HOW DO PRONOUNS DENOTE?[1]

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1. INTRODUCTORY REMARKS

Departing from the transformational tradition of describing certain **anaphoric** pronouns on the basis of syntactically stipulated coreference, the following analysis attempts to describe pronouns in terms of a general approach to context dependency. In order to insure formal explicitness and compatibility, definitions implementing "contextual reconstruction" as well as detailed analyses of different pronouns will be presented in the form of an extension of Montague 1973, henceforth PTQ.

In Sections 2, 3, and 4, I will discuss the relevant data analyses making up the background of this paper. The next step is to give the definitions of contextual reconstruction (Section 5). Finally, Sections 6, 7, and 8 present syntactico–semantic analyses of reflexive and nonreflexive personal T pronouns, possessive T and CN pronouns, and the definite article. These

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analyses include a treatment of the so-called constraints on "backward pronominalization." It is shown that our new approach handles the pertinent data, including certain well-known counterexamples to the standard approach to "pronominalization."

2. OUTLINE OF THEORY

Pronouns in English are basic expressions belonging to certain syntactic categories and functioning according to their category. Their morphology exhibits both regular and (relatively) irregular paradigms. But the crucial question is: **How do pronouns denote?**

In transformational grammar, an attempt is made to answer this question at least for a subclass of pronouns, the so-called anaphoric pronouns: The denotation of anaphoric pronouns is inferred through **syntactically stipulated coreference** between the pronoun and its **antecedent.** An antecedent is a "full" expression occurring in the same sentence as the pronoun and somehow responsible for a certain possible interpretation of the pronoun.

However, it is quite common for pronouns like *he*, *she*, *it* to refer **without** an explicit antecedent. This is the **indexical** use of pronouns. Indexical pronouns depend on contextual information for their proper interpretation. Contextual information may be nonverbal; at any rate, contextual information does not always appear on the linguistic surface of the expression containing the pronoun in question. This means that any analysis which syntactically stipulates coreference in its account of anaphoric pronouns is bound to construe a principled syntactico–semantic contrast between the anaphoric and the indexical use of pronouns.

The transformational approach to anaphoric pronouns has resulted in a number of interesting observations, in particular, the so-called "constraints on backward pronominalization" (Lees and Klima, 1963; Chomsky, 1965, Postal, 1969; Langacker, 1969; Ross, 1969; Lakoff, 1968, etc.). These analyses, however, were never able to resolve certain technical problems arising with complex constructions such as Bach–Peters sentences, the donkey sentence, or the paycheck sentence (cf. Sections 3 and 4). At the center of these difficulties is the use of stipulated coreference.

In transformational grammar, coreference is usually stipulated on the basis of an identity principle: Two NPs are coreferential if they are identical in the "deep structure." In the writings of Richard Montague, however, coreference is stipulated in terms of underlying pronouns with an identical index. That Montague indeed adopted a syntactico–semantic concept of anaphoric pronouns is obvious from a comparison of the treatment of anaphoric pronouns in Montague 1970a (henceforth EFL), PTQ, and the quite different treatment of indexicals in Montague 1968.

In contrast to the "identical-NP approach" of transformational grammar,

Montague's proposal for stipulating coreference is at least based on well-defined semantics, namely, the independently motivated principle of **bound variables,** familiar from predicate calculus. The transformational approach, on the other hand, is linguistically more detailed: It handles several syntactic constellations of anaphoric pronouns, whereas Montague's rules permit only "forward pronominalization." The crucial point is that neither approach to the anaphoric use of a small subgroup of pronouns is naturally extendable to the indexical use of these same pronouns. Furthermore, neither approach is able to account for all pertinent data. Anaphoric pronouns which elude a given analysis are commonly called "dangling pronouns."

The alternative approach to pronouns developed in this paper finds no essential syntactico–semantic difference between indexical and anaphoric pronouns. Instead, we are guided by certain semantic similarities between definite descriptions and pronouns like *he, she, it, they.* Both kinds of terms may be used anaphorically as well as indexically, and both give rise to curiously restricted coreference phenomena. Concerning the semantics of definite descriptions, I will follow the analysis of Hausser (1974b, Ch. 5).

This analysis of the definite article shares certain intuitions with Vendler (1967, Ch. 2), where it is proposed that the proper denotation of definite descriptions should be insured syntactically by generating "underlying relative clauses" in the "deep structure" of the definite description in question; transformations using "recoverable deletions" are intended to reconcile the unexpanded surface structure with the widely expanded deep structure. A problem arises for this approach, however, because recoverable deletions are defined only with respect to the explicit linguistic surface. Vendler is aware of this problem and suggests that if there is no suitable previous discourse (that is, a discourse which contains the information necessary to recover the presumed deletions), then definite descriptions function like proper names. This assumption, however, is incompatible with the rigid-designator analysis of proper names presumed here (cf. Kripke, 1972, PTQ, and Hausser, 1974b). The point is that definite descriptions are context dependent in their denotation, whereas proper names are assumed to be context **in**dependent.

Instead of a syntactic approach, let us implement Vendler's idea in the form of **contextual reconstruction.** Contextual reconstruction is a formal mechanism for filling in contextual information into the translations of context-dependent expressions. It is defined as an interpretational device: The surface syntax is not affected by contextual reconstruction.

This approach to context dependency is able to insure the proper denotation of definite descriptions by providing a formal basis for expanding the **descriptive content** of the definite description in question. The descriptive content of a definite description is the (basic or complex) property (corresponding to a CN phrase) which remains after subtracting the quantificational machinery that makes up most of the semantic representation of defi-

nite descriptions. For example, the descriptive content of *the man* is the property *man'*. Formally, the descriptive content of a given context-dependent term is extended by introducing additional properties provided by the context.

For this purpose, I will define a context model, which not only specifies the denotation of the constants, but in addition assigns a **stage description** to each point of reference. A stage description is a regimented, formal description of the presumed utterance situation. Furthermore, context-dependent expressions of English are translated in part by means of characteristic **context variables.** A reconstruction function applied to a context variable results in replacing the argument by a "suitable" contextual value (according to certain standards).

Contextual reconstruction is a general approach to phenomena of context dependency. It is not only able to handle the interpretation of definite descriptions and nonredundant answers (cf. Hausser, 1976c), but also various kinds of pronouns. Take, for example, such T pronouns as *I, you, he, she, it, we, they*. We determine the denotation of these pronouns simply by expanding their descriptive content through contextual reconstruction. The only difference between T pronouns and definite descriptions is that (i) one is syntactically derived whereas the other is basic, and (ii) one carries a great amount of descriptive content, whereas the other consists of nothing but a quantifier expression with a context variable (and sometimes a gender specification).

The constraints on backward pronominalization are naturally implemented as constraints on the "internal reconstruction" of third person T pronouns: The constraints exclude expressions in certain locations from being possible contextual arguments. The interpretation of Bach–Peters sentences, the donkey sentence, the paycheck sentence, etc., presents neither complication nor exception in this approach. Furthermore, no syntactico–semantic contrast is postulated between anaphoric and indexical use of certain expressions. According to my analysis, a pronoun (or definite description) is used **indexically** if it is reconstructed **externally,** and **anaphorically** if it is reconstructed **internally.** Some pronouns permit only exterior reconstruction (that is, reconstruction with respect to a stage description), for example, *I, you, we*. Other pronouns permit only interior reconstruction (that is, reconstruction with respect to the translation of the target sentence), for example, *himself*. And some pronouns permit both external and internal reconstruction, for example, *he, she, it, they*.

My approach is similar to that of Jackendoff (1969, 1972) in that I reject a syntactic analysis of coreference. Jackendoff's rules of "interpretation," however, do not determine the denotation of pronouns; they only specify whether a third person T pronoun may or may not receive a coreferential interpretation. Although the interpretive approach to pronouns avoids some of the problems of the standard transformational approach, it is plagued by

Convention (if a pair of NPs have not been marked coreferential by previous applications of the interpretive rules of coreference, they are to be marked as noncoreferential, [cf. Postal, 1972; see also Dougherty, 1969, and Wasow, 1973 for interpretive analyses of pronouns]). My approach differs from transformational accounts in general in that I develop a syntactico–semantic treatment of pronouns in a well-defined semantic framework (that is, through standard model-theoretic semantics).

3. TWO SYNTACTIC APPROACHES TO ANAPHORIC PRONOUNS

Pronouns occur in a number of different syntactic categories, and not only as noun phrases. Hence, the term "pronoun" is unfortunate. For example, the so-called nonreflexive personal pronouns *I, you, he, she, it, we, they,* the reflexive personal pronouns *myself, yourself, himself, herself, ourselves, themselves,* and the possessive pronouns *mine, yours, his, hers, its, ours, theirs,* are all of category T (noun phrase). The pronouns *one, ones,* however, are of category CN (common noun). Furthermore, there are possessive pronouns of category T/CN (quantifiers), namely, *my, your, his, her, its, our, your, their.* There are also the pronouns *here, there, therefore, then, thus,* which are of Category IAV (adverbials).

Syntactically, a pronoun is characterized by the category to which it belongs. For example, a T pronoun like *he* or *she* may serve as subject or object, and is assigned to different genders, numbers, and cases. That T pronouns function at least syntactically like full noun phrases is apparent from the following examples:

(1) a. *She kissed him.*
b. *Mary kissed the man who arrived yesterday.*

Similarily, CN pronouns may serve as head nouns of restrictive relative clauses, may be modified by adjectives (*green one*), and may combine with a quantifier to make a noun phrase (*the green one*). Pronouns of Category IAV are subject to the same subcategorization typical of all adverbs: *Here* and *there* are adverbs of **place** and **direction,** *therefore* is an adverb of **cause,** *thus* is an adverb of **manner,** and *then* is an adverb of **time.**

There are no special syntactic restrictions on the occurrence of pronouns. Compare, for example, (2) and (3):

(2) *John kissed Mary in front of the Eiffel Tower.*

(3) *I kissed her there.*

Syntactically, (2) and (3) are of the same structure, and in this sense the syntax of pronouns is trivial. The general syntactic rules apply to pronouns in exactly the same way as to other expressions of the corresponding category.

Semantically, on the other hand, pronouns differ from ordinary denoting expressions. Consider the difference in interpreting (2) as opposed to (3) with respect to an interpretation and a point of reference. In (2), the truth value depends on the denotation of *John, kiss, Mary,* and *in front of the Eiffel Tower* as specified by the model. In particular, *John, Mary,* and *in front of the Eiffel Tower* are to be defined as denoting particular individuals and a particular place (area). In (3), however, the situation is quite different insofar as it would be intuitively wrong to assign fixed denotations to the pronouns *I, her,* and *there.* The denotation of the pronouns in (3) depends on who utters (3), where, and with respect to whom. Ordinary denoting expressions like *John, Mary,* or *in front of the Eiffel Tower* differ from pronouns in that they are not context dependent in the indicated sense.

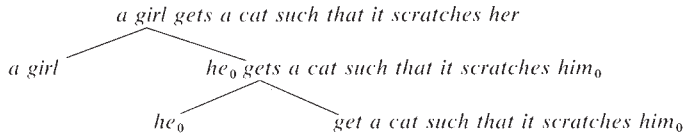
The assumption that pronouns are context-dependent expressions naturally suggests a linguistic treatment in terms of context dependency. Most of the recent literature, however, has concentrated on syntactic solutions in terms of stipulated coreference (including EFL and PTQ). Before turning to my alternative approach, I will discuss in the present and the following section the goals and inadequacies of three representative attempts to handle pronouns syntactically. Those readers who are familiar with this material may safely go on to Section 5. Let me mention, however, that the analysis to be developed in Sections 6, 7, and 8 will be evaluated with respect to the data discussed in Sections 3 and 4.

What is the difference between the standard transformational approach to pronominalization and the approach presented in EFL and PTQ? Consider example (4).

(4) ***A girl** got a cat which scratched **her.***

In PTQ, the pronoun *her* (on its anaphoric interpretation with *a girl* as antecedent) is derived from an **underlying pronoun.** The derivation of (4) in PTQ may be characterized by the following analysis tree.

(5)



The pronouns he_0 (him_0) are translated into variables which are bound by the same quantifier:

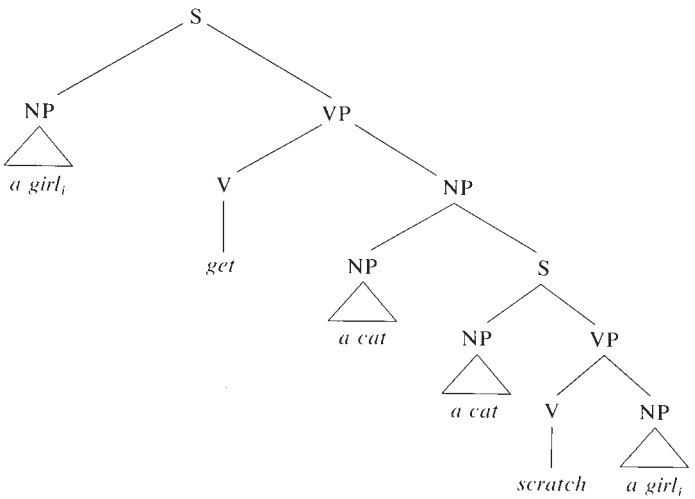
(5′) $\bigvee x[girl'(x) \wedge \bigvee y[[cat'(y) \wedge scratch'(y, \hat{P}P\{x\})] \wedge get'(x, \hat{P}P\{y\})]]$

In other words, Montague realizes the suggestion (for example, in Quine, 1960) that "pronouns are variables" on the level of semantic representation, and utilizes the ready-made binding principle of predicate calculus in order to handle stipulated coreference semantically. In the categorial syntax of

PTQ, coreference is marked in terms of underlying coindexed pronouns; the antecedent is "quantified in."

On the other hand, within the standard theory of TG (for example, Chomsky, 1965), coreference is stipulated on the basis of underlying identical full noun phrases. As an example of a standard transformational derivation of an anaphoric pronoun, consider (6):

(6)



Obligatory pronominalization changes the second occurrence of *a girl* in (6) into the pronoun *her*.

The coindexed underlying pronoun approach of PTQ and the identical-NP-reduction approach of the standard theory are equally well-founded syntactic principles for stipulating coreference. But both approaches are subject to fundamental empirical limitations. Let us discuss a number of standard counterexamples to either or both of the two approaches. First, consider the following sentence from Partee 1975:

(7) *Every man who loves* ***a woman*** *loses* ***her.***

On the dominant reading of (7), *every man* has wider scope than *a woman* (that is, on this reading *a woman* is interpreted nonspecifically, cf. Hausser, 1976b). This reading, however, cannot be derived in a standard derivation within the PTQ framework:

(7′) $\wedge x[man'(x) \wedge \vee y[woman'(y) \wedge love'(x, \hat{P}P\{y\})] \rightarrow lose'(x, \hat{P}P\{y\})]$

The point is that the variable y at the end of the formula is outside the scope of the existential quantifier. In other words, *her* on its coreferential reading (antecedent *a woman* on nonspecific interpretation) is not analyzable as an anaphoric pronoun within a framework that uses coindexed underlying pronouns in combination with the bound variable principle for handling stipulated coreference. Instead, *her* in (7) must—under the specified reading—be

classified as a dangling pronoun (Partee uses the term "pronoun of laziness").

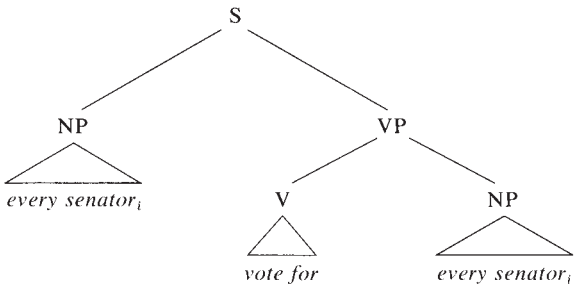
While sentence (7) raises a fundamental problem for the coindexed pronoun approach as implemented in PTQ, it is a straightforward case of "forward pronominalization" for the identical-NP-reduction approach of TG. Thus, whether a pronoun is classified as "anaphoric" or as "dangling" depends on the specific mechanism used for stipulating coreference.

Although the identical-NP-reduction approach is fine for examples like (7), it has its own special problems with examples like (8):

(8) *Every senator voted for himself.*

According to the original pronominalization approach of TG, the deep structure of (8) should look like (8a):

(8a)



Obligatory pronominalization (reflexivization) transforms (8a) into the surface form (8). The problem is that (9)

(9) *Every senator voted for every senator.*

happens to be assigned the same deep structure as (8), yet (9) has a different meaning than (8). This is in conflict with the assumptions (i) that transformations are meaning preserving, and (ii) that the deep structure of a sentence represents its full meaning (deep structures are the sole input to the rules of semantic interpretation).

The problem that sentences like (8) and (9) raise for the identical-NP-reduction approach as defined in standard TG finds a natural solution in frameworks using the pronoun-as-variable approach. In PTQ, for example, (8) would translate into (8′), whereas (9) would translate into (9′):

(8′) $\wedge x[senator'(x) \rightarrow vote\ for'(x, \hat{P}P\{x\})]$

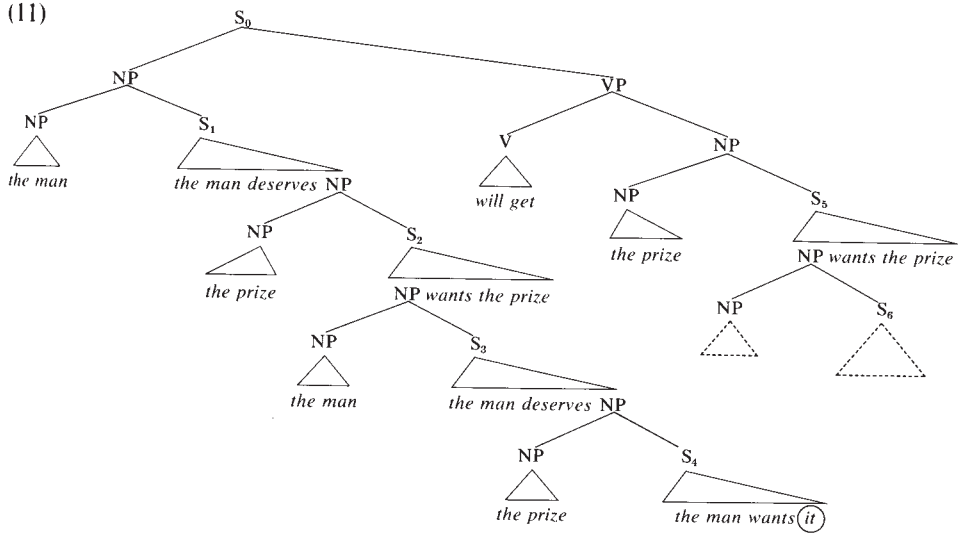
(9′) $\wedge x[senator'(x) \rightarrow \wedge y[senator'(y) \rightarrow vote\ for'(x, \hat{P}P\{y\})]]$

The truth conditions for (8′) and (9′), respectively, reflect the intuitive semantic difference between (8) and (9) adequately.

One kind of example, however,—involving the so-called Bach–Peters sentences—is unsolvable both for the identical-NP-reduction approach and the pronoun-as-variable approach. Consider (10):

A standard deep structure of (10) in TG is (11).

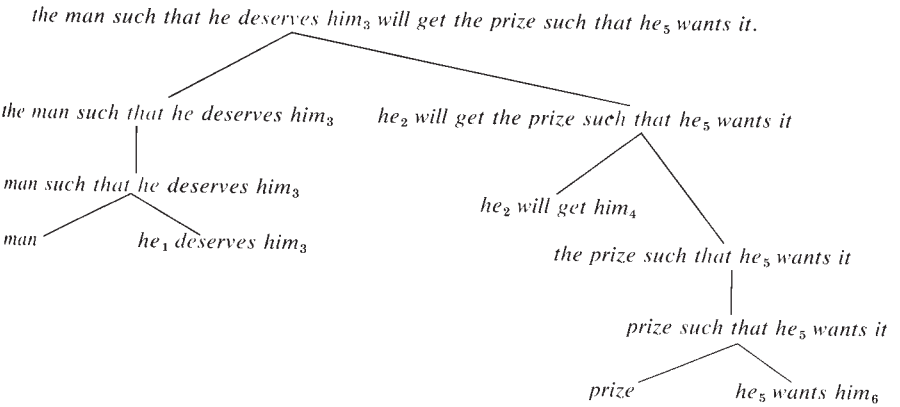
(11)



Let us assume that the left branch of embeddings in (11) is finite, and that pronominalization has applied once to yield the circled *it*. The problem is that *the prize* in cycle S_2 cannot pronominalize *the prize which the man wants* in S_3 (derived from *the man* [*the man wants it*]) because the two NPs in question are not **identical.** The problem arising in connection with example (10) is related to the assumption that the full-NP-reduction approach as defined in TG operates on identical NPs.

In PTQ, however, the Bach–Peters sentence in (10) raises a problem of a different kind. Consider analysis tree (12).

(12)



That the pronoun indices in the top line of (12) cannot be eliminated in the standard derivation of sentence (10) reveals the fact that Bach–Peters sen-

tences present a variable-binding problem on the level of semantic representation. Remember that the problem raised by sentence (7) was similarly a variable-binding problem for PTQ.

It seems to me that the fundamental difficulty arising with the identical-NP approach, on the one hand, and that arising with the coindexed-pronoun approach, on the other, simply coincide in the case of Bach–Peters sentences. Furthermore, it seems possible that combining the full-NP-reduction approach and the pronoun-as-variable approach into one system may allow the generation of Bach–Peters sentences. But apart from the fact that such a solution [which would also take care of example (7)] is costly and results in a great number of alternative syntactic derivations which do not correspond to different readings, there are still further data which elude even such a combined approach. I refer to the so-called donkey sentence.[2]

(13) *Every man who marries a woman who owns a donkey that* $\left\{\begin{matrix}he\\she\end{matrix}\right\}$ *likes beats it.*

To show this in detail requires a long and tedious argument. (For a discussion see Cooper, this volume.)

A problem of a different nature is raised by example (14) (from Karttunen, 1969):

(14) *Every man*$_1$ *who gave* ***his paycheck*** *to his*$_1$ *wife is smarter than the man*$_2$ *who gave* ***it*** *to his*$_2$ *mistress.*

The *it* in (14) is not coreferential with its antecedent! Is it the use of **stipulated** coreference which results in the indicated differences? To see that this is not the case, let us consider next an approach to pronouns which avoids stipulating coreference but retains a separate analysis of anaphoric pronouns. This "definiteness approach" has been pursued in various forms by a number of linguists.

4. A "DEFINITENESS" APPROACH TO ANAPHORIC PRONOUNS

It has been recognized for some time that there exists a close relation between T pronouns and definite terms (for example, Postal, 1969; Kuroda, 1968; Stockwell, Schachter, and Partee, 1973). Without going into the technical details of these earlier approaches, let us discuss a related approach to anaphoric pronouns which is based on the hypothesis that

(i) anaphoric pronouns are to be derived from an underlying definite article + CN pronoun (*one*),

[2] This example was pointed out to me by Barbara Partee. It is due to Ed Gethier (in response to a proposal by Terence Parsons).

(ii) coreference should be established in terms of definiteness.

This tentative definiteness approach to anaphoric pronouns still proceeds on the assumption that anaphoric and indexical pronouns are, in a semantically relevant sense, different phenomena, and that therefore a separate analysis of anaphoric pronouns is justified. The pronominalization mechanism employed, however, does **not** depend on stipulated coreference for determining the denotation of an anaphoric pronoun. Instead, anaphoric third person nonreflexive T pronouns are derived from underlying *the + one*.

With regard to the relation between T pronouns and definite terms, consider (16a) and (16b):

(16) a. *Every man who loves* ***a woman*** *loses* ***her.***
b. *Every man who loves* ***a woman*** *loses* ***the woman.***

The point is that (16a) and (16b) are synonymous on the respective coreferential readings. Thus, if we manage to relate the corresponding readings of (16a) and (16b) to one and the same semantic representation, we may solve the coreference problem in (16a) in terms of concrete semantic properties of definiteness (provided we have a semantic treatment of definiteness).

Definite terms are special in that they are equipped with a characteristic coreference mechanism. This is demonstrated in (17):

(17) *Every man who loves* ***a woman*** *loses* ***a woman.***

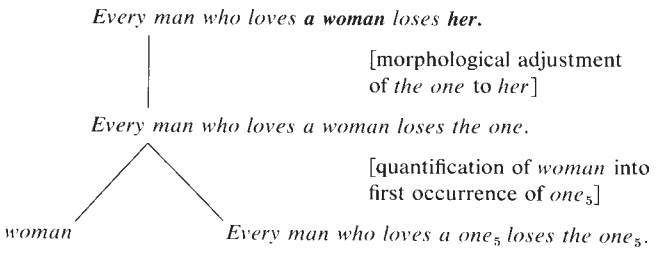
There is no reading of (17) in which the underlined terms can be interpreted as coreferential, which illustrates how artificial the identity principle of the "standard theory" is from an intuitive semantic point of view.

In order to realize our tentative definiteness approach to anaphoric pronouns we have to

(18) a. linguistically motivate the transition from *the woman* (in (16b)) to *her* [in (16a)].
b. formally capture the possible coreference between *a woman* and *the woman* in (16b) (that is, provide a **semantic** treatment of definiteness capable of explaining the phenomenon of possible coreference in (16b)).

As one possible solution to (18a), consider the surface syntactic approach exemplified by the following analysis tree (read from bottom up):

(19)



Let us assume that one_n is a CN pronoun which functions also in the derivation of such sentences as (20):

(20) *Bill bought a blue* ***book*** *and Frank bought a red* ***one.***

[CN quantification, $F_{10,4}$]

book *Bill bought a blue* ***one***$_4$ *and Frank bought a red* one_4.

The CN quantification rule in (20) puts a common noun in place of the first pronoun of a certain index and adjusts all other pronouns with the same index in the usual way. CN pronouns that have the same index may be called "codescriptive."

Semantically, let us treat one_n as a variable $P_n \in ME_{f(CN)}$. The semantic results of CN quantification replace all occurrences of P_n with the translation of the common noun in question. By deriving *her* from *the one* and by using CN pronominalization in (19), we translate (16a) and (16b) into the same semantic representation. Note that CN pronominalization is independently motivated by data like (20).

The morphological transition from underlying *the one* to the anaphoric pronoun *her* in analysis (19) is somewhat problematic. It may be argued, however, that the quantifier + **unmodified** CN pronoun is subject to an irregular morphology in general. Consider for example:

(21)

a one → *one*
my one → *mine*
your one → *yours*
his one → *his*
our one → *ours*
their one → *theirs*
etc.

The surface syntactic solution for deriving anaphoric pronouns indicated in analysis (19) does not stipulate coreference. Instead, we resort to **stipulating codescriptiveness** and appeal to certain (so far unspecified) semantic properties of definiteness.

What such a semantic analysis of definiteness will involve is captured in informal terms by the following quotation from O. Jespersen:

> The chief use of the definite article is to indicate the person or the thing that at the moment is uppermost in the mind of the speaker and presumably that of the hearer too. Thus it recalls what has just been mentioned—or else the whole situation is sufficient to show what is meant [1933, p. 162].

But if definiteness is a general context-dependency phenomenon—as Jespersen suggests—and anaphoric pronouns are explained through definiteness, then the semantic justification of the concept of anaphoric pronouns falls away: If anaphoric pronouns require a general context-dependency

treatment anyway (definiteness has to be explained), then it is of no advantage to treat anaphoric and indexical pronouns separately. Also, since there are no morphological differences between indexically versus anaphorically used third person pronouns, a uniform treatment is highly desirable.

This tentative definiteness approach to anaphoric pronouns would capture certain important intuitions (given that the missing treatment of definiteness is supplemented). But it is already obvious that this approach is no more successful than the other two treatments of anaphoric pronouns discussed in Section 3. This is illustrated by the following difficulties:

(23) a. The constraints on backward pronominalization apply only to third person T pronouns, but not to CN pronouns (see Stockwell, Schachter, and Partee, 1973). This raises serious problems if we want to incorporate the constraints into a system which derives anaphoric pronouns from codescriptive CN pronouns.

b. Assuming that proper names are **basic** T phrases, proper names can never serve as antecedents of anaphoric pronouns derived from complex definite terms (that is, definite article + CN pronoun) because codescriptiveness cannot be stipulated in these cases.

c. The problem in (23b) could be circumvented if we resort to a second pronominalization process (for example, the pronoun-as-variable approach as defined originally in PTQ), in addition to the definiteness approach in question. This inflationary move would at least permit the generation of Bach–Peters sentences, which otherwise could not be accounted for.

d. The donkey sentence [see (13)], however, would still elude the combined approach suggested in (23c).

The linguistic motivation for postulating a syntactico–semantic difference between indexical and anaphoric pronouns is that it permits us in this one case to answer the question "How do pronouns denote?" in terms of a syntactically stipulated coreference (or codescriptiveness) relation. This concept of anaphoric pronouns, however, leads into fundamental descriptive difficulties. This, in combination with the fact that anaphoric pronouns are not a morphologically distinct class and do not even relate to the whole class of nonreflexive personal T pronouns,[3] is reason enough to turn to a quite different approach to pronouns, based on a general treatment of context dependency. The first step is to define a **context-dependent extension** of the intensional logic of PTQ, which allows for a formal semantic description of indexicals in natural language.

[3] Only third person nonreflexive T pronouns are open to the anaphoric—indexical dichotomy, while first and second person are always indexical.

5. A NEW APPROACH TO CONTEXT DEPENDENCY

A number of logicians and philosophers have been interested in the semantic problem posed by indexicals. Montague (1968) notes that it was Bar Hillel (1954) who suggested that "pragmatics concern itself with what C. S. Peirce had in the last century called *indexical expressions*. An indexical word or sentence is one of which the reference cannot be determined without knowledge of the context of use; an example is the first person pronoun 'I' [p. 119]." Currently, the notion **pragmatics** may be understood as referring to either a subpart of semantics also called "indexical semantics," or to the theory of language *use* as opposed to semantics. Since Montague (1968) treats indexicals in a purely semantic way, it is clear that he used the notion pragmatics in the former sense.

A treatment of indexicals in a formal semantic framework requires

(24) a. specification of the formal nature of the **context**
b. specification of the formal nature of the **reference mechanism** by means of which the denotation of indexicals is determined via the context in question.

Before we begin to develop an analysis based on contextual reconstruction, it will be helpful to discuss briefly two earlier approaches to the treatment of context dependency in a model–theoretic framework.

One approach is the **coordinates approach** (Montague, 1968; Lewis, 1972). Besides the coordinates specifying a possible world and a moment of time, additional coordinates are defined for every single context-dependency phenomenon to be treated. Lewis (1972), for example, uses different coordinates for possible speakers (pronoun *I*), for possible hearers (pronoun *you*), possible places (pronoun *here*), possible indicated objects (pronoun *this*), and even for possible previous discourses. In short, the coordinates approach defines a context of use simply as an extended point of reference.

It seems to me, however, that the modal coordinate specifying a possible world and the tense coordinate specifying a moment of time represent phenomena which are intuitively different from the instances of context dependency to be characterized by the various other coordinates. Furthermore, to define a context of use as an arbitrary *n*-tuple does not capture the highly specific structural interaction between context-dependent expressions and a context. Yet the coordinates approach at least provides a clear, formal semantic answer to (24b).

An alternative treatment of context of use is the **proposition approach** (Stalnaker, 1968; Karttunen, 1974). The proposition approach defines a context of use simply as a **set of propositions.** This analysis was developed in connection with certain problems of counterfactual conditionals, and it is not clear how the denotation of indexicals is to be determined formally from

approach slightly by defining a context as a function from "tokens" into propositions (in the sense that a context is a property of tokens, where the property is captured in the form of a proposition). However, since neither Stalnaker nor Cresswell go beyond specifying domain and range of the crucial function postulated, neither system provides a satisfactory solution for (24b).

In order to interpret such context-dependent expressions as pronouns, definite terms, and nonredundant answers (cf. Hausser, 1976c) at a point of reference with respect to a context, a context has to be more than an n-tuple of arbitrary values or a set of uninterpreted propositions. It seems to me that the speaker interprets context-dependent expressions on the basis of very specific properties of the utterance situation (both verbal and nonverbal)—structures which none of the context concepts discussed are equipped to capture. And we cannot expect that a theory will render linguistically satisfactory formalizations of contextual phenomena if the grammar operates on a smaller basis of contextual information than the speaker uses in daily life.

What we need is a formal concept of context which is able to capture all the information necessary for the interpretation of context-dependent expressions. My proposal is to define a context of use as a **stage description.** A stage description is a regimented description of a certain time interval (representing the utterance situation) assigned to a point of reference. My program is to define a context-dependent intensional logic IL_2, which is interpreted with respect to a **context model** $\langle \mathfrak{A}, con \rangle$, where $\mathfrak{A}$ is an interpretation as defined in PTQ and con is a function which assigns exactly one stage description to each point of reference. I want to interpret the constants and variables of IL_2 as usual with respect to $\mathfrak{A}$ and a point of reference $\langle i,j \rangle$. The denotation of a context-dependent expression defined in IL_2 is to be determined via $con(\langle i,j \rangle)$, where $con(\langle i,j \rangle)$ is the stage description assigned to the point of reference $\langle i,j \rangle$.

This definition of a stage description is based on the notion of a **moment specification.** A moment specification is defined as an ordered pair $\langle j, \phi \rangle$, where j is a moment of time and ϕ is a declarative sentence of a certain context language IL_1 (which is a specification of the intensional logic defined in PTQ). I interpret $\langle j, \phi \rangle$ intuitively in the sense that the IL_1 formula ϕ *describes* the moment j. For example, (26)

(26) $\langle j, enter'(\hat{}b) \wedge say'(\hat{}b, \hat{}m, \text{"}I\ love\ you\text{"}) \rangle$

is a rough illustration of a moment specification which asserts that at moment j Bill comes in and says to Mary, "I love you."[4]

Formally, we shall introduce a moment specification as a member of the set M which is defined as follows:

[4] For obvious reasons, it would be more adequate to define interval specifications rather than moment specifications. However, a reasonably simple tense logic based on intervals is presently not known to me. The fact that we use moment specifications does not affect any of the basic ideas of our approach to context dependency.

(27) A set of moment specifications M is the Cartesian product $J \times ME_t^{IL_1}$, where J is a nonempty set serving as the field of a simple ordering (J is regarded as a set of moments of time), and $ME_t^{IL_1}$ is the set of formulas generated by a context language IL_1.

A stage description is defined as a sequence of moment specifications characterizing a certain interval of time:

(28) A stage description is an n-tuple $\langle \mu_1, \ldots, \mu_n \rangle$ of elements of $J \times ME_t^{IL_1}$ for some $n \in N$ such that for all its elements $\mu_\iota = \langle j', \phi \rangle$, $\mu_\kappa = \langle j'', \phi \rangle$, $\iota < \kappa$ if and only if $j' < j''$ $(1 \leq \iota, \kappa \leq n)$.

It follows that the first element of a stage description describes the earliest moment of the interval specified, while the rightmost element consists of the moment specification with the latest time index in the stage description. Furthermore, for each moment of time there is only one moment specification in a stage description.

Finally let us define a *context model* $\mathfrak{B}$. $\mathfrak{B}$ is an ordered pair, consisting of the PTQ interpretation $\mathfrak{A} = \langle A, I, J, \leq, F \rangle$, and the context-assignment function *con:*

(29) $$\mathfrak{B} = {}_{\text{def}}\langle \mathfrak{A}, con \rangle$$

The context-assignment function *con* is defined as follows:

(30) Let I, J be nonempty sets, $\leq$ a simple order on J. Let $\mathfrak{M}$ be a set of stage descriptions defined with respect to J and $ME_t^{IL_1}$. *Con* is a function from $I \times J$ into $\mathfrak{M}$, such that for all $i \in I, j \in J$, if $con(\langle i,j \rangle) = \langle \langle j_0, \phi_0 \rangle, \langle j_1, \phi_1 \rangle, \ldots, \langle j_n, \phi_n \rangle \rangle$, then $j = j_n$.

A context model is defined with respect to a context language IL_1. *Con* assigns to each point of reference of the interpretation $\mathfrak{A}$ one and only one stage description defined with respect to J and $ME_t^{IL_1}$. The link-up condition in (30) stipulates that the final moment of the interval specified by a stage description **coincides** with the moment specified by the time index of the point of reference to which *con* has assigned the stage description in question.

An important kind of context model is what I call a **proper** context model:

(31) $\mathfrak{B}$ is a proper context model if and only if
(i) $\mathfrak{B}$ is a context model $\langle \mathfrak{A}, con \rangle$, where $\mathfrak{A} = \langle A, I, J, \leq, F \rangle$, and
(ii) it holds for all $i \in I, j \in J$ that if $con(\langle i,j \rangle) = \langle \langle j_0, \phi_0 \rangle, \langle j_1, \phi_1 \rangle, \ldots, \langle j_n, \phi_n \rangle \rangle$, then ${\phi_0}^{\mathfrak{A},i,j,g}$, ${\phi_1}^{\mathfrak{A},i,j_1,g}$, ..., and ${\phi_n}^{\mathfrak{A},i,j_n,g}$ are all 1 for arbitrary g

(where $j_n = j$ [according to (30)] and $j_0, j_1, \ldots,$
$j_n \in \mathrm{J}$, and $\phi_0, \phi_1, \ldots, \phi_n \in \mathrm{ME}_t^{\mathrm{IL}_1}$).

The interpretation of the IL_1 expressions $\phi_0, \ldots, \phi_n$ in a stage description with respect to $\mathfrak{A}$ and the specified points of reference [see (31ii)] is according to the truth conditions of IL as defined in PTQ. In a proper context model, possible values of $con(\langle i,j \rangle)$ are only those stage descriptions that happen to describe situations which are in accord with the "facts" as laid down by the interpretation $\mathfrak{A}$ with respect to the interval assigned to the point of reference $\langle i,j \rangle$.

The problem of interpreting a context-dependent[5] language is to assign proper denotations to the context-dependent expressions in question. I propose to translate various context-dependent expressions of English by means of different **context variables.** A context variable is a new kind of expression which is neither a constant nor a variable. It is not **interpreted** in the usual sense, but rather is **replaced** by a suitable denoting expression taken from a stage description. The replacement is performed by a **reconstruction function** G which maps context variables into denoting expressions of corresponding type derived from the stage description assigned to the point of reference under interpretation. Once all context variables in a given IL_2 expression are **contextually reconstructed,** the semantic interpretation of the reconstructed IL_2 expression runs standard. The auxiliary language IL_2 is a context-dependent intensional logic in the sense that it contains context variables. The syntax and semantics of IL_2 may be characterized as follows.

The vocabulary of IL_2 is the vocabulary of IL (that is, the intensional logic defined in PTQ) united with the set *C-var,* where C-var is defined as $\bigcup_{a \in \mathrm{Type}} \mathrm{C\text{-}var}_a$. $\mathrm{C\text{-}var}_a$ is the set of context variables of type a. We assume that there are denumberably many context variables of each type, and if $n \in \mathrm{N}$ and $a \in \mathrm{Type}$, we shall understand by $\mathrm{cv}_{n,a}$ the nth context variable of type a.

By $\mathrm{ME}_a^{\mathrm{IL}_2}$ is understood the set of **meaningful expressions** of type a; this notion has the following recursive definition, which replaces (1)–(8) of PTQ, p. 256.

1. Every variable, constant, and context variable of type a is in $\mathrm{ME}_a^{\mathrm{IL}_2}$.

The other seven clauses correspond to (2)–(8) in PTQ, with "ME_a" replaced by "$\mathrm{ME}_a^{\mathrm{IL}_2}$."

Let us turn now to the semantics of IL_2. Suppose that $\mathfrak{B}$ is a context model $\langle \mathfrak{A}, con \rangle$ defined with respect to the context language IL_1, where $\mathfrak{A}$ is defined as $\langle A, I, J, \leq, F \rangle$ in the usual way. Suppose also that g is an $\mathfrak{A}$-assignment (of values to variables), that is, a function having as its domain the set of all variables (but not context variables), and such that $g(u) \in \mathrm{D}_{a,A,I,J}$

[5] A context-dependent language in the sense here defined is not to be confused with a **context-sensitive** language, that is, a language generated over context-sensitive rewriting rules as discussed in, for example, Lyons (1968, p. 235, fn.)

whenever u is a variable of type a. Suppose further that G is a reconstruction function having as its domain the set of all context variables and such that $G(\Gamma)$ is an expression of type a whenever Γ is a context variable of type a.

If α is a meaningful expression of IL_2, we shall understand by $\alpha^{\mathfrak{B},g,G}$ the **intension** of α with respect to $\mathfrak{B}$, g, and G; and if $\langle i,j\rangle \in I \times J$, then $\alpha^{\mathfrak{B},i,j,g,G}$ is to be the **extension** of α with respect to $\mathfrak{B}$, i, j, g, and G—that is, $\alpha^{\mathfrak{B},g,G}(\langle i,j\rangle)$, or the function value of the intension of α when applied to $\langle i,j\rangle$. These notions may be introduced by the following recursive definition:

1. If α is a constant, then $\alpha^{\mathfrak{B},i,j,g,G}$ is $F(\alpha)(\langle i,j\rangle)$
2. If α is a variable, then $\alpha^{\mathfrak{B},i,j,g,G}$ is $g(\alpha)$.
3. If α is a context variable, then $\alpha^{\mathfrak{B},i,j,g,G}$ is $G(\alpha)^{\mathfrak{B},i,j,g,G}$.

These clauses are followed by clauses corresponding to (2)–(10) in PTQ (1973, pp. 258–259), the only difference being that all indices $\mathfrak{A}$, i, j, g are replaced by $\mathfrak{B}$, i, j, g, G.

We call an IL_2 expression α **reconstructible** with respect to a context model, a point of reference, and a reconstruction function G if and only if for every context variable Γ occurring in α, $G(\Gamma)$ is defined (reconstruction functions are partial functions). If ϕ is an IL_2 formula (that is, a member of $ME_t^{IL_2}$) such that ϕ is reconstructible with respect to $\mathfrak{B}$, i, j, g and G, then ϕ is true with respect to $\mathfrak{B}$, i, j, and G, if $\phi^{\mathfrak{B},i,j,g,G}$ is **defined** and 1 for every $\mathfrak{A}$-assignment g, and false otherwise. If ϕ is not reconstructible with respect to $\mathfrak{B}$, i, j, g and G, however, then $\phi^{\mathfrak{B},i,j,g,G}$ is **undefined.** The build up of stage descriptions is treated on a par with the build up of a traditional interpretation or model (which fully continues its function as part of our extended context model).

6. ANALYZING PRONOUNS IN TERMS OF CONTEXTUAL RECONSTRUCTION

Having given the general definitions of the context-dependent intensional logic IL_2 and of a context model, let us turn now to the task of incorporating a linguistically satisfying description of pronouns into our extended system. To do this we have to

(32) a. motivate detailed translations for various pronouns, whereby the aspect of context dependency is to be captured in terms of characteristic context variables
b. specify the possible values for each context variable employed.

Clause (32b) will require further assumptions concerning the build up of "appropriate" stage descriptions. Based on these assumptions, we can specify the position of possible values for each context variable in any appropriate

stage description (the **type** of possible values must agree with the type of the context variable in question).

Although the whole translation expression corresponding to a T pronoun is going to be of type $f(\mathrm{T})$, this does not determine the type of the context variable to be **contained** in the translation (representing the aspect of context dependency in T pronouns). As illustrations of two reasonable possibilities consider (33) and (34), which are alternative rough translations:

(33) $\hat{P}\bigvee x[male'(x) \wedge \Gamma\{x\} \wedge P\{x\}]$

(34) Γ^m

In (33), Γ is a context variable of type $\langle s, f(\mathrm{CN})\rangle$, ranging over **properties of individual concepts;** in (34), Γ^m is a context variable of type $\langle s, f(\mathrm{T})\rangle$, ranging over properties of properties of individual concepts (cf. PTQ, p. 259).

How are we going to decide between such alternatives? Note that there may be **indefinite** antecedents to T pronouns, as in (35):

(35) *Every man who loves* ***a woman*** *loses* ***her.***

Assuming we choose proposal (34) and translate *her* by means of a context variable of type $f(\mathrm{T})$, we would on one reading reconstruct (35) into an expression which is equivalent to the translation of (36):

(36) *Every man who loves* ***a woman*** *loses* ***a woman.***

The identical noun phrases in (36), however, may under no circumstances be interpreted as coreferential [also, proposal (36) would require the specification of context variables which are *sorted* with respect to gender and number].

For this reason, let us choose the proposal indicated in the tentative translation (33). This choice has the advantage of allowing us to reconstruct (35) automatically into an IL_2 expression which is *equivalent* to the translation of (37):

(37) *Every man who loves* ***a woman*** *loses* ***the woman.***

The sentences in (33) and (37) are synonymous on their respective anaphoric readings.

Our semantic representation of nonreflexive personal T pronouns should formally capture the characteristic numerically qualified, existential presupposition and (sometimes) gender. These semantic properties are jointly implemented in the following translations of the T pronoun *he*:[6]

[6] Note that $\hat{P}\bigwedge x \in [\ \ldots\ ]^1 P\{x\}$ and $\hat{P}\bigvee x \in [\ \ldots\ ]^1 P\{x\}$ are logically equivalent, assuming that $[\ \ldots\ ]^1$ is defined as representing a **unit set.** Since *they* (like the plural of the definite article) must translate by a universal rather than an existential quantifier, the use of a restricted universal quantifier in the translation of *he* (as well as in the singular of the definite article) reduces the semantic difference between singular and plural of the terms (quantifier expressions) in question to a simple difference in the cardinality of the respective quantifier restrictions ($[\ \ldots\ ]^1$ versus $[\ \ldots\ ]^2$).

(38) *he* translates into $\hat{P}\wedge x \in [\wedge y[male'(y) \wedge \Gamma_3\{y\}] \leftrightarrow x = y]]P\{x\}$, which is abbreviated as $\hat{P}\wedge x \in [male'(x) \wedge \Gamma_3\{x\}]^1P\{x\}$

The $\wedge x \in [f(x)]g(x)$ notation in (38) represents **restricted quantification** as defined in Hausser 1976a (see also Belnap, 1970; Hausser, 1974b; Rescher, 1968; and Quine, 1963). The truth conditions for restricted quantification are such that $\wedge x \in [f(x)]h(x)^{\mathfrak{A},i,j,g}$ and $\vee x \in [f(x)]h(x)^{\mathfrak{A},i,j,g}$ are **bivalent** (that is, true or false, but not truth valueless) as long as there exists at least one variable assignment g' such that $f(x)^{\mathfrak{A},i,j,g'}$ is 1. On the other hand, if the existential presupposition concerning $f(x)$ is not fulfilled, the mentioned formulas are # (undefined) with respect to the point of reference in question ($\mathfrak{A}$ is an interpretation as defined in PTQ, (i,j) is a point of reference, and g is a variable assignment function). The truth conditions of restricted quantification and the usual nonrestricted quantification (for the latter, for example, $\wedge x[f(x) \rightarrow h(x)]$ and $\vee x[f(x) \wedge h(x)]$) **agree,** however, as long as $f(x)$ is true at the point of reference in question.[7]

Note that translation (38) induces the **presupposition** that *he* denotes one and only one individual concept (thus the uniqueness presupposition is fulfilled). What this amounts to in a more general context is exemplified in (39),

(39) *He walks.*

which would translate into (39a).

(39′) $\wedge x \in [male'(x) \wedge \Gamma_3\{x\}]^1walk'(x)$

The expression (39′) is # (truth valueless, or rather, **undefined**) with respect to an interpretation $\mathfrak{A}$, a point of reference $\langle i,j\rangle$, a stage description $con(\langle i,j\rangle)$, and a reconstruction function G, **if** there is **no** or **more than one** individual concept which has the property *male′*, the property *walk′*, and the property $G(\Gamma_3)$—the contextual value for Γ_3.

Following these remarks, the definition of the (distributive) plural of the third person T pronouns *they* is fairly obvious:

(40) *they* translates into $\hat{P}\wedge x \in [\Gamma_3\{x\} \wedge \vee y[\Gamma_3\{y\}] \wedge \vee z[\Gamma_3\{z\}]]P\{x\}$, which is abbreviated as $\hat{P}\wedge x \in [\Gamma_3\{x\}]^2P\{x\}$.

(I follow here the treatment of singular, distributive plural, and collective plural presented as an extension of PTQ in Hausser, 1974b, Ch. 2; for the sake of simplicity I will limit the following discussion to the singular and the

[7] Since our system combines the treatment of semantic presuppositions presented in Hausser 1976a with the system of contextual reconstruction, we combine a **strong** and a **weak** presuppositional logic in our grammar (cf. Rescher, 1969).

Although for the phenomena described in connection with *P*-inducers and cancelling contexts only a presuppositional logic of the strong type is adequate (as argued in Hausser, 1976a), the interpretation of context-dependent expressions clearly requires a weak presuppositional logic. Note that there are expressions which are context-dependent and P-inducing at the same time,

distributive plural only.) Based on translation (40), example (41) will translate into (41′):

(41) *They walk.*

(41′) $\wedge x \in [\Gamma_3\{x\}]^2 walk'(x)$

(41′) will be # with respect to an interpretation $\mathfrak{I}$, a point of reference $\langle i,j\rangle$, and a stage description $con(\langle i,j\rangle)$, if Γ_3—which is to be reconstructed with respect to $con(\langle i,j\rangle)$—does not turn out to refer to **more than one** individual concept (**non**uniqueness presupposition). Note that a specification of a natural gender is not appropriate in translation (40) because *they* (in contrast to the **singular** third person) does not specify a gender.

Apart from number and gender, T pronouns differ regarding person. This semantic property will be represented by means of different context variables. Consider the following translations of all personal pronouns:

(42)
(i) *I* translates into $\hat{P}\wedge x \in [\Gamma_1\{x\}]^1 P\{x\}$.
(ii) *you* translates into $\hat{P}\wedge x \in [\Gamma_2\{x\}]^1 P\{x\}$.
(iiia) *he* translates into $\hat{P}\wedge x \in [male'(x) \wedge \Gamma_3\{x\}]^1 P\{x\}$.
(iiib) *she* translates into $\hat{P}\wedge x \in [female'(x) \wedge \Gamma_3\{x\}]^1 P\{x\}$.
(iiic) *it* translates into $\hat{P}\wedge x \in [neuter'(x) \wedge \Gamma_3\{x\}]^1 P\{x\}$.
(vi) *we* translates into $\hat{P}\wedge x \in [\Gamma_1\{x\}]^2 P\{x\}$.
(vii) *you* translates into $\hat{P}\wedge x \in [\Gamma_2\{x\}]^2 P\{x\}$.
(viii) *they* translates into $\hat{P}\wedge x \in [\Gamma_3\{x\}]^2 P\{x\}$.[8]

[8] In line with my analysis of scope ambiguities and scope restrictions (Hausser, 1976b), the nonreflexive T pronouns *I, you, he, she, it, we, you, they* should be marked [+w, −r] like the definite article *the*. As proof consider the following examples:

(i) *They read a book.*
(i′) $\wedge x \in [\Gamma_3\{x\}]^2 \vee y[book'(y) \wedge read'(x, \hat{P}P\{y\})]$
(i″) $\vee y[book'(y) \wedge \wedge x \in [\Gamma_3\{x\}]^2 read'(x, \hat{P}P\{y\})]$

(i) is ambiguous between a nonspecific (i′) and a specific (i″) reading regarding *a book*. With respect to negation, however, nonreflexive T pronouns are subject to a scope restriction:

(ii) *They didn't walk.*
(ii′) $\wedge x \in [\Gamma_3\{x\}]^2 \sim walk'(x)$
(ii″) $*\sim \wedge x \in [\Gamma_3\{x\}]^2 walk'(x)$

Expression (ii) is unambiguous and permits intuitively only the narrow scope negation reading (ii′). With respect to embedding, finally, nonreflexive T pronouns exhibit the scope restriction typical of presupposing terms:

(iii) *A girl who saw them panicked.*
(iii′) $\vee x[[girl'(x) \wedge \wedge y \in [\Gamma_3\{y\}]^2 see'(x, \hat{P}P\{y\})] \rightarrow panic(x)]$
(iii″) $*\wedge y \in [\Gamma_3\{y\}]^2 \vee x[[girl'(x) \wedge see'(x, \hat{P}P\{y\})] panic(x)]$

Thus, (iii) permits intuitively only the reading (iii′), where the relativized element has wider scope than the pronoun in the relative clause.

By marking nonreflexive T pronouns in the lexicon as [+w, −r], the undesired readings will be filtered, provided that our extension incorporates the syntactic refinements developed in Hausser 1976b.

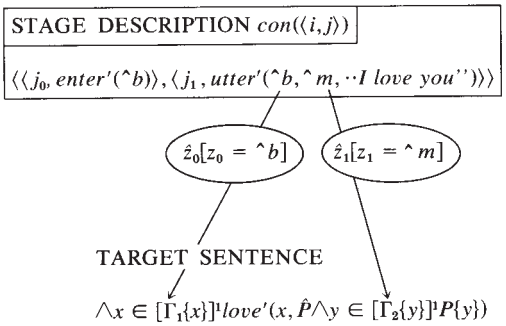
In (42), we distinguish three different kinds of context variables (Γ_1, Γ_2, and Γ_3) all of type f(CN).[9] The reason for this distinction is that we want to characterize the difference between first, second, and third person T pronouns in terms of the **position of possible contextual arguments in a respective stage description.** As an example, consider (43), which, according to our definitions, translates into (43′):

(43) *I love you.*

(43′) $\wedge x \in [\Gamma_1\{x\}]^1 love'(x, \hat{P}\wedge y \in [\Gamma_2\{y\}]^1 P\{y\})$

The intended contextual reconstruction and interpretation of (43′) with respect to a context model $\mathfrak{B}$ (defined as $\langle \mathfrak{A}, con\rangle$, where $\mathfrak{A}$ is an interpretation $(A, I, J, \leq, F\rangle$ as specified in PTQ), a point of reference $(\langle i,j\rangle)$ $(i \in I, j \in J)$, a variable assignment g, and a reconstruction G is illustrated below:

(44)



RECONSTRUCTION

$\wedge x \in [\hat{z}_0[z_0 = \hat{}\,\boldsymbol{b}]\{x\}]love'(x, \hat{P}\wedge y \in [\hat{z}_1[z_1 = \hat{}\,\boldsymbol{m}]\{y\}]P\{y\})$

(for the pertinent definitions, see Section 8) The reconstruction in (44) reduces via lambda-conversion to (45):

[9] In sentences that contain more than one pronoun of a certain "person," the context variables in the translations of the different pronouns need to be kept distinct in order to insure separate reconstruction of each pronoun. This may be done by adding an occurrence-index, thus creating an infinite number of context-variables of a given kind, for example, $\Gamma_{3,0}$, $\Gamma_{3,1}$, $\Gamma_{3,2}$, . . . , $\Gamma_{3,n}$ $(n \in N)$ for context variables representing the context-dependency aspect of third-person. A sentence like

He brings it and she kisses it.

would thus translate into, for example,

$$[\wedge x_0 \in [male'(x_0) \wedge \Gamma_{3,0}\{x_0\}]^1 bring(x_0, \hat{P}\wedge x_1 \in [neuter'(x_1) \wedge \Gamma_{3,1}\{x_1\}]^1 P\{x_1\})] \wedge [\wedge x_2 \in [female'(x_2) \wedge \Gamma_{3,2}\{x_2\}]^1 kiss(x_2, \hat{P}\wedge x_3 \in [neuter'(x_3) \wedge \Gamma_{3,3}\{x_3\}]^1 P\{x_3\})].$$

(45) $\wedge x \in [x = \hat{}\, b]^1 love'(x, \hat{P} \wedge y \in [y = \hat{}\, m]^1 P\{y\})$

The diagram (44) gives an example of a stage description which reports both nonlinguistic and linguistic events occurring in the given interval. Linguistic events are quoted in the stage description, that is, they occur as the third argument [of type $f(T)$] of certain **utterance predicates** of IL_1. For the sake of simplicity, let us assume that the first and second argument of utterance predicates in a stage description are to be **constants** of type $\langle s, e \rangle$.

A stage description $con(\langle i,j \rangle)$ is called **appropriate** for a given target sentence if an L surface of the target sentence is quoted in the last utterance predicate of the last moment specification of $con(\langle i,j \rangle)$. We can now specify the values of reconstruction functions for the context variables Γ_1 and Γ_2 as follows:

(46) Let ϕ be a meaningful IL_2 expression containing Γ_1 or Γ_2. If $con(\langle i,j \rangle)$ is an appropriate stage description with respect to ϕ, and α, β are the first and second argument of the last utterance predicate in $con(\langle i,j \rangle)$, then ${\Gamma_1}^{\mathfrak{B},i,j,g,G}$ and ${\Gamma_2}^{\mathfrak{B},i,j,g,G}$ are to be $\hat{x}[x = \alpha]$ and $\hat{y}[y = \beta]$, respectively. If $con(\langle i,j \rangle)$ is not an appropriate stage description for ϕ, then ${\Gamma_1}^{\mathfrak{B},i,j,g,G}$ and ${\Gamma_2}^{\mathfrak{B},i,j,g,G}$ are **undefined** for all $G \in \mathfrak{G}$ (where $\mathfrak{G}$ is a set of reconstruction functions).

Stage descriptions which are appropriate for a given target sentence ϕ describe by definition an **utterance** of the L-correlate of ϕ.

7. COREFERENCE PHENOMENA ARISING WITH DEFINITE TERMS

It is the defining property of context-dependent expressions that they depend on certain properties of the utterance situation for their interpretation. The use of context variables and the inductive development of progressively more detailed stage descriptions (and more specific restrictions on possible values of reconstruction function) is well-suited to describe these linguistic phenomena in a differentiated formal fashion. Before discussing further details of the contextual reconstruction of different context variables, however, let me explain the handling of coreference phenomena (arising with T pronouns and definite descriptions) in this system.

T pronouns are characterized by the fact that they are

(47) a. **basic** terms
b. **context-dependent** terms.

On the one hand, proper names and T pronouns have in common that they are basic terms. (They differ, however, in that proper names are context in-

dependent.) Definite descriptions and T pronouns, on the other hand, have in common that they are context dependent. They differ, however, in that definite descriptions are derived (that is, nonbasic) terms. It follows that [as far as (47a) and (47b) are concerned] T pronouns do not differ from so-called full NPs. On the contrary, it is my hypothesis that T pronouns are equipped with sufficient syntactico–semantic properties to denote *without* any additional mechanism designed only for pronouns (for example, stipulated coreference, stipulated codescriptiveness). T pronouns function no differently from ordinary full NPs.

To further support this hypothesis, let me compare the semantics of *definite descriptions* and T pronouns. One goal is to find a basic semantic principle which jointly explains the possible coreference of the boldface italic terms in (16a) and (16b), respectively:

(16) a. *Every man who loves* ***a woman*** *loses* ***her.***
b. *Every man who loves* ***a woman*** *loses* ***the woman.***

I will assume the semantics of the definite article developed in Hausser (1974b, Ch. 5), where definiteness is treated as a combination of two independently motivated semantic principles, namely,

(48) a. presupposition of existence
b. context dependency

Regarding the phenomenon of context dependency arising with definite descriptions, compare examples (49) and (50), which contain a definite and an indefinite term, respectively:

(49) ***The dog*** *is outside.*

(50) ***A dog*** *is outside.*

In what way do the truth conditions of (49) and (50) differ? A necessary and sufficient condition for the truth of (50) is that there is something outside which fits the description of a dog. The existence of a dog which is outside is also a necessary condition for the truth of (49), but it is not a sufficient condition. It is the existence of a special "intended" (a "unique") dog, which is required for the truth of (49). In other words, (49) refers not to any old dog, but, for example, to the dog we have been talking about, the dog our neighbors own, etc. Thus, the denotation of definite descriptions is specified not only in terms of the explicit descriptive content of the term (for example, the property *dog'*), but in addition by certain implicit properties, which are to be supplied by the context.

The semantic properties of being an "existential" P-inducer and of being context dependent are formally treated in the following translations of the singular and the distributive plural of *the:*

(51) a. *the* (sg.) translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \Gamma_0\{x\}]^1 P\{x\}$.

b. *the* (d.pl.) translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \Gamma_0\{x\}]^2 P\{x\}$.

The numerically qualified existential presupposition induced by singular *the* (uniqueness presupposition) and plural *the* (nonuniqueness presupposition) is captured in the form of restricted quantification, whereby the **cardinality** of the set restricting the range of the quantifier expression is indicated in form of the superscripts "1" and "2". These superscripts are abbreviations for longer expressions of standard predicate calculus. For further details on the semantics of the singular, as well as the distributive and collective plurals presumed here, see Hausser (1974a and 1974b, Ch. 2).

The aspect of context dependency, furthermore, is treated in form of the context variable Γ_0 contained in the above translations of the definite article. The combination of a numerically qualified presupposition and a context variable leads to a characteristic semantic effect, which is illustrated with our example (50), translating into (50′):

(50) *The dog is outside.*

(50′) $\wedge x \in [dog'(x) \wedge \Gamma_0\{x\}]^1 outside'\{x\}$

Only those reconstructions of Γ_0 (with respect to a stage description) may be called successful which are **compatible** with the numerically qualified existential presupposition.

What are the syntactico–semantic restrictions on possible reconstructions of Γ_0 in the environment of (50′)? Possible values of any given reconstruction $G(\Gamma_0)$ will have to be of type f(CN). Furthermore, possible values will have to be semantically compatible. For the sake of illustration, let us assume that the f(CN) expressions $\hat{}dog'$, $\hat{}cat'$, and $\hat{z}(own'(\hat{}m, \hat{P}P\{z\}))$ are the values of the possible reconstructions $G'(\Gamma_0)$, $G''(\Gamma_0)$, and $G'''(\Gamma_0)$, respectively, presuming that we interpret (50a) with respect to a context model $\mathfrak{B}$, a point of reference $(\langle i,j\rangle)$, a variable assignment g, and the reconstruction function G', G'', or G'''.

Without going into the definitions of the interpretation in question, we can say already that **neither** $G'(\Gamma_0)$ nor $G''(\Gamma_0)$ are likely to turn out to be **successful** reconstructions (that is, reconstructions which do not directly cause lack of truth value). The reason is that $[dog'(x) \wedge \Gamma_0\{x\}]^{1\,\mathfrak{B},i,j,g,G'}$ will correspond to the empty set except with respect to "one-dog" worlds. $[dog'(x) \wedge \Gamma_0\{x\}]^{1\,\mathfrak{B},i,j,g,G''}$, on the other hand, will correspond to the empty set except with respect to worlds where there is a unique animal which is a dog and a cat at the same time. $[dog'(x) \wedge \Gamma_0\{x\}]^{1\,\mathfrak{B},i,j,g,G'''}$, however, will correspond to a unit set provided that $\vee x[dog(x) \wedge \wedge y[[dog'(x) \wedge own'(\hat{}m, \hat{P}P\{y\})] \leftrightarrow x = y]]^{1\,\mathfrak{B},i,j,g,G}$ (for arbitrary G) is true.

The requirement of compatibility drastically limits the number of possible contextual reconstructions which may be called **successful** (at any given point of reference). The narrowing of the range of possible denotations (resulting from the interaction of a numerically qualified existential presupposi-

tion and a context variable) presents the formal semantic essence of "definiteness."

Regarding the semantic similarity of third person nonreflexive T pronouns and definite descriptions, compare the following translations:

(52) a. *the dog* translates into $\hat{P}\wedge x \in [dog'(x) \wedge \Gamma_0\{x\}]^1 P\{x\}$.
b. *he* translates into $\hat{P}\wedge x \in [male'(x) \wedge \Gamma_3\{x\}]^1 P\{x\}$.

(53) a. *the dogs* translates into $\hat{P}\wedge x \in [dog'(x) \wedge \Gamma_0\{x\}]^2 P\{x\}$.
b. *they* translates into $\hat{P}\wedge x \in [\Gamma_3\{x\}]^2 P\{x\}$.

According to our analysis, the only semantic difference between definite descriptions and T pronouns is that the descriptive content of T pronouns is comparatively limited. This explains why the number of possible successful reconstructions is usually higher in the case of T pronouns than in the case of definite descriptions (compatibility is satisfied more easily in the case of T pronouns).

Let us turn now to the phenomenon of possible coreference arising with definite descriptions of third person T pronouns and definite descriptions alike. Consider (54):

(54) *John told Bill that he was sick.*

The pronoun *he* in (54) may either refer to John, Bill, or some other male individual specified by the context (for example, Bill's son). Consider now, what it would mean to call (54) **syntactically ambiguous.** To say that (54) is two-ways ambiguous amounts to maintaining the contrast between anaphoric and indexical use of pronouns, which I reject. To call (54) indefinitely many ways ambiguous, however (because of indefinitely many possible indexical uses) reduces the notion of syntactic ambiguity to absurdity.

According to the approach to context dependency proposed here, (54) is not syntactically ambiguous. Instead, the pronoun *he* is treated as being semantically unspecified in a certain well-defined respect. The specific semantic incompleteness of *he* is equated with the characteristic aspect of context dependency inherent in this pronoun; formally, it is represented in terms of the context variable Γ_3. Consider the translation of (54):

(54′) $tell'(\hat{}j, \hat{P}P\{\hat{}b\}, \hat{}\wedge x \in [male'(x) \wedge \Gamma_3\{x\}]^1 sick'(x))$

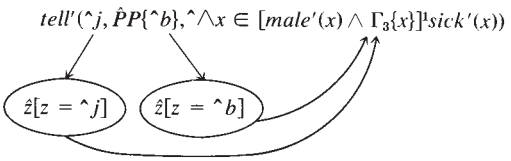
(I presume here a treatment of TV/t-verbs such as *tell-that*.)

Translation (54′) represents the one and only reading of (54). The various reference possibilities of *he* in (54) are treated where they belong, namely in the realm of interpretation. In this particular example, we have to distinguish between two different types of possible reconstructions:

(i) exterior reconstructions
(ii) interior reconstructions

The possible interior reconstructions of (54′) are formally indicated in (55):

(55)



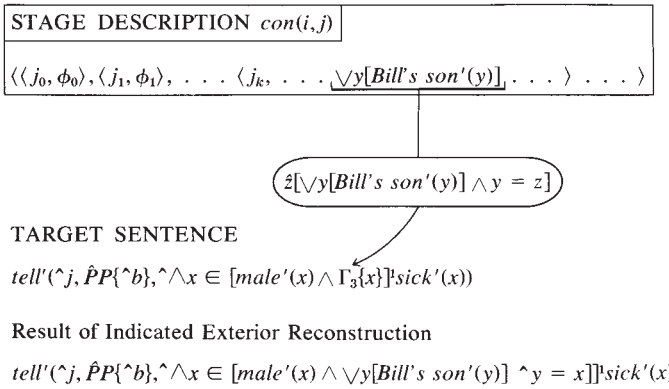
RESULTS:

$$tell'(\hat{}j, \hat{P}P\{\hat{}b\}, \hat{}\wedge x \in [male'(x) \wedge x = \left\{ \begin{matrix} \hat{}j \\ \hat{}b \end{matrix} \right\}] sick'(x))$$

The two interior reconstructions indicated represent the reading in which *he* is coreferential with John, and the reading in which *he* is coreferential with Bill.

As an example of an exterior reconstruction of (54′) with respect to $\mathfrak{B}$, i, j, g, and G, consider (56):

(56)



The distinction between interior and exterior reconstruction relates to the concepts of anaphoric and indexical use of certain pronouns. I propose to call those interpretations of context-dependent expressions *anaphoric* which are based on interior reconstruction, whereas interpretations of context-dependent expressions based on exterior reconstruction may be called **indexical.** The crucial point is that our approach avoids the use of different reference mechanisms for handling anaphoric and indexical use. Thus, we assign uniform semantic representations to both uses of T pronouns, which corresponds to the fact that they exhibit a uniform surface morphology.

It is an important feature of our analysis of nonreflexive personal T pronouns that the context variables are of type f(CN) rather than f(T) or $\langle s, e \rangle$. It is for this reason that we are able to simultaneously

(57) a. implement numerically qualified existential presuppositions directly into the semantic representation of nonreflexive personal T pronouns,
b. employ the requirement of compatibility for the characterization of successful reconstructions,
c. account for the general phenomenon of coreference arising with reconstructed T pronouns and definite descriptions alike,
d. account for those special cases where a reconstructed T pronoun is **not** coreferential with its "antecedent."

Since we have already discussed the points specified in (57a), (57b), and (57c), it remains to deal with (57d). The standard example of a noncoreferential anaphoric T pronoun is the so-called paycheck sentence:

(58) *The young man who gave **his paycheck** to his wife was smarter than the old man who gave **it** to his mistress.*

On the relevant reading of (58), *it* refers to a different paycheck than its assumed antecedent, *his paycheck*.

In order to formally explain the indicated interpretation of (58) in terms of contextual reconstruction, it is necessary to provide detailed translations of possessive T/CN pronouns:

(59) *my* translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \wedge y \in [\Gamma_1\{y\}]^1 relate'(x, \hat{P}P\{y\}]^1 P\{x\}$.
your translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \wedge y \in [\Gamma_2\{y\}]^1 relate'(x, \hat{P}P\{y\}]^1 P\{x\}$.
his translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \wedge y \in [male'(y) \wedge \Gamma_3\{y\}]^1 relate'(x, \hat{P}P\{y\}]^1 P\{x\}$.
her translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \wedge y \in [female'(y) \wedge \Gamma_3\{y\}]^1 relate'(x, \hat{P}P\{y\}]^1 P\{x\}$.
its translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \wedge y \in [neuter'(y) \wedge \Gamma_3\{y\}]^1 relate'(x, \hat{P}P\{y\})]^1 P\{x\}$.
our translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \wedge y \in [\Gamma_1\{y\}]^2 relate'(x, \hat{P}P\{y\})]^1 P\{x\}$.
your translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \wedge y \in [\Gamma_2\{y\}]^2 relate'(x, \hat{P}P\{y\})]^1 P\{x\}$.
their translates into $\hat{Q}\hat{P}\wedge x \in [Q\{x\} \wedge \wedge y \in [\Gamma_3\{y\}]^2 relate'(x, \hat{P}P\{y\})]^1 P\{x\}$.

According to these translations, a term like *my car* is analyzed as *the car which stands in a relation to me*. Note that (59) specifies *singular* quantifiers. While *my car* translates into

$$\hat{P}\wedge x \in [car'(x) \wedge \wedge y \in [\Gamma_1\{y\}]^1 relate'(x, \hat{P}P\{y\}]^1 P\{x\},$$

my cars would translate into

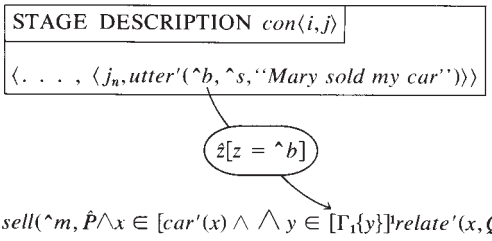
$$\hat{P}\wedge x \in [car'(x) \wedge \wedge y \in [\Gamma_1\{y\}]^1 relate'(x, \hat{P}P\{y\}]^2 P\{x\}.$$

As an illustration of the interpretation of T/CN possessives consider (60).

(60) *Mary sold my car.*

(60′) $sell(\hat{}m, \hat{P}\wedge x \in [car'(x) \wedge \wedge y \in [\Gamma_1\{y\}]^1 relate'(x, \hat{Q}Q\{y\})]^1 P\{x\})$

Example of a reconstruction of (60′):



Note that the translations of T/CN possessives contain the same context variables as nonreflexive personal T pronouns (namely, Γ_1, Γ_2, and Γ_3; compare with (42) Section 6). It follows that *my*, *your*(sg.), *our*, and *your*(pl.) permit only exterior reconstruction, while *his*, *her*, *its*, and *their* permit both interior and exterior reconstruction. As an example, consider (61):

(61) *John sold* **his** *car.*

His in (61) may either relate to *John* (interior reconstruction of Γ_3) or to some other male person specified in the stage description assigned to the point of reference under interpretation.

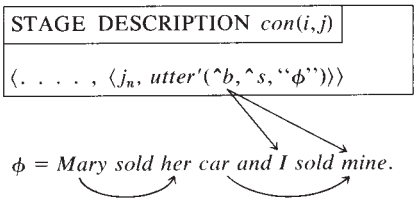
Besides the T/CN possessives there are also T possessives, namely, *mine*, *yours*, *his*, *hers*, *its*, *ours*, *yours*, and *theirs*. In light of our discussion, the semantic representation of T possessives should be as follows:

(62) *mine* translates into $\hat{P}\wedge x \in [\Gamma_0\{x\} \wedge \wedge y \in [\Gamma_1\{y\}]^1 relate'(x, \hat{Q}Q\{y\})]^1 P\{x\}$.
yours translates into $\hat{P}\wedge x \in [\Gamma_0\{x\} \wedge \wedge y \in [\Gamma_2\{y\}]^1 relate'(x, \hat{Q}Q\{y\})]^1 P\{x\}$.
his translates into $\hat{P}\wedge x \in [\Gamma_0\{x\} \wedge \wedge y \in [male'(y) \wedge \Gamma_3\{y\}]^1 relate'(x, \hat{Q}Q\{y\})]^1 P\{x\}$.
hers translates into $\hat{P}\wedge x \in [\Gamma_0\{x\} \wedge \wedge y \in [female'(y) \wedge \Gamma_3\{y\}]^1 relate'(x, \hat{Q}Q\{y\}]^1 P\{x\}$.
its translates into $\hat{P}\wedge x \in [\Gamma_0\{x\} \wedge \wedge y \in [neuter'(y) \wedge \Gamma_3\{y\}]^1 relate'(x, \hat{Q}Q\{y\}]^1 P\{x\}$.
ours translates into $\hat{P}\wedge x \in [\Gamma_0\{x\} \wedge \wedge y \in [\Gamma_1\{y\}]^2 relate'(x, \hat{Q}Q\{y\})]^1 P\{x\}$.

yours translates into $\hat{P}\wedge x \in [\Gamma_0\{x\} \wedge \wedge y \in [\Gamma_2\{y\}]^2 relate'(x, \hat{Q}Q\{y\})]^1 P\{x\}$.
theirs translates into $\hat{P}\wedge x \in [\Gamma_0\{x\} \wedge \wedge y \in [\Gamma_3\{y\}]^2 relate'(x, \hat{Q}Q\{y\})]^1 P\{x\}$.

(The above definitions specify only the singular of T possessives.) Our analysis captures the fact that T possessives are two-way context dependent. One context variable in the translation of T possessives represents the aspect of person (Γ_1, Γ_2, or Γ_3); the other is Γ_0, which also appears in the translation of the definite article. As an example of the interpretation of a T possessive consider (63):

(63)



The interpretation of *mine* in (63) is based on an exterior as well as an interior reconstruction.

Let us return now to the paycheck sentence (58):

(58) *The* ***young man*** *who gave* ***his paycheck*** *to his wife was smarter than the* ***old man*** *who gave* ***it*** *to his mistress.*

Reconstructing *it* into *his paycheck'* results in an expression **which is itself context-dependent.** While the context variable in the original occurrence of *his paycheck'* can be internally reconstructed with respect to *young man*, the context variable in the reconstruction of *it* (that is, the Γ_3 in the reconstruction *his paycheck'*) relates to *old man*. *His paycheck* in (58) is what we will call the **primary antecedent** of *it*. The **secondary antecedent** of the primary reconstruction of *it* (that is, *his paycheck'*) is *old man*. The indicated interpretation of *it* in (58) is an example of an interior two-step reconstruction which does not result in coreference with the primary antecedent. The reason is obvious: The descriptive content of the reconstructed primary antecedent does not intersect with the descriptive content of the two-step reconstruction of the pronoun.

Two-step reconstructions also play an important role in the interpretation of Bach–Peters sentences. Consider (12):

(12) *The* ***man who deserves*** **it** *will get the* ***prize*** **he** ***wants.***

The primary antecedent of *he* is *man who deserves it* [remember that the context variable in nonreflexive personal T pronouns is of type f(CN)]. The secondary antecedent of *he* is *prize*, which relates to the *it* occurring in the primary reconstruction of *he*. The primary antecedent of *it* occurring explicitly in (12) is *prize he wants*. The secondary antecedent (relating to *he* occur-

ring in the primary reconstruction) is *man*. In other words, the indicated reconstruction of (12) is equivalent to:

(12a) *The man who deserves* ***the prize the man wants*** *will get the prize which* ***the man who deserves the prize*** *wants.*

This reading of (12) (based on two internal two-step reconstructions) includes a coreferential interpretation of the two pronouns with their respective primary antecedents. The reason is that the descriptive content of the two-step reconstruction of the pronouns overlaps with the descriptive content of the respective reconstructed antecedents.

The principle employed here, of establishing the denotation of definite terms through the reconstruction of the descriptive content of the terms in question, accounts not only for the coreferential readings in (12) as well as the lack of coreference in (58), but also for "pronominal epithets" (Jackendoff, 1972). Consider for example:

(64) *I wanted* ***Charley*** *to help me, but* ***the bastard*** *wouldn't do it.*

In (64), coreference between the marked terms may be introduced by reconstructing *the bastard* into (roughly) *the bastard who is Charley*.

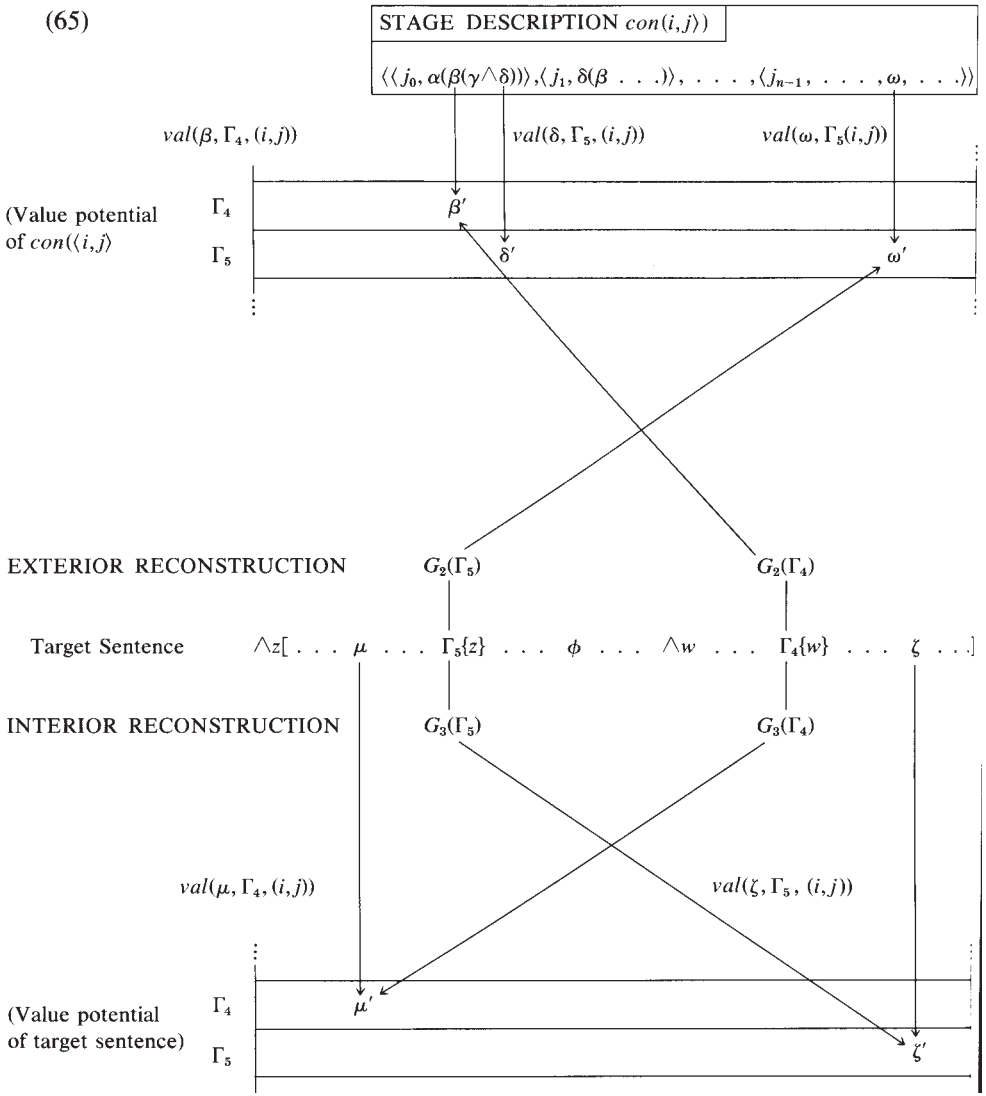
8. CONSTRAINTS ON RECONSTRUCTIONS

The descriptive power of our analysis resides to a large extent in the fact that we can specify the set of possible contextual values at any point of reference and for any given context variable (that is, any aspect of context dependency) in any degree of syntactico–semantic detail. For example, in Section 6, (46), we specified the respective reconstructions of *I'* and *you'*: For all $G \in \mathfrak{G}$ (where $\mathfrak{G}$ is a set of reconstruction functions), $G(\Gamma_1)$ and $G(\Gamma_2)$ are defined as $\hat{x}[x = \hat{}\alpha]$ and $\hat{y}[y = \hat{}\beta]$, where α, β are of type e and α, β are the first and second argument, respectively, of the last utterance predicate in the stage description under interpretation (provided that it is an "appropriate" stage description).

In specification (46), various different functions of a contextual reconstruction are intertwined: the constraints on types and positions of possible sources, the derivation of contextual values from possible source expressions, and the actual reconstruction. For the sake of a more perspicuous formulation, however, it seems advisable to separate the derivation of sets of suitable values from the contextual reconstruction proper. More specifically, we define a reconstruction function G ($G \in \mathfrak{G}$) as a function from the set of all context variables of IL_2 into the set of contextual values *Val*. Consequently we specify that for all $G \in \mathfrak{G}$ and all context variables Γ_n, ${\Gamma_n}^{\mathfrak{A},i,j,g,G} = val(\alpha, \Gamma_n, (i,j))$, where α is an IL_1 or an IL_2 source and *val* is a function generating contextual values for any context variable from any pos-

sible source available at any given point of reference. In other words, *val* is a function from $(\text{SOURCE}^{(i,j)} \cup TS) \times C \times (I \times J)$ into *val* [where $\text{SOURCE}^{(i,j)}$ is the set of all meaningful expressions occurring in the stage description $con(\langle i,j \rangle)$, *TS* is the set of meaningful expressions contained in the target sentence, *C* is the set of all context variables, and $I \times J$ is the set of all reference points]. For example, $val(\alpha, \Gamma_n, (i,j))$ specifies the contextual value α', where α' is derived from the source α, α' is a possible value for Γ_n, and α is an element of $\text{SOURCE}^{(i,j)}$, or of *TS*. Consider (65) as an illustration.

(65)



The elements β', δ', ω', μ', ζ' are members of the set $Val^{(i,j)}$ of all contextual values generated at (i,j), sorted with respect to different context variables.

A reconstruction $G(\Gamma_n)$ at a point of reference (i,j) is *successful* if and only if

(66) a. $G(\Gamma_n) = \alpha'$ is defined for some $\alpha' \in Val^{(i,j)}$,
b. $val(\alpha, \Gamma_n, (i,j)) = \alpha'$ is defined for a source expression α,
c. α' is semantically compatible with its reconstruction environment [. . . Γ_n . . .].

If at a given point of reference (i,j) there is *more than one* possible contextual argument for a given context variable Γ_n (occurring in the target sentence ϕ under interpretation) then ϕ is **pragmatically ambiguous at** (i,j) [compare, for example, the target sentence in (65)]. Pragmatically different interpretations of a context-dependent expression ϕ correspond to different reconstruction functions G. Thus, if there are only three contextual values α', β', and γ' at (i,j) for the context variable Γ_n occurring in the target sentence ϕ, and $G_1(\Gamma_n) = \alpha'$, $G_2(\Gamma_n) = \beta'$, and $G_3(\Gamma_n) = \gamma'$, $(G_1, G_2, G_3 \in \mathfrak{G})$ are defined at (i,j), then for all other reconstruction functions G_m $(G_m \in \mathfrak{G}, m \neq 1,2,3)$, $G_m(\Gamma_n)$ is undefined at (i,j). Thus, the denotation of a context-dependent expression ϕ depends on the particular reconstruction function employed in the interpretation in question.

The existence of a reconstruction function G, $G \in \mathfrak{G}$, such that $G(\Gamma_n)^{\mathfrak{A},i,j,g,G}$ is *defined* for a given Γ_n, depends on whether the set *Val* contains at least one element $val(\alpha, \Gamma_n(i,j))$ which is defined for α, Γ_n, and (i,j). The definedness of $val(\alpha, \Gamma_n, (i,j))$, in turn, depends on whether α is a *source expression* at (i,j) which corresponds to the *value specification* Γ_n. As examples consider the specifications on values for Γ_1 and Γ_2:

(67) If α is of type e, and α is the first argument of the last utterance predicate of $con(\langle i,j \rangle)$, then $val(\alpha, \Gamma_1, (i,j))$ is $\hat{x}[x = \hat{}\alpha]$; otherwise $val(\alpha, \Gamma_1, (i,j))$ is undefined at (i,j).

(68) If β is of type e, and β is the second argument of the last utterance predicate of $con(\langle i,j \rangle)$, then $val(\alpha, \Gamma_2, (i,j))$ is $\hat{y}[y = \hat{}\beta]$; otherwise $val(\beta, \Gamma_2, (i,j))$ is undefined at (i,j).

These are specifications on the value-generating function *val*. They reformulate specification (46), which was a specification on the reconstruction function G.

What is the specification concerning Γ_3, the context variable representing "third person"? We know that externally the reconstruction of Γ_3 will be basically unrestricted, whereas internally, the reconstruction of Γ_3 is subject to the constraints on backward pronominalization. These limit the relations that may hold between a noun phrase serving as antecedent and an ana-

phoric pronoun. We reformulate this question as: What are the positional restrictions on the internal reconstruction of Γ_3?

In order to formulate the restrictions on $val(\alpha, \Gamma_3, (i,j))$, we need the auxiliary notion of a **coargument** of Γ_3. A coargument of a context variable Γ_3 is an individual concept which stands in a relation (in intension or extension) with the referent of the *argument* of Γ_3. The pertinent kind of environment characterizing a coargument of a given Γ_3 in our extension is specified in (69):

(69) If $\delta \in \mathrm{ME}_{f(\mathrm{TV})}$, and ϕ is $\delta(y, \hat{P}\wedge x \in [\ldots \Gamma_3\{x\}] \ldots)$, then y is the coargument of $\Gamma_3\{x\}$ in ϕ.

We may now formulate the restriction on the reconstruction of Γ_3 [or rather $\Gamma_{3,n}$ ($n \in \mathrm{N}$), cf. Footnote 9], which covers the constraints on backward pronominalization as formulated by Langacker 1969 or Ross 1969 without impeding the interpretation of such examples as Bach–Peters sentences, the paycheck sentence, or the donkey sentence.[10]

(70) If $\alpha \in \mathrm{ME}_e$ and $\phi \in \mathrm{ME}_t$, then

$val(\alpha, \Gamma_3, (i,j))$ is $\hat{x}[x = \hat{}\alpha]$,
$val(\phi, \Gamma_3, (i,j))$ is $\hat{x}[\phi \wedge \mu = x]$, for all $\mu \in \mathrm{ME}_{\langle s,e\rangle}$ occurring in ϕ,

provided that α, ϕ do not arise in the scope of $\wedge x \ldots \Gamma_3\{x\} \ldots$ on the dominant reading of the target sentence ψ, and α, μ are not coarguments of $\Gamma_3\{x\}$ in ψ'.[11]

What is the linguistic motivation for the provision in (70)? The function of a Γ_3 reconstruction is to sharpen the descriptive content of the quantifier expression binding the argument of the Γ_3 in question. The provision in (70) excludes precisely those possible sources of internal reconstruction which are potentially unsuited to perform this function because their own denotation may depend on the reconstruction of the Γ_3 under consideration. The source expressions excluded from the internal reconstruction of a given Γ_3 are all expressions in the scope of $\wedge x \ldots \Gamma_3\{x\} \ldots$ as well as basic or derived coarguments of $\Gamma_3\{x\}$.

In order to illustrate this requirement of relative structural independence of a potential internal source from the Γ_3 it is supposed to reconstruct, let us consider a number of examples.

[10] Specification (70) does not yet handle the fact that "following antecedents" have to be definite, and that noun phrases embedded under certain prepositions may not serve as an antecedent (Lakoff, 1968). I leave these details to a later analysis.

[11] It is understood in general that possible source expressions of a given context-variable in a given target sentence at a given point of reference (i,j) arise either in the stage description ($\langle i,j\rangle$) or in the target sentence. Furthermore, in order to maintain certain binding relations (consider (7) and (80) in this respect), simultaneous substitution of variables in an internal source is *suspended* until after the reconstruction is completed.

(71) *The girl sees her.*

(71′) $\wedge x \in [girl'(x)]^1 see'(x, \hat{P} \wedge y \in [female'(y) \wedge \Gamma_3\{y\}]^1 P\{y\})$[12]

The expression $girl'(x)$ in (71′) may not reconstruct the Γ_3 in question because x happens to be a coargument of $\Gamma_3\{y\}$.

(72) She sees the girl.

(72′) $\wedge y \in [female'(y) \wedge \Gamma_3\{y\}]^1 see'(y, \hat{P} \wedge x \in [girl'(x)]^1 P\{x\})$

In (72′), $girl'(x)$ may not reconstruct Γ_3 because $girl'(x)$ happens to be in the scope of $\wedge y \ldots \Gamma_3\{y\} \ldots$. Note that Γ_3 specification (70) excludes identical expressions which are on the *dominant* reading in the scope of $\wedge y \ldots \Gamma_3\{y\} \ldots$. The dominant reading of a surface sentence is understood as that reading which mirrors the surface order of the quantifiers and other operators involved in scope ambiguities on the level of semantic representation (cf. Hausser, 1976b).

(73) *The girl who kissed her loves Mary.*

(73′) $\wedge x \in [girl'(x) \wedge kiss'(x, \hat{P} \wedge y \in [female \cdot'(y) \wedge \Gamma_3\{y\}]^1 P\{y\})]^1 love'(x, \hat{P} P\{\hat{}m\})$

In (73′), x is a coargument of $\Gamma_3\{y\}$, which excludes $girl'(x)$ from being a possible source for the internal reconstruction in question. The constant m, however, is neither a coargument nor in the scope of $\wedge y \ldots \Gamma_3\{y\} \ldots$, and thus qualifies as a source.

(74) *She kissed the girl who loves Mary.*

(74′) $\wedge y \in [female' \cdot (y) \wedge \Gamma_3\{y\}]^1 kiss'(y, \hat{P} \wedge x \in [girl'(x) \wedge love'(x, \hat{P} P\{\hat{}m\})]^1 P\{x\})$

In (74′), both $girl'(x)$ and m are on the dominant reading in the scope of $\wedge y \ldots \Gamma_3\{y\} \ldots$ and therefore do not qualify as a possible source for the interior reconstruction of the Γ_3 in question.

(75) *The girl who kissed Mary loves her.*

(75′) $\wedge x \in [girl'(x) \wedge kiss'(x, \hat{P} P\{\hat{}m\})]^1 love'(x, \hat{P} \wedge y \in [female'(y) \wedge \Gamma_3\{y\}]^1 P\{y\})$

In (75′), x is a coargument of $\Gamma_3\{y\}$, which excludes $girl'(x)$ from being a possible source. However, m is neither in the scope of $\wedge y \ldots \Gamma_3\{y\} \ldots$ nor a coargument, and thus qualifies as a possible source.

(76) *Mary kissed the girl who loves her.*

[12] For the sake of simplicity, I will translate the definite article in the following examples without its characteristic context variable.

(76′) $kiss'(\hat{}m, \hat{P}\wedge x \in [girl'(x) \wedge love'(x, \hat{Q}\wedge y \in [female'(y) \wedge \Gamma_3\{y\}]^1 Q\{y\})]^1 P\{x\})$

In (76′), x is a coargument of $\Gamma_3\{y\}$, which excludes $girl'(x)$ from being a possible source. (It holds in general that the head noun of a relative clause is a coargument of a pronoun in that relative clause, except for cases where the pronoun is further embedded). However, m is neither in the scope nor a coargument of $\wedge y \ldots \Gamma_3\{y\} \ldots$ and qualifies as a possible source.

(77) *The girl who kissed her knows the lady who treated Mary.*

(77′) $\wedge x \in [girl'(x) \wedge kiss'(x, \hat{P}\wedge y \in [female'(y) \wedge \Gamma_3\{y\}]^1 P\{y\})]^1 know'(x, \hat{P}\wedge z \in [lady'(z) \wedge treat'(z, \hat{P}P\{\hat{}m\})]^1 P\{z\})$

In (77′), x is a coargument of $\Gamma_3\{y\}$, which excludes $girl'(x)$ from being a possible source. Neither z nor m are coarguments or in the scope of $\wedge y \ldots \Gamma_3\{y\}$; therefore, both $lady'(z)$ and m qualify as possible sources.

(78) *The girl who kissed Mary knows the lady who treated her.*

(78′) $\wedge x \in [girl'(x) \wedge kiss'(x, \hat{P}P\{\hat{}m\})]^1 know'(x, \hat{P}\wedge z \in [lady'(z) \wedge treat'(z, \hat{P}\wedge y \in [female'(y) \wedge \Gamma_3\{y\}]^1 P\{y\})]^1 P\{z\})$

In (78′), z is a coargument of $\Gamma_3\{y\}$, which excludes $lady'(z)$ from being a possible source (Compare with (77)). However, x and m are neither coarguments nor in the scope of $\wedge y \ldots \Gamma_3\{y\}$. Therefore, both $girl'(x)$ and m qualify as possible sources.

The reference to the **dominant reading** in specification (70) accounts also for the fact that *Mary* may be coreferential with *her* in (79), but not with *she* in (74) (where (79) is the passive of (74)):

(79) *The girl who loves Mary was kissed by her.*

(79′) $\wedge x \in [girl'(x) \wedge love'(x, \hat{P}P\{\hat{}m\})]^1 \wedge y \in [female'(y) \wedge \Gamma_3\{y\}]^1 kiss'(y, \hat{P}P\{x\})$

In (79′), x is a coargument of $\Gamma_3\{y\}$, which excludes $girl'(x)$ from being a possible source. The constant m, however, is outside the scope of $\wedge y \ldots \Gamma_3\{y\} \ldots$ and is not a coargument of Γ_3. Thus m is a possible source for Γ_3 in (79′)—though not in (74′). The reason is that the order of the quantifiers on the dominant reading of (79) is reversed in comparison to (74).

The indicated treatment of the constraints on backward pronominalization in terms of constraints on the internal reconstruction of Γ_3 differs from transformational accounts in that it is neither based on rules of possible coreference nor on rules of obligatory noncoreference. Rather, coreference, or lack of it, is treated entirely as a consequence of the (internally) recon-

structed **descriptive content** of the pronoun under interpretation. Note that the value specification for Γ_3 stated in (70) does not impede the "anaphoric" interpretations of such standard puzzles as examples (10), (13), and (14). The proof on the basis of formal IL_2 translations is left as an exercise to the reader. But even without formal translations, it is obvious that the respective source expressions are neither coarguments nor in the scope of the respective pronouns on the dominant readings.

The restrictions on the **position** of possible source expressions of Γ_3 stated in the $val(\alpha, \Gamma_3, (i,j))$ under specification (70) are crucially complemented by the requirement of **semantic compatibility,** briefly discussed in section 7, and based on the treatment of numerically qualified existential presuppositions developed in Hausser 1976a. A contextual value α is said to lack semantic compatibility in a given reconstruction of a context variable if the reconstruction results directly in a presupposition failure. Thus, lack of semantic compatibility of an otherwise possible contextual argument explains in many instances why the source expression in question can not be an antecedent of the pronoun or definite description under interpretation. Consider, for example, the fact that on the *nonspecific* reading of (80) there is no possible interpretation of *it* as being coreferential with *a car*.[13]

(80) *Bill doesn't have* ***a car*** *and* ***it*** *is in the garage.*

Why is there no successful interior reconstruction of *it'* with respect to *no car Bill has'*? The nonspecific reading of (80) translates into (80'):

(80') $\sim\bigvee x[car'(x) \wedge have'(\hat{}b, \hat{P}P\{x\})] \wedge \bigwedge y \in [neuter'(y) \wedge \Gamma_3\{y\}]^1 in\ garage'(y)$

If ϕ is the translation of the first conjunct of (80), and we interpret (80') with respect to a given $\mathfrak{B}$, i, j, g, G, then $val(\phi, \Gamma_3, (i,j))$ will be the contextual value given under (80''):

(80'') $\hat{z}[\sim\bigvee x[car'(x) \wedge have'(\hat{}b, \hat{P}P\{x\}) \wedge x = z]]$

Replacing Γ_3 in (80') by (80'') results in the following reconstruction of the pronoun (after lambda conversion):

(81) $\hat{P}\bigwedge y \in [neuter'(y) \wedge \sim\bigvee x[car'(x) \wedge have'(\hat{}b, \hat{P}P\{x\}) \wedge x = y]]^1 P\{y\}$

The reconstruction (81) does not result in a proper quantifier restriction, because under the assumption that the first conjunct of (80) is **true** under the nonspecific reading, then **all** individual concepts will have the property of "not being Bill's car." Since the indicated contextual reconstruction does not narrow the quantifier restriction in (81) as compared to the unreconstructed pronoun translation in (80'), the quantifier restriction will not corre-

[13] This example was pointed out to me by Lauri Karttunen.

spond to a unit set. This results in a presupposition failure (violation of the uniqueness condition indicated by the superscript "1").

On the **specific** reading of (80) (with respect to *a car*), however, *it* may be interpreted as being coreferential with *a car*. This corresponds to the fact that the respective reconstruction may result in a proper restriction of the reconstructed pronoun denotation: Under the indicated interpretation *it* will refer to a certain car which Bill does not have.

Another notable feature of the analysis of pronouns in terms of contextual reconstruction proposed here, is that a sentence like (82) is not treated as being **syntactically ambiguous** between a reading where *he* refers to *Bill* and a reading where *he* refers to *John*.

(82) *John told Bill that he was in danger.*

Presuming a treatment of TV/t verbs like *tell-that*, (82) translates unambiguously into (82'):

(82') $tell\text{-}that'(\hat{}j, \hat{P}P\{\hat{}b\}, \hat{}\wedge x \in [male'(x) \wedge \Gamma_3\{x\}]^1 in\ danger'(x)$

The use of context variables permits us to treat the various reference possibilities of the pronoun in (82) where they belong, namely in the realm of interpretation. Treating (82) as syntactically ambiguous would amount to analyzing pronouns as **indefinitely many times ambiguous**—unless we return to the standard anaphoric/indexical dichotomy. Our analysis of pronouns as being semantically unspecified in certain well-defined respects (presented by a characteristic context variable) avoids either of these unattractive alternatives, and allows for a restricted and meaningful notion of the term "syntactic ambiguity."

The misguided attempts to treat anaphoric pronouns as being syntactically ambiguous has resulted in "puzzles" which find a completely natural solution in this framework. Karttunen (1977), for example, construes a contrast between (82) and (83) in terms of syntactic ambiguity:

(82) *John told Bill that he was in danger.* [*he* = *John* or *he* = *Bill*]

(83) *If Mary has* ***a car*** *or John has* ***a bicycle, it*** *is in the garage.*

According to Karttunen, in (82) "the pronoun requires a unique antecedent; the ambiguity . . . is due to the fact that there are two possible antecedents for the pronoun." In (83), however, "the availability of two antecedents does not result in any ambiguity." "The interesting fact about (5) [my example (83)] is that the pronoun *it* is perceived as unambiguous. There is no reading of (5) under which *it* is interpreted as definitely referring to a car or to a bicycle. Instead *it* seems to mean 'a car or a bicycle, whichever of these it is that exists.'"

According to our analysis, **both** (82) and (83) **translate unambiguously** into formulas of intensional logic. The translation of (83) is (83′):

(83′) $[\vee x[car'(x) \wedge have'(\hat{}m, \hat{P}P\{x\})] \vee \vee y[bicycle'(y) \wedge have'(\hat{}j, \hat{P}P\{y\}) \rightarrow [\wedge z \in [neuter'(z) \wedge \Gamma_3\{z\}]]^1 in\ the\ garage'(z)$

On the level of contextual reconstruction, we may now explain Karttunen's observation that *it* in (83) refers to **whichever** of the possible antecedents exist (assuming **internal** reconstruction) on the basis of the familiar assumptions of our approach. Consider the following truth table (84), which characterizes the semantic interaction of the components of (83′) within the here presumed presuppositional logic, where A stands for *Mary has a car*, B stands for *John has a bicycle*, and C stands for *it is in the garage*.

(84)

A	B	C	$A \vee B$	$(A \vee B) \rightarrow C$
1	1	1	1	1
1	0	0(≠)	1	1(≠)
0	1	1(≠)	1	1(≠)
0	0	≠	0	1
1	1	0	1	0
1	0	0(≠)	1	0(≠)
0	1	0(≠)	1	0(≠)
0	0	≠	0	1

The undefined values (≠) in the rightmost row of (84) represent interior reconstructions of C which are unacceptable because of presupposition failure. For example, if B (=*John has a bicycle*) is 1, while A (=*Mary has a car*) is 0, then the antecedent of (83), $A \vee B$, will be 1. If we now reconstruct *it* in C (=*it is in the garage*) with respect to Mary's car, then the consequent C will be # (undefined), and thus the whole sentence $(A \vee B) \rightarrow C$ will be # according to Kleene's definition of "→" (cf. Rescher, 1968, and Hausser, 1976a). However, if we reconstruct *it* with respect to John's bicycle, then the consequent will be bivalent, which in turn insures that the whole sentence will come out as bivalent. Thus Karttunen's intuitions regarding the interpretation of (83) find a straightforward explanation in truth functional terms: Only the "whichever" reading results in a defined truth value of (83).

9. ON REFLEXIVE PRONOUNS

Our treatment of pronouns is characterized by the assumption that expressions like *I, you, he, she, it, we, you, they, mine, yours, his, hers, its*, are full noun phrases which happen to be both basic and context-dependent (and similarily for the T/CN possessives *my, your, his, her, its, our, your, their*, which are treated as context-dependent quantifiers). The aspects of context dependency connected with the various pronouns are formally represented by characteristic context variables which serve as place holders for the se-

mantic material to be provided by the context. The replacement of a given context variable by denoting expressions from the target sentence (interior reconstruction) or the stage description assigned to the point of reference under interpretation (exterior reconstruction) is defined as a highly restricted procedure. In order to be a suitable contextual value, an IL expression has to correspond to specifications regarding semantic type and position (in the target sentence or the stage description), and fulfill the requirement of semantic compatibility.

Rather than stipulating coreference syntactically in the case of anaphoric use, coreference is treated as a consequence of the similarity of the descriptive content of a reconstructed pronoun and its internal source (antecedent). I have shown that this approach to coreference offers solutions to long-standing puzzles such as the paycheck sentence, Bach–Peters sentence, etc.

The basic motivation for treating the pronouns mentioned above in terms of contextual reconstruction is to provide a uniform treatment for both anaphoric and indexical use. When we turn to the so-called **reflexive** T pronouns, however, this motivation does not apply because reflexives may be used **only** anaphorically. Thus, a treatment in terms of syntactically stipulated coreference and syntactic occurrence restrictions would be feasible in the case of reflexive pronouns. On the other hand, a treatment in terms of contextual reconstruction would be appealing because it would subsume reflexive pronouns under a uniform, general approach to all pronouns.

Since a syntactic treatment of reflexive pronouns in a Montague framework has already been presented (Bennett, 1974), let me discuss the ramifications of a treatment of reflexives in terms of contextual reconstruction. Consider (85) and (86):

(85) *John shaved him.*

(86) *John shaved himself.*

In (85), *him* cannot be interpreted as being coreferential with *John*, as accounted for by the restrictions on Γ_3 reconstruction stated under (70). In other words, *him* in (85) may be reconstructed only **externally.** In (86), however, the reflexive pronoun *himself* **must** refer to *John*. And it holds in general that reflexive pronouns permit **only** interior reconstruction; they are thus anaphoric pronouns *par excellence*.[14]

Although the contextual values of nonreflexive T pronouns are for various reasons defined as being of type f(CN), this would not work for the contextual values of reflexive T pronouns. Consider for example (87):

(87) *Every senator voted for himself.*

[14] Indeed, the preoccupation with "anaphoric pronouns" in transformational grammar started with an analysis of reflexive pronouns (Lees and Klima, 1963).

If we treated reflexive T pronouns as nonreflexive T pronouns, then (87) would reconstruct into something corresponding to (88),

(88) $\textit{Every senator voted for} \left\{ \begin{array}{c} a \\ the \end{array} \right\} \textit{senator}(s).$

(depending on whether we translate the reflexive pronoun on the basis of restricted or nonrestricted quantification). However, (88) is intuitively not equivalent to (87). What is required instead is a reconstruction of (87) into something equivalent to (89).

(89) $\wedge x \in [\textit{senator}'(x)]^2 \textit{vote}'(x, \hat{P}P\{x\})$

Regarding the reconstruction of reflexive pronouns, furthermore, we have to account for the so-called sentence condition. In (90), for example,

(90) *John thinks that Bill shaves himself.*

the reflexive pronoun can be coreferential only with *Bill*, but not with *John*. The reason, according to Lees and Klima (1963), is that *John* and *himself* do not arise in the same "simplex."

The indicated characteristics of reflexive pronouns are accounted for by the following IL_2 translations (cf. (91)) in combination with the specification on the reconstruction of reflexive pronouns (cf. (92)). In the latter, the sentence-condition will be reformulated as a restriction on the interior reconstruction in terms of the already familiar notion of a coargument.[15]

Let $\Gamma_{\text{refl}.i,n}$ ($i = 1, 2$, or 3, $n \in \mathbf{N}$) be a context variable of type $\langle s, e \rangle$. Reflexive T pronouns are to be translated as follows:

(91) *myself* translates into $\hat{P}[P\{\Gamma_{\text{refl}.1,n}\}]$
yourself translates into $\hat{P}[P\{\Gamma_{\text{refl}.2,n}\}]$
himself translates into $\hat{P}[\textit{male}'(\Gamma_{\text{refl}.3,n}) \wedge P\{\Gamma_{\text{refl}.3,n}\}]$
herself translates into $\hat{P}[\textit{female}'(\Gamma_{\text{refl}.3,n}) \wedge P\{\Gamma_{\text{refl}.3,n}\}]$
itself translates into $\hat{P}[\textit{neuter}'(\Gamma_{\text{refl}.3,n}) \wedge P\{\Gamma_{\text{refl}.3,n}\}]$
ourselves translates into $\hat{P}[P\{\Gamma_{\text{refl}.1,n}\}]$
yourselves translates into $\hat{P}[P\{\Gamma_{\text{refl}.2,n}\}]$
themselves translates into $\hat{P}[P\{\Gamma_{\text{refl}.3,n}\}]$

[15] Although the intuitive notion of a coargument is straightforward, its formal characterization is complicated by the fact that the semantic type of arguments in a PTQ-like grammar **varies** depending on the particular semantic build up of the argument as well as on the extensional reductions. In (69) we specified the coargument of Γ_3 (where $\Gamma_3 \in \text{ME}_{f(\text{CN})}$ is the characteristic context variable of a nonreflexive third person T pronoun) as an individual concept standing in a relation with the **argument** of Γ_3. However, since the context variable $\Gamma_{\text{refl}.k}$ translating reflexive pronouns is of type $\langle s, e \rangle$, let us define a coargument of $\Gamma_{\text{refl}.k}$ as an individual concept standing in a relation with $\Gamma_{\text{refl}.k}$ itself.

The specification of possible values for $\Gamma_{\text{refl}.k,n}$ ($k = 1$, 2, or 3, and $n \in \mathrm{N}$) is stated in (92):

(92) If α is of type $\langle s, e\rangle$, then

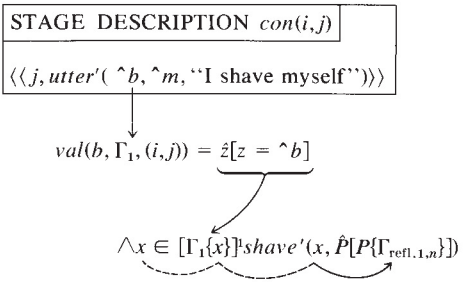
$$val(\alpha, \Gamma_{\text{refl}.k,n}, (i,j)) \text{ is } \alpha$$

provided that (i) α is a coargument of $\Gamma_{\text{refl}.k,n}$, and (ii) it holds that $\Gamma_k\{\alpha\}$ (that is, α has the property of being first, second, or third person in the nonreconstructed translation of the target sentence, depending on whether k in $\Gamma_{\text{refl}.k,n}$ is 1, 2, or 3).

The reconstruction of reflexive T pronouns is illustrated below:

(93) *I shave myself.*

(93′) $\wedge x \in [\Gamma_1\{x\}]^1 shave'(x, \hat{P}[P\{\Gamma_{\text{refl}.1,n}\}])$



Reconstructed Formula

$\wedge x \in [x = \hat{}b]^1 shave'(x, \hat{P}[P\{x\}])$

(94) *Every senator voted for himself.*

(94′) $\wedge x \in [senator'(x)]^2 vote\ for'(x, \hat{P}[male'(\Gamma_{\text{refl}.3,n}) \wedge P\{\Gamma_{\text{refl}.3,n}\}$

Reconstructed Formula

$\wedge x \in [senator'(x)]^2 vote\ for'(x, \hat{P}[male'(x) \wedge P\{x\}])$

(95) *John tries to shave himself.*

(95′) $try\text{-}to(\hat{}j, \hat{y}(shave'(y, \hat{P}[male'(\Gamma_{\text{refl}.3,n}) \wedge P\{\Gamma_{\text{refl}.3,n}\}])))$

Reconstructed Formula

$try\text{-}to(\hat{}j, \hat{y}(shave'(y, \hat{P}[male'(y) \wedge P\{y\}])))$

By treating reflexive T pronouns on the basis of context variables of type $\langle s, e\rangle$, we are able to exploit the principle of bound variables without stipu-

lating coreference between the reflexive pronoun and its antecedent syntactically. Furthermore, by reconstructing reflexive T pronouns with respect to their coargument, we can handle examples like (95) without reference to underlying simplex sentences.

We also have to account for the unacceptability of examples like (96) and (97):

(96) **John was shaved by himself.*

(97) **Himself was shaved by John.*

The apparent reason why (97) is unacceptable is that reflexives do not occur in the nominative case (as reflected morphologically by the absence of, for example, **heself* in English). Thus, generation of (97) may be prevented in terms of surface syntactic restrictions along the lines of the treatment of scope restrictions proposed in Hausser 1976b.

Sentence (96), on the other hand, could be ruled out on the basis of restrictions on the reconstruction of $\Gamma_{\text{refl}.k,n}$. Compare (96′), which is the presumable translation of (96), with the translation of (98):

(96′) $shave'(\Gamma_{\text{refl}.3,n}, \hat{P}P\{\hat{}j\})$

(98) *John shaved himself.*

(98′) $shave'(\hat{}j, \hat{P}P\{\Gamma_{\text{refl}.3,n}\})$

By restricting the reconstruction of $\Gamma_{\text{refl}.k,n}$ to "left" coarguments, the interpretation of (96) may be prevented without impairing the interpretation of (98′). The general principle underlying the restrictions on the occurrence of reflexive pronouns seems to be that reflexives are excluded from surface as well as underlying **subject** positions.

This treatment of reflexives is subject to one difficulty, however, concerning the treatment of number agreement between a reflexive pronoun and its antecedent. Consider the following examples:

(94) *Every senator voted for himself (*themselves).*

(99) *John and Bill voted for themselves (*himself).*

(100) *After they (*he) arrived, every senator voted.*

Although the nonreflexive pronoun in (100) reflects the **cardinality** of its antecedent (presuming that the pronoun in (100) is to be coreferential with *every senator*), the reflexive pronouns in (94) and (99), respectively, have to agree with the **syntactic number** of their antecedents.

Since the number agreement between reflexives and their antecedents is purely surface syntactic, there is no straightforward way to account for the resulting occurrence restrictions in terms of restrictions on the reconstruction (interpretation) of reflexive pronouns. Thus, the treatment of reflexives

outlined above is in its present form only suited to account for languages which do **not** mark syntactic number in reflexives (for example, German).

A similar problem arises in connection with **gender agreement** between a pronoun and its antecedent in languages which operate with syntactic rather than natural gender. Since English uses natural gender, we are justified in treating the gender of pronouns as a semantic property of the referents. Consider, for example, (101):

(101) *The man who saw Robin recognized him.*

(101′) $\wedge x \in [[man'(x) \wedge see'(x, \hat{P}P\{\hat{}r\})]^1 recognize'(x, \hat{P} \wedge y \in [male'(y) \wedge \Gamma_3\{y\}]^1 P\{y\})$

The internal reconstruction of Γ_3 with respect to r will be successful only if the referent of r has the property of being male. However, apart from the fact that the definition of this property is not without difficulty, this treatment of gender could not be applied in languages like Latin or German, which use syntactic gender.

One way to handle this general type of problem (which is language dependent in its various realizations, as we have indicated) would be to copy the relevant surface syntactic features into the translation formulas. Assume, for example, that the translations of English noun phrases which are syntactically singular are marked by a simple underlining, while the translations of noun phrases in the syntactic plural receive a double underlining. Thus (102) would translate into (102′):

(102) **Every senator voted for themselves.*

(102′) $\underline{\wedge x \in [senator'(x)]}^2 vote(x, \underline{\underline{\hat{P}P\{\Gamma_{\text{refl},3,n}\}}})$

We may now rule out the reconstruction of $\Gamma_{\text{refl},3,n}$ with respect to x in (102′) by adding the requirement to the specification of $val(\alpha, \Gamma_{\text{refl},k,n}, (i,j))$ (cf. (92)) that the context variable and the source expression must have the same kind of underlining, and similarly for a treatment of the gender–agreement between a pronoun and its source (antecedent) in languages which use syntactic gender.

The difficulty we have encountered with number agreement in connection with reconstructing reflexive pronouns points to a general question: What is the nature of the relation between the level of surface syntax and the level of semantic representation? More specifically, is a universal semantic representation for all natural languages feasible?

The idea of a universal semantic representation in terms of a highly developed intensional logic is certainly attractive. The particular properties of a given natural language could be treated in terms of an individual surface syntax to be combined with a set of individual translation rules, which relate the surface structures under consideration to the universal semantic representation. We may even characterize the syntactico–semantic properties of dif-

ferent natural languages by defining a typology on the different kinds of sets of translation rules.

But what about contextual reconstruction? Since these procedures are part of the interpretation (their outcome depends on the point of reference), they are part of the semantics of the language in question. The need to refer to surface syntactic features like gender, number, etc. (depending on the natural language under consideration) in order to properly specify the restrictions on the internal reconstruction of pronouns indicates, however, that at least the specifications on the internal reconstruction of context variables cannot be treated in universal terms. However, the use of context variables (and of the apparatus required to interpret them) may provide the necessary measure of flexibility to allow for a semantic representation which is universal except for the specifications on the reconstruction of context variables through the linguistic context.

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