Factors influencing assignment of pronoun antecedents*

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Abstract

In two experiments a group of adult subjects and a group of 10 - 13 year old subjects completed sentences of the format NP1 V NP2 because Pro... *The fragment,* John telephoned Bill because he..., *elicited completions such as* had good news, *which locate the impetus for telephoning in NP1 (John). The fragment,* John admired Bill because he..., *elicited completions such as* was a fine athlete, *which locate the impetus for admiring in NP2 (Bill). The assignment of the subject pronoun of the second clause as coreferential with NP1 or NP2 shows that this choice depends on a factor, direction of causality, which may be assigned to verb roots. This factor was isolated from interacting semantic and syntactic features of sentences in which the verbs occurred. Manipulation of these features resulted in greater or lesser salience of the direction of causality factor. The potential of this technique for investigation of verb semantics and for interaction of semantic, pragmatic and syntactic features in the psychological study of comprehension is discussed.*

Anaphoric prowords are generally thought to be assigned appropriate referents by some process that matches a symbol of the deep structure to an available antecedent. The matching is in many cases facilitated by explicit cues to the features shared by proword and antecedent. For example, in 1) below:

(1) Henry trusted the woman because she was efficient.

the pronoun *she* and the antecedent *woman* share the critical feature, [Female], as well as other features not critical in this context, e.g., [+Human], [+Singular]. In sentence 2)

(2) Henry trusted the secretary because she was efficient.

we must assume that *secretary* also bears the feature [Female], but the basis for this assumption is somewhat different. It must be either that we know that secretaries are

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marked [Female] for linguistic purposes or that we know that *she* must select a semantically feminine antecedent, and *secretary* is the only available candidate. If we examine 3), however,

(3) Rosemary trusted the secretary because she was efficient.

it again appears that the basis for selecting the antecedent is different. No obvious semantic feature of the antecedents can provide a unique basis for assignment, since both antecedents share all obvious critical features. Here it would appear that the listener may rely on some expected compatibility in the meanings of *secretary* and *efficient* to accomplish the matching. A sentence such as 4) reveals that listeners may rely on yet other kinds of information to make an assignment:

(4) Rosemary trusted the secretary because she was a good administrator.

4) may be read as meaning that Rosemary, being a good administrator, habitually supported her staff by entrusting them with her confidence. *Or,* it may be read as meaning that Rosemary, noting the administrative capabilities of the secretary, believed that these capabilities indicated a trustworthy character. The problem is how to account for the way in which a listener understands the pronoun *she* as coreferential with the first noun phrase (NP_1 = *Rosemary*) or with the second noun phrase (NP_2 = *the secretary*).*

Finally, a sentence such as 5) can be produced and comprehended, i.e., assigned a reading.

(5) Rosemary trusted the secretary because she was gullible.

This example brings us directly to the question of the role of semantic factors in the assignment of pronoun antecedents. Although sentences 5) and 3) are both ambiguous, they appear to differ in the availability or salience of alternative assignments. If this is the case then there are some as yet poorly understood semantic features associated with the matching of noun phrases. Sentences with contrasting assignments, such as 6) and 7) indicate that some property of verb roots may be implicated in the process of pronoun assignment.

(6) George telephoned Walter because he wanted sympathy.

(7) George criticized Walter because he wanted sympathy.

Such a property (or properties) would be normally obscured in the presence of disambiguating cues, such as are present in 1) and 2), and, perhaps, in 3). But sentences such as 6) and 7) raise the question of the role of verb semantics in pronoun assignment as well as the question of possible interaction of semantic properties with syntactic or pragmatic

*The listener may entertain both readings, simultaneously or sequentially, and subsequently choose one of them, or he may perceive only one reading at the time of responding. In the absence of strong evidence for either alternative process, we will assume that at the time of response only one interpretation is salient, i.e., consciously available to the listener.

features of sentence structure. Specifically, the question being raised concerns the kinds of knowledge a listener might use in selecting the antecedent of a potentially ambiguous pronoun. If the listener employs some sort of pragmatic strategy, it would still be subject to qualifications. For example, on hearing 4) the hearer might predict: "The topic of the first clause is likely to be the topic of the second clause as well. Lacking any counter-indications, I will assume that the antecedent of the pronoun topic *she* is the topic *Rosemary*". Some such strategy would provide one acceptable reading for 4) and would work smoothly for 5) and 6). But it would produce an unexpected reading for 7).

Study I

Before examining the question of listener strategies, however, it is necessary to confirm the informal observation that speakers do indeed produce sentences with supposedly "ambiguous" pronouns and to obtain some information on interspeaker agreement on selection of antecedents. A pilot study was undertaken to provide this basic information. In addition, this first study was designed 1) to identify a number of verbs which appear to influence pronoun assignment and 2) to explore certain pragmatic and syntactic factors which might influence the phenomenon.

Method

Subjects: Twenty-eight volunteer subjects from an introductory psychology class participated in the experiment.

Procedures: Subjects were tested in a group in the classroom. They listened to recorded instructions which stated that the objective of the experiment was to find out how people ascribed reasons or motives for actions. Subjects were told that they would hear 24 incomplete sentences. Their task was to complete each sentence, writing a response which supplied a credible motive for the action or attitude presented in the first part of the sentence. A separate set of instructions introduced the second part of the task in which subjects were asked to write answers to 11 recorded questions concerning reasons or motives. In this part they were asked to begin their response with the word *because.* They were informed that the recorded items allowed only 10 seconds for completion and that a signal tone would be heard before the beginning of each item.

Materials. Part 1 consisted of 16 test items and eight distractor items. All were fragments of the format: *NP1 Past-V NP2 because Pro...* All subject and at least one of the non-subject nouns referred to human beings. In the test items no grammatical cues were available to assist pronoun assignment to either NP1 or NP2, e.g., *The father scolded his*

son because he... The distractor items, which were interspersed among the test items, did provide grammatical cues, e.g., *Mary returned the records to Sam because she...* Items were recorded with approximately equal stress on NP1, NP2 and on the pronoun. Of the 16 test items, eight were expected on the basis of preliminary work to elicit NP1 assignment, and eight to elicit NP2 assignment of the potentially ambiguous pronoun. Sentences were heterogeneous as to grammatical form.* The different structures were chosen to allow comparison of positions of assertional focus, e.g., *Bill sold the exam questions to John because he...* versus *Henry sold Bill the bike because he...* and to reflect some diversity in the status relations between the two candidate antecedents, e.g., *prisoner–guard, mother–daughter.* Status was conceived as a semantic dimension reflecting relative ranking of two [+Human] nouns within a single field or system of reference, e.g., within the family, *father–son*; within job or institutional system, *director–actor.*

Part 2 consisted of eight test items and three distractor items, (11 questions) which requested a 'because' answer, e.g., *Why did the mother punish her daughter?* These items were designed to test 1) the effect of interrogative structure on the selection of antecedent and 2) the effect of implicit negativeness in the verbs, e.g., *director praised* versus *criticized the actor.*

Response sheets were scored independently by two judges with 99% interjudge agreement. Scoring consisted of judging the completed sentence as indicating either NP1 or NP2 assignment of the pronoun of the second clause. Judges also scored a response as ambiguous (A) if it was not clearly interpretable as NP1 or NP2; as unintelligible (U) if illegible or if it indicated lack of understanding the test item; or as no response (NR). The last three scoring categories did not appear to be systematically distributed in relation to test items. Total number of possible responses was 652; 15% of these were comprised of A+U+NR responses. The results report the percentages of the dominant response obtained (either NP1 or NP2) for each item after A+U+NR responses were subtracted from the possible total for each item.

Results and Discussion

Subjects were indeed able to complete the potentially ambiguous sentence fragments. Informal questioning after the experiment revealed that the ostensible objective of the experiment had been accepted. None reported noticing that the second clause pronoun was potentially ambiguous. Thus, Study I suggests that the processing of such sentences lies within the competence of speakers and that the technique may be useful for investigating the processes involved in assignment of pronouns to antecedents.

*A list of the test items as well as a list of the items used in Study II may be obtained, on request, from the authors.

Table 1. *Total number of N1+N2 responses; number of N1 and N2 responses; percentage of dominant response/subordinate response; and level of probability.*

I. Sentence Completion

Sentence Number		Total[a]	N1	N2	%	*p* (2-tailed)
	(verb)					
11	tie up	18	10	8	55	0.814
4	help	27	18	9	66	0.230
18	distrust	21	6	15	71	0.078
13	confide in	19	14	5	74	0.064
19	pick up	26	6	20	77	0.014
10	rush to	26	6	20	77	0.014
6	criticize	28	4	24	85	0.004
16	sell	23	20	3	87	0.002
24	scold	26	3	23	88	0.001
3	fear	24	2	22	92	0.001
22	confess to	25	23	2	92	0.001
1	call	13	13	0	100	–
14	join	23	23	0	100	–
9	blame	23	0	23	100	–
20	sell	24	24	0	100	–
7	kill	27	0	27	100	–

II. Questions

Sentence Number		Total[a]	N1	N2	%	*p* (2-tailed)
	(verb)					
7	help	23	9	14	61	0.404
2	kick	21	7	14	67	0.190
8	fear	21	7	14	67	0.190
5	confess to	27	25	2	93	0.001
9	give	25	1	24	96	0.001
4	praise	26	1	25	96	0.001
11	punish	27	1	26	96	0.001
1	sell	21	21	0	100	–

[a] N = 28.

Table 1 presents the total responses obtained (maximum number of responses for an item = 28), the number of NP1 and NP2 responses obtained for each item, the percentage of the dominant response, and the probability level for the dominant response. Part I presents the data for the sentence completion task and Part II for the answer-to-question task. The results for Part I indicate that most of the test items elicited a biased response. One third of the items received only NP1 completions (three items) or only NP2 completions (two items). The majority of items showed an intermediate response bias to NP1 or NP2 completions, and only a few revealed no clear bias. NP1 items ranged from 55% to

100% and NP2 items from 71% to 100%. It would appear that any psychological rule designed to account for antecedent assignment in this type of sentence must reflect the continuous (rather than simply dichotomous) nature of this distribution.

The answer-to-question task revealed a similar patterning of results. As shown in Table 1, Part II, two questions received a majority of NP1 responses (93% and 100%), three were moderately biased toward NP2 (61%–67%), and three were strongly biased toward NP2 (96%). The existence of moderate as well as extreme values in the dominant responses confirms the continuous nature of the bases for antecedent assignment under conditions of potential ambiguity and extends the phenomenon to the interrogative structure. Part II results suggest that the rule or rules which determine antecedent assignment apply to intersentential discourse as well as to the sentence types of Part I.

Results obtained for specific items generally supported the notion that verbs play a role in pronoun assignment and do so in some consistent way. Verbs from test items are indicated in Table 1. The variations in syntactic structure and lexical composition of the test items prevent us from drawing any conclusions at this point about the influence of the particular verb on the responses. However, comparison of Part I items 3 (*fear*), 16 and 20 (*sell*), and 22 (*confess to*) with Part II items 8 (*fear*), 1 (*sell*), and 5 (*confess to*), does indicate that a dominant response is not unique to a particular sentence, but is associated with the verb in some way. Only one verb elicited different responses in the completion task as compared with the answer task. *Help* elicited NP1 dominant responses in Part I (item 4) and NP2 dominant responses in Part II (item 8). In both tasks the dominant response was weak and was not statistically significant.

Several other tentative observations emerged from the item analysis. Briefly, 1) implicit negative or positive value of the verb was not an important factor in determining the response bias, e.g., items with *criticize*, *praise*, and *blame* all elicited strong NP2 responses; 2) the position of assertional focus may have some influence on strength of response, but it did not appear to influence the type of response. Subjects responded similarly to *Bill sold the exam questions to John* and *Henry sold Bill the bike*. 3) The status relationships of the antecedent noun phrases, though not systematically compared in Study I, appeared to be a potential factor in the strength of the response.

Study II

A second study was designed to replicate the results obtained for specific verbs (see 1 below) and to pursue several factors (see (2)–(5) below) which Study I and a previous linguistic analysis (Garvey & Caramazza, 1974) suggested might interact with the influence of the verb in the process of pronoun assignment. The notions to be tested were the following:

(1) Certain verbs (i.e., those identified in Study I and perhaps others) bear a semantic feature which imputes the cause of an event or situation to either the subject or non-

subject of the clause in which it serves as a main verb. The feature, however, is best described as a bias or valence rather than as a simple binary feature.*

(2) A linguistic analysis (Garvey & Caramazza, 1974) had suggested that sentences completed with NP2 assignments were in general amenable to passive transformation (P–T) whereas those with NP1 assignments were not compatible with P–T. Since this observation relates the semantic phenomenon to an important syntactic property of sentences (i.e., applicability of P–T), comparisons between active (A) and passive (P) sentences were included.

(3) Although the implicit positive or negative valences of verbs such as *praise* or *blame* did not strongly affect the pronoun assignment responses in Study I, explicit negation is an important factor in semantic judgments. Thus, a comparison of explicit negative (–) versus positive (+) verb phrases was included in Study II as a factor likely to influence the bias of implicit causality for a given verb.

(4) The postulated causality feature operated in the selection of antecedents of anaphoric pronouns in both intra- and intersentential sequences. In the latter, the feature was unaffected by the presence of [+ interrogative] in the first sentence. To further substantiate this result comparisons between interrogative (?) and declarative (!) sentences were included.

(5) Finally, the relative status of the candidate noun phrases of the first clause might have been a factor in the strength of the responses obtained in Study I. Certain actions or attitudes referenced by the verb may be viewed as congruent with those relations, e.g., *father praised son,* or noncongruent with those relations, e.g., *son praised father.* Contradiction of such congruence would be expected to attenuate or modify the attributed direction of causality to some extent. Therefore, comparisons of congruent and noncongruent collocations of NP1–V–NP2 were included.

In summary, then, the effects of the following variables on the pronoun assignment response were tested:

Variable I - Active–Passive, e.g., (A) John recognized Michael because he... (P) Michael was recognized by John because he...

Variable II - Positive–Negative, e.g., (+) The soldiers feared the natives because they... (–) The soldiers did not fear the natives because they...

Variable III - Interrogative–Declarative, e.g., (?) Why did the mother punish her daughter? (!) The mother punished her daughter because she...

Variable IV - Congruent and Noncongruent, e.g., (Cong) The prisoner confessed to the guard because he... (NonC) The guard confessed to the prisoner because he...

*In using the term 'semantic feature' we do not espouse any particular theoretical position as to the dividing line between semantic knowledge and 'knowledge of the world'. We leave open the question of whether the phenomenon investigated in these studies should be classed as a grammatical or extragrammatical one.

Method

Subjects: 110 junior high school students, ages 10–13, who participated in the experiment as part of a battery of tests administered in an independent study.

Materials: Twenty-six verbs were selected so as to compose a heterogeneous set. No *a priori* classification was possible, since pilot work failed to reveal categories which consistently partitioned verbs into those that exhibit the proposed causality feature and those that do not. Nor could any systematic categorization of NP1 and NP2 verbs be made.

Four sets of five 'kernel' sentences were each transformed to provide contrasting sentences for each sentence in each variable set. The resulting 40 sentences were divided into two sets of response sheets, each containing 20 sentences. Form A, for example, contained five A–P items, three passive and two active sentences; and Form B contained the converse of this set. Order of sentences within and between variable sets was randomized as was the order of verbs. For example, the order of sentences in Form A proceeded as follows: 1. chase (P); 2. sail (+); 3. sell (?); 4. confess to (NonC); 5. hit (A); whereas Form B proceeded as follows: 1. recognize (A); 2. kill (+); 3. give (?); 4. sail (+); 5. sell (!). Of the 20 verbs used in the 20 'kernel' sentences, 11 had been employed in Study I.

A second set of items was composed of 10 sentence frames of the format: "_____ verb_____ because...." In this set one verb (blame) was taken from Study I, one verb (telephone) was a synonym of a verb in Study I (call), and the remainder were included for the first time. These items were presented in the same order to all subjects.

Materials were presented in two parts. Part I included the 20 sentences described above. Part II included the 10 frames of the format: "_____ verb_____ because..." in which subjects were required to supply NP1, NP2 of the first clause as well as the entire 'reason clause'. All items were test items and no distractor items were used. However, three items of Part II which did not elicit [+Human] NP2's were omitted from the analysis.

Procedure: Subjects were tested together in a large room. Fifty-five subjects received a copy of Form A of the written test materials and 55 received Form B. They were asked to provide written responses. The instructions were also written as follows:

Part I. *Instructions:* Think of a good way to complete each of the sentences below, then write it down in the blank space provided. There are no right or wrong answers, but the sentence should make good sense after you complete it. Work rapidly. The sentences are easy, but, if you have trouble completing one, continue on to the other sentences and return later.

Part II. *Instructions:* For each 'sentence frame' below, fill in the blanks to make a sensible sentence. Fill in the first two blanks with names of people or things and then

complete the sentence by giving a reason for the event, just as you did before. If you have trouble filling in a sentence frame, don't spend too much time on it. Go on to the remaining sentences, and then return. Example: Tom ate the apple because he was hungry.

Scoring: The same scoring procedure as in Study I was used in Study II. Again, two scorers categorized the sentence completions into surface NP1 and NP2 type responses (99% agreement). The total possible number of responses for any single sentence was 110 (55 in Form A plus 55 in Form B). Thus there were 2200 possible responses. A third category comprising responses which were either ambiguous (A), unintelligible (U), or absent (NR) was also used. A+U+NR responses equalled 122 (6%) of total possible responses). A+U+NR responses did not appear to be distributed systematically in relation to test items and were omitted from further analysis. The NP1 and NP2 type completion data for Part I are presented separately for each of the four variables investigated.

A nonparametric statistic, chi-square, was used since the type of data collected did not meet requirements for parametric analyses: First, the data are not interval scale data, and second, we do not know anything about the distributions of these data. A chi-square analysis is sufficient given that it reveals changes in the distribution of NP1 to NP2 relative to the various experimental factors manipulated. The analyses focus on the differences in distributions as a function of experimental factors rather than absolute shifts in directionality of antecedent choice.

Results

I. Active–Passive.

Table 2 presents the number of surface NP1 and NP2 responses for each of the five sentences in the active and passive voice. The distribution of NP1 and NP2 responses suggests that voice influenced the assignment of pronoun antecedents ($\chi^2_1 = 43.4$, $p < 0.001$). Comparison of column 1 with 4 and column 2 with 3 in Table 2 indicates that: (a) sentences which were strong NP1's in the active voice appeared as weak NP2's in the passive voice (sentences 2, 4 and 5); (b) the sentence which in the active voice was a weak NP1 appeared as a stronger NP1 in the passive voice (sentence 1); and (c) the sentence with weak NP2 in the active voice appeared as a weak NP1 in the passive voice. Thus, with passivization, which reverses the surface order of logical subject and nonsubject of the sentence, there is a general drift in the assignment of pronoun antecedents toward the grammatical subject or 'topic' of the sentence (in this case, the surface structure NP1). Separate χ^2 tests for each sentence to further evaluate the statistical reliability of this effect reveal highly significant effects for sentences 1, 2, 4 and 5 ($p < 0.001$ in each case) and marginal significance for sentence 3 ($p < 0.10$).

Table 2. *Completions for active and passive sentences*[a]

Sentence	Active		Passive		(Verb)
	NP1	NP2	NP1	NP2	
1	30	18	43	9	chase
2	52	2	24	25	hit
3	23	29	37	13	recognize
4	48	2	14	36	strike
5	53	1	13	39	approach
Total	206	52	131	122	

[a] NP1 refers to the first noun phrase of the surface structure; thus NP1 in the Active and NP2 in the corresponding Passive sentence is the same lexical item.

These results clearly implicate the surface structure properties of sentences as a determinant of antecedent assignment. Thus, in addition to whatever other factors may contribute to the directionality of pronoun assignment, the overt marking of sentence topic (at least as achieved by P–T) introduces a further independent dimension along which antecedent selection is made.

II. Positive–Negative

The effects of verb negation on the assignment of pronoun antecedents on each of five sentences tested are presented in Table 3. (The appropriate comparison in Table 3 is that of column 1 with 3 and column 2 with 4.) With the exception of sentence 1, the positive verb sentences show NP2 preference, which is attenuated in the verb negated versions ($\chi_1^2 = 31.5$, $p < 0.001$). χ^2 tests for each individual sentence revealed highly significant effects for sentences 2 and 3 ($p < 0.001$ for both) and marginal significance for sentence 5 ($p < 0.10$). Sentence 4 was also affected in this direction but only slightly ($p < 0.20$). Sentence 1 stands in contrast to the other four sentences in several respects. First of all, it was the only sentence that showed preference values for NP1 in its positive version;

Table 3. *Completions for positive verbs and negative verbs*

Sentence	Positive		Negative		(Verb)
	NP1	NP2	NP1	NP2	
1	52	1	56	0	sail (past)
2	3	50	29	26	kill
3	11	42	32	21	fear
4	13	41	19	31	blame
5	22	33	29	20	pick (up)
Total	101	167	163	98	

secondly, it differed from sentences 2 to 5 in that they all involved animate subjects and nonsubjects while sentence 1 had an inanimate subject and nonsubject; thirdly, and most importantly, sentence 1 involved a movable NP1 (rocket) and, for our purposes, a fixed NP2 (moon). This latter juxtaposition apparently restricted drift in attribution of cause independently of other factors that may be relevant to the antecedent choice.

In general, then, we may conclude that verb negation affects pronoun antecedent assignment. This obviously reinforces our earlier claim that the verb implicitly specifies a causality relationship between the nouns of a sentence, which to a major extent determines the direction of pronoun antecedent assignment.

III. Interrogative and Declarative

In Table 4 are presented the pronoun antecedent assignments for five sentences in the interrogative and declarative forms. As is immediately obvious from these results, there is no difference in the direction of pronoun assignment as a function of the two forms investigated. These results stand in contrast to those obtained for the active/passive variable discussed earlier. There a surface structure factor, presumably purely syntactic, significantly influenced the directionality of the pronoun assignment. In the present case, however, the surface structure variable we manipulated did not have any noticeable effects.

Table 4. *Responses to interrogative and declarative sentences*

	Interrogative		Declarative		
Sentence	NP1	NP2	NP1	NP2	(Verb)
1	40	12	39	14	sell
2	0	55	3	52	punish
3	25	26	19	35	help
4	32	18	34	13	miss
5	23	26	36	16	give
Total	120	137	131	130	

IV. Congruent–Noncongruent

The effects of congruent and noncongruent collocation of noun status with the lexical features of the verb are presented separately for verbs identified (in pilot work) as NP1's and NP2's. Table 5 presents the results of sentences with NP1's and Table 6 for those with NP2's. In both types of sentences the Congruent–Noncongruent variable has a large effect on choice of antecedent ($\chi^2_1 = 15.3$, $p < 0.001$ for data in Table 5 and $\chi^2_1 = 24.7$, $p < 0.001$ for data in Table 6).

Table 5. *NP1 verbs: Responses to congruent and noncongruent noun phrase–verb phrase collocations*

	Congruent		Noncongruent		
Sentence	NP1	NP2	NP1	NP2	(Verb)
1	41	9	20	30	argue (with)
2	55	0	45	3	confess (to)
3	50	1	50	1	join
Total	146	10	115	34	

Table 6. *NP2 verbs: Responses to congruent and noncongruent noun phrase–verb phrase collocations*

	Congruent		Noncongruent		
Sentence	NP1	NP2	NP1	NP2	(Verb)
1	8	44	22	30	praise
2	7	46	28	27	criticize
Total	15	90	50	57	

χ^2 tests for each sentence in Table 5 showed a highly significant effect for sentence 1 ($p < 0.001$) and sentence 2 reveals only a slight drift in assignment. Sentence 3 reveals no difference between the congruent and non-congruent collocations. χ^2 tests for the two sentences in Table 6 were both highly significant ($p < 0.001$).

Thus, Tables 5 and 6 together show that the status values of the NP1 and NP2, as these interact with the lexical meaning of the verb, appear to be a factor in determining pronoun assignment. These results provide independent confirmation of the interaction of components in sentential structures (Heise, 1970). The patterning of results for this complex variable suggests that the evaluative loading of the verb plays a role in producing a congruent collocation.

The results of Part II, the task which employed a framework containing verb and conjunction only, provided further evidence for the contention that sentences such as we have discussed can indeed be produced by subjects. The response scores (numbered in order of item presentation with items *read*, *won*, *scratch* omitted) are presented in Table 7. Response bias for verbs previously studied confirms earlier findings on directionality, i.e., *blame*, NP2, ($p < 0.02$) and *telephone* NP1, ($p < 0.001$). Further, the range of response bias obtained ranged from 61% for *blame* to 96% for *congratulate*, adding weight to the hypothesis that verb roots differ in the degree to which a bias toward causality is present.

Table 7. *Responses to unaccompanied verbs: Total number of N1 + N2 responses; number of N1 and N2 responses; percentage of dominant response/subordinate response; and level of probability*

Sentence Number		Total[a]	N1	N2	%	p(2-t)
	(verb)					
3	blame	96	37	59	61	0.0200
1	anger	87	55	32	63	0.0182
8	envy	91	20	71	78	0.001
6	love	93	20	73	78	–
7	admire	90	16	74	82	–
9	telephone	86	81	5	94	–
2	congratulate	100	4	96	96	–

[a] N = 110.

Discussion

Aside from the specific concern with factors affecting pronoun antecedent assignment, the results reported in the present studies bear on two general issues central to the explication of a comprehension model of language. First, the identification of structural components of a sentence that have psychological import; and, second, a specification of how these components relate to each other such as to permit the assignment of a semantic reading (comprehension) to a sentence.

To the extent that we have identified specific factors that affect pronoun antecedent assignment, we have also identified linguistic elements that must play a role in a psychological theory of comprehension. The significance of this rests upon the distinction that can be drawn between a linguistic and a psychological explanation of the relationship between sentence structure and meaning. It is considered the task of a linguistic grammar to assign a unique structural representation to any and all interpretations of a sentence, but the linguistic grammar is not required to account for a listener's selection of one or another possible meaning of an ambiguous surface structure. Rather, it is the task of a theory of comprehension to determine the means by which a listener assigns one or another possible readings to a given sentence token. To do so, it must explain how these operate in the selection of a particular interpretation. By identifying linguistic factors which contribute to obtained response bias in the comprehension of sentences with potentially ambiguous pronouns, we have attempted to uncover clues to the nature of the interpretive process. Consider the example (6) cited in the introduction:

(6) George telephoned Walter because he wanted sympathy.

As we pointed out, this sentence has at least two underlying representations: The pronoun *he* can be coreferential with either of the two noun phrases in the antecedent clause. With potentially ambiguous sentences of this type, it is often the case, however,

that subjects seem to prefer one reading over another. At the level of linguistic description this bias for one reading would be inconsequential – it would be ascribed to performance variables. At the psychological level, on the other hand, the bias supplies an important source of information on how a subject may actually determine the specific meaning of a particular sentence. Thus, to pursue this example further, if we find that for sentence (6) subjects generally tend to interpret the pronoun as coreferential with the first NP (George), then we must assume that there are some aspects of this sentence that "restrict" the interpretation of the sentence.* The identification of those variables that restrict the interpretation of the sentence and a description of the interaction of these variables is a positive step towards the development of a comprehension model of language.

In examining the factors that affect the assignment of pronoun antecedents, several interesting results emerge. First, individual sentence fragments appeared to evoke consistent biases in pronoun assignment in the sentence completion task. Even when sentences were presented in the form of questions to be answered rather than incomplete statements, there was little change in the proportion of NP1 to NP2 responses. In addition, these sentences that were common to Study I and II maintained remarkably consistent biases even though the nature of experimental materials and subject populations were clearly different.

In contrast to the stability of the effect over variables of age and context, several linguistic variables produced marked changes in the direction and extent of bias and thus are indicated as governing factors in the assignment of pronoun antecedent relations. The operation of these linguistic variables has been heretofore neglected, in part perhaps because purely grammatical cues, such as gender or number marking, often operate to assist the process of antecedent assignment. For example in (8)

(8) George telephoned Anne because she wanted sympathy.

the grammatical use of gender directly blocks alternative interpretations.

In particular, the semantics of verbs seems to be important, perhaps dominant, in determining antecedent choice. When verbs were given alone, they produced distributions comparable to those produced by questions or statements, i.e., they produced biases from extreme NP1 to extreme NP2. Also, a verb occurring in isolation, in clauses or in questions, was always biased in the *same* direction. (The single exception to this statement was the verb *help*. See page 232 above.) These results support the notion that a semantic property of the verb influences the selection of antecedents for ambiguous pronouns and further suggest that the influence operates both within and across sentential structures. The property itself was identified as 'implicit causality', a feature that selects one or the other of the available candidate nouns as primarily responsible for instigating the action

*In normal language use, of course, both linguistic and extralinguistic context would play an important role in the interpretation process. We are concerned here with those aspects which are basic to (though perhaps not limited to) intrasentential structure.

or state denoted by the antecedent clause (Garvey and Caramazza, 1974). This feature establishes a primary direction of cause in the antecedent clause; and, unless some modulating influence is exerted by other linguistic elements, the feature will proceed to assign the pronoun according to the direction established by the verb. The actual values taken by the causality direction feature are not binary. Rather, as indicated by the data, the strength of imputed cause should be conceptualized as varying continuously. Thus, as shown in Table 7, each verb varies in terms of the degree to which it restricts or determines a particular reading, e.g., the verb *telephone* strongly determines the choice of N1 whereas *anger* does so only weakly. Further evidence that supports our analysis of the relative importance of the verb as a major determinant of antecedent choice accrues from the results obtained with explicit negation of the verb. The fact that negation strongly influenced bias in pronoun-antecedent assignment clearly indicates that at least one important locus of antecedent determination is indeed the verb.

A possible objection to the existence of an implicit causality feature is that some other linguistic property of verbs might account more simply for the results reported here. For example, underlying relations of case (Fillmore, 1968) might explain the tendency of certain verbs to attract pronoun assignment to the underlying Agent or Experiencer of the antecedent clause. We propose that the sensitivity of bias to semantic properties of noun status in N–V–N collocations, e.g., *praise*, Table 6, and *argue with*, Table 5, rules out any direct relation between case structure and the implicit causality feature. In the congruent collocation, *The assistant argued with his boss*, a strong NP1 response was obtained. In the noncongruent collocation, *The boss argued with his assistant*, a weak NP2 response was obtained. The underlying case relations, however, would presumably be the same in both variants. Similarly, it does not seem possible to attribute the results of the active–passive sentence variants to an underlying case structure, since the structure would be the same for both variants. Thus, the postulated feature of implicit causality cannot be reduced in any direct way to deep case relations.

As for other possible semantic interpretations of these results, we should note that many 'NP2' type verbs reference emotional states on the part of the subject of the antecedent clause, e.g., *admire*. Some, however, do not, e.g., *punish*. Also, verbs which have performative potential in other constructions may be either NP1 types, e.g., *confess to*, or NP2 types, *congratulate*. These observations suggest but, of course, do not confirm the independence of the implicit causality feature in the semantic structure of verbs investigated here.

A final point on the analysis of the verb concerns the generality of the phenomenon described. The results obtained for the feature 'direction of causality' is not an artifact of the connective *because*. The direction of bias for specific verbs can be predicted to hold under other conditions. For example, *congratulate* led to NP2 responses and *confide* to NP1 responses when marked for past tense and in sentences connected by because. In (9) and (10) these verbs appear to maintain the same direction in future verb phrases and in sentences connected by *if* and *when*.

(9) NP2: Arthur will congratulate Henry $\begin{pmatrix} \text{if} \\ \text{(when)} \end{pmatrix}$ he gets the raise.

(10) NP1: Alice will confide in Mary $\begin{pmatrix} \text{if} \\ \text{(when)} \end{pmatrix}$ she gets in trouble.

These examples clearly attest to the generality of the phenomenon.

Two other factors that significantly affected the choice of antecedents were (1) the relative status of the person referenced in the two candidate noun phrases and (2) passivization. These factors are best thought of as modulating the causal valence of the verb rather than as operating independently in determining antecedent choice. That is, the effect of these last two factors is to attenuate or augment the causal valence of the verb and not to establish causality independently of the verb. Thus, in the case of the effect of the relative status of the two nouns in the antecedent clause, it seems that the status contrast between the two nouns interacts with the causal valence of the verb to produce a sentence-specific causal valence. The process through which the interaction actually emerges seems to involve the perceived plausibility of verb-established direction of causality in the context of permissible social relations obtaining between the referents of the two nouns.

Passivization is the variable examined which, at least superficially, seems to suggest a direct effect of a syntactic factor on pronoun antecedent selection. Whether this effect should be attributed directly to the syntactic properties of the passive versus the active forms or to the concomitant pragmatic effect of 'topicalization' which the passive form marks (Anisfeld and Klenbort, 1973) depends on whether a linguistic or a psycholinguistic level of explanation is stressed. A linguistic analysis would suggest that the passive element is either present or not present in the deep structure. If the surface structure reflex of this element interacts with the direction of causality of the verb in sentence comprehension, however, it does not apparently do so in an all or none fashion. We may consider that the marked topic (ordered by the syntactic transformation) exerts – for the listener – a bias value for NP1. This value then interacts with the directionality value of the verb to produce a sentence-specific value. This explanation is parallel to that advanced for the operation of the Congruence variable.

To conclude, we have demonstrated a technique whereby an implicit semantic feature can be related to a grammatical alternative (pronoun-antecedent assignment) and thereby made explicit. We have also demonstrated that pragmatic, syntactic and other semantic features interact in an orderly way with this implicit feature of causality in verbs. The next steps are to determine whether the interacting influences can be more precisely isolated in sentence comprehension processes and to study directly how listeners understand or comprehend what we believe to be not wholly ambiguous sentences.

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Résumé

Les deux expériences présentées ici, utilisant d'une part un groupe de sujets adultes, d'autre part un groupe de sujets agés de 10 à 13 ans, consistent à faire compléter des phrases de la forme:

NP_1–V–NP_2 Prénom...

Le fragment de phrase: "John a téléphoné à Bill parce qu'il..." induit des complétions du type, "...avait de bonnes nouvelles". L'impetus du verbe téléphoner est localisé en NP_1 (John). Le fragment de phrase, "John admirait Bill parce qu'il" induit des complétions du type, "...était un bon athlète". L'impetus est alors en NP_2 (Bill). Le choix de la référence du prénom de la subordonnée, en NP_1, ou en NP_2, montre le rôle du facteur de directionalité de la causalité. Celui-ci peut être déterminé par la racine du verbe. On a isolé ce facteur des traits sémantiques et syntaxiques avec lesquels il peut interagir. L'incidence plus ou moins importante du facteur de directionalité de la causalité, dépend de la manipulation de ces traits. Dans la discussion, on examine la portée de la technique utilisée dans cette recherche, pour l'étude de la sémantique des verbes et pour la mise en évidence, dans la compréhension psychologique du langage, de l'interaction de traits sémantiques pragmatiques et syntaxiques.