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Authors	Lust, B.;Mangione, L.
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The Principal Branching Direction Parameter
in First Language Acquisition of Anaphora¹

B. Lust
L. Mangione

Cornell University

Much current work is concerned with the definition of principles of Universal Grammar, in particular with principles which characterize and constrain the domains of well-formed anaphoric relations (Chomsky, 1982, 1981). These principles are theorized to play a crucial role in first language acquisition.

This paper reports critical results from a series of empirical studies of first language acquisition of anaphora in several radically different languages. These data provide crucial support for positing a parameter which constrains the form of anaphora in natural language. On the basis of this parameter, it is argued that the acquisition of anaphora cannot be accounted for in terms of general cognitive principles of linearity, but must make reference to specifically linguistic structure-dependent principles. It is also argued that this parameter contributes to the resolution of several issues regarding the correct characterization of binding principles in the current theory of Universal Grammar.

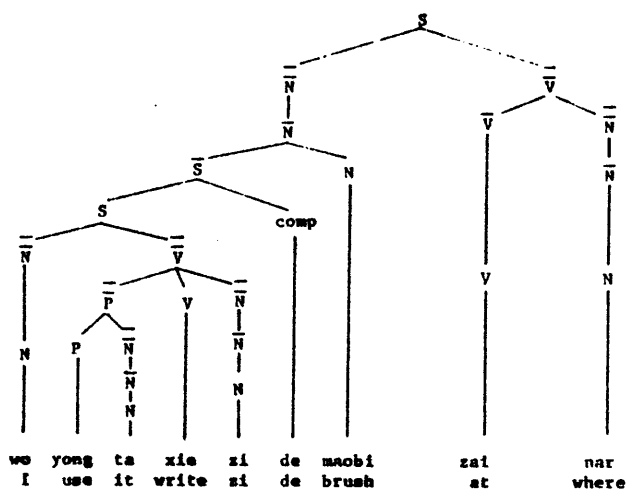
Within Government and Binding theory, three categories of nominal expressions have been posited, where for each category (anaphors, pronominals and 'r' expressions), distinct binding principles have been assigned to account for the behavior of these categories in their structurally defined domains. Within these domains, pronominals and r-expressions have been characterized as free, while anaphors have been characterized as bound.

Cross-linguistic analyses however show that characterization of free and bound anaphora in terms of such category membership is not universally adequate. For example, 1 shows that resumptive pronouns in a class of relative clauses of Chinese are obligatorily controlled by the head of the relative clause and thus bound. Example 2 shows (for Japanese) that phonetically null pronominals frequently behave as free pronouns do in English.

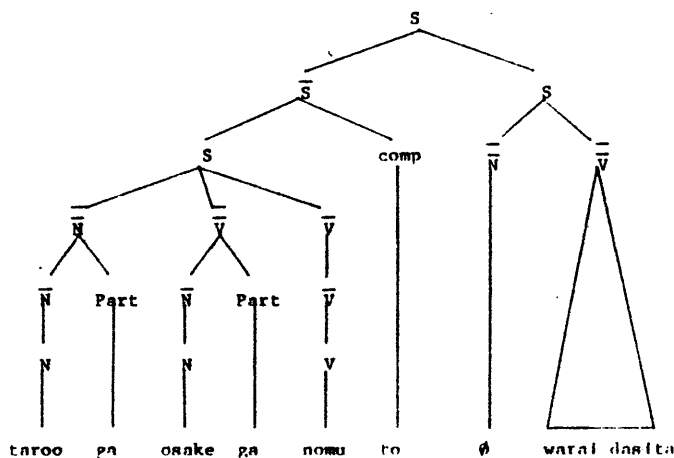
1. (a) wǒ yòng tā xiě zìde máobi zài nǎr?
 I use it write character de brush at here
 'Where is the brush with which I write characters?'
- (b) wǒmen bǎ tā kànzuò lǎoshi de nèige rén zǒu le
 we ba (s)he consider teacher de that-M person leave asp
 'The person we consider to be a teacher left'
2. Taroo ga osake o nomu to, Ø warau
 Taroo subj sake obj drink when Ø laugh
 'When Taroo_i drinks sake, he_{i,j} laughs'

For both examples 1 and 2, it is not possible to characterize bound and free anaphora in terms of nominal category membership. It is possible, however, to characterize this distinction in terms of the structural configurations in which members of the various nominal categories occur. As 3 shows, the bound anaphora in 1 involves a configurational structure in which the antecedent constitutes the head of the phrase structure in which the anaphor is located. In contrast, as 4 shows, the potential antecedent of the free anaphor in 2 does not constitute the head of the structure dominated by the highest S.²

3 (1a)



4. (2)



Theory of this paper

Since characterization in terms of category membership is inadequate to provide a universal categorization of the behavior of anaphoric nominals, we will investigate the first language acquisition of anaphora by children within a framework which makes crucial use of this structural characterization. This investigation is conducted within the general framework of X-bar theory, where for our purposes X-bar theory abstractly specifies dominance in head-complement relations. It is these relations which crucially distinguish the structures in 3 and 4, and which distinguish bound and free anaphora in these cases.

A second property of X-bar theory which is crucial to our investigation of anaphora is recursion. As is well-known, recursion leads to two types of branching direction. 5a gives the PS rule for a RB structure in which a complement beta is generated to the right of a head X, where beta is some category which can dominate X-bar. 5b gives the rule for a LB structure in which the complement beta is generated to the left of a head X. Although we will not go into the details here, we allow the value of X in 5 to range beyond the lexical categories in order to include constituents in structural configurations which mirror typical X-bar head-complement relations.

5. a $\bar{X} \rightarrow X \beta$
 b $\bar{X} \rightarrow \beta X$
 (where β is some category which can dominate \bar{X})

PBD parameter

Individual languages can be characterized as having what we call a "Principal Branching Direction" as Right or Left, in the case where BD holds consistently over major recursive structures in the language. Six shows our working definition of PBD.

6. 'Principal Branching Direction' (PBD)

PBD refers to the branching direction which holds consistently in unmarked form over major recursive structures of a language, where "major recursive structures" are defined to include relative clause formation of complex NP, adverbial subordinate clause, and sentential complementation.

We hypothesize that PBD is a member of the set of parameters provided by UG, with values to be set as L or R in individual languages. We hypothesize that this parameter constrains the first language acquisition of anaphora, as stated in 7.

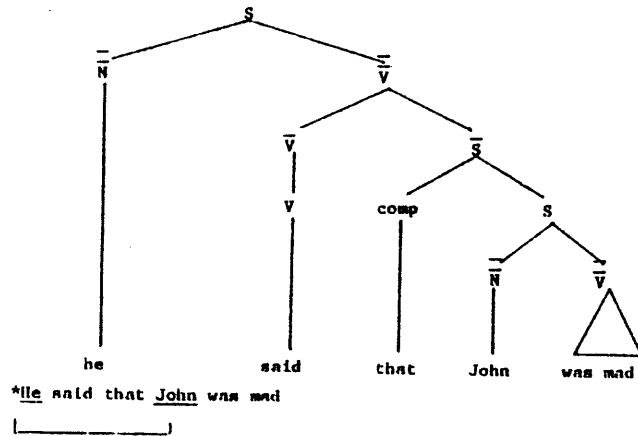
7. Constraint on Anaphora

In early child language, the direction of grammatical anaphora accords with the Principal Branching Direction (PBD) of the specific language being acquired. Anaphora is constrained forward in a principally right-branching language. It is constrained backward in a principally left-branching language.

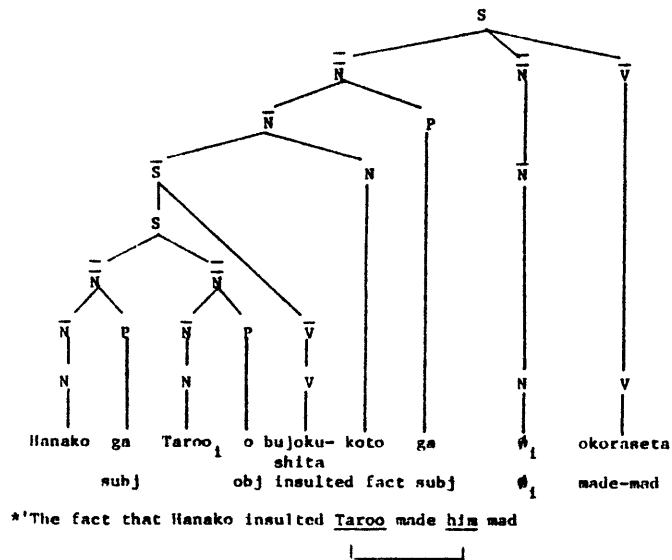
Specifically we hypothesize that the acquisition of both free and bound anaphora will be constrained in a forward direction in RB languages. However, in LB languages, we hypothesize that children will not evidence a predisposition for forward anaphora and may evidence a predisposition for backward anaphora.

This parameter contributes in an interesting way to a theory of learnability of anaphora. Namely, the constraint in 7 will rule out a large class of possible anaphoric errors in both L and RB languages. As is sketched in 8a and b, the relevant directionality constraint in 7 will generally rule out the cases where an anaphor dominates its antecedent. It should be noted from 8 that the constraint has opposite consequences with respect to directionality in R and LB languages. While it rules out ill-formed backward anaphora in RB languages, as in the English 8a; it rules out ill-formed forward anaphora in LB languages, as in the Japanese 8b. (8b is due to N. Terazu p.c.).

8.(a)



8.(b)



Data

Within this theoretical framework, we have conducted a series of experimental cross-linguistic studies of young children's production and comprehension of anaphora using a standardized, controlled and systematic methodology. In this paper we will review critical data from the production studies. These studies consist of tests of young children's elicited imitation of stimulus sentences with directionally varied anaphora, where these sentences were controlled for length and for other aspects of structural, lexical and pragmatic difference. Within each of several languages, children from 2-5 years of age were tested.

The first series of studies involved English, a typically RB language, as evidenced by the positioning of relative clauses, sentence complements and adverbial subordinate clauses, as shown in 9.

9. English: Right BranchingRelative Clause

- i. [The child [who is eating rice]] is crying

Subordinate Clause

- ii. [The child drank the milk [after he ate the rice]]

Sentential Complement

- iii. [It is good [that Tatsuko went to the village]]

These studies consisted of a series of tests of children's elicited imitation of various coordinate and subordinate constructions with directionally varied anaphora, as in examples 10 and 11. Examples 10 illustrate forward anaphora, 11 backward anaphora. The 'a' sentences involve null anaphora. The 'b' sentences involve anaphoric pronouns. As can be seen, both sets of constructions, 10 and 11, are freely accessible in the adult grammar. (Elicited imitation has been found to be one of the most sensitive indicators of children's grammatical competence, cf. Slobin and Welsh, 1963, Gallimore and Tharp, 1981, Lust, 1977.)

10. Forward Anaphora

- a. i. John ate and \emptyset read.
 ii. Push the car and \emptyset the truck.
- iii. John read when \emptyset eating
- b. i. John read when he ate
 ii. When John ate he read

- ii. Backward Anaphora
- a. i. John \emptyset and Mary ate lunch
 - ii. Push \emptyset and pull the truck
 - iii. When \emptyset eating, John read
 - b. i. When he ate, John read

A directionality effect favoring forward anaphora has been evidenced in children's elicited imitation of sentences like these. Children acquiring English find it significantly easier to imitate sentences with forward anaphora such as in 10, than sentences like 11 with backward anaphora. Children's imitations in fact show frequent reversal of anaphora direction, particularly in the case of pronouns, from backward to forward. For example, children frequently convert a sentence like 11b1 to 10b1 in their imitation. This directionality effect favoring forward anaphora has been further evidenced in study of young children's natural speech where coordinate forms with forward anaphora like in 10, have been found to appear earlier than coordinate forms with backward anaphora like 11. Evidence of this forward directionality of anaphora preference in children acquiring English has also been reported by several other researchers.

12. Tavakolian, S. 1977, 1978; Solan, 1978, 1981; Lust, 1981; Lust, Loveland and Kornet, 1980; Lust and Clifford, 1982.

This directionality effect is clearly consistent with the constraint in 7. Forward anaphora corresponds to the RB properties of English. However, there are a number of possible alternative explanations for these English data. The preference for forward anaphora direction could be explained if it were the fact that young children accessed mainly general processing strategies, which determine that forward anaphora taxes processing mechanisms that operate in real time significantly less than backward anaphora does. Alternatively, if it were the case that children accessed mainly discourse strategies, the forward direction preference would be explained, because discourse generally involves the explicit mention of a referent before the use of anaphoric items to refer to that referent.

Although these alternative explanations are viable for these English acquisition data, if the constraint in 7 were confirmed in LB languages, both these alternative explanations would be ruled out. Since the constraint in 7 predicts that children in LB languages should not show this preference for forward anaphora and in fact may show a preference for backward anaphora, neither the processing nor the discourse principles discussed would be consistent with these data.

We have extended our study of the first language acquisition of anaphora to several LB languages, including Chinese and Japanese, working with Chien and Wakayama respectively. Both Chinese and Japanese can be characterized as principally left branching, since their major recursive structures occur to the left of their heads, as evidenced for example by relative clauses and adverbial subordinate clauses, as in 13a, Chinese, and 13b, Japanese. In structures such as the relative clause in these languages, e.g., 13biv, the directionality of anaphora is obligatorily backward. However, these languages also productively allow forward anaphora in a wide range of structures as exemplified in 14a, Chinese and 14b, Japanese.

13. Left-Branchinga. Chinesei. Relative Clause

- [[Zhēn dū-le Mǎlì xiě \emptyset] de shū]
 Jan read asp. Mary write Rel. \emptyset book.
 'Jan read the book that Mary wrote.'

ii. Subordinate Clause

- [[Dāng Mǎlì dāsǎo fāngzi-de shíhòu] māma huílái-le]
 While Mary clean house-Rel when mother come back-asp
 'While Mary was cleaning the house, mother came back.'

iii. Sentential Complement

- [[Wǒmen nénggòu ānquán-de huídào jiā] zhēn hǎo]
 we can safely-Mod come-arrive home really good
 'It is really good that we could come back home safely.'

b. Japaneseiv. Relative Clause

- [[Gohan-o tabete-iru] ko-ga] naite-imasu
 Rice-OBJ. eating is child-SUBJ. crying is.

v. Subordinate Clause

- [[Kodomo-ga gohan-o tabete kara] okasan-wa sooji-shita.]
 Child-SUBJ rice - obj. eating after mother TOP cleaned up

vi. Sentential Complement

- [[Tatsuko-san-ga sono mura-e itte] yokatta]
 Tatsuko-SUBJ that village to going good-was

14. Forward Anaphora in Left Branching Languagesa. Chinese

- i. Ā-xī, tā yiding bú qù kàn diànyǐng
 Ah-hsi he certainly not go look movie
 Ah-hsi is certainly not going to see the movie
- ii. Ā-xī xiǎo de shíhòu \emptyset méi qián
 Ah-hsi little de time \emptyset not money
 'When Ah-hsi was little he was poor'

- b. Japanese
- i. Taroo wa atama ga itai kara, \emptyset gakkoo ni ikanai
 Taroo TH head SUBJ aches since \emptyset school to go-neg
 'Since Taroo's head hurts he's not going to school'
- ii. Taroo ga osake o numu to, \emptyset warai-dasi-ta
 Taroo SUBJ sake OBJ drink when, \emptyset laugh-begin-perf
 'When Taroo drank sake he began to laugh'

Chinese acquisition

In Chinese we conducted a series of elicited imitation tests with young children (2-5 years) on sentences like those exemplified in 15 and 16, analagous to those we had tested in English. These sentences again involved both coordinate and subordinate constructions with directionally varied anaphora. 15 involves forward anaphora, 16 backward. The 'a' sentences involve coordinate structures, the 'b' sentences involve adverbial subordinate clauses, and the 'c' sentences relative clauses. All the Chinese sentences involved null anaphora. Both the forward items as in 15 and the backward items as in 16 are freely accessible in the adult grammar.³

15. Forward

- a. i. Wánwán xiào gòuxióng hàn xiào huòchē
 Play with teddy-bear and train
 'Play with the teddy-bear and the train'
- b. i. Yīnwei gēge yào chī táng, suoyi \emptyset dákāi hézi.
 Because older-brother want eat candy, so \emptyset open box.
 'Because older brother wants to eat candy, so \emptyset opens (the) box.'
- ii. Shūshu kàn bào yìqián, \emptyset hēle guózhì
 Uncle read paper before, \emptyset drink-ASP. juice
 'Before uncle read the paper he drank juice'
- iii. Bàobao xǐguo shǒu yìhòu, \emptyset kàn kǎtōng
 Baby wash-ASP hands after, \emptyset watch cartoons
 'After the baby washed her hands she watched cartoons'
- iv. Jiējie dú shū de shíhòu \emptyset ná qiānbì
 Older sister read books REL.time, \emptyset hold pencil
 'When the older sister read she held a pencil'
- c. Lǎo-popo \emptyset kàn gùshìshū de \emptyset , zuò-zài yǐzi-shàng
 Old lady, \emptyset read story book REL \emptyset sit-on chair-TOP
 'The old lady, the one who is reading a story book is sitting on a chair'

16. Backward

- a. Xī-yì-xì yě cā-yì-cā wáwa
Wash and dry the doll.
'Wash and dry the doll'
- b. i. Yīnwei \emptyset yào sǎodì, suóyì xiǎo-dìdì nǎ sàoba.
Because \emptyset want to sweep, so little-younger brother take broom.
'Because \emptyset wants to sweep, so little younger brother takes (the) broom.'
- ii. Kàn diǎnyǐng yìqian, wáwa shuā le yá
 \emptyset watch movie before, baby brush ASP teeth
'Before watching the movie, the baby brushed its teeth'
- iii. \emptyset chīwan fàn yìhòu, ā yí kai diànshì
 \emptyset eat-asp rice after, aunt \emptyset watch television
'After \emptyset eating, the aunt watched television'
- iv. \emptyset chī táng de shíhou, dìdì kāi bīngxiāng
 \emptyset eat candy Rel. time, younger brother open refrigerator
'When he ate candy, the younger brother opened the refrigerator'
- c. \emptyset diū shítou- de xiǎo-háizi, pǎo-dào zhuōzi-shàngmian
 \emptyset throw stone REL little-child, crawl to table top
'The little child who threw the stone, crawled on top of the table'

Results from these studies showed that across all types of structures children never evidenced a significant preference for forward anaphora. For percent correct see figure 20.

In the case of coordinate sentences (as in the a sentences), Chinese children find it significantly easier to imitate coordinate forms with backward anaphora such as in 16a, where children imitated 73% of the sentences correctly, than those with forward anaphora such as 15a where children only imitated 52% of the sentences correctly. In the case of sentences with adverbial subordinate clauses of various types, 71% of the sentences like 15b were imitated correctly while 63% of the sentences like 16b were (a non-significant difference). This shows that the backward forms were as easy for Chinese children to imitate as the forward forms. In the case of relative clause constructions there was a significant preference for backward forms like 16c, where children imitated 63% of the sentences correctly, over forward forms like 15c, where children only imitated 40% of the sentences correctly.

Japanese acquisition

In Japanese, we conducted a parallel series of tests of young children's elicited imitation of sentences exemplified in 17 and 18, analagous to those we had tested in Chinese and English. The sentences varied again in whether they were coordinate or subordinate and directionally varied in anaphora. Sentences in 17 are forward anaphora; sentences in 18 are backward anaphora. Again 'a' sentences involve coordination, and the 'b' sentences involve adverbial subordinate clause constructions marked by the form 'to.'

17. JapaneseForward

- a. i. Inu-wa hoeru-shi kamitsuku
Dog bark and bite
 '(The) dog(s) bark and bite'
- ii. Booru-o nageru-shi tsukamaeru.
Ball throw-and catch
- iii. Mushi-o sagashite tsukamaeru.
Insects look for and catch
- iv. Juusu-ga tsumetakute amai
Juice is cold and sweet
 '(The) juice is cold and sweet'
- b. i. Papa-ga gohan-o taberu-to, \emptyset ocha-o ireta
 Papa-SUBJ meal-OBJ eat-when, \emptyset tea-OBJ poured
 'When Papa ate the meal, he poured (the) tea'
- ii. Mama-ga kasa-o otoshita-no, \emptyset doa-o akeru-to.
 Mama-SUBJ umbrella -OBJ dropped-when, \emptyset door open-when
 'Mama dropped the umbrella, when she (he) opened the door'

18. Backward

- a. i. Sumire-to tanpopo-ga saku
 Violet-and dandelion bloom
 'Violets and dandelions bloom'
- ii. Zubon-to seetaa-o kiru
 Pants-and sweater put on.
- iii. Zubon-to hankachiifu o arau
 pants-and handkerchief wash.
- iv. Gohan-to suupu-ga oisii.
 rice-and soup good-is
 'The rice and soup is good'
- b. i. \emptyset mado-o akeru to, oneesan-ga kusyami-o shita
 \emptyset window-OBJ open-when, sister-SUBJ sneeze-did
 'When (s)he opened the window, the sister sneezed'

- ii. \emptyset akubi-o shita-no, mama-ga denki-o kesu-to
 \emptyset yawn-OBJ did, mama-SUBJ lights turn off-when
 'When (s)he yawned, mama turned off the lights'

As with the Chinese, results from these Japanese studies showed that across all types of structures Japanese children never evidenced a preference for forward anaphora. In fact, as the percents of correct responses suggest (see figure 21), the Japanese children consistently significantly favored backward direction of anaphora across both coordination and subordination structures which were tested.

In summary, the results from the studies of both LB languages, Chinese and Japanese, confirm our hypothesis that there would be no preference for forward directionality and in fact in several cases a significant preference for backward directionality in anaphora. The 3 figures 19-21 summarize these directionality effects. Figure 19 evidences the directionality effect favoring forward anaphora on the English coordinate and subordinate data. Figure 20 represents the directionality effects for each of the 3 types in Chinese. Figure 21 summarizes the directionality effects favoring backward anaphora in Japanese subordinate and coordinate data.

This confirmation of our predictions for the left branching languages provides evidence for sensitivity to the PBD parameter in early acquisition and for its role in constraining anaphora as described in 7. These results also provide evidence that the PBD explanation of the English acquisition results showing forward directionality preferences should be more highly valued in a theory of first language acquisition than either of the alternatives we mentioned, namely a real-time, on-line processing model or a discourse model. Only the PBD parameter explanation can be generalized to both left and right branching languages for these acquisition facts.

Conclusions

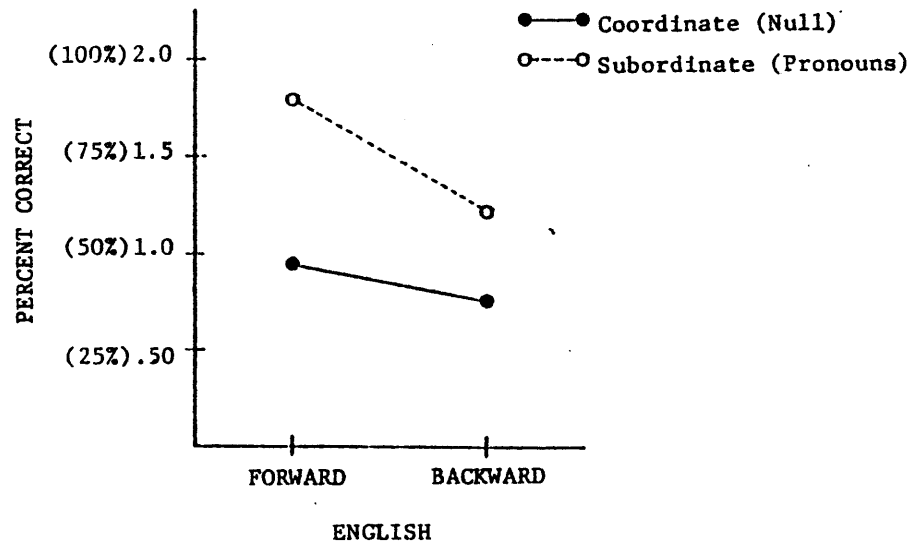
These results have implications for a theory of Universal Grammar, both from a linguistic and psychological point of view. With regard to linguistic theory, these results support the positing of one particular parameter of UG and evidence its empirical consequences. This parameter, formulated as PBD of a language, is set by experience of a particular language as either right or left, and once set has wide deductive consequences. Specifically these results have identified the consequences of this parameter as constraining first language acquisition of anaphora. The consequences of this constraint are wide in the sense that the directionality effect provided by the constraint was found to generalize over several different structures, including coordinate and subordinate, as well as over free and bound anaphora.

These results which rule out an anaphor dominating its antecedent can only be accounted for by making reference to the role of structure-dependence in the early acquisition of anaphora. Thus this parameter was found to evidence one of the essential properties of UG.

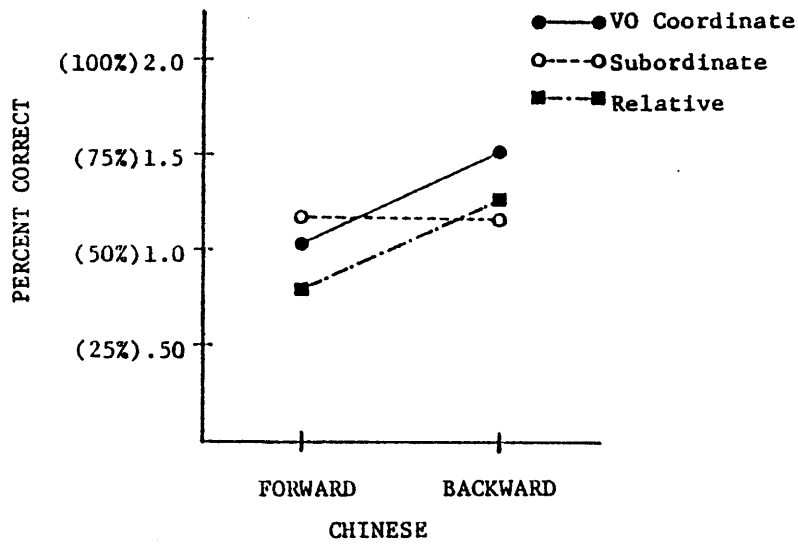
However, our results are inconsistent with certain recent specific proposals regarding binding theory in UG. Specifically the distinction between free and bound anaphora in terms of nominal category distinctions is not supported by our

THE PBD PARAMETER

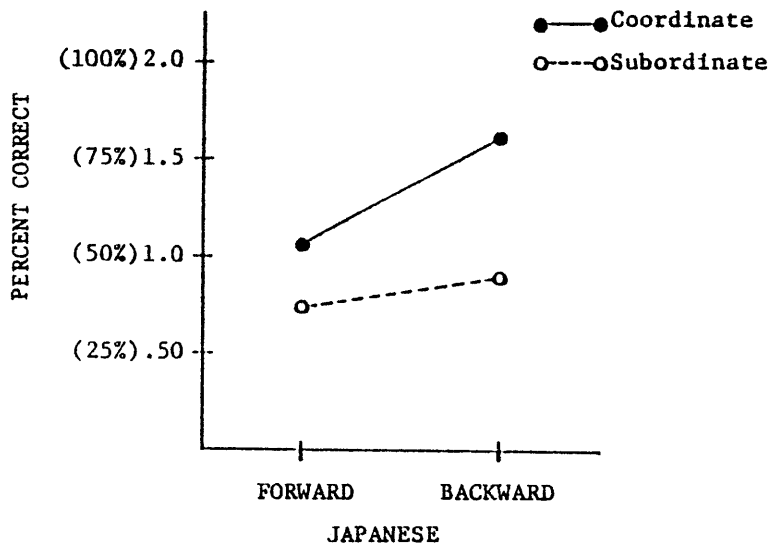
19.



20.



21.



data, which clearly show that children generalize a principle of structure-dependence across anaphora types. The sensitivity to PBD leads the child to make deductive generalizations which range over free and bound anaphora independent of nominal categories.

Further, these results suggest that in generalizing over free and bound anaphora, children do distinguish these configurationally. This is shown for example by the difference between Chinese relative clauses and adverbial subordinate clauses and by the similarity between the directionality effect on the coordinate structure and relative clauses. The headed relative clause and the coordinate structures (with bound anaphora) evidence a much stronger directionality effect than the subordinate clauses (with free anaphora) (see this in Figures 19-21).

Both the general consequences of the parameter and the configurational differences between free and bound anaphora can be interpreted within an X-bar theory of PSG. The principle recursive branching direction of the PSG provide the generalizations for the child, *viz.*, the consistent directionality effects within a language, while the dominance involved in PSG provide a basis for distinguishing between free and bound anaphora.

With regard to psychology proper, our results rule out several claims which have been made in recent theories of language acquisition. These results have implications for processing models which are usually given on-line left-right representation. Although such models may appear adequate to describe the facts of RB languages, these models would have to be significantly enriched to account for the full range of data including LB languages. Unless such processing models were enriched to include reference to the PBD parameter, they could only account in an ad-hoc manner for the diversity of facts we have addressed across languages.

These results also have implications for the dogmatically held methodological assumption that first language acquisition can only be significantly studied within specific pragmatic contexts and within specific semantic encodings. Our results clearly show significant generalization of the PBD parameter to generalize over different pragmatic contexts, since they have been found to generalize over elicited imitation, natural speech and comprehension tests. They also show generalization over semantic encodings and other semantic features like agency, and animacy. These generalizations are also found to be independent of specific cultural variations, and hold over many other linguistic parameters, including language families, and traditional typologies based on word order or morphology.

Finally, our results point to an autonomous specifically linguistic component, which is formal, in the modelling of cognitive competence. Unless such a specifically linguistic component were posited, it would be impossible to account for the generalizations or the systematic empirical differences of the PBD, which were found over this whole set of cultural and contextual differences. In particular the specific effect of preferred backward directionality in LB languages can only be determined grammatically, since it is inconsistent with the forward linearity determined by non-grammatical general cognitive principles.

Footnotes

- 1 This paper was prepared with the support of NSF grant BNS 7825115. We thank Yu-Chin Chien and Tatsuko Wakayama, for critical collaboration on our Chinese and Japanese results. We also thank Joan Chow, Kazuyo Otani, Ed Cimafonte and Shirley Hsu for their invaluable assistance.
- 2 Any pronoun or null which is designated as free may either be interpreted by reference to another constituent within the complex or coordinate structure in which it occurs, or be interpreted based upon information independent of the sentence in which it occurs. Although in current GB theory relative clause binding is from a head to a Comp, for Chinese we feel that there are strong reasons to assume that a head directly binds a null in a lower clause. Space limitations prevent us from investigating this problem here.
- 3 Although we represent various structures with nulls, for coordination our analysis does not require the presence of syntactic nulls (as in 15-18). Our analysis requires that there be some constituent of a category X which immediately dominates two or more constituents of the same category X and that the highest X be in a syntactic relation to some constituent of a category Y where this syntactic relation is semantically interpretable only by making individual reference to the relationship between Y and each of the constituents of the category X which is immediately dominated by the highest X.

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