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Interface problems: Structural constraints on interpretation?

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Abstract

Five experiments investigated the interpretation of quantified noun phrases in relation to discourse structure. They demonstrated, using questionnaire and on-line reading techniques, that readers in English prefer to give a quantified noun phrase in (VP-external) subject position a presuppositional interpretation, in which the noun phrase limits or restricts the interpretation of an already available set, rather than giving it a nonpresuppositional or existential interpretation, in which it introduces completely new entities into the discourse. Experiment 1 showed that readers prefer a presuppositional interpretation of three ships over the existential interpretation in Five ships appeared on the horizon. Three ships sank. Experiment 2 showed longer reading times in sentences that are disambiguated toward the existential interpretation than in sentences that permit the presuppositional interpretation. Experiment 3 suggested that the presuppositional preference is greater when the phrase three ships occurs outside the verb phrase than when it occurs inside the verb phrase. Experiment 4 showed that Korean subjects marked with a topic marker received more presuppositional interpretations than subjects marked with a nominative marker. Experiment 5 showed that German subjects in VP-external (but nontopic) position received more presuppositional interpretations than VP-internal subjects. The results suggest the syntactic position of a phrase is one determinant of its interpretation, as expected according to the mapping hypothesis of Diesing (1990).

Keywords

language processing; syntax-semantics interface; cardinals; mapping hypothesis

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Consider the interpretation of three ships in (1):

(1) Five ships appeared on the horizon. Three ships sank.

Three ships has two interpretations. One interpretation presupposes that a set of three or more ships is already contextually available or part of the shared assumptions of the speaker/writer and listener/reader. On this “presuppositional” interpretation (Diesing, 1992) three ships in (2) is understood as three of the five ships already mentioned.

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The other interpretation is nonpresuppositional or “cardinal.” On this nonpresuppositional reading, three ships introduces three new ships into the discourse. This interpretation is the only interpretation of a sentence like There were three ships. In (1), the cardinal reading of three ships could be paraphrased as the “cardinality of the set of ships that sank is three.”

The present paper explores the possibility that structural factors, specifically position of phrases in some syntactic representation, affect the interpretation of discourses like (1), in addition to the undeniable influence of plausibility, discourse coherence, and the like. Diesing (1990, 1992) discussed the grammatical treatment of these ambiguities and proposed that whether a phrase receives an existential/cardinal or a presuppositional interpretation is determined by its position with respect to the verb phrase at Logical Form (LF). She advanced a general principle of interpretation, the “mapping hypothesis,” that relies on the distinction between phrases that are inside vs. outside the verb phrase (VP) at LF (see May, 1986, for discussion of LF). Material which is VP-internal receives a nonpresuppositional (cardinal, existential) interpretation. Material which is VP-external at LF receives a presuppositional (or quantificational) interpretation. VP-external (presupposed) material is presumed to limit the interpretation of VP-internal (existential) material in certain ways.

The mapping hypothesis can be formalized in the semantic framework of tripartite structures (Diesing, 1992; Partee, 1991), as illustrated in (2). Each tripartite structure contains an operator, a restrictor clause expressing restrictions on the domain of quantification, and the asserted materials which are called the “nuclear scope.” A quantifier is mapped onto the operator position; material outside the VP at LF is mapped onto the restrictor clause; and material inside the VP at LF is mapped onto the nuclear scope.

(2) Sentence:

The quantifier in (2) is every. The overt restrictor is woman. An implicit restrictor on the domain may also exist (von Stechow, 1994). For example, in a conversation about the women in a linguistics class, the domain of quantification in (2) might only include the women in the class. Both restrictors are presupposed. The nonpresupposed information is the predicate in the nuclear scope, laughs.

The mapping hypothesis applies at surface structure in some languages, e.g., Diesing offered German examples where a VP-external numeral phrase is claimed to only have a presuppositional interpretation. English is less restrictive¹. The subject of an English sentence is outside the VP at surface structure, allowing for the presuppositional interpretation, but it is frequently assumed to bind a trace inside the VP. At Logical Form (LF) the subject may be interpreted in the position of the trace inside the VP, giving rise to the existential/cardinal interpretation. In (1), the possibility of the existential interpretation of five ships is presumably due to the trace in the VP internal subject position. Given the presentational verb and the lack

¹Different languages have different relevant properties. Eg., see Longobardi, 2000, for discussion of the mapping hypothesis in Italian, and see Experiments 4 and 5 for discussion of German and Korean.

of any preceding discourse context, in (1) essentially must receive the nonpresuppositional/existential interpretation.

Returning to the interpretation of three ships in the second sentence, however, the phrase is ambiguous not just in principle but also given the actual preceding discourse context. The presupposition of the presuppositional interpretation is satisfied by the five ships mentioned in the preceding sentence. The existential interpretation carries no presupposition and hence there is no presupposition violation in this sentence.

Below we explore the preferences concerning the interpretation of mini-discourses like (1). One question is simply whether there is a tendency to interpret three ships presuppositionally. If so, is this preference due to a general tendency to favor presuppositional interpretations of phrases in all positions, perhaps because this helps the reader to integrate the new sentence into the preceding discourse, or is this tendency restricted to or stronger for phrases which appear in particular syntactic positions, e.g., VP-external positions?

Interpretive preferences

One could imagine that an interesting answer to the question of whether presuppositional or nonpresuppositional interpretations would be preferred, and why, might be developed by reference to widely-accepted analyses of the interpretation of pronouns and other anaphors. A pronoun or anaphor is generally assumed to find a preferred antecedent in a discourse, rather than introducing a new entity into a discourse. This amounts to saying that a pronoun receives a presuppositional interpretation: Its referent is presupposed to exist in the discourse. However, it is clearly too strong to claim that noun phrases in general, or more particularly quantified noun phrases like three ships in (1), typically receive presuppositional interpretations. Such phrases commonly introduce new entities into a discourse (carry a nonpresuppositional interpretation). We must begin to spell out when they receive a presuppositional interpretation (and be treated in some ways like an anaphor), and when they receive a nonpresuppositional interpretation.

Similarly, one could attempt to develop a prediction about whether the presuppositional or the nonpresuppositional interpretation is preferred based on speakers' and listeners' bias to relate new material to already given material. The principle of Referential success ("Favor analyses which succeed in referring to an entity already in the hearer's mental model of discourse over one that does not," Crain & Steedman, 1985) seems to suggest a preference for a presuppositional interpretation.² But whether the principle of referential success actually applies depends on how that principle is fleshed out. In our examples, e.g., Three ships sank, are the three ships already present in the discourse model, or not? In one sense, they are. If a set is available (five ships) in one sense its subsets are also available. But in another sense, the particular subset introduced by three ships is new. So the principle of referential success does not apply unambiguously to the examples studied here. Nevertheless, referential overlap may be important in establishing discourse coherence. Complete overlap may be a special case.

In a similar line, one might suggest that listeners prefer the presuppositional interpretation because they assume that a speaker is likely to continue talking about the same thing in successive sentences. This "continuity preference" explanation is vague, and it carries hidden assumptions. It assumes that when uttering Five ships appeared on the horizon the speaker is talking about five ships, rather than talking about what happened last night or about the recent

²The stronger Parismony Principle advanced by Crain and Steedman (1985), which favors readings with fewer unsatisfied presuppositions, does not apply to ambiguities like those in (1). Neither the presuppositional nor the nonpresuppositional interpretation has any unsatisfied presuppositions; the nonpresuppositional interpretation has no presuppositions, and the presuppositions of the presuppositional interpretation are satisfied..

naval battle. Further, it assumes that a partitive relation (the three ships were among the initial five) supports continuity better than some other relation (e.g., contrast; five ships returned from a battle, but the remainder of the fleet did not).

A more explicit version of this suggestion appears in Hendriks and De Hoop (2001), who discuss examples like those tested here, e.g. the example in (3).

(3) Ten students attended the meeting. Three spoke.

In an Optimality Theoretic semantics, they proposed that the principle of forwards directionality in (4) applies to the interpretation of such examples.

(4) Forwards Directionality (Hendriks and De Hoop, 2001): The topic range induced by the domain of quantification of a determiner (set A) is reduced to the topic range induced by the intersection of this determiner ($A \cap B$) [B is the set introduced by the nuclear scope, i.e. the VP.]

The principle basically specifies that after processing the first sentence in (3) the hearer expects the next sentence to be about the students who attended the meeting. The insight behind the forwards directionality principle seems related to a topic-based account: given a quantifier in subject position of one sentence, a very likely continuation of the discourse does seem to involve the intersection of the restrictor of the quantifier and its nuclear scope.

An alternative (or additional) approach, which we consider in the present paper, assumes that something along the lines of Diesing's mapping hypothesis applies to human sentence comprehension. Imagine further that readers follow a "minimal effort" principle and prefer to keep phrases in the same position at LF that they appear in at surface structure (see Frazier, 1987, for discussion of the "minimal attachment" principle in parsing which is similar in that it minimizes processing time and effort; see Frazier, 1999, 2000, for an extended development of minimal effort in the form of a "minimal lowering" principle). When three ships appears in subject position, as in (1), it is in a VP-external position at surface structure, and will by default be in a VP-external position at LF. It will therefore receive a presuppositional interpretation. Only if the processor moves the subject back into the VP at LF would we expect a cardinal reading of three ships. Thus, a preference for presuppositional interpretations should apply to sentence subjects, as in (1), due simply to a minimal effort strategy.

The experiments reported here examined discourses like (1), which are ambiguous between a presuppositional and an existential interpretation of the NP introduced in the final sentence. Experiment 1 tested the prediction that presuppositional (minimal effort) interpretations would be preferred in a written questionnaire study, and Experiment 2 provided confirmation in an online eyetracking study. Experiments 3–5 explore whether the preferences observed in Experiments 1 and 2 are modulated by the structural position of phrases, as expected under the assumption that the mapping hypothesis applies in sentence interpretation. Experiment 3 investigated the effects of presenting the quantified term (three ships) in English object vs. subject position (presumably biasing whether it is taken to be VP-internal). Experiment 4 investigated the role of topic and nominative markers on interpretation of corresponding Korean sentences. Experiment 5 examined German.

Experiment 1

Experiment 1 simply asked readers for their preferred interpretation of quantified noun phrases that appeared in sentence subject position. Readers were given a choice between a presuppositional and a nonpresuppositional interpretation.

Method

Materials—16 two sentence discourses were prepared. The first sentence always introduced a plural set into the discourse, as illustrated in (5) and (6).

(5) Five ships appeared on the horizon. Three ships sank.

(6) Many kids were playing in the park. When it started raining, some kids ran in.

The subject of the second sentence, the “ambiguous phrase,” could in principle be interpreted to pick out a subset of the already introduced set, on the presuppositional reading, or it could be interpreted to introduce additional entities into discourse, on the existential or cardinal reading. For example, in (5) three ships could be interpreted as three of the five ships or as three additional ships. A question was prepared for each experimental item. It queried the interpretation of the ambiguous phrases, e.g., “Were the three ships that sank among the five ships that appeared on the horizon? Yes__ No__” All experimental items appear in Appendix 1.

Procedure and participants—The materials were randomized together with 16 other two-sentence discourses that did not contain quantified noun phrases. Two lists were prepared with different random orders. All Experiment 1 items appeared in both lists; only the order of items and the form of the filler items differed across lists.

Seventy-five undergraduate students at the University of Massachusetts received course credit for participating in the experiment. They were instructed to read each discourse and answer a question about it by checking the appropriate (yes/no) answer.

Results

Overall, 65% of all responses chose a presuppositional interpretation. This is significantly greater than a presumed 50% “chance” baseline ($t(74) = 7.99$, $p < .001$; $t(15) =$, $p < .03$). The individual sentence means are provided in Appendix 1.

Discussion

A clear preference for a presuppositional reading of the ambiguous subject was observed in Experiment 1. While the preference for a presuppositional reading is probably very clear to the intuition of anyone reading this paper, it is a preference that requires an explanation. One explanation can be found in the mapping hypothesis (Diesing, 1992) and a minimal effort principle (Frazier, 1999, 2000) which predicted the preference. Other explanations can be found in the earlier discussion of the principles of Referential success and Forward Directionality and related principles. Experiment 2 began to evaluate whether these other explanations are sufficient, by examining both ambiguous and unambiguous discourses and evaluating the effects of plausibility, and in addition explored the on-line nature of the preference.

Experiment 2

A persistent question in psycholinguistic research concerns whether an interpretive preference is the result of a ruminative analysis, in which all available information is brought to bear, or the results of the initial analysis arrived at in real time while a sentence is being heard or read. If evidence supports the latter sort of effect, psycholinguistic theorists are often more willing to concede that the interpretive preference reflects principles governing a possibly-specialized human sentence processing mechanism.

Experiment 2 therefore investigated the processing of ambiguous subjects (three ships) in an eye movement recording study to determine whether the preference for a presuppositional reading could be observed on-line and in the absence of any judgment task. The mini-discourses from Experiment 1 were disambiguated by adding a third sentence consistent with the presuppositional reading (7a,c) or consistent only with the nonpresuppositional e.g. cardinal reading (7b,d). (Note, (7) includes marks indicating the division of the sentence into analysis regions, described below.)

(7)

- a. Five ships / appeared on the horizon. / Three ships / sank. / Two / were bombarded / by enemy fire. / (Ambiguous presuppositional)
- b. Five ships / appeared on the horizon. / Three ships / sank. / Six / were bombarded / by enemy fire. / (Ambiguous nonpresuppositional)
- c. Five ships / appeared on the horizon. / Three of them / sank. / Two of them / were bombarded / by enemy fire. / (Unambiguous presuppositional)
- d. Five ships / appeared on the horizon. / Three others / sank. / Another six / were bombarded / by enemy fire. / (Unambiguous nonpresuppositional)

If the ambiguous subject of the second sentence in (7a, b) is initially given a presuppositional interpretation, then following that sentence with a third sentence that requires a nonpresuppositional interpretation should disrupt reading of sentence three. In (7a) and (7b), the quantifier (two, six) of the subject of the third sentence biases or disambiguates its interpretation because of the relation of its cardinality to the cardinality of the phrase introduced in context. Our application of the mapping hypothesis predicts that the subject of the second sentence (three ships) would tend to be interpreted presuppositionally, as “three of the five ships.” In (6a) the third sentence can also be interpreted presuppositionally (“two of the three [or the five] ships”), which is consistent with the presuppositional interpretation of three ships in the second sentence. In (7b), the third sentence cannot be interpreted presuppositionally because its cardinality was always greater than that of the second sentence (and in all cases save two where the cardinality of the first sentence subject was specified, greater than that). Continuing the presumed presuppositional interpretation of the second sentence should be easier than shifting to a nonpresuppositional interpretation, leading to faster reading times for the third sentence of (7a) than of (7b).

The (7c) and (7d) forms were included as unambiguous controls. In (7c) the subjects of both the second and third sentences are unambiguously partitive and therefore presuppositional. In (7d) the subjects are unambiguously nonpresuppositional. Any differences in reading time between (7c) and (7d) must reflect lexical differences or differences in the plausibility of the presuppositional vs. nonpresuppositional interpretations. The basic prediction of the experiment is that there will be a reading time penalty in (7b) relative to (7a) in addition to any difference due to lexical or plausibility differences between (7a,c) and (7b, d). Reading time for the subjects of the third sentences cannot legitimately be compared across conditions, because the subjects in the unambiguous conditions (Two of them and Another six in 7c, d) differ from one another and cannot be lexically identical to the corresponding subjects in the ambiguous conditions (Two and Six in 7a, b).³ However, comparisons of the predicate of the third sentence are legitimate, since all conditions are lexically identical in the predicate.

³The materials were designed this way to make the quantifier of the third sentences directly comparable in (7a) and (7b), which they are not in (7c) vs (7d). This aspect of the design unfortunately made it impossible to directly compare the quantifiers of (7a) and (7c), or of (7b) and (7d).

Method

Materials—The 16 two sentence discourses of Experiment 1 were extended by adding a third sentence, illustrated in (7a) - (7d). This third sentence biased or disambiguated the quantified NP of the second sentence by being consistent with a presuppositional reading (7a, 7c) or with a nonpresuppositional reading (7b, 7d). Disambiguation was effected simply by the cardinality of the sets in (7a) and (7b) (and (7a) was not strictly speaking disambiguated, merely made consistent with a presuppositional reading). In contrast, (7c) and (7d) were sharply disambiguated by the subjects of both the second and the third sentences.

Four lists of these 16 discourses were constructed in a counterbalanced fashion, ensuring that each discourse appeared in only one version in a given list but that each discourse appeared once in each version across the four lists. A total of 61 other short discourses were added to each list. A practice list of ten sentences was also made. Twenty of the sentences were followed by a simple question (e.g., How many ships appeared on the horizon? Five or Two) to ensure that experimental participants were paying attention to the materials.

Participants—Data were collected from 48 undergraduate students at the University of Massachusetts, plus 16 who had to be discarded because of equipment problems. They participated in individual 45 min sessions for pay or for course credit. Each subject read the 77 discourses in a list, presented in an individually-randomized order, while their eye movements were recorded.

Apparatus—Eye movements were recorded from the right eye using a Fourward Technologies Dual Purkinje Eye tracker. Resolution of the eye tracker is less than 10' of arc. The eye tracker was interfaced with a microcomputer which controlled all phases of the experiment. Eye position was sampled every millisecond (ms). Onset of a fixation was defined as the point when five successive samples each differed from the sample taken five ms earlier by less than 1/3 of a character space. The onset of a saccade was defined as the point when three consecutive samples each differed from the prior sample by at least 1/3 of a character space.

The passages were displayed in standard upper and lower case format using cyan characters on a black background. Three horizontal character spaces equaled 1° of visual angle and the vertical distance between lines was about 2 line spaces, equal to 2° of visual angle. The brightness of the monitor was adjusted to a comfortable level for each participant. Participants' eyes were 80 cm from the monitor and viewing was binocular. The experimental texts occupied 2 to 3 lines and the maximum line length was 80 characters. To optimize the accuracy of the eye tracking data, the lines of the texts were arranged such that the target regions occurred in the central region of a line.

Procedure—Each participant was tested individually. A bite bar was made for each participant to help minimize head movements during the experiment. Participants were given a brief description of the eye tracker and were told that the purpose of the experiment was to study how people read. Participants were instructed to read at a comfortable pace. They were told that some of the passages would be followed by a two-choice alternative question. Once the instructions were understood, the eye tracker was calibrated.

Before reading each passage, a row of five fixation boxes was displayed where the first line of a text would appear. The participant was instructed to look at the middle box, and then to look at each box to the left until reaching the left-most box, which indicated the position of the first letter in the upcoming text. If the calibration was accurate, the experimenter initiated the trial. If there was any question, the experimenter had the participant look to the boxes on the right, and recalibrated if necessary. After reading the passage the participant pressed a response key,

which cleared the screen. On those trials for which there was a question, the cue ‘Question’ was presented for 500 ms, and then the question and alternatives were presented. Participants responded to the question by pressing the key corresponding to the correct alternative. The row of five boxes was displayed again, and the next trial was conducted. Half way through the experiment, participants were given a break.

Results

Following standard practice in analyzing eye movement data (Rayner, Sereno, Morris, Schmauder & Clifton, 1989), a variety of measures were examined. First, each two-sentence discourse was divided into regions as indicated in (7). For our purposes, the critical regions are Region 5, the quantifier phrase of the third sentence which disambiguated toward a presuppositional vs. a nonpresuppositional interpretation, and Region 6, the following region which was defined as the following word or string of words spanning at least seven characters.

The measures which proved to be most informative were first pass reading time (the sum of all fixation durations made in a region from first entering it to first leaving it) and total time (the sum of all fixations made in a region, including those made after the eye had left the region then returned). Since the length of Region 5 varied systematically among conditions, an attempt was made to correct for length differences by using a “deviation from regression” analysis introduced by Ferreira & Clifton, 1986 (cf. Trueswell, Tanenhaus & Garnsey, 1994). In this analysis, a linear regression equation is computed for each subject, based on all the data in the experiment, predicting reading time as a function of region length, and then the parameters of this regression are used to predict the expected reading time for the region of interest. The signed difference between the observed time and the predicted time is used as the statistic of interest, “adjusted reading time,” positive numbers being slower than predicted. Since Region 6 did not differ among conditions, and since the results of analyses of these adjusted times did not differ materially from analyses of unadjusted times, only the analysis of unadjusted times will be reported for Region 6.

The data appear in Figure 1 and Table 1. The former contains first pass adjusted times for all regions of the sentences, while the latter contains the unadjusted first pass and total times for the critical regions. Consider first pass times first. Recall that the lexical items in Region 5, the subject of the final sentence, differed systematically among the four conditions, making clear predictions about reading time impossible. This region was much shorter in conditions 1 and 2 than in conditions 3 and 4, resulting in faster reading time for the former than the latter (261 vs 409 ms). Adjusting first pass times for region length made the difference disappear or even reverse slightly (75 vs. 131 ms faster than predicted by length). There were too many missing observations in the short Region 5 of conditions 1 and 2 to do an statistical analysis. However, simple t-tests comparing the adjusted first pass times for Condition 3 (unambiguous presuppositional, 110 ms faster than predicted) and Condition 4 (unambiguous nonpresuppositional, 39 ms faster than predicted) indicated that the former was significantly faster ($t(1,47) = 5.09$; $t(1,15) = 3.14$, $p < .01$). There may have been a fast-appearing source of difficulty in the nonpresuppositional sentence, even when it is clearly disambiguated. However, this conclusion is uncertain, because the comparison involved the lexical items N of them and another N in all cases, confounding any comparison.

Clear predictions can be made about Region 6. A 2X2 analysis of variance of Region 6 first pass times with the factors ambiguity and presuppositionality showed a significant interaction ($F(1,47) = 4.08$, $p < .05$; $F(1,15) = 11.11$, $p < .01$). Both main effects were also significant (ambiguity: $F(1,47) = 8.03$, $p < .01$, $F(1,15) = 11.39$, $p < .01$; presuppositionality: $F(1,47) = 3.99$, $p < .06$, $F(1,15) = 9.10$, $p < .01$), but they reflect the same effect that gave rise to the interaction: Condition 2, the temporarily ambiguous nonpresuppositional form, was slower (at 570 ms) than the other three conditions, which did not differ from each other (and ranged from

463 to 490 ms). Disambiguating toward the nonpresuppositional form was costly in reading time, suggesting that readers preferred the presuppositional interpretation.

Total time data support compatible conclusions. Once again, in Region 5, Condition 3 was faster than Condition 4 according to simple t-tests (459 vs 546 ms in unadjusted time; $t(47) = 3.93$; $t(15) = 2.68$, $p < .05$). This may indicate difficulty in even the unambiguous nonpresuppositional form, or it may reflect lexical differences between the regions.

Considering Region 6, once again Condition 2 (ambiguous nonpresuppositional) was notably longer in total reading time than the rest (725 vs. an average of 608 ms., ranging from 582 to 624 ms). This time, the interaction was nonsignificant ($F(1,47) = 1.70$, $p > .15$; $F(1,15) = 2.29$, $p > .10$), although both main effects were again significant (ambiguity: $F(1,47) = 11.85$; $F(1,15) = 4.66$; presuppositionality: $F(1,47) = 5.47$; $F(1,15) = 9.05$; all $p < .05$). A more powerful test contrasted Condition 2 with the remaining conditions, and indicated a significant difference ($F(1,47) = 13.63$, $p < .001$; $F(1,15) = 9.05$, $p < .01$) while the differences among the remaining conditions were not significant (F and $F2 < 1$).

Discussion

Descriptively, the data show a quick disruption of reading immediately following a region that disambiguates the interpretation of a quantified NP in subject position in favor of a nonpresuppositional vs. a presuppositional meaning. Condition 2, the temporarily ambiguous nonpresuppositional condition, was read more slowly in Region 6 than Condition 1, the temporarily ambiguous presuppositional condition. The data also show possible evidence of earlier disruption when a syntactically unambiguous sentence forces a nonpresuppositional interpretation. The quantified NP was read slowly in Condition 4, the disambiguated nonpresuppositional condition, compared to the Condition 3, the disambiguated presuppositional condition. Neither disruption was massive, and the comparison of Conditions 3 and 4 at the quantified NP is difficult to interpret because of the lexical differences between the two conditions. Total reading times were only modestly longer than first pass reading times, suggesting that most subjects usually did not have to devote substantial time to re-reading sentences. Analyses not reported above indicated that some re-reading was done (e.g., the frequency of regressive eye movements out of Region 6 was greater in the ambiguous than the unambiguous conditions; 20 vs 12%, $F(1,47) = 7.53$; $F(1,15) = 6.39$; $p < .02$) but the amount was modest.

One possible view of the disruption shown in ambiguous nonpresuppositional items and possibly in unambiguous ones is simply that they are less plausible than presuppositional items, perhaps because they violate principles such as Referential success or Forward Directionality, or perhaps because they conflict with the “minimal effort” application of Diesing’s mapping hypothesis, discussed above. We explored this possibility by having 44 University of Massachusetts undergraduates rate the unambiguous versions of the items used in Experiment 2 on a five-point scale where “1” was “implausible” and “5” was “plausible.” Each subject saw the first two sentences from half the items in the unambiguous presuppositional version and other half in the unambiguous nonpresuppositional version. Two counterbalanced questionnaire forms were used, so that each item was tested equally often in each version. The mean rating of presuppositional items was significantly higher than the mean rating of nonpresuppositional items, 3.97 vs 3.64 ($t(43) = 3.10$, $p < .01$).

This plausibility difference is not unexpected, given the possibly greater naturalness of the presuppositional version. However, the difference might be a concern if it reflects idiosyncratic factors making individual unambiguously nonpresuppositional items implausible rather than a general dispreference for nonpresuppositional items. To evaluate this possibility, we computed the difference in plausibility between the presuppositional and nonpresuppositional

versions of each item and divided the items at the median of these differences. The mean difference was .77 for the eight items with the largest difference, and .10 for the eight items with the smallest difference. First pass eyetracking means for Region 6, the predicate of the final sentence, were computed for the items in each group. The time penalty for ambiguous nonpresuppositional sentences compared to ambiguous presuppositional sentences was 56 ms for the eight items with the largest difference in plausibility between nonpresuppositional and presuppositional forms, and 96 ms for the eight items with the smallest difference in plausibility. It thus seems unlikely that the overall effect of presuppositional status on reading times is due to adventitious implausibility of some of the nonpresuppositional items.

Experiment 2 provides an on-line demonstration of what was apparent in Experiment 1: Presuppositional readings are favored for quantified NPs in sentence subject position. It further suggests that the advantage of the presuppositional interpretation reflects an interpretive choice principle, not simply the greater plausibility of presuppositional readings. If presuppositional readings were harder, or unpreferred, simply because they are implausible, then we would have expected to find larger reading time penalties when the plausibility difference between presuppositional and nonpresuppositional readings is greatest. We did not. Further, if presuppositional reading were harder just because of their implausibility, we should have found slow reading times in the lexically-constant Region 6 for unambiguous presuppositional than for unambiguous nonpresuppositional discourses (as was found for temporarily-ambiguous discourses). We did not.

We do not want to claim that discourse continuity principles are irrelevant to the preference we observed for the presuppositional interpretation. But we do want to explore the possibility that they are not sufficient. They differ from the minimal effort application of Diesing's mapping hypothesis that we have described in that this latter application claims that the syntactic position of a phrase is also important. A phrase is often ambiguous between being presuppositional and nonpresuppositional, as in the case of the theme argument of a passive or active sentence. If the phrase appears in VP-internal position, readers should be less likely to take it as presuppositional than if it appears in VP-external position according to the mapping hypothesis, but not according to the continuity preference, Referential success, or Forwards directionality principle. Strictly speaking, the mapping hypothesis prediction depends on the position of the phrase in LF, not at surface structure. However, if Diesing's mapping hypothesis applies to normal reading in a minimal effort fashion, placing the ambiguous phrase in postverbal position should result in fewer presuppositional interpretations than placing it in subject position, as has been done up to now. In other words, readers will be more likely to compute an LF with the object interpreted in the VP when the object is placed in the VP in surface structure than when it occurs outside the VP at surface structure.

Intuition suggests that this prediction may be correct. Consider the discourses in (8) and (9).

(8) Three men were standing in the restaurant when I came in. The waiter beckoned to me.

(9) Three men were standing in the restaurant when I came in. I beckoned to the waiter.

Our intuitions suggest that the waiter is less likely to be one of the three men in (9) than in (8). That is, it is less likely to receive a presuppositional interpretation when it is in postverbal position than when it is in subject position. Experiment 3 tested this intuition.

Experiment 3

Method

The 16 two-sentence discourses used in Experiment 1 were modified to permit each one to have two versions, one which introduced the term whose presuppositional status is in question in subject position and one in postverbal (generally object or indirect object) position. An example, with following question and answers, appears in (10). All items appear in Appendix C.

(10)

- a. Five ships appeared on the horizon. Three ships were sunk by pirates.

Were the ships that pirates sank included in the five ships that appeared on the horizon?

YES NO

- b. Five ships appeared on the horizon. Pirates sank three ships.

Were the ships that pirates sank included in the five ships that appeared on the horizon?

YES NO

Four forms of a questionnaire containing these 16 items were constructed. No filler items were used. The subject version of eight items appeared on two forms together with the postverbal version of the remaining 8 items; the other two forms contained the alternate versions. Within a pair of versions, half the items appeared with YES on the left and NO on the right. An independent random order was used for each version.

Sixty University of Massachusetts undergraduates completed this questionnaire immediately after completing an unrelated on-line reading experiment. Fifteen completed each of the four forms.

Results

The discourses in which the ambiguously presuppositional term appeared in subject position (like 10a) received a presuppositional interpretation 65.2% of the time. Their postverbal counterparts (10b) received a presuppositional interpretation 59.0% of the time. This difference is significant by subjects ($F(1,59) = 4.08, p < .05$) and nearly significant by items ($F(1,15) = 4.54, p = .07$). A replication of Experiment 3 was carried out, using the same items, but this time randomly included among 56 other items of various forms, all requiring a choice between two interpretations. Forty-eight subjects from the same population were tested in the same way, except that this time the YES alternative always appeared on the left. In this replication, subject-position discourses received 66.2% presuppositional interpretations, and postverbal discourses received 60.9%. This difference was once again significant by subjects ($F(1,47) = 4.12, p < .05$) but not by items ($F(1,15) = 2.04, p > .15$). The lack of significance in the items analysis may be due to a lack of power caused by using only 16 items to observe a small effect. However, the joint probability under the null hypothesis of obtaining the reported by-items significance levels in Experiment 3 and its modified replication is less than .02. Thus, we are willing to conclude that the effect is real, even if it is small.

Discussion

Surface position (VP external vs. internal) of the quantified NP seemed to have a small effect on whether it received a presuppositional or a nonpresuppositional interpretation. The mapping hypothesis, together with minimal effort hypothesis, predicted the observed effect. However, one can legitimately ask, if VP external phrases receive presuppositional interpretations and

VP internal phrases nonpresuppositional, as we have claimed, why is the difference so small? (Though we note that an effect can be real even if it is small. The question is really whether it replicates.) One may also ask how a VP internal phrase can receive nearly 60% presuppositional interpretations. We suspect that various reasons are possible. There is certainly some slippage between position in surface structure and position at LF. The latter position is what matters, but the former is what we can manipulate. However, out of context, a reader can treat the sentence subject as introducing new information (by, e.g., putting focus on it) and thus as VP internal nonpresupposed information. Further, although it goes against the default mapping principle, a reader could treat material inside the surface VP as old, presupposed, information (“Who hit Jack? JILL hit Jack”), mapping it onto the nuclear scope (the asserted material, cf. (3)). Such interpretations go against our presumed minimal effort principle, whereby the surface position of a phrase is mapped into its interpretation as presuppositional or not, but minimal effort may be just one of many factors that influence interpretation. In the present case, discourse factors are likely to be part of the answer. But our point is that syntax too is playing a role.

Assuming that VP-external subjects in English tend to be interpreted presuppositionally when possible (Experiment 1 and 2) and tend to receive more presuppositional interpretations than VP internal phrases (Experiment 3) the important question is why? Must these results be attributed to the mapping hypothesis? In English, the highest subject seems to serve as the default topic. For example, pronouns typically take the highest subject as antecedent when it is available (Clifton & Ferreira, 1987) and repeated name penalties are observed for subjects (Gordon, Grosz & Gilliam, 1993, Gordon & Hendrick, 1997). This raises the question of whether the presuppositional preference observed in the preceding experiments might really be due not to the VP-external position of the numeral phrase but instead due to information-structure and the default topic status of the subject.

The possibility that topichood is what’s at issue in the preceding experiments may be assessed by examining a language where the subject is explicitly marked with either a topic marker or with a nominative case marker. Ideally one would like to test the effect of having a topic marker without varying the syntactic position of a phrase. Korean is, a language which contains both a topic marker and a nominative marker though, as will be discussed below, the question of the syntactic position of topics has not been fully resolved. Experiment 4 tests the preferred interpretation of Korean counterparts to the sentence tested in English to see if overt marking of a phrase as topic matters. Experiment 5 will then examine subjects that vary in whether they are VP-internal or VP-external, in German, where VP-external subjects occur in a within clause non-topic position.

Experiment 4

Method

The 16 mini-discourses of Experiment 1 (Appendix A) were translated into Korean. The first sentence was translated as literally as possible. The subject of the second sentence was translated either with a Nominative marker, as in (11a), or with a Topic marker, as in (11b). (See Schütze, 2001 and references therein for a discussion of case in Korean.)

(11) Bae daseos cheog-i supyeongseon – e natanassda

‘Ship five classifier-Nom horizon-postpos (“in”) appeared’

Nominative-marker:

a Bae se cheong-i chimolhaeda

‘ship three classifier - Nom sank.’

Topic-marker:

Bae se cheog - eun chimolhaeda.

‘ship three classifier-topic sank.’

The 32 mini-discourses made up of the two versions of the 16 sentences were presented without filler items in two counterbalanced questionnaires. Forty participants at Gyeongsang National University in Chinju, Korea indicated in individual or small group sessions whether the set of entities mentioned in the second sentence were included among the set of entities in the first sentence.

Results

67.5% of the participants chose the presuppositional (“yes, in the first set”) interpretation of the quantified NP when it was marked by a topic classifier. A significantly smaller 59.7% of the participants chose the presuppositional interpretation when the NP was marked as subject ($F(1,39) = 5.71, p < .05$; $F(1,15) = 5.86, p < .05$).

Discussion

The Korean results indicate that a numeral phrase marked as a topic is more likely to be interpreted presuppositionally than the same phrase marked as nominative. This result suggests that a topic-marked phrase may either corefer with the current discourse topic or in the circumstance tested here refer to a subset of the current discourse topic.

With respect to English, the results of Experiment 4 suggest that in principle the English results might be due to the default topic status of the highest subject. In principle, there might be no role for the Mapping hypothesis other than capturing the descriptive generalization that in English-like languages with VP-external subjects, the subject is the most likely topic.

One problem with this approach is that it would fail to capture the fact that in English there-constructions, the subject is not VP-external and cannot be interpreted presuppositionally (There is a/the man in the garden.). Similarly, in Italian (unmodified) bare nominals receive generic interpretations in VP-external/pre-verbal subject position but only existential interpretations in VP-internal/postverbal subject position (Longobardi, 2000). These and other facts support a broader generalization of the mapping hypothesis variety rather than the narrower generalization that likely-topics are interpreted presuppositionally.

Experiment 5

To further explore the issue, we turn to German. In German, phrases may scramble outside the VP, in front of a speaker-oriented adverb like ja doch ‘certainly’ or leider ‘regretfully’. A subject in this position (12a) is VP-external, but it is not in topic position. Topic position is higher in the structure and sentence-initial, i.e., it precedes the highest tensed verb. (Gegen Mittag is generally considered the topic in (12a, b).)

(12) Am Morgen sind fünf Schiffe am Horizon erscheinen.

‘At morning are five ships at horizon appeared.’

- a. Gegen Mittag sind drei Schiffe leider gesunken. (VP-external)

‘Around noon are three ships regrettably sunk.’

b. Gegen Mittag sind leider drei Schiffe gesunken. (VP-internal)

In the scrambled position, the subject is VP-external but not in topic position, allowing one to tease apart the topic-based account and the position-based account. If subjects in VP-external position receive more presuppositional interpretations than subjects in VP-internal position, this would support the broader generalization of the mapping hypothesis. However, if subjects in these two positions do not differ in how often they are interpreted presuppositionally, this would favor the view that the Korean and English results are due to topichood, not syntactic mapping constraints between syntactic position and interpretation.

The English sentences of Experiment 1 were adapted to permit the inclusion of an adverb, so that the position of the subject was unambiguous. Two forms of each mini-discourse were constructed. They differed only with respect to the relative position of the subject and the adverb, as illustrated in (12). When the subject occurs after the adverb, as in (12b), it is VP-internal. When the subject scrambles over the adverb, as in (12a), it is in VP-external position.

Method

Materials—The 16 two-sentence discourses of Experiment 1 were translated into German, as shown in (12). The first sentence was translated as literally as possible. The second sentence was translated with the following restrictions applying. First, SpecCP was filled with an adverbial. The part of the sentence following the finite verb contained the crucial indefinite NP (*fünf Schiffe/five ships*) as well as one of those adverbials which delimit the left edge of VP in German (cf. Diesing, 1992; Frey & Pittner, 1998), mainly sentential adverbials but also some temporal adverbials. The indefinite NP either followed or preceded this adverbial.

A question was prepared for each mini discourse. It queried the interpretation of the ambiguous phrase, e.g. “Gehörten die drei Schiffe, die sanken, zu den fünf Schiffen, die am Horizont erschienen? Ja __ Nein __” (“Did the three ships that sank belong to the five ships that appeared on the horizon? Yes __ No __”) for the discourses in (12). For each discourse, the same question was used for both orders of subject and adverbial.

Two lists of the 16 discourses were constructed in a counterbalanced way, ensuring that each discourse appeared in only one version in a given list and that each list contained the same number of discourses of each type.

Procedure and participants—The materials were randomized together with 16 other two-sentence discourses that did not contain quantified noun-phrases. Seventy-seven students of the University of Konstanz either received course credit or were paid for participating in the experiment. They were instructed to read each discourse and answer a question about it by checking the appropriate (yes/no) answer.

Results

The discourses in which the subject preceded the adverbial (like (12a)) received a presuppositional interpretation 72.3% of the time. Discourses in which the subject followed the adverbial (like (12b)) received a presuppositional interpretation 63.1% of the time. This difference was significant by subjects ($F(1,76) = 4.56, p < .05$) and almost significant by items ($F(1,15) = 3.57, p = .08$).

Discussion

The German results are informative. In VP-external position, subjects received more presuppositional interpretations than in VP-internal position. Further, the size of the effect (9.2%) is very comparable to the size of the topic-nominative difference in Korean. However,

as discussed above, the effect in German cannot be attributed to topichood: Neither the VP-external nor the VP-internal position is a topic position. It appears necessary to attribute the effect to whether the subject NP is internal vs. external to the VP, congruent with the Mapping hypothesis.

General Discussion

Are there structural constraints on the interpretation of a phrase or do discourse and the intrinsic properties of a phrase alone determine its interpretation? The present results address this question with respect to one ambiguity: the presuppositional vs. existential interpretation of numeral phrases.

Two striking generalizations emerge from the questionnaire data (Experiments 1, 3, 4, and 5). Overall readers preferred the more presuppositional interpretation of the ambiguous phrase -60% or higher in all cases. As noted earlier, this might be related to some principle like a continuity preference, referential success or forwards directionality - any principle which favors relating new material to old independent of position (although as discussed in Experiment 2, the principle apparently must act as an ambiguity resolution principle, not simply a source of added plausibility or felicity).

The second generalization about the questionnaire data is the close comparability of the distinct manipulations in the three languages: subject vs. object in English, topic vs. nominative in Korean, and VP external vs. VP-internal subject in German. Though the mechanisms for conveying information structure differ across these languages, the effect on interpretation is surprisingly similar. Indeed, Kaan and Wijnen (2001) have also reported data from Dutch examples similar to those tested here. They too found a preference for presuppositional interpretations.

The English and German examples can, of course, be attributed directly to the predictions of the mapping hypothesis. But what about Korean? Is it possible that the Korean examples too should be attributed not to the particular particle per se, but to distinct positions of the phrase the particle attaches to? Since the German results cannot be attributed to topicalization, they raise the question of whether the apparent topic effect in Korean might really be an effect of structural position. Although the order of constituents is the same for the Korean topic sentences and the nominative sentences, the position of the subject might differ. A Korean sentence may have a topic preceding the nominative subject, as in (13) (We are grateful to M. Kim for discussion of Korean syntax.)

(13) John - un sakwa-ka mat-iss-ta.

John-top apple-nom taste-exist-declarative.

‘As for John, apples are delicious,’

The grammaticality of (13) suggest that a topic phrase may occur higher than a nominative subject. Further, in sentences like (13) above or other types of sentences including both a topic and a nominative (e.g., 14), the nominative cannot be scrambled outside the topic phrase, appearing before it, unless it is given a special contrastive interpretation.

(14) Sakwa-ka John-un mat-iss-ta.

Apple-nom John-top taste-exist-declarative.

‘It is apples that John likes.’

If topic-marked subjects and nom-subjects occupied the same syntactic position, these facts would be surprising. There would be no reason to expect an ordering restriction or a special interpretation just in case the nominative subject occurs in front of a topic-marked phrase. If the nominative sentences we tested really have VP internal subjects, then assuming the topic phrase is VP-external, the Korean examples might in fact be further evidence for a structural effect on interpretation of the mapping hypothesis variety. In short, the German results prevent us from attributing all of the results of Experiments 1–5 to topichood. But nothing prevents all of the results being attributed to the mapping hypothesis.

Many interesting studies of information structure differences among languages exist (Valluvu and Engdahl, 1996, Frey, 2002, for example). The current work contributes to this tradition, we hope. Like the purely linguistic work, based on intuitive judgments, the current work suggests that it is not the intrinsic properties of a phrase alone that determines its interpretation. Nor is it just the discourse context in which the sentence containing the phrase occurs. It is also the structure in which the phrase occurs. Speakers use the devices available in the grammars of their languages to encode the (non-)presuppositional status of phrases. Across languages many devices are available. But where a VP-internal vs. VP-external choice exists presuppositional phrases preferentially occur outside the VP.

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Appendix A: Materials from Experiment 1 (with percentages of YES [presuppositional] answers)

1. Five ships appeared on the horizon. Three ships sank. Were the three ships that sank included among the five that appeared on the horizon? 80%
2. Dozens of stars were brought in for the European fashion show. Two models stumbled. Were the two models who stumbled included among the dozens of stars that were brought in for the fashion show? 65%
3. A group of teenagers approached a sleazy bar. Two teenagers slouched in. Were the teenagers who slouched in included among the group of teenagers who approached the bar? 85%
4. Many kids were playing in the park. When it started raining, some kids ran in. Were the kids who ran in when it started raining included among the kids who were playing in the park? 90%
5. Several animals ravaged our backyard. Yesterday two rabbits hopped by. Were the two rabbits included among the animals that ravages our backyard? 50%
6. We saw many planes in a brief visit to the air show. Two MIGs shot into view. Were the two MIGs included among the planes that were seen at the air show? 75%
7. An unknown number of people went to the outdoor concert. A few adults drove. Were the adults who drove included among the people who went to the outdoor concert? 85%
8. Some girls in my class went on a winter camping trip at a local park. Several girls walked. Were the girls who walked included among the girls who went on the camping trip? 65%
9. A group of boyscouts were stranded on an island during the recent flood. Many boys swam back. Were the boys who swam back included among those who were stranded on the island? 80%
10. More Americans are now vacationing in this country going to places like Disney world. Some tourists fly around. Were the tourists that fly around included among those Americans who are now vacationing in this country? 65%
11. Many kids didn't walk to school this morning. Three kids skateboarded here. Were the three kids that skateboarded here included among the kids who didn't walk to school? 90%
12. The roads were still flooded the day of our annual lake party. Many guests sailed here. Were the guests who sailed here included among those invited to the lake party? 100%
13. A group of soldiers came into view. Four soldiers limped. Were the four soldiers who limped included among the group of soldiers who came into view? 95%
14. Our kids had discovered the babysitter's hiding place and were ganging up on her. Two kids crawled. Were the two kids that crawled included among our kids who dicovered the hiding place? 55%
15. One hundred students participated in the high school graduation ceremony. Several students tripped. Were the students who tripped included among those who participated in the graduation ceremony? 100%

16. The tent roof collapsed during the tight-rope act last night at the circus. Three performers fell. Were the performers who fell included among those who were performing in the tight-rope act? 95%

Appendix B: Materials from Experiment 2

1. Five ships appeared on the horizon. Three ships sank. Two were bombarded by enemy fire.

Five ships appeared on the horizon. Three ships sank. Six were bombarded by enemy fire.

Five ships appeared on the horizon. Three of them sank. Two of them were bombarded by enemy fire.

Five ships appeared on the horizon. Three others sank. Another six were bombarded by enemy fire.

2. A dozen airplanes were visible from the terminal. Eight airplanes were on the runway. Four were cleared for take-off.

A dozen airplanes were visible from the terminal. Eight airplanes were on the runway. Nine were cleared for take-off.

A dozen airplanes were visible from the terminal. Eight of them were on the runway. Four of them were cleared for take-off.

A dozen airplanes were visible from the terminal. Eight others were on the runway. Another nine were cleared for take-off.

3. Four kites were being flown at the beach. Two kites were above the dunes. Two were rising over the parking lot.

Four kites were being flown at the beach. Two kites were above the dunes. Six were rising over the parking lot.

Four kites were being flown at the beach. Two of them were above the dunes. Two of them were rising over the parking lot.

Four kites were being flown at the beach. Two others were above the dunes. Another six were rising over the parking lot.

4. Five cars were stopped at the intersection. Two cars were turned over. Three at the periphery seemed undamaged.

Five cars were stopped at the intersection. Two cars were turned over. Eight at the periphery seemed undamaged.

Five cars were stopped at the intersection. Two of them were turned over. Three of them at the periphery seemed undamaged.

Five cars were stopped at the intersection. Two others were turned over. Another eight at the periphery seemed undamaged.

5. Four photographs were nominated for awards. One photograph was sold to a collector. Three were exhibited at the museum.

Four photographs were nominated for awards. One photograph was sold to a collector. Seven were exhibited at the museum.

Four photographs were nominated for awards. One of them was sold to a collector. Three of them were exhibited at the museum.

Four photographs were nominated for awards. One more was sold to a collector. Another seven were exhibited at the museum.

6. Nine sculptures were cleaned. Seven sculptures were painted. Two were repaired.
 Nine sculptures were cleaned. Seven sculptures were painted. Six were repaired.
 Nine sculptures were cleaned. Seven of them were painted. Two of them were repaired.
 Nine sculptures were cleaned. Seven others were painted. Another six were repaired.
7. Three billiard balls collided. One ball was moving unimpeded. Two were stationary.
 Three billiard balls collided. One ball was moving unimpeded. Ten were stationary.
 Three billiard balls collided. One of them was moving unimpeded. Two of them were stationary.
 Three billiard balls collided. One more was moving unimpeded. Another ten were stationary.
8. Four plants looked dry. One plant was dead. Three were dying.
 Four plants looked dry. One plant was dead. Eight were dying.
 Four plants looked dry. One of them was dead. Three of them were dying.
 Four plants looked dry. One more was dead. Another eight were dying.
9. A couple of players were photographed while clowning around. One player looked happy. One looked slightly drunk.
 A couple of players were photographed while clowning around. One player looked happy. Ten looked slightly drunk.
 A couple of players were photographed while clowning around. One of them looked happy. One of them looked slightly drunk.
 A couple of players were photographed while clowning around. One more looked happy. Another ten looked slightly drunk.
10. Four teachers held a conference to discuss policy. Three teachers wanted more rigid discipline.
 One argued for moderation.
 Four teachers held a conference to discuss policy. Three teachers wanted more rigid discipline.
 Ten argued for moderation.
 Four teachers held a conference to discuss policy. Three of them wanted more rigid discipline.
 One of them argued for moderation.
 Four teachers held a conference to discuss policy. Three others wanted more rigid discipline.
 Another ten argued for moderation.
11. Six reporters met in the hotel lobby. Four reporters were leaving Beirut. Two were quitting their jobs.

Six reporters met in the hotel lobby. Four reporters were leaving Beirut. Ten were quitting their jobs.

Six reporters met in the hotel lobby. Four of them were leaving Beirut. Two of them were quitting their jobs.

Six reporters met in the hotel lobby. Four others were leaving Beirut. Another ten were quitting their jobs.

- 12.** A handful of girls were dressed up. Two girls came in mini-skirts. Three wore pants suits.

A handful of girls were dressed up. Two girls came in mini-skirts. Twenty wore pants suits.

A handful of girls were dressed up. Two of them came in mini-skirts. Three of them wore pants suits.

A handful of girls were dressed up. Two others came in mini-skirts. Another twenty wore pants suits.

- 13.** A half dozen diplomats were invited to the meeting. Two diplomats gave long reports. Three walked out in protest.

A half dozen diplomats were invited to the meeting. Two diplomats gave long reports. Seven walked out in protest.

A half dozen diplomats were invited to the meeting. Two of them gave long reports. Three of them walked out in protest.

A half dozen diplomats were invited to the meeting. Two others gave long reports. Another seven walked out in protest.

- 14.** Six paramedics arrived at the accident immediately. Four paramedics rode in the ambulance.

Two came with the police.

Six paramedics arrived at the accident immediately. Four paramedics rode in the ambulance. Ten came with the police.

Six paramedics arrived at the accident immediately. Four of them rode in the ambulance. Two of them came with the police.

Six paramedics arrived at the accident immediately. Four others rode in the ambulance. Another ten came with the police.

- 15.** A few policemen were already at the scene. Two policemen lived near there. One responded to a call on the car radio.

A few policemen were already at the scene. Two policemen lived near there. Ten responded to a call on the car radio.

A few policemen were already at the scene. Two of them lived near there. One of them responded to a call on the car radio.

A few policemen were already at the scene. Two others lived near there. Another ten responded to a call on the car radio.

- 16.** Seven security guards were assigned to the front door. Three security guards were armed. Four only had radios.

Seven security guards were assigned to the front door. Three security guards were armed. Nine only had radios.

Seven security guards were assigned to the front door. Three of them were armed. Four of them only had radios.

Seven security guards were assigned to the front door. Three others were armed. Another nine only had radios.

Appendix C: Materials from Experiment 3. VP-external and VP-internal alternatives are separated by a/. Percentage of presuppositional answers are indicated in parentheses, first for the VP-external and then for the VP-internal alternative

1. Five ships appeared on the horizon. Three ships were sunk by pirates./Pirates sank three ships. (70%, 67%)
2. Dozens of stars were brought in for the European fashion show. Two models tripped on a loose carpet./A loose carpet tripped two models. (67%, 57%)
3. A group of teenagers approached a sleazy bar. Two kids got in past the bouncer./The bouncer let two kids in. (87%, 87%)
4. Many kids were playing in the park. Some kids ran inside to get out of the rain./The rain drove some kids inside. (87%, 83%)
5. Several animals ravaged our backyard. Yesterday two rabbits dug big holes./Yesterday big holes were dug by two rabbits. (97%, 63%)
6. Some girls in my class went on a winter camping trip at a local park. Several girls were punished by the teacher./The teacher punished several girls. (67%, 53%)
7. One hundred students received their high school diplomas at the graduation. Several students caught the flu./The flu hit several students. (60%, 60%)
8. Several animals headed for the trees. Two monkeys let out a sharp cry./A sharp cry escaped from two monkeys. (67%, 67%)
9. Many students entered the school accompanied by police. Two girls were stopped by the principal./The principal stopped two girls. (50%, 50%)
10. Twenty employees had circled the entrance to the driveway. Five employees were taken to the hospital in an ambulance./An ambulance took five employees to the hospital. (30%, 40%)
11. Several people moved toward the capitol. Two women were shot by a sniper./A sniper shot two women. (70%, 70%)
12. Many spectators were at the side of the lake. Three boys wearing baseball hats signaled a police boat./A police boat signaled three boys wearing baseball hats. (74%, 60%)
13. Two strangers entered the bank. One man guarded the door./The door was guarded by one man. (60%, 27%)
14. Loads of passengers disembarked at the border. Many angry Mexicans swarmed near the guard's door./The guard's door swarmed with many angry Mexicans. (60%, 70%)
15. Many serious-looking people entered the courtroom. Two black-suited men stood near the lawyers./The lawyers stood near two black-suited men. (50%, 57%)

16. Seven reporters entered the conference room. Two Americans were evicted by a guard./A guard evicted three Americans. (51%, 31%)

Figure 1.

Mean first pass reading time (in ms deviation from predicted time) for each region of sentences 2 and 3, Experiment 2. Region 5 is indicated by "Two..." and Region 6 is indicated by "were b'ded."

Table 1
Means of Unadjusted Eyetracking Measures, Experiment 2

Condition	First Pass Time, Unadjusted Ms	
	Region 5 (<i>two [of them]</i>)	Region 6 (<i>were bombarded</i>)
1. Ambiguous, Presuppositional	262	490
2. Ambiguous, Nonpresuppositional	260	570
3. Unambiguous, Presuppositional	372	463
4. Unambiguous, Nonpresuppositional	446	469
	Total Time, Unadjusted Ms	
1. Ambiguous, Presuppositional	281	624
2. Ambiguous, Nonpresuppositional	282	725
3. Unambiguous, Presuppositional	459	582
4. Unambiguous, Nonpresuppositional	546	617