory knowledge, points to a processing challenge as explanation for participants' limited success on the control-type blocked-forward stimuli. Thus the balanced distribution of participants between Groups 2 and 3 may indicate that those who had not yet acquired the target grammar were either selecting a fallback strategy or guessing under excessive processing load (cf. Grodzinsky and Reinhart 1993). Fallback strategies would include resort to permissiveness in the case of forward coreference, leading to the Group 2 profile; or decision based only on S-structure c-command without attention to either abstract structure or control facts, producing the Group 3 profile. A fourth motivation for a processing account of the delayed acquisition of blocked forward coreference involves the depth-of-embedding effect displayed in (11a–b):

(11) a. (= (4a)) *Near Max$_i$, he$_i$ saw a guitar.
b. Near the woman Max$_i$ loved, he$_i$ saw a guitar.

Although we saw that both the blocked forward and the good backward preposed-PP structures might be interpreted appropriately on an S-structure c-command analysis, the presence of contrasts like (11a–b) lends further support to the proposal that the mature grammar processes preposed-PP structures on an abstract (reconstructed) interpretation (cf. Carden 1986). The possible coreference in (11b), in contradistinction to the blocked coreference in an example like (11a), suggests that clausemate status of the pronoun-antecedent pair on a reconstructed representation plays a crucial role in pronominal interpretation. The contrast between (11a) and (11b) cannot be predicted on the basis of S-structure c-command but can be derived via appeal to reconstruction in the clausemate case.

The response distribution on the control-type and preposed-PP blocked forward structures is consistent with the proposal that in the adult grammar, both blocked forward structures are more demanding from a processing perspective. Both require that the language user integrate grammar strands: The control blocked forward structure requires that two separate grammar modules (Control Theory and Binding Theory) be consulted as the target grammar interpretation is derived; and assessment of the preposed-PP blocked forward structure references an additional, abstract structural level.

5 Conclusions

Studies of Condition C acquisition have shown that constraints on forward coreference are relatively slow to emerge. Review of Condition C acquisition studies suggested examination of an additional blocked forward coreference structure in order to test for the presence of a persistent directionality preference, with concomitant reluctance to block forward coreference. Results in this study showed responses on structure types (good and blocked backward, good and blocked forward) that were consistent with those appearing in the literature, revealing an outstanding delay in the acquisition of the good-blocked forward coreference contrast, relative to the backward coreference contrast. Coreferent responses on the second blocked forward coreference structure were at an even higher level than were coreferent responses on the preposed-PP structure. Crucially, however, inspection of participant response patterns did not show the two blocked forward structures treated similarly by individuals. Response patterns instead suggested processing complexity as a source of delay in the mastery of blocked forward coreference; thus the preposed-PP blocked forward structure references an abstract representational level (with reconstruction in the target grammar), and the control structure is

assessed on a single representational level but calls for the integration of information from two grammar modules: Control Theory and Binding Theory.

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