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⁴ English has an adverb of completion that has a strong preference for event-type-related, as opposed to participant-related readings, namely *halfway*: (1b) unlike (6d), is unambiguous, allowing only for the event-related reading. But a participant-related is available in (1c).

(1) a. John is halfway drunk.
b. John halfway opened the presents.
c. John has halfway eaten the cake.

⁵ English *partly* has another function, which relates to the entire situation in question, rather than the described event. (1a) can mean part of what John was doing was playing with Mary. In this function, *partly* is not a VP-internal adverbial, as it is when it relates to the described event, but rather a VP-external sentence adverbial. This can be seen by usual tests for sentence adverbials, as given in (1b) - (1d).

(1) a. John partly played with Mary.
b. # John played with Mary partly.
c. (?) Partly, John played with Mary.
d. John (partly) has (partly) been playing with Mary.
Notice that the two functions of *partly* correlate syntactically and semantically with the two functions of adverbs like *rudely*, as is illustrated in (2) (cf. McConnell-Ginet 1982). VP-internal *rudely* (2a) and b) specifies a property of the described event, VP-external *rudely* specifies a property of the entire situation (2b and c).

(2) a. Mary departed rudely.
b. Mary rudely departed.
c. Rudely, Mary departed.

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Semantics of Common Noun Phrase Anaphora

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1 Introduction

This paper analyzes the semantics of common noun phrase—or \bar{N} —anaphora in English.² Even though this is not a common subject for theoretical investigation, the construction is varied and commonly used:

- Who are Abrams's supervisors?... Who are Browne's \emptyset ?
Are Abrams's accounts in domestic?... Whose \emptyset_i are these \emptyset_j ?
Who are the managers in printing?... Which \emptyset are in California?
Did GM order software?... Will they order any (more) \emptyset ?
Did GM order printers?... Will they order any (more) \emptyset ?
They tried two systems... How many \emptyset did they order?
They've tried several systems... Did they order (more than) a thousand \emptyset ?
but none \emptyset have worked out. Did they order the new ones?
but neither (one) has worked out. Did their order match P&G's \emptyset ?
and didn't stay with either (one). and none \emptyset have worked out.

several
(a) few
most
all
two
many
some
at least two
all but two
and
 \emptyset are adequate.

The paper is structured as follows: we first articulate background linguistic assumptions; then review the best known previous treatments (because \bar{N} anaphora is a relatively unfamiliar theoretical topic, the literature review section will also serve to introduce the main analytical problems in this field). We turn to a presentation of the situation semantics apparatus required for this analysis, and then the analysis itself. Finally, we examine the theory of anaphora which emerges from this treatment, especially in comparison to Gawron and Peter's (1990) treatment of VP ellipsis in Situation Semantics, and the distinction between "surface" and "deep" anaphora drawn by Hankamer and Sag (1976).

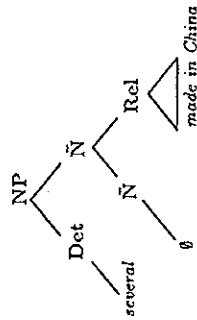
¹Stanley Peters suggested a substantial improvement in this paper, and Mark Gawron, David Israel, Ivar Tonkison, and Ivan Sag have made other useful suggestions. Remaining problems are ours.

²The analysis was developed and fully implemented for use in a natural language processing system, and it has been daily (experimental) use for over eighteen months.

2 Background Assumptions

2.1 Grammatical Preliminaries

Nerbonne, Iida, and Ladusaw (1989) provide extensive lexical and syntactic analysis justifying very standard grammatical structure for \bar{N} anaphors, even those with null heads. Semantics processing must then compute meaning representations for syntax trees e.g. of the following form:



There are therefore no idiosyncratic forms requiring "special interpretation". This simplifies the presentation of the semantics below, but does NOT restrict its generality. That is, we claim that a less pedestrian syntactic structure would complicate the rules mapping syntax into semantics, but the semantics itself could stand. The syntactic analysis tree serves only to vivify the analytical task in semantics.³

2.2 Assumption of Anaphora as Reuse

Gawron and Peters (1990:121) (citing Dahl, 1972) nicely formulate what has been an unarticulated, but a very standard assumption in dealing with VP ellipsis.

- (2) Elliptical VP Hypothesis: The described object of an elliptical VP is the described object of some other VP in the discourse.

It will be useful to distinguish two issues: One requirement of the elliptical VP hypothesis—that there be a linguistic, not contextual, antecedent that shares content with an anaphor—may clearly NOT be transferred to the case of \bar{N} anaphora, as we note below (cf. Section 3.1); we must allow for deictic binding.

But the elliptical VP hypothesis has the further import that the relation between the semantics of antecedent and anaphor be identity, not some more complex relation. This is a standard—though, as Gawron and Peters note, hardly unassailable—assumption in linguistic semantics. One import of this is e.g. that one NOT attempt to specify the semantics of \bar{N} anaphors as the value of some function applied to antecedents. Anaphor and antecedent must have the same content. We shall follow Gawron and Peters therefore in accepting the hypothesis of Anaphora as Reuse:

- (3) Anaphora as Reuse: The described object of an anaphor is either (i) the described object of its antecedent; or (ii) provided contextually.

2.3 Restriction to Extensional Semantics

\bar{N} anaphors can bind nominal senses, and not merely nominal extensions:

Jones had a real gun, and Smith had a fake one.
Jones is a fool, and ought to be regarded as one.

³Cf. Westerstähl (1984:51-53) for a technique of deriving appropriate restricted determiner meanings from sets which restrict the range of elements which determiners (and therefore, quantifiers) range over.

Both $[take(y)]$ and $[regard-as(x, y)]$ are intensional in the relevant (y) positions. (These are instances of so-called 'identity of sense' anaphora.) Our focus of interest here is on two sources of extensional interpretations of \bar{N} -bar anaphors. As we have nothing new to contribute to the analysis of these intensional cases and since any analysis which covered these cases as well would still have to account for the contrasts discussed below, we will henceforth restrict our attention to the extensional cases.

3 Previous Work on Semantics of \bar{N} Anaphora

We examine two theories of the interpretation of \bar{N} anaphora, a "textual" hypothesis due to Halliday and Hasan (1976), and defended in Webber (1978:3-1), and a "set" hypothesis due to Webber (1983:364-70).⁴ We use this examination to note properties of \bar{N} anaphora which we shall be concerned to account for.

3.1 A "Text" View

Halliday and Hasan view the antecedent as supplying a "text" (or in Webber's formulation a "description"), on the basis of which the anaphor is interpreted. Under this hypothesis, a phrase of the preceding text provides a restricting predicate for the anaphor. This view is interesting as a kind of "null hypothesis" because it postulates no abstract entities whatsoever, and it turns out also to be wrong for much the same reason. Dahl (1985:9) pinpoints the central theoretical flaw in the text hypothesis: \bar{N} anaphora is sensitive to WORD SENSE identity, not TEXTUAL identity. Her example:

- (4) ? Bill broke his leg falling over a log, and Lois entered it in her daily one.

Second, it is clear that the textual hypothesis cannot be a general account of the relation, since the relation need not be textual at all: in a sufficiently rich context, no textual antecedent whatsoever has to be found (cf. *'If take two at a food vendor's—Hankamer and Sag's 'deictic binding'; Hankamer and Sag, 1976*). Deictic binding is felicitous even in the absence of appropriate linguistic material.

A third reason for rejecting this textual theory is seen in examples such as the following:

- (5) Some friends of mine are coming over on Saturday
—Which ones?

The \bar{N} anaphor *ones* is understood as "friends of yours", which simply is not available in the text. We take this to be further evidence that some processing (interpretation) has been done to the text.⁵ These considerations move us to the unsurprising conclusion that some more abstract (semantic) relationship between antecedent and anaphor must be postulated; we turn now to a more promising candidate.

3.2 A "Set"-Reference View

The "set" hypothesis is introduced by Webber (1983:360), who aims to reduce the problem of \bar{N} anaphora interpretation "to the problem of identifying the possible resolvents of definite plural anaphors [*they, them*]; these refer to sets "evoked" by the context.⁶ Under the "set" hypothesis, we find a set in the discourse context and use it (or its characteristic predicate) to restrict the anaphor's range. It is worth noting that this view overcomes the difficulties which

⁴We regret that in our original survey of work on this topic we missed including Stump 1978, which provides a complete Montague-style analysis of common noun anaphora as variable-binding but does not assume a syntactic analysis involving NPs with null heads. This omission could not be adequately remedied given time constraints on the completion of this paper. Stump's account treats the identity-of-sense cases and what we have called the unrestrained readings, but does not handle the restrained readings on which we focus here.

⁵A similar argument about VP ellipsis may be found in Sag and Hankamer (1984:331), who attribute it to Partee (1975).

⁶Dahl (1985, 1988) subscribes to this view as well, though emphasizes her innovations in pragmatics.

founded the textual hypothesis: it allows abstract entities to interpolate between textual antecedent and anaphor; and it allows that these entities be provided by extralinguistic context or computations on linguistic elements. Under the "set" view, the interpretation of anaphoric one should be the same as the interpretation of *one of them*. Webber (1983:367-74) demonstrates these parallels in a number of cases.

For our purposes, the view that \bar{N} anaphors make reference to sets available in context is tied to an important observation about \bar{N} anaphora, which is illustrated in (6):

- (6) Ten students attended the meeting. Three \emptyset spoke.

We normally understand the \bar{N} anaphor in (6) as referring NOT to the entire set of students, but rather to those who attended the meeting. Notice that the \bar{N} antecedent *students* DOESN'T refer to the right set; Webber (1983) therefore allows that \bar{N} anaphors refer to sets "evoked" by the discourse. We refer to this reading of the \bar{N} anaphor as RESTRAINED, which we contrast with an UNRESTRAINED reading, e.g. the only reading available in (7):

- (7) Most deliveries were on time, but some \emptyset weren't

The reference to *some* in the second conjunct is clearly NOT understood as referring to "some of the deliveries that were on time".⁷ We shall accommodate the unrestrained reading, but not focus on it because it is theoretically less problematic.

Webber's 'set hypothesis' would require generalizing in order to handle the case of mass nouns (cf. the software examples in (1)). Our proposed generalization from 'set' to 'non-atomic individual' will handle these cases. Webber's attempt to reduce \bar{N} -bar interpretation to the interpretation of they/them would also find the 'identity of sense' cases mentioned above problematic. We shall claim as an advantage of our treatment that it can EXPLAIN the possibility of the restrained reading of (6) as a consequence of the semantic distinction between general and nongeneral NP's in situation semantics (Barwise and Perry, 1983; Barwise, 1987) (and discourse representation theory) and thereby partially systematizes Webber's notion of "evoking".⁸

4 A Situation Semantics Proposal

Our contribution to the semantics of \bar{N} anaphora is to refine Webber's "set" hypothesis, to make it more precise, and to ground the insight about the restrained readings of \bar{N} anaphors in the contemporary anaphora theories of Kamp (1981), Heim (1982), and Barwise (1987). Semantics is responsible for specifying the information carried by \bar{N} anaphors as well as the information in antecedents.

4.1 Representation of Plurals

Since crucial examples of \bar{N} anaphora involve plurals, and since our task is to make the "set" hypothesis more precise, we need a representation language which accommodates plurals. Here

⁷ Nor is it the case that the restrained property is used unless it leads to contradiction; this may be seen in examples such as the following:

Tom likes fast computers, and Dick likes sexy ones.

Dick is not normally understood as liking, of all the fast computers that Tom likes, the sexy ones; rather, he is understood to like sexy computers. This is the unrestrained, not the restrained reading.

⁸ It is worth noting a further point where we refine, or generalize, Webber's "set" hypothesis. We allow that antecedents contain parameters that must be re-anchored in the context of the anaphor:

Tom gave a picture of himself to Sue, and Lew gave one to Chris.

The most natural interpretation here is that Lew's gift was a picture of Lew, even though no such set is mentioned. We follow Gawron and Peters (1990:75ff *et passim*) and others in regarding the difference between the "sloppy" and "strict" readings as stemming ultimately from distinct contents for the antecedent, but we cannot attempt to justify these here. We would represent the different contents as follows: $\lambda x \text{ picture}(x, r)$ ("strict") vs. $\lambda x \text{ picture}(x, r)$, where $r \in \text{Reflexives}$ ("sloppy"). The latter construction is not reducible to a set. For Gawron and Peters' *affordances*, it might be worth adding that the example appears to strengthen the conclusions of Clapp, S.3, that anaphora may not be reduced to role-linking.

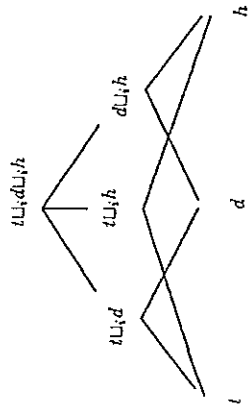


Figure 1: Sample of semilattice for plural reference (for 3-individuals). ' U_i ' is lattice join; ' \sqsubseteq ' holds if one can travel from a up to b along U_i -lines. E.g. $d \sqsubseteq d U_i/d U_i/h$.

we borrow from the now extensive literature on the logic of plurals and mass terms (Link 1983, 1987; Lenning, 1987, 1989, 1989a).⁹ The plural semantics is independently motivated and requires no special modifications for \bar{N} anaphora.

We begin therefore with a universe of discourse E upon which Link's familiar semilattice structure has been imposed, ordered by ' \sqsubseteq '. This is the relation that holds both between subgroups and groups, and also between individuals and groups containing them. The atoms in the lattice satisfy the predicate $\text{atom}(x)$, and they correspond to individuals; the nonatomic elements correspond to groups of individuals. Cf. Figure 1. We use D to designate the set of the atoms in E —corresponding to the nongroup individuals; this is appropriate since D corresponds to the normal domain of discourse. We shall let ' $\bar{\sqsubseteq}$ ' represent itself, and, let $x \text{ atom-} \bar{\sqsubseteq} y \Leftrightarrow \text{atom}(x) \wedge x \bar{\sqsubseteq} y$. Link furthermore requires that the lattice be complete, so that we may allow, for any predicate of atoms P , that $*P$ refer to the supremum of $[P]$, i.e. $[*P] = \vee [P]$; this is just the lub (under ' $\bar{\sqsubseteq}$ ') of the atoms in $[P]$. To ease reading formulas in the plural logic, we shall follow the typographical convention of using uppercase variables where the variables are restricted to plural entities (though this does NOT correspond to any distinction in the logic).

We let CN phrases refer to these lattice suprema, so that unrestrained readings of \bar{N} anaphors simply reuse the semantic contents of the restrictors of their antecedents. The restrictors are then just the interpretation of the \bar{N} heads of the NP's. Ignoring the nonreferential cases (cf. Section 2.3 above), we obtain the result that the anaphors cohere with the restrictors of their antecedents; they thus use the same "sets".^{10 11}

"[Most] employees [have pc's]" "Several \emptyset [have printers]"

- (8) \bar{N} Antecedent Meaning \bar{N} Anaphor Meaning

*employee

\bar{N}

\bar{M} is just a variable over nonatomic elements of E , i.e. $E - D$. Of course, the \bar{N} anaphor can be arbitrarily complex in meaning. For example, the reduced relative example from Section

⁹The generalization to cases involving mass reference is straightforward, but space prohibits examining it separately.

^{10 11}In these quantified logical forms, in which variables range over plural entities, have-truth conditions which depend on the lattice atoms, and atomic quantifiers, Link (1987) discusses the need for genuinely quantifying over the plural entities.

¹²We might include [Count/Mass: Count] in semantics such as (8), because, as Dahl (1985:8) notes, one anaphor can count nouns which may not use mass noun antecedents (and while there is no general restriction on null head anaphors, determiners such as *several* may require plural—and therefore count—head nouns):

*I hate hot oatmeal, but I like cold one(s).

(2.1), \emptyset made in China, would be represented semantically as $\mathcal{M} \cap_i (\sigma Y) \exists z (\text{make}(z, Y, \text{China}))$. In every case the \bar{N} containing the \bar{N} anaphor will be represented as a nonatomic individual containing a variable (\mathcal{M} above) which ranges over $E - D$, and which must find a binding in discourse. Where there is no modification of the \bar{N} anaphor, the \bar{N} meaning is exactly \mathcal{M} .

4.2 Nongeneral NP's

SITUATION SEMANTICS (Barwise and Perry, 1983; Gawron and Peters, 1990) distinguishes general NP's such as *no logician* or *few students* from nongeneral ("singular") NP's a *professor*, *two customers* (Barwise and Perry, 1983:290-291; Barwise, 1987). The latter can be used both to refer and to describe, while the former cannot be used for either purpose. Formally, this distinction is captured by translating general NP's as quantifiers and nongeneral NP's as restricted parameters, a kind of term.¹² As terms, crucially, the nongeneral NP's REFER. From the reference of nongeneral NP's we obtain further properties which \bar{N} anaphors may exploit.

As illustration, we provide the rule of interpretation for noun phrases consisting of the nongeneral determiner *some* in construction with plural \bar{N} 's. Given that the \bar{N} denotes a supremum in the lattice of individuals, the function of the nongeneral determiner is to pick out a subelement of this supremum—to which crucially the nongeneral NP refers. For example,

$$(9) \{[\text{some } \bar{N}]_{NP}\} := X : \neg \text{atom}(X) \wedge X \subseteq_i \bar{N}$$

Thus a plural NP determined by *some* REFERS to some nonatomic individual-part of the supremum denoted by its head. 'X' is a parameter ranging over elements that satisfy its restriction, i.e. everything to the right of the abstraction colon. As a restricted parameter, X is a term with a denotation. This denotation may (and of course may just as well not) fall within the extension of nonlogical predicates, and it may be anaphorically referred to, e.g. by the plural pronoun *they*.

The employment of plural terms in natural language meaning representations is desirable because it provides an account of essentially plural predicates such as *meet*, *disperse*, and *be numerous*. Using plural terms in pragmatics not only provides antecedents for plural pronouns (*they*, *them*), but also enables us here to give an account of the very typical interpretation of the \bar{N} anaphor in (6): this anaphor uses its antecedent NP's reference (X introduced in (9)) to derive its own. Since this X has been asserted to have attended the meeting, we understand the anaphor as referring to the students who attended the meeting, and the discourse can only be satisfied if three of them spoke.

Figure 2 illustrates how the semantics of expressions involving \bar{N} anaphors is calculated in exact analogy to sentences with nonanaphoric \bar{N} 's. The meaning of the \bar{N} anaphor is simply a variable ranging over nonatomic elements of the domain, E (before it has been supplied a binding). The antecedent of the \bar{N} anaphor must denote an element in $E - D$, and there are two candidates in the example under consideration. These are the \bar{N} and NP nodes (cf. Figure 2).

The binding required for restrained readings binds the individual-sum variable to the denotation of the antecedent NP, $X | X \subseteq_i \text{student} \wedge |X| = 10$. If this binding is adopted, we can obtain the required result, viz. that the discourse only holds if three of the students who attended spoke. We sketch a semantic proof of this below, where assumptions derived from Barwise's semantics for restricted parameters are noted as "model definitions". The key here is step 3, an object language substitution, which is valid only because the same variable assignment function must be used for all of the sentences in the discourse.

¹²The situation semantics distinction parallels a distinction made within discourse representation theory (Kamp, 1981; Heim, 1982)—general NP's map semantically to novel discourse representations (and therefore scopes), while nongeneral NP's map effectively to terms. For present purposes, this is identical to the situation semantics proposal, and any credit attached to the one should accrue to the other as well.

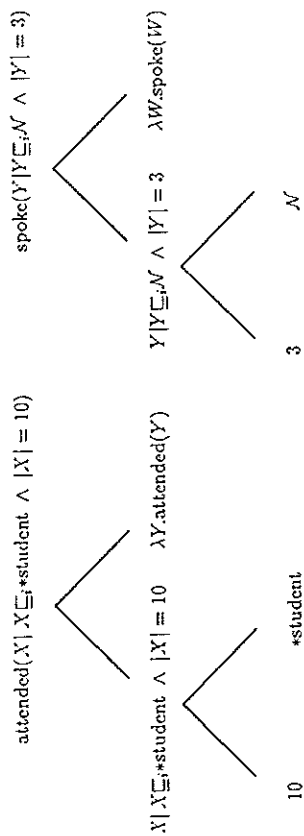


Figure 2: Semantics of "Ten students attended. Three theta spoke." Note that there are two candidate antecedent bindings—the NP and the \bar{N} meanings—with denotations in the range of \mathcal{M} , i.e. in $E - D$.

- 1 spoke(Y|Y ⊆_i M ∧ |Y| = 3) assumption
- 1' [Y] ∈ [spoke], |[Y]| = 3 model definitions, 1
- 2 attended(X | X ⊆_i *student ∧ |X| = 10) assumption
- 2' [X] ∈ [attended], [X] ⊆_i V[student] model definitions, 2
- 3 spoke(Y|Y ⊆_i(X | X ⊆_i *student ∧ |X| = 10) ∧ |Y| = 3) substitution, X for N
- 3' [Y] ⊆_i [X] model definitions
- 4 [Y] ⊆_i V[student] transitivity of ⊆_i; 2', 3'
- 5 z₁ ⊆_i z₂ ∧ z₂ ∈ [attended] ⇒ z₁ ∈ [attended] [attended] ⊆_i -closed (distributive) 2', 3', 5
- 6 [Y] ∈ [attended] 1', 6, 4
- 7 [Y] ∈ [spoke], [Y] ∈ [attended], [Y] ⊆_i V[student], |[Y]| = 3 model definitions, 7
- 7' spoke(Y|attended(Y) ∧ Y ⊆_i *student ∧ |Y| = 3) model definitions, 7

Thus the normal understanding of the restrained readings is rendered well by the the restricted parameter analysis; the unrestrained readings, as we noted above, are straightforward.

It is also worth noting that both of the readings are obtained by binding a variable to a semantic content which previous discourse has made available. The analysis therefore upholds the Anaphora as Reuse assumption (from Section 2.2).

4.3 Missing Restrained Readings

We can now examine a further prediction: general NP's do not refer (in the Situation Semantics view); accordingly, they function as \bar{N} antecedents only for unrestrained interpretations. Thus (10), unlike (6), has no restrained interpretation (the semantics of (10) is sketched in Figure 3):

(10) Few students attended. Three theta worked.

In other words, the second sentence in (10) is not understood to mean that three of the students who attended worked, but rather only that three students worked. In fact, this is an old observation. Webber (1979:2-17) suggests contrasts like the following:

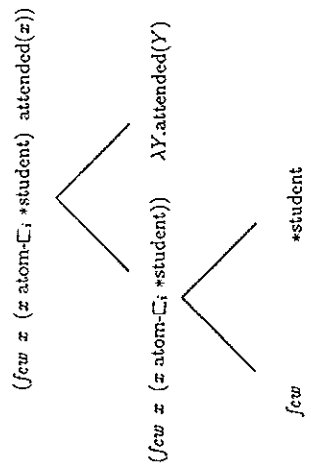


Figure 3: Semantics of "Few students attended." Note that the only candidate antecedent binding for \bar{N} anaphors here is *student ; the NP denotation is a quantifier, not in $E \rightarrow D$.

- (11)
- $\left\{ \begin{array}{l} \text{Few} \\ \text{Not many} \\ \text{Almost all} \\ \text{Not all} \end{array} \right\}$ linguists got drunk. Two \emptyset went home early.
 - $\left\{ \begin{array}{l} \text{Some} \\ \text{Several} \\ \text{More than half the} \\ \text{Ten} \end{array} \right\}$ linguists got drunk. Two \emptyset went home early.

Webber noted that the second group of determiners systematically allowed what we have dubbed the "restrained reading", and went on to propose postulates (Webber, 1979, Chap.2) about the ability of these determiners to "evoke" discourse entities to which reference can be made. These postulates could be extended to cover other cases, but they still would not follow from a theory of nominal denotation and logic.¹³ The situation semantics division between nongeneral vs. general NP's systematizes some of Webber's postulates. According to this division, there are, on the one hand, nongeneral NP's, which DENOTE the entities to which later references are made; and there are general NP's, which denote generalized quantifiers, to which no later reference is possible. Moreover, there are logical differences between the two classes which interact crucially with this classification—the quantificational force of nongeneral NP's depends on their logical context.

Let us note here that this fundamental tenet of Situation Semantics (and Discourse Representation Theory), the division of NP's into nongeneral (normally referential) and general (quantificational), results in a correct prediction about the distribution of restrained and unrestrained readings for \bar{N} anaphors.

4.4 Partitives—Nonanaphoric Empty \bar{N} 's

It is worth noting that, according to some analyses, partitives and determined \bar{N} anaphors are syntactically parallel (Nerbonne, Iida, and Ladusaw, 1989). These nonanaphoric uses of empty \bar{N} 's are *apparent* restrained readings of \bar{N} anaphors with general NP antecedents; in every case, we claim that the readings are not genuinely distinct, but merely subcases of readings we propose:

¹³Most linguists know Halle's syllogism. Some \emptyset learn it by heart.

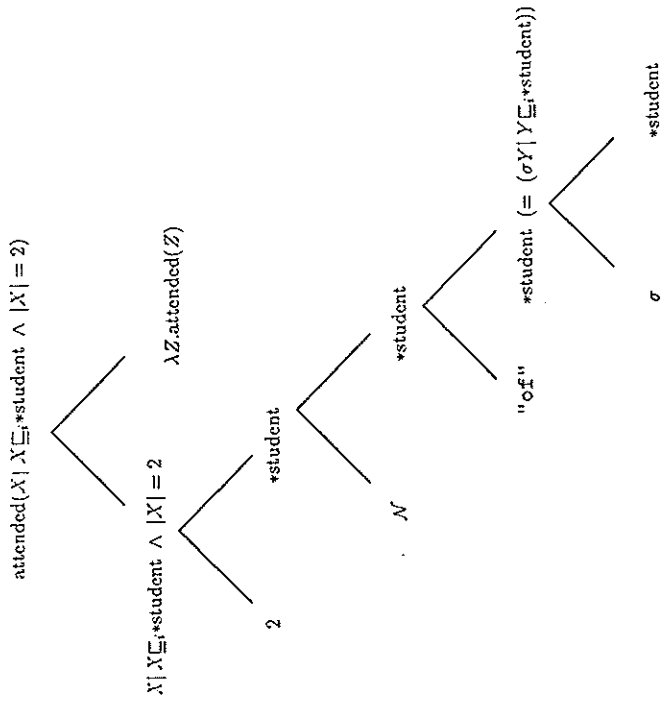


Figure 4: Semantics of the partitive "Two of the students attended."

\bar{N} s readily submit to analysis along the lines proposed here, as Figure 4 illustrates.

4.5 Parametric Objects

The Situation Semantics perspective further suggests that the meaning of the \bar{N} in the case of general NP's should not always be a simple object—plural object, set or property—but rather that it can more generally be a parametric object—one which contains a parameter. Following Barwise (1987), Rooth (1987), and Gawron and Peters (1990a), Geach's donkey sentence, *Every farmer who owns a donkey beats it*, receives an analysis in which the \bar{N} *farmer who owns a donkey* denotes a parametric object corresponding to the sum of farmers who meet a condition involving a parameter Y :

$$\text{*farmer } \bar{c}_i (\sigma X | \text{own}(X, Y | Y \bar{c}_i \text{*donkey} \wedge |Y| > 1))$$

From the parametric \bar{N} denotation, we can derive the parametric property of being an atomic individual which is part of the denotation. The determiner 'every' is then a relation between parametric properties; it holds between $\langle X, P, Y, P' \rangle$ just in case every individual in X with respect to parameters P is also in Y with respect to $P' \supseteq P$.¹⁴

¹⁴We are following a suggestion from Gawron and Peters (1990a) here about the parameterization of the restrictor set. Barwise and Rooth parameterize differently; according to them, the restrictor denotes a set of pairs of farmers and variable assignments satisfying the predicate (in particular assigning an index associated with a donkey to a donkey owned by the farmer in the pair). We use the Gawron/Peters reformulation for its simplicity. It is also worth noting that we have not followed Gawron and Peters where they suggest using *every* generalized quantifiers (relativized to appropriateness conditions).

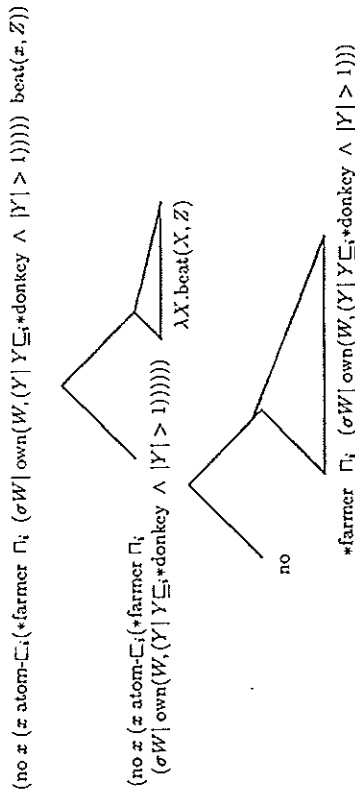


Figure 5: Semantic Analysis of "No farmer who owns several donkeys beats them."

The crucial point for present purposes is that, when an \bar{N} anaphor uses one of these meanings as antecedent, the parameters are available for use as well (cf. Figure 5 for an illustration of the semantics we assign to the first sentence in (12):

- (12) No farmers who own several donkeys beat them. Few \emptyset even scold them.

It is important to note that *them*, in (12) can mean "the donkeys they own", and not merely "donkeys", since "they/them" is not restrictive about scope.¹⁵ But this is the case on the preferred reading. Note that the only explicit antecedent candidate for *them* is trapped within the scope of the general NP *No farmers who own several donkeys*, so that the preferred reading is completely unexpected unless the \bar{N} anaphor supplies a parameter which can function as antecedent. But this is exactly what it does on the Situation Semantics analysis.

Recall that the introduction of parametric objects was initially motivated by rather different concerns: (i) general and nongeneral NP's have different logics (e.g. indefinite NP's have universal force in the antecedents of conditionals, etc.); (ii) general and nongeneral NP's have different notions of scope—general NP's define a scope, nongeneral NP's identify their scope via a genuinely scope-inducing logical context (general NP's, negation, etc.). This explains the difference in anaphoric potential. We take the possibility of anaphoric reference to the parameters within a parametric object as a third striking confirmation of the postulation of the parameters.

4.6 Summary of Analysis

We have advanced the analysis of \bar{N} anaphora here in the following points:

- generalization from *one's* anaphora to \bar{N} anaphora
- systematization of some of Webber's postulates about "evoked" entities, which are analyzed as the denotations of nongeneral NP's
- discovery and analysis of \bar{N} anaphors rousing the parametric contents of \bar{N} 's (12)

¹⁵A further qualification is that unused parameters are not available for reuse. This is not part of our formal account, though we hope to incorporate it.

• No farmers who own several donkeys, need trainers. Few \emptyset even scold them.

We can assign a nonparametric object to the \bar{N} antecedent and still obtain a correct semantics; we believe this is the reason why the parameters are unavailable for reuse.

Several points which require further work also deserve mention:

- intensional readings (cf. Section 2.3)
- explanation of why the only parameters which may be reused by anaphors are those which are actually used—and not merely available for use—by the antecedent. Cf. note 15 above.
- an account of "Skolem individuals", i.e. references such as (cf. Webber, 1979:3-24):

Each boy gave Wendy a T-shirt. The red ones she found too gaudy.

5 Theory of Anaphora

We turn here to the more general question of how the present analysis of \bar{N} anaphora informs the more general theory of anaphora. The point in this section is to show how the application of parametric objects just proposed illuminates an influential typology of anaphoric processes proposed by Hankamer and Sag (1976).

5.1 "Surface" and "Deep" Anaphora

Hankamer and Sag proposed a dichotomy of anaphoric processes: DEEP anaphoric processes, on the one hand, are fundamentally contextual and thus relatively free of syntax; SURFACE anaphoric processes, on the other, are quite closely tied to particular forms and constructions. We shall explicate this further below, but let us note here that, so drawn, the demarcation makes anaphoric type a matter of information resources. Surface anaphora has access to the syntax module, as it were, while deep anaphora does not. We propose in this section that the surface vs. deep dichotomy may correspond more precisely to a difference in semantic content. Put briefly, we propose that surface anaphora is to potentially parametric objects, while deep anaphora is to nonparametric objects.

Hankamer and Sag take VP ellipsis as a paradigm case of surface anaphora, and sentential anaphora with it as paradigm deep anaphora. They provide three test for the two types:

- only deep anaphors may refer in the absence of a linguistically explicit antecedent.
- only surface anaphora must meet constraints of syntactic parallelism
- only surface anaphora harbors MISSING ANTECEDENTS

Figure 6 summarizes and illustrates these distinctions.

5.2 \bar{N} Anaphora as Surface Anaphora

It is worth clarifying the term "missing antecedents", since we shall be concerned with the analysis of the phenomenon. For example, the antecedent of the pronoun *it* is missing in the example from Figure 6, repeated below for convenience. In particular, the antecedent cannot be the NP *a dog*, since that is in the scope of negation and unable to function as antecedent:

- (13) \bar{A} didn't buy a dog, but Bo did, and it's [=dog] big.
 \ast \bar{A} didn't buy a dog, and it's [=dog] big.

We wish here to demonstrate that (12), repeated here for convenience, contains an example of a "missing antecedent", i.e. a case in which the pronoun *them* could NOT have been licensed by the explicit NP *several donkeys*, but could only be licensed by material "missing" in the anaphor *few*.

No farmers who own several donkeys beat them. Few \emptyset even scold them.

Distinguishing surface and deep anaphora		
Behavior	VP Ellipsis	Sentential <i>it</i>
Deictic Binding	* <i>Al</i> did \emptyset . [discourse initial]	<i>Al</i> did <i>it</i> !
Syntactic Parallelism	*The kids had to be scolded, so we did \emptyset .	The kids had to be scolded, so we did <i>it</i> .
Missing Antecedents	<i>Al</i> didn't buy a dog, but <i>Bo</i> did, and <i>it's</i> [=dog] big.	* <i>Al</i> didn't buy a dog, but <i>Bo</i> did <i>it</i> , and <i>it's</i> [=dog] big.

Figure 6: Behavior of Hankamer and Sag's surface and deep anaphora.

The pronoun *they*₁ could not be licensed by the explicit NP *several donkeys* because it necessarily falls outside its scope, closed by the "trapping" quantifier *No*. So it is an unavailable antecedent. One might try to avoid this conclusion, for example by noting that the plural anaphor *they* does not obey scope restrictions as strictly as its singular counterparts, *she*, *he* and *it*. For example, the following is certainly felicitous:

(14) No farmers who own several donkeys beat them₁. They₁ are too valuable.

But this use of the pronoun can only refer to a group of donkeys. Given this binding, we would expect the second sentence in (12) to mean simply that few of the farmers in question scold that group of donkeys—which it perhaps can mean. Nonetheless, the more prominent reading is the one, roughly, that few farmers who own several donkeys scold THE DONKEYS THEY OWN. This is the reading we capture on the parameterized property analysis. And on this reading, there is simply no appropriate antecedent for *them*₁—it is missing. Thus \bar{N} anaphora meets one of the crucial tests for surface anaphora.¹⁵ We shall recognize below that there are counterindications, but we should like first to note that situation semantics may easily account for this phenomenon.

5.3 Other "Missing" Antecedents

Can the view that missing antecedents are ultimately parameters of anaphoric contents be extended to other cases? We shall examine one other case, that of VP ellipsis, and note that the case has effectively been made already. The situation semantics account of VP ellipsis in Gawron and Peters (1990:91) postulates that the described objects of nongeneral NP's—restricted parameters—must be ABSORBED whenever a type representing a VP's contents is formed (p.93). This has the effect of parameterizing the n -place relation denoted by the VP meaning—turning it into an $n + m$ -place relation. Gawron and Peters (1990:93) thus plead for the following representation of the content of *wash his r*:

$$\left[\lambda x \lambda y. y(\langle \langle WASH, x, y \rangle \rangle \langle \langle OWN, x, y \rangle \rangle) \right]$$

y is a parameter in the type above, and as such available for reuse wherever the type is used (or reused). Gawron and Peters thus postulate that VP meanings contain parameters for nongeneral NP's, so that their treatment may explain "missing antecedents" in exactly the fashion argued for here.

¹⁵Thoroughly nonreferential uses of \bar{N} anaphors similarly allow missing antecedents:

We elected Tom president, and we know he'll be a good one.

We didn't make Tom chair of a committee, but we made Sue one, and it'll improve under her.

5.4 \bar{N} Anaphora as Deep Anaphora

On the other hand, the indications that \bar{N} anaphora is deep anaphora were strong enough to lead Hankamer and Sag to postulate exactly this. The sort of evidence one can marshal to buttress this claim is summarized here:

\bar{N} Anaphora—Examples	
Deictic Binding	Two \emptyset please!
Syntactic Parallelism	
Missing Antecedents	*Harry didn't sink a boat carrying a gorilla, but George sank one, and it [=gorilla] drowned. —IF&S(39)

(15)

The unavailability of missing antecedents in the example in (15) is parallel to their unavailability in the example in note 15, and is likely explained in parallel fashion: parameters must be used to be available for reuse.

But the possibility of deictic binding is absolutely clear. If this is symptomatic of deep anaphora, then some \bar{N} anaphora is deep. On the other hand, if the ability to harbor missing antecedents is critical, then some \bar{N} anaphora is surface anaphora.

Since we have no indication that there are two distinct \bar{N} anaphoric processes, this should make the overall distinction suspect. If there were two \bar{N} anaphoric processes, we would expect to find subtle differences between them, especially since the \bar{N} construction is associated with elaborate lexical and syntactic conditions (cf. Nerbonne, Iida, and Ladusaw, 1989). But there is no empirical justification—lexical, syntactic, semantic or pragmatic—for the postulation of distinct constructions. It seems therefore more promising to try a different tack.

5.5 What is the Surface vs. Deep Distinction?

Before attempting to recast the Surface vs. Deep distinction in a way more congenial to the \bar{N} anaphora facts, it is worth reviewing the grounds for the distinction critically.

The parallelism differences are unconvincing. First, the sort of "syntactic parallelism" which Hankamer and Sag noted is partially reflected in unsaturated semantics. They noted the following pair:

- (16) *The kids asked to be squirted with the hose, so we did \emptyset .
The kids asked to be squirted with the hose, so we did *it*.

The Hankamer and Sag account of the infelicity of the VP ellipsis example is that it fails to be syntactically parallel—the antecedent is passive, while the anaphor "wants" to be active (to be parallel to the sentential *it* case). But there is semantic differentiation as well: the putative antecedent is associated with a described content of being squirted, while the anaphor "wants" a content of squirting—and these properties are NOT identical.¹⁷

Second and more generally, the parallelism distinction is too weak given Hankamer and Sag's characterization of surface anaphora as anaphora with access to syntactic information. If surface and deep anaphora were really distinguished by information resources, and only surface anaphora had access to the syntax module, then we would expect to find syntactic conditioning only on surface anaphora, and never on deep anaphora. But nothing of the sort holds. In fact, we find some syntactic conditions on all anaphoric constructions, no matter how paradigmatically "deep". For example, the disjoint reference conditions on NP anaphora seem syntactic (Binding Theory).

Turning to the distinction involving missing antecedents, we note that we have already proposed a purely semantic and nonmodular account of this:

¹⁷The failure of semantic parallelism here may be less important than the fact that the VP ellipsis must be [-AUX] in order to combine with *did*, while the putative antecedent is [+AUX], since it contains the passive *be*.

Only Anaphors with parametric contents may harbor "missing antecedents".

This goes beyond Hankamer and Sag's GENERALIZATION about missing antecedents to a proposed MECHANISM about how they are interpreted. There probably should be a single mechanism general to account for missing antecedents whether they appear in VP ellipses, or within parametric \bar{N} 's, since, after all, the two interact:

- (17) Every small college that has a football field will allow it to be used for frisbee, but no large university that does will [allow it to be used that way].

Finally, let us consider why some anaphors require linguistic antecedents while others allow deictic binding. Here again, \bar{N} anaphora is instructive: some \bar{N} anaphors allow deictic binding (cf. (15)), while others require surface antecedents. To appreciate the latter point, consider how difficult it would be to deictically bind the following null \bar{N} anaphor to the SAME content one can nondictically bind it to:

No farmers who own several donkeys beat them. Few \emptyset even scold them.

The required explanation should therefore not postulate distinct classes of anaphoric processes (or it should show why \bar{N} anaphora is really two processes). The required distinction, which must crosscut the surface vs. deep distinction, may be as simple as this:

There are no parametric objects available for deixis.

This formulation does NOT explain why nonparametric VP contents are unavailable for deixis; this could remain an unexplained restriction on VP ellipsis.¹⁸

5.6 Semantic Account of Surface vs. Deep Account

Our critical review of the Surface vs. Deep distinction leaves rather little for the distinction to explain. Still, if one wished, one could reinterpret the distinction in the light of our investigation of \bar{N} anaphora in the following way: Rather than view the surface vs. deep distinction as a distinction in the modular resources of anaphoric processes, we could view it as a primarily semantic distinction.

- (18) Semantics of Surface and Deep Anaphora: Surface anaphora involves parametric semantic contents; deep anaphora involves nonparametric contents.

In this view TOKEN ANAPHORS are surface or deep, not anaphoric processes. \bar{N} anaphors may be parametric or nonparametric, but that is alright: there is no expectation that a given construction be either deep or surface. This may be the case—there may even be constructions whose contents are NECESSARILY PARAMETRIC; but the definition does not depend on it.

6 Conclusions

The descriptive contributions of this paper have been two: First, we distinguish two readings of \bar{N} anaphors—the restrained and the unrestrained—and we systematize the account of when these readings are expected: restrained readings are expected for anaphors arising from non-general NP's (which have \bar{N} 's), and unrestrained readings may arise from any \bar{N} whatsoever. Second, we show that the semantic content of some restrained \bar{N} anaphors is not provided by any simple set available in discourse, but that parametric objects provide a reasonable account of the required readings.

The theoretical contributions are likewise two: First, we provide further motivation for the use of parametric objects in semantics, following directly on the descriptive accomplishment. Second, we note that \bar{N} anaphora seems to straddle the well-known deep vs. surface anaphora distinction of Hankamer and Sag (1976), and we show that, given modifications required for the case of \bar{N} anaphora, and exploiting the resources of parametric objects, there is a reasonable semantic account of the distinction in terms of nonparametric and parametric semantic objects.

¹⁸On the other hand, it is at least worth noting that VP contents normally include a parameter (or some such) for tense. Gawron and Peters do not follow this line, however.

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1. INTRODUCTION. One of the most interesting properties of natural languages is the mismatch between semantics and prosody. One illustrative example of such a property comes from the so-called 'clitic climbing' phenomenon (CC, henceforth) evidenced in some Romance languages. Observe the pair of sentences in (1) and (2) from Spanish.

- (1) a. Pueden estudiarlo.
they-can study it
b. Lo pueden estudiar.
it they-can study
'They can study it'
- (2) a. Están leyéndonlo.
they-are reading us it
b. Nos lo están leyendo.
us it they-are reading.
'They are reading it to us'

Sentences in (1) and (2) illustrate that the clitic *lo* or the clitic cluster *nos lo*, which are syntaco-semantically linked to the complement verb in their corresponding sentences, can appear attached not only to this verb (as shown in a-sentences) but also to the matrix verb (as shown in b-sentences) exhibiting the so-called 'clitic climbing' phenomenon.

Previous accounts of CC within generative-transformational grammar involve either a movement rule (Quicoli (1976), Strozer (1976), Luján (1980), etc.), or a restructuring operation (Rivas (1977), Rizzi (1978), Contreras (1979), etc.)² Within relational grammar, Aissen and Perlmutter (1976) propose a rule of Clause Reduction, analogous to Restructuring. The purpose of this paper is to propose an alternative analysis of CC in Spanish, using a set of syntactic calculi which eliminates altogether the transformational metaphor, i.e. either a movement rule or a restructuring operation. Our analysis is based on the extended categorial grammar as explored in Hoeksema (1989), Moortgat (1988) and Oehrle (1988). The organization of this paper is as follows. Section 2 presents more detailed data. Section 3 gives a quick overview of previous analyses of CC. Section 4 has two parts: (a) A summary of the theoretical framework adopted for the analysis and (b) a description of the Spanish categorial lexicon. Section 5 proposes our alternative analysis of CC, and Section 6 presents some conclusive remarks.

2. DATA. CC is only permitted from non-finite, i.e. , infinitival or gerundivo, clauses. However, it has been observed that not all verbs that take a nonfinite clause complement allow clitics to 'climb' from the complement clause. Observe sentences (3b) and (4b), where the CC from an infinitival clause yields ill-formed strings.

- (3) a. Esperan estudiarlo. They hope to study it'
b. *Lo esperan estudiar.

¹ Throughout the paper we will be using the term CC to refer to the syntactic phenomenon as shown in (1b) and (2b), and not the movement as postulated in some studies.
² Quicoli's and Rizzi's studies are based on Portuguese and Italian, respectively.

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