Dynamic Situations

0. Introduction

This paper provides an analysis of anaphoric interpretations of quantified expressions and definite descriptions. Two alternatives are examined, one based upon the dynamic binding analysis of Groenendijk and Stokhof (1991) as implemented in Kanazawa (1994), and another based upon the E-type pronoun analysis of Heim (1990). Neither analysis directly addresses the problem of anaphoric QPs/DPs, though both can be extended to account for the full range of anaphoric interpretations available for QPs/DPs. However, only the dynamic binding approach also accounts for the range of presuppositions observed. I conclude that dynamic binding plays an indispensable role in accounting for the full range of anaphoric relations attested in language, and suggest that an E-type strategy for interpreting pronouns can be replaced with a discourse strategy for accommodating antecedents.

1. Pronominal Anaphora

Each of the pronouns in (1) can be anaphoric on the underlined expression preceding it.

(1) a. A man walked in. He sat down.
   b. Every man complained that Mary hit him.
   c. Every donkey who gets beaten by a man kicks him.

In (1a) the pronoun he is anaphoric on an occurrence of a man in the preceding sentence. In (1b), him is c-commanded by a co-sentential antecedent. In (1c), him has a non-c-commanding antecedent in the same sentence. These three types of anaphora all display their own peculiar properties. Anaphora like that in (1b,c), for example, readily displays covariation between the pronoun and its antecedent, while that in (1a) only does so in cases of (quantificational, conditional or modal) subordination. Anaphora like that in (1b) allows a singular pronoun to take any syntactically singular QP as antecedent, while that in (1a,c) is only possible with a singular pronoun when the antecedent is a weak quantifier in Milsark's (1977) sense.
While all three of the examples in (1) clearly involve anaphora, there is not yet a consensus on how the anaphora comes about in each of the three cases, nor of what unites these distinct cases as instances of a single phenomenon. There are two general approaches to dealing with (at least some of) the complexities involved. The first involves interpreting pronouns in at least some of their occurrences as definite descriptions, possibly containing occurrences of variables in their interpretation. Cooper (1979) as well as the E-type analysis of Evans (1977,1980) and its extensions and variations in Neale (1990), Heim (1990), Lappin & Francez (1993) and Krifka (1996) can be fit into this category. The second approach involves interpreting pronouns as simple variables in all of the cases illustrated while complicating the interpretation of quantified expressions by allowing some such expressions (in particular indefinites) to indirectly bind variables occurring outside of their c-command domain. The Dynamic Binding analyses of Groenendijk & Stokhof (1991), Chierchia (1992) and Kanazawa (1994) fall into this camp. Finally, there are mixed cases, such as Chierchia (1995), which argue that both approaches are needed.

The main question that I will be addressing in this paper is what aspects of the above analyses are necessary, which can be dispensed with, and what extensions need to be made in accounting for referential and quantificational anaphora of the type exhibited in (2).

(2)  
\begin{enumerate}
    \item Ten men walked in. \textit{Each man/the men} sat down.
    \item Ten men complained that Mary hit \textit{each man/the men}.\footnote{It has been argued in Lasnik (1989) that R-expressions, presumably including definite descriptions, cannot be bound, a fact held to follow from Condition C of the Binding Theory. I take the judgments to be suspect. Though there are differences between the binding of the \textit{men} in (2b) and that of \textit{he} in (1b), I follow Tancredi (1997) in assuming the primary difference to be that only the latter can be given a \textit{de se} interpretation. In the analysis that I propose below, the definite description is not itself interpreted as a bound variable, and in this sense I am in...} 
\end{enumerate}
c. Every donkey who gets beaten by ten men kicks each man/the men.

Since quantified NPs and definite descriptions cannot plausibly be analyzed either as E-type pronouns or as simple bound variables, none of the analyses referred to above can be adopted wholesale without extension. I will argue that aspects of both classes of analyses are needed to account for the full range of anaphoric phenomena found. In particular, I will show that appeal to situations, most extensively used in E-type approaches to anaphora, is required even within a Dynamic Binding framework. I will also show that Dynamic Binding is required in order to provide the basic mechanism by which quantified NPs can be anaphoric.

To lay out the basic problems to be solved, I set out two analyses of the binding in (1). In each case, I extend the analyses to account for (2), and then show the limitations of the resulting analyses. For ease of exposition, I focus on two analyses concerned specifically with donkey anaphora involving pronouns -- Kanazawa's (1994) Dynamic Binding analysis and Heim's (1990) E-type analysis -- both of which are general enough to account for all cases of anaphora in (1).

1.1 Dynamic Binding

Kanazawa (1994) employs a version of Groenendijk & Stokhof's (1991) dynamic predicate logic (DPL) augmented with generalized quantifiers to account for the anaphora in (1c). The same analysis accounts without modification for the anaphora in (1a,b) as well. As in standard predicate logic, binding in DPL derives from manipulating variable assignment functions. The central difference between DPL and standard predicate logic is that the former allows changes in variable assignment functions introduced by a dynamic existential quantifier to affect the interpretation of variables not in the direct syntactic scope of the quantifier, in effect allowing a dynamic existential quantifier to indirectly bind some such variables. This indirect binding is agreement with Lasnik's analysis in letter if not in spirit. For those who find the acceptable reading of (2b) too difficult to obtain, (i) will serve to illustrate the same point.

i: Ten men wrote a letter which claimed that Mary hit the men.
mediated by the dynamic connectives \& and \rightarrow and by the dynamic generalized quantifiers every, most, etc.? I give an abridged version of Kanazawa's semantics for DPL below, with \textit{M} denoting the universe of model \textit{M} (pp. 134-138).

1. The interpretation \textit{t}^{M}_{g} of a term \textit{t} with respect to a model \textit{M} and an assignment \textit{g} is defined in the same way as in first-order logic.

2. For \textit{\varphi} = t_{1}=t_{2}, R(t_{1}, ..., t_{n}), \neg \psi, \psi \land \chi, \psi \lor \chi, \psi \rightarrow \chi, \psi \leftrightarrow \chi, \forall x \psi, \exists x \psi,

   (a) \textit{M} \models \varphi [g] is defined just as in first-order logic.
   (b) \textit{g} [\varphi]_{M} h \iff \textit{g} = h and \textit{M} \models \varphi [g].

3. For \textit{\varphi} = \psi \& \chi,

   (a) \textit{M} \models \varphi [g] \iff \textit{g} [\varphi]_{M} h.
   (b) \textit{g} [\varphi]_{M} h \iff \textit{g} = h and \textit{M} \models \varphi [g].

4. For \textit{\varphi} = \psi \rightarrow \chi,

   (a) \textit{M} \models \varphi [g] \iff \textit{g} [\varphi]_{M} h implies \textit{M} \models \chi [h].
   (b) \textit{g} [\varphi]_{M} h \iff \textit{g} = h and \textit{M} \models \varphi [g].

5. For \textit{\varphi} = \exists x \psi,

   (a) \textit{M} \models \varphi [g] \iff \textit{g} [\varphi]_{M} h.
   (b) \textit{g} [\varphi]_{M} h \iff \textit{g} = h and \textit{M} \models \exists x \psi [g].

6. For \textit{\varphi} = Qx(\psi, \chi),

   \textit{M} \models \varphi [g] \iff \langle \{a \in \textit{M} : \textit{M} \models \psi [g(a/x)]\}, \{a \in \textit{M} : \textit{M} \models \chi [g(a/x)]\} \rangle \in Q_{M}.
   (b) \textit{g} [\varphi]_{M} h \iff \textit{g} = h and \textit{M} \models \varphi [g].

7. \textit{Q}_{w,x}(\psi, \chi) \Leftrightarrow Qx(\psi, \psi \& \chi)

8. \textit{Q}_{x}(\psi, \chi) \Leftrightarrow Qx(\psi, \psi \rightarrow \chi)^{3}

2 I adopt the convention in Chierchia (1992) of underlining dynamic expressions to distinguish them from their static counterparts.

3 The equivalencies in 7 and 8 are not strictly speaking semantic rules of DPL but rather equivalencies that hold between formulas with dynamic generalized quantifiers and formulas
Generating anaphoric readings for the pronouns in (1) involves first translating the sentences into formulas of DPL and then interpreting the formulas. The DPL translations assumed are given in (3) below.

(3)

a. $\exists x (\text{man}(x) \& \text{walked-in}(x)) \& \text{sat-down}(x)$

b. Every $x$ [man $(x)$, complained $(x$, that Mary hit $x$)]

c. Every $x$ [donkey $(x)$ & $\exists y$ (man $(y)$ & gets beaten $(x$, by $y$)), $x$ kicks $y$]

A complete derivation of the satisfaction conditions for (3a) is given below. Arabic numerals in parentheses to the right of the steps indicate the DPL rule used in that step.

(4)

i. $M \models \exists x (\text{man}(x) \& \text{walked-in}(x)) \& \text{sat-down}(x)$ [g] iff

for some $h$, $g \models [\exists x (\text{man}(x) \& \text{walked-in}(x)) \& \text{sat-down}(x)]_M h$. (3a)

ii. $g \models [\exists x (\text{man}(x) \& \text{walked-in}(x)) \& \text{sat-down}(x)]_M h$ iff

for some $k$, $g \models [\exists x (\text{man}(x) \& \text{walked-in}(x))]_M k$ and $k \models [\text{sat-down}(x)]_M h$. (3b)

iii. $g \models [\exists x (\text{man}(x) \& \text{walked-in}(x))]_M k$ iff

for some $a \in M$, $g(a/x) \models [\text{man}(x) \& \text{walked-in}(x)]_M k$. (5b)

iv. $g(a/x) \models [\text{man}(x) \& \text{walked-in}(x)]_M k$ iff

for some $l$, $g(a/x) \models [\text{man}(x)]_M l$ and $l \models [\text{walked-in}(x)]_M k$. (3b)

v. $g(a/x) \models [\text{man}(x)]_M l$ iff $g(a/x) = l$ and $M \models \text{man}(x)[g(a/x)]$. (2b)

vi. $l \models [\text{walked-in}(x)]_M k$ iff $l = k$ and $M \models \text{walked-in}(x)[l]$ (2b)

with their more familiar static counterparts. 7 is used to represent the weak readings of donkey sentences and 8 the strong readings. (See Kanazawa (1994) for more on this distinction.)
vii. \[ g(a/x) [[ \text{man (x) \& walked-in (x) } ]]_M k \text{ iff } \]

\[ k = g(a/x) \text{ and } M \models \text{man (x) [g(a/x)] and } M \models \text{walked-in (x) [g(a/x)]} \]

(iv, v, vi)

viii. \[ g [[ \exists x \text{ (man (x) \& walked-in (x)) } ]]_M k \text{ iff } \]

\[
\text{for some } a \in M, k = g(a/x) \text{ and } M \models \text{man (x) [g(a/x)] and } M \models \text{walked-in (x) [g(a/x)]}
\]

(iii, vii)

ix. \[ k [[ \text{sat-down (x) } ]]_M h \text{ iff } k = h \text{ and } M \models \text{sat-down (x) [k]} \]

(2b)

x. \[ g [[ \exists x \text{ (man (x) \& walked-in (x)) \& sat-down (x) } ]]_M h \text{ iff } \]

\[
\text{(for some } a \in M, k = g(a/x) \text{ and } M \models \text{man (x) [g(a/x)] and } M \models \text{walked-in (x) [g(a/x)]})
\]

and \( k = h \text{ and } M \models \text{sat-down (x) [h]} \)

\[ \text{iff } \]

\[
\text{for some } a \in M, M \models \text{man (x) [g(a/x)] and } M \models \text{walked-in (x) [g(a/x)]}
\]

and \( M \models \text{sat-down (x) [g(a/x)]} \)

(ii, viii, ix)

xi. \[ M \models \exists x \text{ (man (x) \& walked-in (x)) \& sat-down (x) [g] } \text{ iff } \]

\[
\text{for some } a \in M, M \models \text{man (x) [g(a/x)] and } M \models \text{walked-in (x) [g(a/x)]}
\]

and \( M \models \text{sat-down (x) [g(a/x)]} \)

\[ \text{iff } \]

\[
\text{for some } a \in M, M \models \text{(man (a) and walked-in (a) and sat-down (a))} \]

(i, x, 1)

The same procedure can be applied to give satisfaction conditions for (3b,c) as well, though for reasons of space I give only a fragment of the derivations below, using the weak interpretation of \textit{every} and abbreviating where appropriate to make the expressions more readable.

(5)

a. \[ M \models \textit{every} x [\text{man}(x), \text{complained (x, that Mary hit x))] [g] \text{ iff } \]
\[\langle \{a \in M : M \models \text{man (a)}\} \rangle, \{a \in M : M \models \text{man (a) & complained (a, that Mary hit a)}\}\]
\[\in \text{every}_M \iff \]
\[|\{a \in M : M \models \text{man (a)}\}| = |\{a \in M : M \models \text{man (a) & complained (a, that Mary hit a)}\}| \]

b. \[M \models \text{every x [donkey (x) & } \exists y (\text{man (y) & gets beaten (x, by y)), x kicks y]} [g] \iff \]
\[\langle \{a \in M : M \models (\text{donkey (x) & } \exists y (\text{man (y) & gets beaten (x, by y))) [g(a/x)])\}, \{a \in M : M \models (\text{donkey (x) & } \exists y (\text{man (y) & gets beaten (x, by y)) & (x kicks y)}) [g(a/x)])\}\]
\[\in \text{every}_M \iff \]
\[\langle \{a \in M : M \models \text{for some } b \in M, \text{donkey (a) & man (b) & gets beaten (a, by b)}\}, \{a \in M : M \models \text{for some } b \in M, \text{donkey (a) & man (b) & gets beaten (a, by b) & kicks (a,b)}\}\]
\[\in \text{every}_M \iff \]
\[|\{a: \exists b (\text{donkey (a) & man (b) & gets beaten (a, by b))}\}| = |\{a: \exists b (\text{donkey (a) & man (b) & gets beaten (a, by b))}\} \cap \{a: \exists b (\text{donkey (a) & man (b) & gets beaten (a, by b) & kicks (a,b))}\}| \]

In each of the three cases, the anaphora between the pronoun and its antecedent is captured by analyzing the pronoun as a simple variable. This variable is indirectly bound in (1a,c), and directly bound in (1b), though in the satisfaction conditions this difference between these two types of binding is no longer visible.

The DPL treatment of pronominal anaphora itself says nothing about how to account for the anaphoric QPs and definite descriptions in (2). However, the analysis can be extended to account for these examples by assuming that the anaphoric expressions contain a variable which
can be bound from outside. To implement this idea I assume that the anaphoric expression contains a covert partitive\(^4\) whose interpretation is \(\lambda y.y \Pi x\), where \(x\) is a variable free within the partitive, and \(\Pi\) is the part-of relation relating plural entities to their parts. The relevant DPL translations are given in (6) for the versions with definite descriptions (taken to be referring expressions) and in (7) for the versions with QPs.\(^5\)

\[(6)\]
\(\begin{align*}
a. \ & \exists x (10 (x) \& \text{men (x)} \& \text{walked-in (x)}) \& \text{sat-down (the y: men (y) \& y \Pi x)} \\
& \exists x (10 (x) \& \text{men (x)} \& \text{complained (x, that Mary hit (the y: men (y) \& y \Pi x)))} \\
& \text{Every } x [\text{donkey (x)} \& \exists y (10 (y) \& \text{men (y)} \& \text{gets beaten (x, by y)}),
\quad x \text{ kicks (the z: men (z) \& z \Pi y})]
\end{align*}\]

\[(7)\]
\(\begin{align*}
a. \ & \exists x (10 (x) \& \text{men (x)} \& \text{walked-in (x)}) \& \text{each y [man (y) \& y \Pi x, sat-down(y)]} \\
& \exists x (10 (x) \& \text{men (x)} \& \text{complained (x, that each y [man (y) \& y \Pi x, Mary hit y])} \\
& \text{Every } x [\text{donkey (x)} \& \exists y (10 (y) \& \text{men (y)} \& \text{gets beaten (x, by y)}),
\quad \text{each z [man (z) \& z \Pi y, x kicks z}]}
\end{align*}\]

\(^4\) I refer to the covert expression as a partitive since the analysis given to it is semantically parallel to the analysis I assume for partitives. An alternative approach would be to analyze the covert phrase as a relative clause, perhaps taking all definites to have relative clauses. I will argue below that this covert phrase cannot co-occur with an overt relative clause, a property which is shared by overt partitives but not by overt relative clauses. This makes the covert partitive analysis much simpler to implement, and so I will adopt that analysis without further argument.

\(^5\) Quantification here is over (atomic and non-atomic) plural individuals. Singular nouns are assumed to have only atomic plurals in their extensions. For concreteness, I assume Link's (1983) lattice theoretic analysis of plurals throughout this paper, though the central analysis is compatible with other analyses as well.
Binding the free variable in the translation of *the men* in (6) makes the denotation of *the men* equivalent to *x* under reasonable assumptions about the interpretation of *the*,\(^6\) deriving the anaphoric interpretation observed. In (7), binding of the parallel free variable in the translation of *each man* gives rise to covariation between the range of the quantifier and the values assigned to *x*, again resulting in the anaphoric interpretation observed. I give the satisfaction conditions for (6c) in (8) below under the weak interpretation of *every*, leaving the remainder of the examples for the reader to work out.

\[
(8) \quad \{x: \exists y (10 (y) \& donkey (x) \& men (y) \& gets beaten (x, by y))\} = \\
\quad \{x: \exists y (10 (y) \& donkey (x) \& men (y) \& gets beaten (x, by y))\} \\
\quad \cap \{x: \exists y (10 (y) \& donkey (x) \& men (y) \& gets beaten (x, by y) \& \\
\quad \quad \quad \text{kicks (x, MAX \{z: men (z) \& z \Pi y\})}\} \\
\]

(8) says that the number of donkeys beaten by 10 men is equal to the number of donkeys beaten by 10 men that kick those 10 men. The anaphoric connection is made in the second argument of *every*, employing the equivalence between dynamic and static quantifiers given in 7 of the sketch of DPL above.

### 1.2 Problems with the Analysis of Section 1.1

The sketch of dynamic binding given in section 1.1 covers a wide range of examples. However, the examples in (9) show up a shortcoming of the analysis.

\[
(9) \quad \begin{align*}
\text{a. } & \text{John bought two horses which each gave birth to a colt. He raised both colts.} \\
\text{b. } & \text{Every man who bought two horses which each gave birth to a colt raised both colts.}
\end{align*}
\]

\(^6\) Extending and slightly modifying Heim and Kratzer’s (1997) analysis of *the* in the singular to cover plural descriptions, I take *the* to have the following interpretation:

\[
[[\text{the }]] = \lambda P. \text{MAX}\{z: P(z)\}
\]

\text{MAX} is an operator over sets which when applied to a given set S picks out that element x in S such that \(\forall y (y \in S \rightarrow y \Pi x)\), if such an element exists, and is undefined otherwise.
The quantified expression *both colts* in (9) can intuitively be anaphoric on the preceding occurrence of *a colt*, and yet the dynamic binding approach we have been pursuing cannot account for this connection. To see why, consider the following DPL translations for the sentences:

\[(10) \begin{align*}
\text{a. } & \exists y (2(y) \& \text{horses}(y) \& \text{each } z [z \ast \Pi y, (\exists u (\text{colt}(u) \& (z \text{ gave birth to } u))] \& \\
& \text{John bought } y) \\
& \& (\text{both } v [\text{colts}(v) \& v \Pi ?, \text{raised } (x,v)])
\end{align*} \]

\[(10) \begin{align*}
\text{b. Every } x [(\text{man}(x) \& \\
& \exists y (2(y) \& \text{horses}(y) \& \\
& \text{each } z [z \ast \Pi y, (\exists u (\text{colt}(u) \& (z \text{ gave birth to } u)] \& \\
& x \text{ bought } y)), \\
& (\text{both } v [\text{colts}(v) \& v \Pi ?, \text{raised } (x,v)])]
\end{align*} \]

Under the adaptation of dynamic binding proposed above, the only way the anaphoric interpretation of *both colts* can be accounted for is if that QP contains a dynamically bound variable in its interpretation occupying the position of the question mark in (10). However, no variable inserted into this position generates the most salient interpretation for these sentences, in which the colts being raised are claimed to be those given birth to by the horses bought.

Replacing ‘?’ with *u* fails in one of two ways. Since each is an externally static quantifier, the

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7 *\Pi* is the atomic part of relation defined in Link (1983): *z \ast \Pi y \iff z \Pi y & atomic(z)*.

8 An operator *o* operating over arguments *a₁*, ..., *aₙ* is externally static if it imposes the restriction that the input variable assignment function to *o(a₁, ..., aₙ)* equals the output variable assignment function. All strong quantifiers are externally static in this sense. Since indefinites bind expressions by affecting the variable assignment function, an indefinite contained within the scope of an externally static operator can never indirectly bind an expression outside the scope of
effective scope of the indefinite *a colt* is identical to the scope of *each*. However, the occurrence of ‘?’ is outside the scope of *each*, and hence a variable in this position cannot be bound by *a colt*. Reanalyzing *each* as externally dynamic is of no help. While this would make it possible for *a colt* to indirectly bind an occurrence of *u* in *both colts*, it would also give rise to a presupposition violation for the latter quantifier. *Both* requires that there be exactly two objects satisfying its restriction, but this is incompatible with restrictions imposed by the antecedent *a colt*, whose singular head noun *colt* does not contain plural individuals in its extension. Far from giving the anaphoric interpretation desired, such an approach would merely be a source for semantically determined presupposition failure.

The only way to avoid presupposition failure within the dynamic binding analysis of section 1.1 while including bound variables in the place of ‘?’ in (10) is to analyze the variables as occurrences of *y*. This will yield coherent interpretations which are arguably available for the two sentences, interpretations in which the sentences presuppose that the two horses that were bought by each man are themselves colts. The assertion of the sentence under this interpretation is that it is the colts which were bought that are raised, not their offspring. However, this still leaves the by far more salient interpretations unaccounted for, according to which there is no presupposition that the horses bought are colts, and it is the offspring of the horses purchased which are claimed to be raised. These interpretations simply cannot be generated on the analysis sketched in section 1.1. If a dynamic binding analysis is to be employed, then a further extension will be required. I will return to such an extension below which incorporates situations into the theory of dynamic binding. Before developing this extension, however, I first turn to an E-type pronoun analysis to see how far such an analysis can be pushed.

### 1.3 E-type Pronouns and Situations

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that operator. An operator is externally dynamic if it allows changes made by its arguments to the input variable assignment function to surface in the output variable assignment function.
As a representative E-type analysis, I adopt Heim (1990). This analysis is both explicit and flexible enough to cover a wide range of data. The analysis goes as follows:

Assume run-of-the-mill Logical Forms (LFs), scopally disambiguated by a rule like Quantifier Raising (QR). QR leaves a variable in the extraction site and an identical variable appears as a subscript on the determiner of the moved NP. For intensional examples, assume each predicate to have extra argument slots for world and time.

Pronouns are treated as follows: Use a set of \( n \)-place functor variables \( f_1^n, f_2^n, \ldots \), for \( n \geq 0 \). These range over functions whose arguments are \( n \)-tuples in \((A \cup W \cup T)^n\) and whose values are individuals in \( A \). (\( A, W, \) and \( T \) are the domain of individuals, set of worlds, and set of times, respectively.) These functions may be partial in that their domain need not be the set of all \( n \)-tuples of the appropriate type.

Notice that, for \( n = 0 \), an \( n \)-place functor variable is just a plain individual variable, and we may write \( x_i \) for \( f_0^0 \). The semantics of pronouns consists of one stipulation only: A pronoun is represented at LF as a term of the form \( f_i^n(v_1, \ldots, v_n) \), where \( n \geq 0 \) and \( v_1, \ldots, v_n \) are variables of the appropriate type (i.e., individual, world, or time variables). Interpretation is straightforward, with the proviso that free variables refer to contextually salient entities of the appropriate type. (pp. 138-139)

This analysis handles the examples in (1) straightforwardly. In (1a), the pronoun can be analyzed as a free variable (i.e. as a 0-place functor variable), referring to the contextually salient man who walked into the bar. In (1b), the pronoun can be analyzed as an individual variable bound by its c-commanding antecedent. (1c) can be handled by interpreting the pronoun as a functor applied to a variable, \( f(v) \), where \( v \) is bound by the quantified NP every donkey who gets beaten by a man and \( f \) is the function \( \lambda x.\text{the man who } x \text{ got beaten by} \).\(^9\)

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\(^9\) See Heim (1990) for problems with this analysis as well as for potential work-arounds for these problems.
Since deriving anaphoric readings for the pronouns in (1) depends on assigning appropriate interpretations to these pronouns, it is clear that the analysis says nothing directly about the examples in (2) since these do not contain pronouns. However, the analysis can be extended to account for the latter examples by allowing N in the anaphoric NP to be conjoined at LF with a covert partitive interpreted as $\lambda x. x \Pi \text{pro}$, where pro is replaced by an appropriate E-type pronoun interpretation. The quantifier each man would then be interpreted as equivalent to each man among them, with them interpreted identically to him above in each of the three cases up to semantic number. Though the paraphrase is less colloquial, the same analysis can be applied to the men, deriving an interpretation of this expression in each of its occurrences equivalent to that of the men among them, them an E-type pronoun. Since the function that gets added is semantically equivalent to a partitive, I refer to the function added as an E-type partitive, and to an analysis which employs E-type partitives as an extended E-type analysis.

The extended E-type analysis just sketched has the flexibility to account for the examples in (9) which were problematic for the dynamic approach. This flexibility comes from analyzing the functor variables as pragmatically identified. In the case of (9), this could plausibly be taken to allow the pronoun contained in the covert partitive in both colts to be interpreted as the colts

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10 Heim places no semantic number restrictions on the functor which partially interprets a given pronoun, though she does not address the issue directly of whether such a restriction should be incorporated. Neale (1990), Lappin and Francez (1994) and Krifka (1996), in contrast, all explicitly argue that no semantic number restriction should be placed on the interpretation of E-type pronouns. I argue against this latter assumption in the Appendix. For now, I assume without argument that syntactic number of an E-type pronoun restricts the semantic number of the individuals in the range of the functor which partially interprets the pronoun.
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given birth to by the horses that x bought.11 Analyzing x as bound by \( \exists x \) in (9a) and by every x in (9b) directly gives the most salient interpretations of these examples.

1.4 Stage/Individual Contrasts: Problems for an E-type analysis

To show what problems arise for the extended E-type analysis of section 1.3, it is useful to first see how it applies to a wider range of examples. That not all quantified expressions and descriptions can act as anaphoric expressions can be seen in (11) below.12

(11) Every man who bought two/ten donkeys likes Q donkey(s) (that brayed)

a. Q = each, the, both, neither
b. ?Q = every, most, several, some, two
c. ?#Q = all, few
d. #Q = a, no, s'me

The ? and # marks indicate degrees of unacceptability of an anaphoric interpretation when the determiners are substituted for Q in the immediately preceding sentence. With Q substituted for by each, the sentence is true provided that every man who bought ten donkeys likes each of the donkeys that he bought, regardless of how he feels toward other people's donkeys: the relevant

11 It is not clear that this function qualifies as pragmatically salient, since the function fails to contain an occurrence of each present in the antecedent from which it is derived, though I ignore this potential objection here. In a more constrained analysis like that of Neale (1990) the option of ignoring each would not be available. I suspect that the need to ignore each in giving an E-type interpretation to the pronoun can be turned into an argument against the E-type analysis of (9) under consideration, though I do not pursue this line of argument here. (Thanks to Makoto Kanazawa for useful discussion on this point.)

12 The judgments given are for expressions of the form Q+N only. Partitives of the form Q of the N can all be anaphoric, as can their pronominal counterparts Q. In both of these latter cases, I take the anaphora to be mediated at least potentially by the definite description contained in the partitive, the partitive being covert in the latter case.
donkeys covary with the buyers indicating an anaphoric dependency. Substituting no for Q, in contrast, gives a sentence which is true only if every man who bought ten donkeys likes no donkeys anywhere, including not only the ones he bought but the ones that others bought as well. Here, there is no covariation between relevant donkeys and buyers and hence no anaphora. (All sentences are of course perfectly acceptable on a non-anaphoric interpretation, though this interpretation is irrelevant to the current discussion.) Thus the availability of an anaphoric interpretation for a QP/DP is sensitive to the choice of quantifier/determiner.

Whether a QP/DP can be anaphoric is independent of whether it contains an overt relative clause, as seen by the fact that presence or absence of the relative clause that brayed does not affect the judgments in (11). On the extended E-type analysis of section 1.3, this can only be accounted for if the availability of an E-type partitive is independent of whether a relative clause exists: the anaphoric reading requires the QP to contain a bound variable which in this case only the E-type partitive can provide. Given this assumption, the extended E-type analysis can give an account of the anaphoric connections in all of the examples in (11) with the single additional assumption that only the Qs/Ds in (11a,b), and not those in (11c,d), select for a covert partitive.

While the E-type analysis just sketched accounts well for the assertions made by sentences containing anaphoric QPs/DPs, it does not fare so well with the presuppositions of these sentences. Heim (1982, 1990) and Heim and Kratzer (1997) argue that the uniqueness requirement imposed by a singular definite description is a presupposition. When the anaphoric expression in the examples we have been considering is a definite description, we thus expect there to be a corresponding uniqueness presupposition. Consider in this light the following paradigm.13

13 A related distinction shows up with plural anaphora.

i: Every man who owns two donkeys likes them/the donkeys/the animals

ii: Every man who owns two donkeys likes the donkeys/animals he owns
(12)  a. Every man who bought a donkey likes the donkey. (no abs. uniq. presup.)
    b. Every man who owns a donkey likes the donkey. ("")
    c. Every man who bought a donkey likes the donkey that he bought. ("")
    d. Every man who owns a donkey likes the donkey that he owns. (abs. uniq. presup.)

Each of the sentences in (12) contains an anaphoric definite description, and hence is expected to
give rise to a uniqueness presupposition. However, (12a,c) do not presuppose that every man
who bought a donkey bought exactly one. Similariy, (12b) does not presuppose that every man
who owns a donkey owns exactly one. Whatever uniqueness presuppositions are introduced by
the definite descriptions in these examples, they are not absolute. These three sentences contrast
with (12d), which does impose an absolute uniqueness presupposition, specifically the
presupposition that every man who owns a donkey owns exactly one.

In (i), *them/the donkeys/the animals* can only be interpreted as the two donkeys mentioned in the
antecedent clause (or irrelevancely as referring to some independently identified individuals). In
(ii), in contrast, *the donkeys/animals he owns* can very naturally be taken to mean all of the
donkeys/animals that he owns, including but not limited to the two mentioned in the antecedent
clause. This can be seen as showing that the pronoun/incomplete definite description in (i) is
required to be anaphoric in a manner in which the complete definite description in (ii) is not.
This distinction is problematic for the E-type pronoun analysis since an interpretation which
should be available for the pronoun *them* in (i) under that analysis is equivalent to *the donkeys he
owns*. Sentence (i) with *them* should thus include every reading available for the sentence (ii)
with *donkeys*, though this is not the case.

14 This can be made clearer by adding "right then and there" to the end of the sentence, or by
adding "no matter how many purchases he made". A similar addition to (12b) or (12d) is not
possible since the individual level predicate *owns* does not provide possible antecedents for the
anaphoric expressions *then* and *there* and it doesn't make sense to talk of separate ownings for
separate donkeys. For more on this, see below.
The problem this paradigm poses for the extended E-type analysis of anaphora is clear. Under that analysis, the LF representation of (12d) without a covert E-type partitive is semantically equivalent to the most likely candidate representation for generating the anaphoric interpretation of *the donkey* in (12b) with an E-type partitive, and a parallel relation holds between (12c) and (12a). Furthermore, addition of the most natural E-type partitive to (12c,d) will have no effect on either their truth conditions or their presuppositions, being entirely redundant. When the definite descriptions are anaphoric, the analysis predicts that all four sentences should have absolute uniqueness presuppositions. The fact that (12d) does while (12a-c) do not is thus unexplained.

Heim (1990) notes that the problem of avoiding excessive uniqueness presuppositions for sentences like (1b) can be handled by allowing the subject QP to quantify simultaneously over both individuals and situations and including situation variables as possible arguments to the functors that provide the E-type interpretation of pronouns. Applying the same idea to (12) will make it possible to eliminate the absolute uniqueness presuppositions here as well. The interpretation of the subject QP would be roughly as in (13), and the interpretation of the E-type pronoun contained in the covert partitive as in (14).

(13) \[\forall x,s: \text{man}(x) \& \text{min}(s, x \text{ bought/owns a donkey})\]  
(14) the donkey that x bought/owns in s

While Heim notes that this solution is not particularly insightful, in the present context it is not even empirically adequate -- without modification, this same analysis eliminates the absolute uniqueness presupposition not only in (12a-c) as desired, but also incorrectly in (12d) as well.  

\[\text{min}(s, \varphi) \iff s \text{ is a minimal situation in which } \varphi \text{ is true, iff there is no } s' \text{ of which } s \text{ is an extension and in which } \varphi \text{ is true.}\]
It should be noted that the dynamic binding analysis outlined in section 1.2 is not in any better shape than our extended E-type analysis. The dynamic binding analysis can easily account for the absence of absolute uniqueness presuppositions in (12a,b) by analyzing the definite description in each case as containing a conjoined covert partitive interpreted as \( \lambda x . x \Pi y \), with \( y \) indirectly bound by a donkey. However, it cannot distinguish between (12c) and (12d) in a principled fashion. Either a covert partitive is available for both sentences, or it is available in neither. In the former case, neither sentence is predicted to have an absolute uniqueness presupposition; in the latter case, both are. Adding E-type partitives to the analysis is of no help for the same reason. With no other means of restricting the interpretation of the definite description, the interpretations of these examples and hence the paradigm as a whole in which they are contained cannot be explained.

2. From Individuals to Situations

In this section I propose a solution to the problems outlined above. In section 2.1, I present an analysis within the dynamic binding framework that overcomes the problems posed by (9) for anaphoric interpretation of QPs/DPs. In section 2.2, I show how this same analysis can be extended to account for the presupposition problem illustrated in the paradigm in (12). In section 2.3, I show that the leading idea of section 2.2 cannot be incorporated into the extended E-type analysis of section 1.3 without also incorporating the mechanisms of dynamic binding.

2.1 Dynamic Binding of Situations

The dynamic binding analysis of section 1.2 failed to account for the most salient interpretation of the two examples in (9). The problem with those examples, it will be recalled, was that there

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17 Note that the over-extension of Heim's analysis involving binding of situations is independent of the decision to add covert relative clauses containing E-type pronouns to each of the anaphoric expressions in (12). Even without such a covert relative, directly interpreting the definite description in (12d) as in (14) will eliminate the absolute uniqueness presupposition in that example.
was no means available for interpreting *both colts* as anaphoric on *a colt* which would satisfy all presuppositions of the sentence. The extension of the E-type analysis considered in section 1.4, however, gives us what is needed to overcome this shortcoming -- situations. By incorporating a dynamic existential quantifier over situations into the antecedent relative clauses in (9), it is possible to account for the apparent anaphoric relationship between *a colt* and *both colts* indirectly, while satisfying the presupposition imposed by *both*.

To incorporate situations into a dynamic binding analysis in a principled fashion, it is necessary to identify the sources both of quantification over situations and of situation variables. I assume that all predicates contain an implicit situation variable which can either remain free or be quantificationally bound. Free situation variables, like all variables, are given a denotation by the local variable assignment function, the denotation presumed to be pragmatically restricted to a situation relevant to the discourse.\(^\text{18}\) I further assume that relative clauses introduce a quantification over situations of the following form: \(\exists s : s \leq S (\varphi(s))\).\(^\text{19}\) The occurrence of \(S\)

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\(^{18}\) Thanks to Sigrid Beck (p.c.) for this suggestion.

\(^{19}\) Strictly speaking, formulas of this form cannot be interpreted in the fragment of DPL presented in section 1.1, since this fragment does not admit restricted quantifiers and the only binary quantifiers admitted are externally static. Two solutions to this problem are possible. The first is to redefine \(\exists\) as an externally dynamic two-place operator. The second is to rewrite formulas of the form \(\exists s : s \leq S (\varphi)\) as \(\exists s (s \leq S \& \varphi)\). Either change is straightforward. I give the former solution below, which for ease of exposition I will assume to be an additional interpretation rule of DPL.

5'. For \(\varphi = \exists x : \psi(\chi)\),

(a) \(M \models \varphi \ [g] \text{ iff for some } h, g \ [\varphi]M h.\)

(b) \(g \ [\varphi]M h \text{ iff for some } a \in M \text{ and some } k, g \ (a/x) \ [\psi]M k \text{ and } k \ [\chi]M h\)

The expression \(q(s)\) in the text abbreviates two processes: abstraction over free occurrences of some situation variable in \(q\) followed by application of the resultant lambda abstract to \(s\).
introduced by a relative clause, like all other situation variables, can be either free or bound. Note that the situation \( s \) with respect to which the content of the relative clause is interpreted is one which is extended by \( S \), i.e. it is a sub-situation of \( S \). This aspect of relative clause interpretation will be seen to be necessary when we examine more complicated examples built from the sentences in (9). Interpreting relative clauses in this manner will result in \( S \) containing all individuals that are contained in \( s \). With this as background, I can now give the relevant DPL translations of the sentences in (9) below.

(15)  

a. \( \exists x (x = john \& \exists y (2 (y,s) \& \text{horses} (y,s)) \& \exists s':s' \leq s (\text{each } z [z \ast \Pi y, \exists u (\text{colt} (u,s') \& \text{(gave-birth-to} (z,u,s'))))) \& \text{bought} (x,y,s)) \& \text{both } v [\text{colts} (v,s'), \text{raised} (x,v,s)] \)\(^{20}\)

b. \( \text{Every } x [\text{man} (x,s) \& \exists s':s' \leq s (\exists y (2 (y,s') \& \text{horses} (y,s')) \& \exists s'' :s'' \leq s' (\text{each } z [z \ast \Pi y, \exists u (\text{colt} (u,s'') \& \text{(g-b-t} (z,u,s''))))) \& \text{bought} (x,y,s')), \text{both } v [\text{colts} (v,s''), \text{raised} (x,v,s)] ]^{21} \)

Technically, this is easiest to implement if it is assumed that all occurrences of a situation variable are initially occurrences of the same default variable, with certain operators (including the relative operator of a relative clause and anaphoric quantifiers such as \textit{both}) capable of abstracting over this variable and applying the result to a (possibly) distinct situation variable.

20 I've interpreted the name "John" here as an existentially quantified variable identified with an individual. This decision is mainly for expository purposes, making the binding of the pronoun \textit{he} in the two examples more obviously parallel. This decision does not affect the analysis under discussion.
The first four lines of (15a), corresponding to the first sentence of (9a), say that a pragmatically determined relevant situation $s$ is a situation of John buying two horses, and this situation extends another situation $s'$ in which each of the horses gave birth to a colt. The last line says that in $s$ John raised both of the colts contained in the birthing situation ($s'$). The indirect binding which gives rise to the anaphoric interpretation of *both colts* is highlighted in italics. (15b) is slightly more complicated in that interpreting the example requires translating the dynamically quantified formula with arguments $\psi (= man(x,s) \& \ldots \& bought (x,y,s'))$ and $\chi (= both v [colts (v,s''), raised (x,v,s)])$ into a statically quantified formula with arguments $\psi$ and $\psi \& \chi$. The indirect binding indicated in italics occurs within the second argument of this statically quantified formula, with the second argument itself equivalent in all relevant respects to (15a) with $x = john$ replaced by $man (x)$. Since the birthing situations in this second argument each extend to a buying situation, and since the buying situations covary with the men, the pairs of colts given birth to in the birthing situations covary with the men as well. The presupposition imposed by *both* that there be exactly two colts is satisfied with respect to the birthing situations, hence avoiding unwanted absolute uniqueness presuppositions. Finally, since there is no direct anaphoric relation between *both colts* and *a colt*, there is consequently no potential for a presupposition clash between the two expressions based on semantic number.

I claimed at the outset of this section that relative clauses have to be analyzed as introducing quantification over sub-situations of the local situation. The obvious alternative would be to analyze them as quantifying over extentions of the local situation. However, quantification over extentions of the local situation would fail to account for the covariation found in examples like (16).

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21 Though I've identified the situation variable contained in the restrictive clause of *both* as $s''$, identifying it as $s'$ would equally give rise to an anaphoric interpretation of *both colts*. This doesn't lessen the need for a dynamic binding analysis, however, since the relevant binding can only be done under a dynamic approach even on the alternative assumption.
The problem is that no situation variable which could be put in place of the question mark in (16) will give plausible truth conditions to the sentence as a whole. If the extentions made to situations by relative clauses are minimal, then either all situations except possibly s* will have 4 colts or only s* will have 4 colts. However, the existential quantifier introducing s* cannot indirectly bind a variable in the position of the question mark: the higher occurrence of each blocks this possibility. The existential quantifiers introducing s' and s" could indirectly bind a variable in the position of the question mark. In order to satisfy the presupposition of the quantifier all four, s'/s" will have to contain exactly 4 colts. Satisfying this requirement is straightforward. However, since s* will have to extend s, s' and s", and since some of these extensions will contain colts not already present in s, s' or s", such an analysis predicts that the sentence should be true in a situation in which there are some 4 colts that every relevant man raised, and in which no man raised any of his son's colts. Since the sentence is unambiguously false in such a situation, the analysis that gave rise to the unwanted prediction is clearly incorrect. Allowing extensions to situations to be non-minimal only adds to the number of false predictions that the analysis makes. Analyzing relative clauses as introducing quantification over sub-situations, in contrast, makes it possible to account for the anaphora without a problem, suggesting strongly that relative clauses should be analyzed as introducing quantification not over extentions to the local situation but rather over sub-situations of the local situation.

2.2 Dynamic Binding and Presuppositions

We just saw how a dynamic binding based analysis which incorporates dynamic quantification over situations can overcome the problem posed by (9) to the dynamic approach to anaphora. That same analysis goes part of the way toward handling the paradigm in (12) as well, repeated below for ease of reference.

(12) a. Every man who bought a donkey likes the donkey. (no abs. uniq. presup.)
    b. Every man who owns a donkey likes the donkey. (" " )
c. Every man who bought a donkey likes the donkey that he bought. (             )

d. Every man who owns a donkey likes the donkey that he owns. (abs. uniq. presup.)

The problem posed by this paradigm is that the four sentences pattern together in allowing an anaphoric interpretation of the definite description, but (12d) differs from the rest in having an absolute uniqueness presupposition. In specific, (12d) presupposes that each man who owns a donkey owns exactly one, whereas no parallel presupposition arises in any of (12a-c). To generate the desired absolute uniqueness presupposition in (12d), it is necessary under the dynamic binding analysis to avoid generating a covert partitive containing a bindable individual variable in the donkey that he owns. Were such a partitive present, the variable contained therein could be indirectly bound by a donkey, giving the sentence an interpretation lacking the observed uniqueness presupposition, an interpretation equivalent to Every man who owns a donkey likes the donkey he owns which is that donkey. To block this possibility, I stipulate that a covert partitive can be added only to QPs and DPs which do not already contain an overt relative clause. This makes it possible to avoid generating unwanted uniqueness presuppositions for (12a) and (12b) by analyzing those examples as containing covert partitives, leaving us only the task of distinguishing (12c) from (12d). Here, appeal to situations becomes necessary.

Under the analysis of section 2.1, an anaphoric interpretation of the definite description in (12c) can be generated from the following (partial) DPL translation.

\[
\text{(17)} \quad \text{Every } x \quad \text{[man (x,s) & } \exists y: s' \leq s (\exists y \text{ (donkey (y,s') & bought (x,y,s'))})],
\text{ likes (x, [the z: donkey (z,s') & } \exists y: s'' \leq s' (\text{bought (x,z,s''))}, s)]\]

The definite description in (17) produces a uniqueness presupposition, but it is an innocuous one -- that for each man who bought a donkey in some situation s’ there is exactly one donkey which he bought in some sub-situation of s’. Since a single man can be the buyer in several separate donkey purchasing situations, (12c) is compatible with some men having purchased a total of many donkeys. Of course, nothing prevents generating a parallel DPL translation of (12d) as well, differing from (17) only in containing the word owns in place of the two occurrences of bought:
Every man who speaks a language likes the language that he speaks.

ii: Every man who speaks with a woman likes the woman that he speaks with.

When given an individual level interpretation in (i), speaks gives rise to an absolute uniqueness presupposition, though when interpreted as stage level in (ii) (or in (i)) it does not.

That the contrast in question is a stage/individual contrast is supported by the following contrast in the two uses of speak’ (Thanks to Sigrid Beck (p.c.) for these examples.)

22 That the contrast in question is a stage/individual contrast is supported by the following contrast in the two uses of speak’ (Thanks to Sigrid Beck (p.c.) for these examples.)
The semantics of *the* presupposes that there is exactly one object $z$ satisfying the restriction $\text{donkey}(z,s') \land \exists s'': s'' \leq s' (\text{owns}(x,z,s''))$ in (18). By hypothesis (19) together with the hypothesis that owning an object is (or at least can be) an individual-level property, any situation like $s'$ and $s''$ in which $x$ occurs is a situation in which $x$ owns everything that he owns. If $x$ owned two donkeys, both donkeys would thus have to be included in $s'$ and $s''$. This would lead to a violation of the uniqueness presupposition of the determiner *the*, however. In order for this presupposition to be satisfied, the number of donkeys that $x$ owns must be exactly one, i.e. the uniqueness of the donkey owned by $x$ must be absolute.

The addition of hypothesis (19) has no effect on the interpretations of (12a-c). For (12a,c), this is because the examples do not contain the word *owns*. For (12b), it is because there is a separate mechanism available for defusing an absolute uniqueness presupposition -- the mechanism of adding to the DP a covert partitive containing a bindable individual variable. Only in (12d), where the presence of an overt relative clause makes the option of adding a covert partitive unavailable, are the effects of (19) visible.

I have now established the adequacy of the analysis involving dynamic binding of situations for explaining the paradigm in (12). In section 1.4, I showed that an extended E-type analysis by itself is inadequate to account for this paradigm. In sections 2.1 and 2.2 I showed that the dynamic binding analysis can account for our intuitions about (9) independently of an extended E-type analysis. It is tempting to conclude from this that an E-type analysis of pronouns is superfluous and that E-type pronouns should be purged from the theory. In section 3

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23 The stage/individual distinction is not lexicalized as an invariant property of predicates. Thus, while *own* appears to be typically assigned an individual-level interpretation, in the context of a high-stakes poker game among farmers who bet animals in place of money, *owns* in (12d) can be readily interpreted as a stage-level predicate, in which case the sentence as a whole lacks the absolute uniqueness presupposition found in more normal contexts. For more on the problem of accounting for stage/individual-level contrasts, see Higginbotham and Ramchand (1997?).
I will return to this question and show that E-type pronouns are in fact ineliminable. Before doing so, however, it is necessary to first demonstrate that a dynamic binding analysis of the type just argued for cannot be replaced by a suitably modified version of the E-type analysis which incorporates hypothesis (19). It is to this task that I now turn.

2.3 Stage/Individual Contrasts in a Non-dynamic Framework

The arguments of sections 2.1 and 2.2 were aimed at showing that a dynamic binding analysis is feasible. They do not yet establish that such an analysis is necessary. I argued in section 1.4 that an E-type analysis which allowed quantificational determiners to quantify simultaneously over both individuals and situations was inadequate to account for the paradigm in (12), in particular being unable to account for the presence of an absolute uniqueness presupposition in (12d). Hypothesis (19) of section 2.1, however, gives us a way of generating just this presupposition.

To see how, consider the following interpretation for (12d), where the final occurrence of in s' is taken to be contributed by the definite determiner.

(20) \[ \forall x,s': \text{man}(x,s) \& \text{min}(s', x \text{ owns a donkey})] x \text{ likes the donkey that } x \text{ owns in } s'

The italicized definite description in (20) presupposes that there is a unique donkey that x owns in s'. It follows from (19), then, that there is a unique donkey that x owns in any situation. This makes (20) generate the desired absolute uniqueness presupposition for (12d) within an extended E-type analysis and without dynamic binding.

While giving us a way to account for our intuitions about (12d), incorporating (19) into the extended E-type analysis runs into problems with (12b). Accounting for the anaphoric interpretation of the incomplete definite description in (12b) requires either binding of an individual variable contained in a covert partitive, binding of a situation variable contributed by the, or both. This gives us the following informal representations to choose from.

(21) a. \[ \forall x: \text{man}(x,s) \& x \text{ owns a donkey in } s] x \text{ likes the donkey that } x \text{ owns in } s
b. \[ \forall x,s': \text{man}(x,s) \& \text{min}(s', x \text{ owns a donkey})] x \text{ likes the donkey that } x \text{ owns in } s

While giving us a way to account for our intuitions about (12d), incorporating (19) into the extended E-type analysis runs into problems with (12b). Accounting for the anaphoric interpretation of the incomplete definite description in (12b) requires either binding of an individual variable contained in a covert partitive, binding of a situation variable contributed by the, or both. This gives us the following informal representations to choose from.

(21) a. \[ \forall x: \text{man}(x,s) \& x \text{ owns a donkey in } s] x \text{ likes the donkey that } x \text{ owns in } s
b. \[ \forall x,s': \text{man}(x,s) \& \text{min}(s', x \text{ owns a donkey})] x \text{ likes the donkey that } x \text{ owns in } s

In (21a), *the donkey that x owns* is required to be unique with respect to situation \( s \), and hence with respect to any situation in which \( x \) owns a donkey, producing an unwanted absolute uniqueness presupposition. The same is true of (21b), in which quantification over \( s' \) is vacuous. In each of (21c,d) quantification over \( s' \) is non-vacuous, the quantifier binding the situation in the anaphoric definite description. (21c) is identical to (20), and hence produces the same absolute uniqueness presupposition in the same way. This leaves (21d) as the only possibility for avoiding the unwanted presupposition. Unfortunately, this example too generates the same presupposition, though in a different way. By hypothesis (19), \( s' \) will be a minimal situation of \( x \) owning a donkey if and only if \( s' \) is a minimal situation of \( x \) owning everything that \( x \) owns. Equating this \( s' \) with the occurrence of \( s' \) in the definite description will yield a presupposition for the description that there is exactly one donkey in the situation of \( x \) owning everything he owns. Thus, by incorporating (19), the extended E-type analysis can account for our intuitions about (12d), but only at the expense of providing us no way of avoiding an unwanted absolute uniqueness presupposition for (12b).

3. **Challenges to a Dynamic Binding Analysis**

The arguments given so far suggest that E-type pronouns can be dispensed with, with all pronouns interpreted as simple variables. Several authors have challenged this suggestion.\(^{24}\) Here I will consider four such challenges. In each case, I will show that a dynamic binding

\(^{24}\) In Tancredi (1997), it is argued that pronouns interpreted *de se* are not simple variables, but are rather definite descriptions whose head N is a perspectival expression. If Tancredi’s arguments are correct, then the suggestion that all pronouns are interpreted as simple variables is clearly mistaken. The present analysis can be brought into line with that of Tancredi (1997), however, by taking pronouns to be interpreted as definite descriptions whose semantic content is entirely determined in the lexicon: a pronoun interpreted as *the x such that x=y*, with \( y \) a simple variable, will be interpretationally indistinguishable from a simple variable \( y \).
analysis is possible which makes no recourse to an E-type interpretation of pronouns. Though not conclusive, these analyses suggest that E-type pronouns may indeed be dispensable.

3.1 Hintikka (1997)

Consider first the following examples taken from Hintikka (1997) (modified slightly).

(22) a. If every farmer buys a donkey, some farmer will beat *it* before he gets home.

b. If you give a gift to every child for Christmas, some child will open *it* today.

In the intended interpretation, the universal quantifiers are given wide scope over their clusemmate indefinites. The problematic pronoun in these examples is the italicized pronoun *it*. This pronoun can readily be interpreted as anaphoric (in some sense) on the occurrence of a donkey/a gift in the antecedent clause, and yet it cannot be analyzed as a variable indirectly bound by the indefinite -- the indefinite is, but the pronoun is not, in the scope of the (externally static) universal quantifier, making indirect binding of the pronoun by the indefinite impossible. An E-type pronoun analysis here would give an account of the observed anaphora -- *it* could be analyzed as $f(x)$, with $x$ bound by some farmer/some child and $f$ a function from individuals to the donkeys they bought in (a), or from individuals to the gift you give them for Christmas in (b). Hence, the argument goes, a dynamic binding analysis which treats all pronouns as variables is insufficient.

While an E-type pronoun analysis is certainly viable here, the conclusion drawn from these examples that the pronouns cannot be analyzed as variables within a dynamic binding account is premature. It was assumed above that bare definite descriptions can be completed with a covert partitive whose interpretation is $\lambda x. x \Pi z$, with $z$ a free variable. If we similarly allow covert relative clauses to be added to QPs/DPs and allow the identity of the covert relative to be recovered from the antecedent context, a dynamic binding account can be given for the

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25 The sentences in (22) are only acceptable with a heavy accent on some, and no accent on farmer/child, indicating that the availability of a covert relative clause is connected to the focus pattern of the QP.
examples in (22) as well. Filling in assumptions about the interpretation of conditionals and ignoring the final adverbial clause, this will allow for the following LF representation for (22a).^{26,27}

\[(\forall x \ [\text{farmer} (x,s), \exists y \ (\text{donkey} (y,s) \ & \ \text{buys} (x,y,s))]) \implies \]

\[\forall S \ [S \leq s \ & \ \forall x \ [\text{farmer} (x,S), \exists y \ (\text{donkey} (y,S) \ & \ \text{buys} (x,y,S))],\]

\[\exists S':S \leq S' \leq s \ (\exists x \ (\text{farmer} (x,S) \ & \ \exists y \ (\text{donkey} (y,S*) \ & \ \text{buys} (x,y,S*))) \& \ \text{will-beat} (x,y,S'))\]

This formula says that if in some relevant situation \(s\) every farmer buys a donkey, then every sub-situation \(S\) of \(s\) in which every farmer buys a donkey can be extended to another sub-situation \(S'\) of \(s\) in which some farmer who buys a donkey in \(S\) will beat the donkey. The italicized occurrences of \(S\) in the third and fourth lines account for the anaphoric interpretation of the quantified expression \textit{some farmer}. The fourth line gives the content of the recovered material, copying from the LF representation of the antecedent of the conditional, abstracting over \(S\), and applying the result to the situation variable \(s*\) introduced by the covert relative operator. In this representation, the occurrence of \(y\) interpreting the pronoun \textit{it} in the last line is

^{26} The universal quantification over situations in the second line of (23) and the existential quantification over situations in the third line are assumed to be contributed by an implicit adverb of quantification (= \textit{always}). Note that the situations introduced by this adverb are not taken to be minimal situations in any sense, in contrast to the analysis of von Fintel (1994). Analyzing \(S\) as a minimal situation in which every farmer buys a donkey would result in \(S\) denoting a null situation. See Percus (1998) for an analysis of adverbials similar to that developed here.

^{27} The approach to adverbial modification given here holds promise for solving the "double-bind" problem of Barker (1997). Since adverbial modification is not the central focus of this paper, however, I leave the details of the analysis to a separate paper.
indirectly bound by the existential quantification over \( y \) in the immediately preceding line. The anaphora is highly indirect, with \( it \) directly anaphoric on a covert expression recovered from the overt occurrence of \( a \) \textit{donkey}. However, the only mechanisms of anaphoric interpretation employed are mechanisms of dynamic binding, establishing the desired conclusion that the example does not argue against a dynamic binding analysis.

### 3.2 Jackson (1994)

A second class of examples taken to argue for an E-type analysis of pronouns over a bound variable analysis (including a dynamic binding analysis) includes examples in which an anaphoric pronoun appears to interact scopally with some other operator in the same sentence. (24) is taken from Jackson (1994).

(24) Every club that has a treasurer always pays \( him \) well.
(25) a. This club always pays the treasurer well.
    b. The treasure (of this club) is an individual \( x \) such that this club always pays \( x \) well.

The claim made for (24) is that \( him \) can be interpreted as \textit{the treasurer (of the club)} and given narrow scope with respect to \textit{always}. Under this reading, paying the treasurer well is a property which is taken to hold of each relevant club regardless of whether the identity of the treasurer changes over time. This interpretation is argued to parallel one interpretation available in (25a). A parallel interpretation is missing in (25b) where a bound individual variable occurs in place of the definite description in the scope of \textit{always}. Jackson concludes from this example that the pronoun in (24) under the (apparent) narrow-scope-definite reading cannot be interpreted as a simple variable, but must instead be interpreted as a definite description. This E-type analysis will make the parallel between (24) and (25) fall out directly. A simple-minded extension of the dynamic binding analysis developed above which analyzes the pronoun \( him \) in (24) as indirectly bound by the occurrence of \textit{a treasurer}, in contrast, fails to explain this apparent scope ambiguity.

To provide a plausible dynamic binding analysis of (24), it is necessary to first give a detailed analysis of the adverb \textit{always}. Such adverbs of quantification have been argued in von
Fintel (1994) to operate over situations. The connection between adverbs of quantification and quantifiers has not been fully made explicit, though the role that adverbs play in facilitating quantificational subordination suggests a plausible integration along the following lines.\(^{28}\)

\[(26)\]

\[\forall x \ [\text{club}(x,s) \land \exists y \ (\text{treasurer}(y,s) \land \text{has}(x,y,s))],\]

\[\forall s':s'\leq s \ [\text{club}(x,s') \land \exists y \ (\text{treasurer}(y,s') \land \text{has}(x,y,s'))],\]

\[\exists s'' \ (s'\leq s''\leq s \land \text{pays-well}(x,y,s''))]\]

In this representation, the quantifier \textit{every} takes two arguments: \textit{club that has a treasurer}, and \textit{always pays him well}. The adverb of quantification \textit{always} also requires two arguments, though it cannot take them directly from the syntactic tree that feeds LF. Instead, \textit{always} takes as its first argument the restrictive clause of the quantifier \textit{every}, and as its second argument the sentence that remains after raising of the subject QP. The anaphoric dependence of \textit{him} on a \textit{treasurer} is handled by taking the indirect binder of \textit{him} to be the occurrence of \(\exists y\) copied into the restrictive clause of the adverb \textit{always}. The ambiguity of (24) can be accounted for by varying the value assigned to the free situation variable \(s\). If \(s\) is large enough to contain sub-situations of a single club having distinct treasurers, then (26) will produce an interpretation equivalent to Jackson's narrow scope reading of the definite. Alternatively, if there are no distinct sub-situations \(s'\) and \(s''\) of \(s\) such that for some club \(x\) the treasurer of \(x\) in \(s'\) is distinct from the treasurer of \(x\) in \(s''\), then the interpretation of (26) will be equivalent to Jackson's alleged wide-scope reading of the definite. Once again we find that a dynamic binding analysis without E-type pronouns suffices to account for the phenomena.

### 3.3 Heim (1982)

Two more problematic examples for treating a pronoun as a variable are given in (27), provided by Heim (1982).

\(^{28}\) Percus (1998) independently analyzes adverbs of quantification as quantifying over sub-situations rather than over minimal extensions of a situation, the analysis originally proposed in von Fintel (1994).
(27)  
   a. Almost every man sold a house. One of them got as much as 300,000 dollars for it.
   
   b. Every motel room has a copy of the Bible in it. In this room, it was hidden under a pile of TV Guides.

The examples pre-date dynamic analyses of binding, though the problems they pose for interpreting pronouns as variables appear at first blush to extend to dynamic binding analyses as well. In (27a) a house cannot indirectly bind it, though it appears to be the antecedent for the pronoun. It would be possible to account for the anaphora of it by analyzing them as going proxy for the definite description the men who sold a house and using the covert occurrence of a house to bind it.\(^{29}\) However, far from eliminating the need for an E-type analysis, such an approach would merely trade an E-type analysis of it for an E-type analysis of them. In (27b) again it cannot be indirectly bound by its apparent antecedent, a copy of the Bible.

As with the examples in (22) and (24), here again a little ingenuity leads to a straightforward analysis. In both of the examples, the possibility of interpreting it anaphorically depends, as it did in (22), on the focus pattern of another expression. In this case, the relevant expressions are ONE of them, and THIS room, capitalization indicating the focus needed to obtain the anaphora. In dealing with Hintikka's examples, I took this focus pattern to correlate with the possibility of a QP having a covert relative clause. The same analysis can be extended to apply here as well, transforming the second sentences in (27) into the following.

(28)  
   a. One of them who sold a house got as much as 300,000 dollars for it.
   
   b. In this room which has a copy of the bible in it, it was hidden under a pile of TV Guides.

Interpretation of (28a) is straightforward, requiring only that one be analyzed as internally dynamic. Deriving the correct interpretation of (28b) will require spelling out an internally dynamic.

\(^{29}\) The definite determiner the would have to be analyzed as externally dynamic, though this poses no technical difficulties and appears to be independently motivated.
dynamic semantics of adverbial *in*, though this raises no problems of principle within an already dynamic analysis. Once again, the dynamic binding analysis has no need of E-type pronouns.\(^{30}\)

### 3.4 Karttunen (1969)

The final example I will examine which has been argued to show that not all pronouns can be interpreted as variables is (29) below from Karttunen (1969). The argument was made in a non-dynamic setting, but the point has an initial plausibility within a dynamic setting as well.

(29) The man who gave his paycheck to his wife was wiser than the man who gave *it* to his mistress.

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\(^{30}\) The pronoun *them* in (28a) raises an independent problem of interpretation, as do plural pronouns with non-plural antecedents in general. Barbara Partee (p.c.) suggests that the plural pronoun in (28a) can perhaps be treated as a surface variant of *the ones*, following an idea of Postal’s. This approach does not extend smoothly to examples of split anaphora as in (i), however, indicating that there is more to the problem of pronominal interpretation than the simple treatment being pushed in this paper.

(i): A man\(i\) told a woman\(j\) that they\(i,j\) were being watched.

Note that (i) cannot be accounted for under Neale’s (1990) D-type analysis of pronouns, which derives the interpretation of a D-type pronoun (a restricted version of an E-type pronoun) from the entire sentence containing its antecedent. Since this sentence also contains the putative D-type pronoun itself, attempting to derive a value for this pronoun will lead to an infinite regress. Under the looser analysis of Heim (1990) this problem can be avoided by analyzing *they* as denoting a plural variable whose atomic parts are the variables bound by *a man* and *a woman*.

The question that arises in the present context is whether anything beyond such simple summation is ever called for in the analysis of plural pronouns. If the answer is negative, then (i) is slim evidence at best for a full-blown E-type analysis. I leave investigation into this question and into the interpretation of plural pronouns in general for future research.
Intuitively, the occurrence of *it* in (29) can be interpreted as something like *his paycheck*, with a hidden *his* bound ultimately by the second occurrence of *the man*. This is the kind of interpretation which can be readily handled by an E-type analysis of pronouns, and once again it cannot be handled by taking *it* to be anaphoric on the occurrence of *his paycheck* in the first half of the sentence. However, the explanation given of Hintikka's and Heim's examples can be extended to account for the anaphora in (29). Again what is needed is a covert relative clause modifying *the man* which can be recovered from some antecedent expression. In distinction to the previous cases, here the relative clause that is needed cannot be copied directly from the antecedent. However, it can be taken from a presupposition of the antecedent clause, in particular from the presupposition that the man who gave his paycheck to his wife had a paycheck. Adding this presupposition to the second occurrence of *a man* will transform the final NP in (29) into (30a), with DPL translation (30b).

(30)  
   a. the man who had a paycheck who gave it to his mistress  
   b. MAX {z: man (z,s) & [∃s':s'≤s] ([∃x: paycheck (x,s')] (had (z,x,s'))) & [∃s":s"≤s] (gave (z,x,x's mistress,s"))}

The analysis just given raises the obvious question of what constrains the process of adding covert relative clauses to NPs. I assume this process to be a typical accommodation process, and hence to be subject to the same general pragmatic constraints that accompany all instances of accommodation. What additional constraints there might be, if any, I leave as an open question.

4. Conclusion

I have argued that in order to account for the anaphoric properties of certain quantified expressions and definite descriptions it is necessary to adopt and extend a dynamic theory of binding. The extensions required are three: (i) allowing covert partitives containing an individual variable to be conjoined with QPs/DPs which lack an overt relative clause; (ii) taking relative clauses to introduce dynamic existential quantification over situations; and (iii) analyzing certain Qs and Ds as containing bindable situation variables in their translations. In
addition, to account for differences in presuppositions associated with the words *bought* and *owns*, I proposed that individuation of situations differs for these two relations, only the former capable of being individuated by the objects to which one stands in the relation. The extensions and proposal together accounted for both the range of anaphoric interpretations available for quantified and definite expressions and for the pattern of presuppositions to which these expressions give rise, while parallel extensions to an E-type analysis were shown to falter on presuppositions. In the final section, I suggested that the dynamic binding analysis arrived at can dispense with an E-type analysis of pronouns altogether by allowing accommodation of covert relative clauses to supply antecedents for pronouns. Whether the alternative will ultimately prove superior to the E-type analysis it is intended to replace will hopefully be made clearer with further research.

**Appendix: Against Numberless Descriptions**

The idea that E-type pronouns are semantically numberless was proposed explicitly in Neale (1990) in order to account for the lack of absolute uniqueness presuppositions in sentences like (31).

(31) Every man who owns a donkey vaccinated it

The analysis developed above makes it clear that this approach to the problem posed by (31) is not necessary. In this section, I argue that it is additionally not workable. The central observation that tells against this proposal is the observation that donkey anaphoric pronouns can be replaced by incomplete definite descriptions without altering either the truth conditions or the assertability conditions of the sentence, while replacement by a complete definite description can alter these conditions. Thus, (32) is exactly parallel to (31) both in the range of anaphoric relations that can obtain for the definite description *the donkey* and in the lack of absolute uniqueness presuppositions associated with this expression. (33) in contrast carries a presupposition that every man who owns a donkey owns exactly one, as we have already seen.

(32) Every man who owns a donkey vaccinated the donkey

(33) Every man who owns a donkey vaccinated the donkey he owns
The pattern illustrated by the sentences in (31), (32) and (33) appears to be fully general in that whatever properties appear on a donkey anaphoric pronoun accrue as well to a donkey anaphoric incomplete definite description, though not necessarily to a corresponding complete definite description. This is illustrated below for a handful of examples which have become standards in the literature.

(34)  
\[ \text{a. No parents who have a teenage son lend him the car on weekends} \]
\[ \text{b. No parents who have a teenage son lend the teenage son the car on weekends} \]
\[ \text{c. No parents who have a teenage son lend the teenage son that they have the car on weekends} \]

(35)  
\[ \text{a. Most men who own a donkey beat it} \]
\[ \text{b. Most men who own a donkey beat the donkey} \]
\[ \text{c. Most men who own a donkey beat the donkey that they own} \]

(36)  
\[ \text{a. Everyone who bought a sage plant bought five other sage plants together with it} \]
\[ \text{b. Everyone who bought a sage plant bought five other sage plants together with the sage plant} \]
\[ \text{c. Everyone who bought a sage plant bought five other sage plants together with the sage plant that he bought} \]

In (34), the (a) and (b) sentences are appropriate even in contexts in which some parents are taken to have more than one teenage son. (34c), however, presupposes that parents with a teenage son have exactly one, and so is inappropriate in these same contexts. Intuitions for the sentences in (35a,b) are hard to pin down in situations in which some men own more than one donkey, though the going opinion seems to be that in such situations the men who own more than one donkey have to beat most of their donkeys in order for the sentence to come out true. (35c), in contrast, is simply inappropriate in such contexts, the anaphoric definite description carrying an absolute uniqueness presupposition absent in (35a,b). Finally, none of the sentences in (36) carries a uniqueness presupposition like that found in (33) (though the judgment is much harder to obtain for (36c) than for the other two sentences).
If we adopt a Neale style analysis for the (a) examples in (34) - (36), the obvious question that arises is how to differentiate the (b) examples from the (c) examples. Analyzing the overt definite determiner *the* as numberless would account for the absence of uniqueness presuppositions in the (b) examples, though at an unacceptably high cost. If the same determiner is assumed to occur in the (c) examples, such an analysis would make it impossible to account for the presence of uniqueness presuppositions in these latter examples. Analyzing the definite determiner of an incomplete description as semantically numberless and that of a complete description as number sensitive fares no better. Such an analysis would make it impossible to account for the uniqueness presuppositions triggered by the occurrences of *the student* in (37).

(37)  
   a. Five students walked into a room. #Then, the student sat down.
   b. Five people walked into a room. Then, the student sat down.
   c. In class today, Professor Smith called the student by his last name.

In (37a), *the student* cannot be anaphoric on *five students*, though if it were numberless such an anaphoric relation would be expected to be possible, with *the student* denoting the five students who walked in. In (37b) we see that the problem is not merely one of syntactic number agreement. Here, as in (37a), we have a syntactically singular definite description anaphoric on a plural antecedent, and yet the absence of syntactic number agreement does not block an anaphoric interpretation of the definite description. The anaphoric interpretation of *the student* gives rise to a presupposition that of the five people who walked into the room exactly one was a student, and this presupposition is left unexplained if the determiner is semantically numberless. Finally, in non-anaphoric uses of definite descriptions as in (37c) as well we find a uniqueness presupposition associated with the definite description, and once again this presupposition is left unexplained if the determiner is taken to be semantically numberless.

(31) - (36) show that bare definite descriptions behave exactly like pronouns in donkey anaphora contexts. If this fact is taken to indicate (contra the proposals of the present paper) that pronouns are nothing more than disguised definite descriptions, then whatever analysis explains the behavior of pronouns should carry over to bare definite descriptions as well, and vice versa.
The fact that definite descriptions with overt determiners are never numberless as seen in (37) thus argues that the descriptions associated with pronouns are never numberless either. For even if a numberless analysis of the pronouns can be made viable, an additional analysis will be needed for the bare definite descriptions, where a numberless analysis is out of the question. If a single analysis is to cover both pronouns and bare definite descriptions, it follows that that analysis will have to be one which takes the number marking on pronouns to be semantically significant.

Bibliography


