

DESCRIPTIONAL ANAPHORA IN DISCOURSE REPRESENTATION THEORY

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ABSTRACT

Standard Discourse Representation Theory (DRT) was designed mainly to explain the so-called donkey-sentences. The pronouns playing such a prominent role in all these sentences belong, however, exclusively to one (particularly simple) type of pronoun. We try to extend DRT in order to cover an equally important type of pronoun, the so-called "descriptive" pronoun. Discourse referents are now used to carry information on the intension of their referents as well as on the extension. This allows, at the same time, to suggest accessibility rules for pronouns which are more appropriate than those suggested by traditional DRT. These new rules are based on the genericness of the sentences involved.

1. PRONOMINAL REFERENCE AS STARTING POINT FOR DISCOURSE REPRESENTATION THEORY

One of the starting points for the development of DRT in Kamp's original paper (Kamp 1981) was the seemingly erratic behaviour shown by indefinite noun phrases under a traditional logical analysis, and the equally erratic interactions that seem to obtain between indefinite noun phrases and inter-sentential and intra-sentential pronominal references to them. Of particular interest was the behaviour of indefinite noun phrases in the so-called donkey-sentences.

1.1 Definiteness and Indefiniteness in Traditional Linguistic Theory

The traditional, and intuitively quite convincing, view has it that definite noun phrases refer to an object that is already familiar to the speaker (and possibly also to the listener), whereas indefinite noun phrases introduce new objects. This theory looks convincing as long as we consider explicit definites, as in

1) John owns a donkey. John beats the donkey

where the donkey is introduced as existing by the indefinite noun phrase and referred to as familiar by the following definite noun phrase. Personal pronouns are, under the accepted interpretation, contracted forms of definite noun phrases, and the familiarity hypothesis often works reasonably well for them, too: In the following paraphrase of 1:

2) John owns a donkey. He beats it

the definite pronoun refers to the donkey which is familiar after it has been introduced by an indefinite noun phrase, and the definite pronoun is, in other words, co-referential with the preceding indefinite noun phrase. For this reason the traditional interpretation of noun phrases and pronouns is called "referential".

But problems surface if we consider sentences such as

3) John doesn't own a donkey
4) Every boy likes his mother

Neither does the indefinite noun phrase in 3 assert that there is a donkey that John owns, nor can we really say that the pronoun "his" in 4 refers to something familiar. Indeed, we can hardly say that it refers to anything at all: If we stick to the traditional view of what reference is, viz. a relationship between an expression of language and a real object, then there can be no reference at all in 4, since no existence of any boys was ever asserted. It was examples such as those that brought the whole familiarity theory into disrepute (cf. the short historical outline given by Heim 1983).

1.2 Definiteness and Indefiniteness in Logically Oriented Linguistics

One radical solution to the problem of non-referring noun phrases was suggested by Russell in his classical Theory of Descriptions. In it, both definite and indefinite articles are interpreted as existential quantifiers (with the addi-

tional constraint of uniqueness in the case of the definite article). Noun phrases do not refer at all, they all assert existence (with the exception of "logically proper names", whose existence Russell could never prove). Example 3 would become "It is not the case that there is a donkey and John owns it", and 4 would become "For every boy there is exactly one mother such that he loves her". Now the truth values for these sentences come out right. This interpretation is, accordingly, called the "quantificational theory of noun phrases". Under this analysis pronouns correspond to the variables bound by quantifiers in First Order Predicate Calculus.

Until recently most linguists and logicians saw no other solution to the problems exemplified by sentences 3 and 4 than to adopt Russell's theory. But the quantificational theory of noun phrases does not seem to help in multi-sentence discourses such as 1 and 2. Here the traditional referential theory still seemed to have much more explanatory power. But this meant, unfortunately, that noun phrases, inclusive pronouns, must be interpreted in (at least) two fundamentally different ways: In single sentences such as 3 and 4 as quantifiers and bound variables, respectively, without any referring function, and in multi-sentence discourses such as 1 and 2 as referring expressions.

But far worse, there are certain cases where neither of these interpretations seems possible. The best-known examples are the so-called donkey-sentences:

- 5) If John owns a donkey he is happy
- 6) If John owns a donkey he beats it

The most natural translation of 5 is

- 7) EXISTS X: (donkey(X) AND owns(john,X))
-> happy(john)

where the indefinite article can be represented as an existential quantifier, and this is in keeping with our intuition: A valid paraphrase of this sentence is "If there is some donkey that John owns he is happy". Example 6, on the other hand, must get, as the only intuitively convincing representation,

- 8) ALL X: ((donkey(X) AND owns(john,X)) -> beats(john,X))

where the indefinite article has to be translated as a universal quantifier ("For any donkey that John owns it will be the case that he beats it"). The only syntactic difference between the two sentences is the pronominal reference to the noun phrase "a donkey", made in 6 but missing in 5. The manner in which an arbitrarily

(in principle) far removed pronoun in the surface sentence can turn an existential quantifier into a universal one has been puzzling logicians and linguists for a long time. The referential theory of noun phrases does not help, either, in these cases. We really are at a loss to explain donkey sentences.

But there are yet more functions of noun phrases, and in particular of pronouns, which seem to resist any straightforward logical or "traditional" interpretation: The Bach-Peters sentences, where pronouns point crosswise forward and backward ("The pilot who shot at it hit the Mig that chased him"), and the so-called E-type pronouns, which point from outside into quantified statements ("Few M.P.s came to the party but they had a good time" (Evans 1980:338)). One particular kind of the E-type pronouns will be given a lot of attention below.

1.3 Pronominal Reference in Discourse Representation Theory

Kamp's DRT and Heim's File Change Semantics are two (very similar) attempts to unify the familiarity/novelty theory and the quantificational theory of noun phrases and, as special cases, the referential theory and the bound-variable theory of pronouns. Both authors took up an idea of Karttunen's (e.g. Karttunen 1976), viz. that we have to distinguish between "normal" referents, i.e. real objects in the world (or a model of it), and special discourse referents, whose existence in the discourse does not in itself say anything about the existence of any objects in the world (or the model). Indefinite noun phrases and proper names introduce (i.e. assert the existence of) new discourse referents. These discourse referents constitute the universe of discourse. The remaining information contained in the sentence defines the conditions on the discourse referents. Now the conflict between the two interpretations of noun phrases can be resolved: We can "refer" (by means of definite noun phrases or definite pronouns) to discourse referents (this is the reference-familiarity component) but these entities are not real world objects but something functionally similar to the variables used in quantified statements (this is the quantification component). This solution works for anaphoric links from inside a sentence (such as 6) as well as for those from outside (e.g. 2), i.e. we have a way to treat both isolated sentences and discourses.

Notationally, discourse referents and conditions are arranged in Discourse Representation Structures (DRSs). Following Guenther 1986, we list on the left

hand side of a DRS the members of the universe of discourse, on the right hand side the conditions on them. Proper names are not used as individual constants; different individuals can have the same name, and proper names are therefore translated as normal predicates. Contrary to Kamp's original notation, but in agreement with the practice now generally adopted, we do not record the whole analysis process of each sentence in the DRS. The first sentence of example 2 would create an initial DRS

9) [u1, u2: john(u1), donkey(u2),
owns(u1,u2)]

whereas the second sentence would extend this DRS to become

10) [u1, u2: john(u1), donkey(u2),
owns(u1,u2), beats(u1,u2)]

Sentences 5 and 6, on the other hand, would become

11) [u1: john(u1), {u2: donkey(u2),
owns(u1,u2)} --> happy(u1)]

12) [u1: {u2: john(u1), donkey(u2),
owns(u1,u2)} --> {beats(u1,u2)}]

Finally, a sentence such as "If a man loves a woman he will give her a ring" would be represented as

13) [[u1,u2: man(u1), woman(u2),
loves(u1,u2)] --> [u3: ring(u3),
gives(u1,u3,u2)]]

2. RESTRICTIONS ON PRONOMINAL REFERENCE IN DISCOURSE REPRESENTATION THEORY

2.1 The Classical Examples

It is claimed in the literature on DRT that the construction principles of DRSs also explain certain restrictions on pronominal reference. Prime examples are discourses with quantified sentences such as

14) Every man who owns a donkey beats it.
* It has a white patch on its forehead

where the pronoun "it" in the second sentence cannot be linked anaphorically to the noun phrase in the first sentence, although the "it" in the first sentence (a donkey-sentence) can. The same thing holds for conditional sentences and negations.

DRT in its present form models the accessibility restrictions encountered in these examples by embedding DRSs inside each other, and by postulating appropriate accessibility rules for anaphoric links (see Pinkal (1986) for a good overview, and extensions concerning definite noun phrases). While the discourse referents of

proper names are "pushed up" to the principal DRS, even when embedded, the others are left "buried" inside the embedded DRSs. Accessibility rules make sure that anaphoric links cannot reach down into embedded DRSs, and only "backwards" in embedded DRSs. We want to show in this paper that the examples normally used to show accessibility restrictions, e.g. 14, are unacceptable not for the reasons given in DRT, but for entirely different reasons. We will furthermore show that other phenomena of anaphora cannot be explained by DRT in its present form. We will then suggest appropriate modifications to DRT to compensate for these deficiencies.

2.2 Counterexamples

It is certainly true that discourse fragments such as 14 are unacceptable, but not because pronouns cannot anaphorically point into quantified (conditional, negated) statements. The following counterexamples show that they can, under certain circumstances:

15) Every man who truly loves a woman respects her. He treats her as his equal and expects the same thing of her

16) Whenever a hunter spots a deer he will kill it. He will cut it up and carry it home

The pronouns "her" and "it" in the second sentence of each example refer to discourse referents which should be inaccessible, according to DRT. The accessibility rules for embedded DRSs, as used in traditional DRT, are too restrictive.

3. THE FUNCTION OF DISCOURSE REFERENTS IN TRADITIONAL DISCOURSE REPRESENTATION THEORY

If we want to cover cases such as 15 and 16 we not only have to modify the accessibility restriction rules but also modify our idea of what discourse referents stand for. We said that DRT tries to unify the referential and the quantificational interpretation of noun phrases. If we use Horn Clause Logic (HCL) as the target language for the interpretation of sentences we get a particularly simple correspondence. In an example such as 2 ("John owns a donkey. He beats it") the "it" in the second sentence ultimately refers to the same individual as the noun phrase "a donkey", and the discourse referent introduced by "a donkey" stands for the individual constant representing this individual in HCL (in standard First Order Predicate Calculus we would, of course, have to use a variable). In sentences such as 14 "Every man who owns a donkey beats it", however, the pronoun plays the role of an individual variable in HCL

(and in standard First Order Predicate Calculus). Discourse referents now turn out to be an abstraction of the concept of individual variable and individual constant in HCL. In other words, a discourse referent stands for an individual variable if the sentence in which it occurs is generic, and for a constant if it is non-generic, as the translation of examples 2 (first sentence) and 15 shows:

```
[u1,u2: john(u1), donkey(u1),
      own(u1,u2)]
becomes
own(john,donkey1).
inst(donkey1,donkeys).
and
[u1, u2: man(u1), woman(u2),
      loves(u1,u2) --> respects(u1,u2)]
becomes
respects(M,W) :- man(M), woman(W),
                  loves(M,W).
```

In addition, discourse referents have to "drag along" all the conditional expressions in which they occur in the DRS ("loves(M,W)" etc.) from there to the logical representation. This concept of what discourse referents stand for has to be modified if we want to cover cases such as 15 and 16.

4. Types of Anaphoric Reference to Noun Phrases

4.1 Denotational Anaphora

In both of the two types of pronominal anaphora considered so far, reference and bound variable anaphora, there is a direct mapping from pronouns to discourse referents, and another one from discourse referent to individual constant or variable in the logical representation. A constant stands for a real object in the world, and a variable will stand for one at evaluation time; this object is the denotation of the pronoun. For this reason both types of anaphora considered so far are usually called "denotational anaphora". This name is unfortunate as it blurs the main idea behind this type of anaphora, viz. the fact that "denotational anaphora" is an abstraction of referential (or: denotational) and non-referential (or: bound variable) uses of pronouns and other noun phrases. It would be much better to speak of extensional anaphora instead.

1. We treat truly generic sentences, such as 15, and general sentences, such as 16, on a par. This is, of course, a gross simplification. Furthermore, it would be more precise to say, instead of "variable", "an expression containing variables" (to include Skolem-Functions). In greater detail: cf. Hess 1985.

4.2 Descriptive Anaphora

However, there is an important type of anaphora that does not fall into this category. 15 and 16 are two examples, but we will first consider a few simpler cases, namely anaphora with indefinite pronouns, i.e. the pronoun "one(s)".

4.2.1 Indefinite Descriptive Anaphora

In both of the following examples, variants of the classical "paycheck-example", the first one non-generic and the second one generic,

- 17) John published a paper in 'Nature' in 1986. Peter published one in 'Science'
- 18) A person who published a paper in 'Nature' does not write one for the 'New Scientist'

the indefinite pronoun "one" does not have the same denotation, or extension, as the noun phrase it is anaphorically linked to. We clearly speak about two different papers (whether they be individually known, as in 17, or taken generally, as in 18). In DRT in its present form, a single discourse referent would be created for "a paper", and if we made the "one" point to it we would get the wrong logical interpretation (namely the one we would legitimately get if the pronoun were "it").

We can get the correct interpretation if we treat the indefinite pronoun as a "macro", i.e. as an abbreviation for part of the preceding sentence. Before we actually interpret the sentence, this abbreviation must be "macro-expanded" (Hirst's expression: Hirst 1981:31), i.e. replaced by a copy of the construction it anaphorically points to. In the simple examples above we can actually copy the surface structure from the antecedent into the place of the pronoun. This was the explanation originally used in Transformational Grammar for all types of pronominal reference, but it soon became clear that this view was too simple. It is sufficient to consider cases where the antecedent contains indexical expressions such as "my", as in "I got my paper accepted by 'Nature'. Peter managed to get one accepted by 'Science'". It is not syntactic expressions which get copied but some kind of "logical form", and the theory that puts this view forward is accordingly known as "identity-of-logical-form theory", or "ILFT" for short. In DRT, the logical form we use are DRSs, and it will consequently be discourse referents that must be copied. During the analysis of a sentence, a "one"-pronoun must first be macro-expanded to an "empty shell" of the discourse referent it anaphorically points

to, and the normal rules of translating DRSS into logic must then be applied to this expanded form of the sentence. If we expand, for instance, the second sentence of 17 we get a representation corresponding to the discourse "John published a paper in 'Nature' in 1986. Peter published a paper in 'Science'". The normal rules for translating discourse referents would now automatically create two different logical representation constants for the two discourse referents ("paper1", "paper2"). Here the pronoun "one" does not (necessarily) refer to the same denotation as the noun phrase it anaphorically points to but rather to a "description" of it. This type of anaphora is therefore often called "descriptional" anaphora.

There is, however, a problem to consider that did not arise with denotational anaphora. If the sentence had been "John published a paper in 'Nature' in 1986. Peter published one, too" we would have to create a discourse referent corresponding either to the sentence "Peter published a paper in 'Nature' in 1986, too", or to "... a paper in 1986, too" or, finally, "... a paper in 'Nature', too". The problem is, of course, to determine what exactly a given pronoun should expand to. This question will not be considered here. The only thing we want to do is to show that a very common type of anaphora, descriptional anaphora, calls for an extension of DRT which must make sure that all the parts of a sentence that can be used for expansion are represented as individually accessible bits of information in the DRS.

4.2.2 Definite Descriptional Anaphora

The two examples we started with, 15 and 16, are acceptable because they, too, are descriptional. But they are definite, as they use both the definite pronoun "it". Furthermore, both of them are generic, and so we consider this type of sentence first.

Again, we have to expand pronouns into newly created discourse referents, and again we must determine what information has to be packed into these new discourse referents. But now it is a bit clearer than with indefinite descriptional anaphora how this can be accomplished. Intuitively it is clear that in sentence 16, for instance, the two instances of "he" (plus one which was elliptically deleted: "... and he will carry ...") must be expanded into three different discourse referents, corresponding to "any hunter who has spotted a deer", "any hunter who has spotted and killed a deer", and "any hunter who has spotted, killed and cut up

a deer", respectively. Why do we have to use these successively more complicated expressions? Because of the definiteness of the pronoun.

The function of the definite pronoun, as opposed to the indefinite one, becomes clear if we compare example 16 with 18. In 18 we talked about different (at least, potentially different) papers. In 16, however, we speak about one single hunter, although in different stages of his deer-killing activities. In other words, definite pronouns require uniqueness of their ultimate referent in the same way that definite noun phrases do. In the case of denotational pronouns in non-generic sentences the uniqueness of the constants, used in HCL to encode existential quantification, itself enforces uniqueness of the ultimate referents. But in the case of descriptional anaphora in generic sentences it is not trivial to enforce this referential uniqueness. As each generic sentence ultimately translates into an independent rule in the logical representation we cannot establish uniqueness of a referent named in different rules by simply using the same variable name. This becomes quite obvious if we remember that any implementation of a HCL prover, such as Prolog, must create a new internal representation for the same variable name, when this name is used in different clauses. We can nevertheless enforce uniqueness of reference, even across generic sentences which map into separate clauses, by adding the consequences of each preceding clause to the conditions of the following one:

```
kills(H,D)      :- hunter(H), deer(D),
                  spots(H,D).
cuts_up(H,D)    :- hunter(H), deer(D),
                  spots(H,D), kills(H,D).
carries_home(H,D):- hunter(H), deer(D),
                    spots(H,D), kills(H,D),
                    cuts_up(H,D).
```

Thus we not only see why examples 15 and 16 are possible but also how the pronouns have to be expanded.

Definite descriptional anaphora can also occur with non-generic sentences. In

19) Here are the results of the analyses for samples 101 to 105. The result of the analysis for sample 101 for oxygen is negative.

- 20) It was positive last time
- 21) It is positive for nitrogen
- 22) It is positive for sample 102

the pronoun "it" clearly means "the result of the analysis for sample 101 for oxygen" in 20, but "the result of the analysis for

sample 101" in 21 and "the result of the analysis for oxygen" in 22. If we concatenate all four sentences into one discourse we have to generate three different discourse referents for these noun phrases. As the sentence is non-generic they would give rise to three different constants in the logical representation ("result1" to "result3"). That these sentences really are the definite version of descriptonal anaphora can also be seen from the fact that a valid paraphrase of 21 is "The one for nitrogen is positive".

5. AN EXTENSION OF DISCOURSE REPRESENTATION THEORY

If DRT is to cover descriptonal anaphora (both definite and indefinite, in generic as well as in non-generic sentences) we have to pack more information into discourse referents than in standard DRT. In addition, we will have to explain how those types of anaphora that really are impossible (such as 14) are blocked while those that are possible are not. First we want to design discourse referents which contain all the information necessary for the different types of pronominal anaphora, and then we will sketch some accessibility restrictions on this background.

5.1 The Functions of Discourse Referents in Revised Discourse Representation Theory

What kind of information must be available in a discourse referent to allow the resolution of both denotational and descriptonal anaphora? Consider example 17 with indefinite descriptonal anaphora. We want a logical representation of this discourse to look like²

```
event(c(1),publish).
agent(john,c(1)).
inst(c(2),papers).
object(c(2),c(1)).
location('Nature',c(2)).
event(c(3),publish).
agent(peter,c(3)).
inst(c(4),papers).
object(c(4),c(3)).
location('Science',c(4)).
```

The discourse referent we introduce, for instance, for the noun phrase "a paper" must allow the system to later access the constant which was created in the logical representation to stand for this particular paper ("c(2)"), in the case we have to resolve a denotational anaphora. But it

must also permit that, in the case of descriptonal anaphora, a copy of itself is made to serve as new discourse referent, used subsequently to create a new entry in the logical representation (e.g. "inst(c(4),papers)"). The discourse referent should furthermore carry information about the grammatical gender and number of the underlying word, to further facilitate pronoun resolution (e.g. "m+s" for "male and singular"). A discourse referent with sufficient information could have a general structure like that: "dr(U,V,X,I,G+N)". "U" is the unique identifier of this discourse referent. "V" is the discourse variable created for each newly introduced discourse referent, which will get bound to the extension as soon as the entire sentence is translated into HCL. This term, which is common to discourse referents and Horn Clauses created by them, is directly accessible for denotational anaphora; it is, so to speak, the link from the discourse level into the logical representation. "G+N" stand for gender and number. In "I" we have to list those elements of a sentential component which are minimally required for denotational anaphora. It turns out that these elements are all those of the conditions on a discourse referent that can be represented as unary predicates (i.e. mainly nouns, adjectives, and some intransitive verbs). They form, together, the intension of the phenomenon represented by the discourse referent. This would suggest the term "intensional anaphora" for what has been called "denotational anaphora" so far. The "X", finally, tells us which variable in the intension corresponds to the discourse variable "V", and thus the "X" and "I" together correspond to "lambda X.(I)", applicable to "V". For the noun phrase "a paper" this would give "dr(3,V,X,[inst(X,papers)],n+s)". The DRS for the entire example 17 then looks like that:

```
[[dr(1, john, S, [inst(S, humans)], m+s),
dr(2, nature, T, [inst(T, journals)], n+s),
dr(3, c(1), U, [inst(U, papers)], n+s),
dr(4, c(2), V, [event(V, publish),
agent(S, V), object(U, V),
place(T, V), time(1986, V)], n+s)]
dr(5, peter, W, [inst(W, humans)], m+s),
dr(6, science, X, [inst(X, journals)], n+s),
dr(7, c(3), Y, [inst(Y, papers)], n+s),
dr(8, c(4), Z, [event(Z, publish),
agent(S, Z), object(Y, Z),
place(X, Z), time(1986, Z)], n+s)]
: 1,2,3,4,5,6,7,8 ]
```

2. In the implementation we use constants such as "c(1)" rather than "paper1", and expressions like "inst(_,papers)" rather than "paper(_)".

The last line gives the overall logical structure of the entire DRS and states here that all the conditions in the named discourse referents have to be entered

conjunctively into the logical representation, as shown above. This overall logical structure is all that is left of the "conditions"-part of traditional discourse referents, and most information originally encoded in this "conditions"-part has been moved into the discourse referents. This is closer to Heim's notation (for "file cards") than to Kamp's.

A generic sentence will be translated into HCL rules, with variables. "If a hunter spots a deer he will kill it" will become

```
event(c(1,(H,D,W)),kill):-
  inst(H,hunters),
  inst(D,deer),
  event(W,spot),
  agent(H,W), object(D,W).
agent(H,c(1,(H,D,W))) :-
  inst(H,hunters),
  inst(D,deer),
  event(W,spot), agent(H,W),
  object(D,W).
object(D,c(1,(H,D,W))) :-
  inst(H,hunters),
  inst(D,deer),
  event(W,spot), agent(H,W),
  object(D,W).
```

where the expression event "c(1,(H,D,W))" is a Skolem function (more commonly written as "sk1(H,D,W)"). In order to get this logical representation we will have to generate discourse referents such as "dr(1,v(2).X.[inst(X,hunters)]._+s)" for "a hunter", where the discourse variable is bound to "v(2)", the discourse level representation of an object level variable ("H", "D", etc.). The DRS for the entire sentence will be

```
[[dr(1,v(1),R,[inst(R,hunters)],_+s),
  dr(2,v(2),S.[inst(S,deer)],n+s),
  dr(3,v(3),T,[event(T,spot),
  agent(R,T),object(S,T)],n+s),
  dr(4,v(4),U,[event(U,kill),
  object(v(2),v(4))],n+s)]
: 1,2,3 ---> 4 ]
```

Again the last line outlines the logical structure which is used to create the entries in the logical representation.

5.2 Accessibility Restrictions in Revised Discourse Representation Theory

We noted above that classical DRT defines accessibility restrictions which rule out some perfectly legitimate examples, such

as 15. We think that the accessibility restrictions that really hold, are the result of interactions between the genericness of the sentences involved, and the genericness of a sentence is reflected (among other things) in the type of discourse referents it generates. Example 14 starts out with a generic statement and suddenly switches over to a non-generic statement whereas the acceptable examples 15 and 16 consist of two generic sentences. It seems to be this switch of genericness which makes the pronominal reference impossible in example 14, and not the fact that we point into a quantified sentence. But it is not necessary that the sentences concerned belong to the same genericness category. The first of the following examples is unacceptable but the second and third examples are acceptable, despite mixed genericness:

- 23) * Whenever a farmer spots a donkey he abuses it. He is beating and kicking it right now.
 24) Whenever Pedro spots a donkey he abuses it. He is beating and kicking one right now.
 25) There is a farmer beating and kicking a donkey. I've seen him before. Whenever he spots it he abuses it.

This asymmetry finds an explanation in the fact that non-generic sentences, such as the second sentence of example 23, (almost always) speak about individuals. A pronoun in such a sentence is therefore (in almost all cases) a denotational pronoun, trying to find an extensional value in an antecedent which could be used as its own denotation. Hence we will have to make sure that a denotational pronoun accepts only representations of individuals (of the form "c(X)") in the preceding sentence(s), and that a failure to find them must result in the entire discourse becoming unacceptable. Thus the "he" and "it" in the second sentence of example 23 will try to find representations of individuals in the first sentence, but there are only representations of "stereotypes", i.e. meta-level names for object level variables (of the form "v(X)"). This makes denotational anaphora impossible in this case.

3. Basically the same idea was developed by Bartsch 1979, though not in the framework of DRT. She says that pronouns such as those in 15 and 16 refer to stereotypes of objects rather than to the objects themselves. However, we think she overstretches this idea by claiming that ordinary donkey-sentences must be explained by means of stereotypes, also. There are, after all, perfectly non-generic donkey-sentences, such as "Every farmer who bought a donkey slaughtered

The same problem does not arise in example 24. Here we have an explicitly descriptive pronoun ("one"), and it will not care about the type of value that its antecedent has (i.e. whether it is "c(X)" or "v(X)"), as it will only use the antecedent's intension anyway.

Example 25, finally, is acceptable because generic sentences can talk about either individuals or "stereotypes". Although the third sentence ("Whenever he spots it he abuses it.") is generic, the pronouns in it will first try to find denotations in their antecedents. In this case, they will succeed: The first sentence of 25 is non-generic and has, of course, created representations of individuals (i.e. "c(X)"). If there had been no suitable extensional antecedents, the pronouns would have started looking for intensional ones. This was the case in examples 15 and 16. In examples 19 to 22, finally, there were actually extensional antecedent values, but pragmatic considerations (i.e. world knowledge) forces the hearer in these cases to drop the (formally possible) denotational anaphora in favour of (definite) descriptive anaphora. Just finding intensional antecedents of descriptive pronouns is, however, not enough: You have then to decide how much of the intension (often scattered over several discourse referents) has to be copied in the place of the pronoun. But this is an other question altogether, often involving inferences over world knowledge, plausible reasoning etc., which cannot be dealt with here.

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it", and stereotypes are entirely out of place here.