# Invisible endings of English adjectives and nouns

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In the context of a categorial grammar for English, which assigns syntactic types to words, certain metarules concerning adjectives and nouns may be paraphrased by saying that adjectives and common nouns may have invisible endings that carry syntactic information.

## 1. Introduction.

The English adjective fulfills two distinct syntactic functions; it may occur as a predicate or it may modify a noun:

*the man is good*; *the good man*.

One reason why we must attach different types to these two occurrences of *good* is that we can say

*the good old man*

but not

**the man is good old*.

It follows that the phrase *good old* acts like an attributive adjective but not like a predicative one.

In other languages, the two types of adjectives may have distinct morphological representation. For example, in German, a close relative of English, one says:

*der Mann ist gut*; *der gute Mann*.

Here the ending $+e$ transforms the predicative adjective into an attributive one.[2)]

I will argue that the functional dichotomy of the English adjective can be explained by saying that its attributive form too has an ending, albeit an invisible one, which carries an appropriate syntactic type.

While the invisible endings of English attributive adjectives may be justified on historical grounds, assuming that an early form of English was more like German, invisible relative pronouns seem to be an innovation of the English language. I will argue that one way to analyze the noun phrase

*the man I saw yesterday*

is to assume that the noun *man* has an invisible ending which carries the syntactic type of the missing relative pronoun *whom/ which/ that* after *man*.

The reader will have noticed by now that our investigation is motivated by the kind of grammar, sometimes called "categorial grammar", which computes sentencehood with the help of syntactic types assigned to each word in the dictionary. In particular, I now favour an algebraic approach to grammar which seeks these types as elements of a *free pregroup*, to be explained in the next section. I hope the present investigation will serve as a gentle introduction to this approach, accessible to readers without mathematical training.

**2. The algebraic framework**.

This article is part of an ongoing investigation of the structure of sentences and other phrases in various languages, bases on the premiss that sentences or phrases are constructed by stringing words together, each word having attached to it one or more types. In the particular approach I now favour, these types are elements of a (partially ordered) algebraic system, called a *free pregroup*, and their concatenation is to be justified by a calculation performed in this system.

In this article, addressed to linguists rather than mathematicians, I will confine myself to a few aspects of the English noun phrase and employ only a minimal algebraic machinery. We assume that each word in the dictionary has attached to it one or more types. These *types* are strings of simple types

$$\alpha_1\alpha_2\cdots\alpha_n$$

and each *simple type* $\alpha_i$ may be a *basic* type, say $a$, or may be made up from a basic type by attaching to it one or more superscripts:

$$^{\ell} \quad (\text{for } left\ adjoint)$$

or

$$^{r} \quad (\text{for } right\ adjoint).$$

Thus, a simple type has the form

$$\cdots,\ a^{\ell\ell},\ a^{\ell},\ a,\ a^{r},\ a^{rr},\ \cdots,$$

though, in practice, never more than two superscripts are needed. (In many languages, one superscript seems to suffice.)

The basic types are assumed to be elements of a given partially ordered set. We write $a \to b$ and take the arrow to be reflexive, transitive and anti-symmetric, that is, we stipulate

$$a \to a, \quad \frac{a \to b\ b \to c}{a \to c}, \quad \frac{a \to b\ b \to a}{a = b}\ .$$

The partial order may be extended to simple types, thus

$$\frac{a \to b}{b^{\ell} \to a^{\ell}}\ ,\ \frac{b^{\ell} \to a^{\ell}}{a^{\ell\ell} \to b^{\ell\ell}}\ ,\ \cdots$$

and similarly for $r$. It may furthermore be extended to (compound) types, thus

$$\frac{\alpha \longrightarrow \beta}{\cdots\alpha\cdots \to \cdots\beta\cdots}$$

The only universal grammatical rules we require are (generalized) *contractions*:

$$\frac{\alpha \longrightarrow \beta}{\cdots\beta^{\ell}\alpha\cdots \to \cdots\cdots}\ , \quad \frac{\alpha \longrightarrow \beta}{\cdots\alpha\beta^{r}\cdots \to \cdots\cdots}.$$

The algebraic system we have described is called a *free pregroup*.[3)] The word "free" here implies that the partial order is originally confined to basic types. We are not permitted to postulate $\alpha \to \beta$ unless $\alpha$ and $\beta$ are both basic, although such a relation may be inferred from the postulates governing basic types.

**3. Nouns**.

A noun phrase, by definition, contains a noun as its head. To each noun we assign a basic type:

$n$ to names,

$n_0$ to mass nouns,

$n_1$ to count nouns,

$n_2$ to plurals.

Thus, for example,

$$\begin{gathered} \mathit{John}:\ n; \\ \mathit{consideration},\ \mathit{mankind},\ \mathit{rice},\ \mathit{pork}:\ n_0; \\ \mathit{man},\ \mathit{bean},\ \mathit{pig}:\ n_1; \\ \mathit{police},\ \mathit{men},\ \mathit{beans},\ \mathit{pigs}: n_2. \end{gathered}$$

While *beans* is clearly the plural of *bean, police* has no singular form. Count nouns have plurals, mass nouns don't. These categories are not fixed for all times, they depend on context. When the waiter shouts to the kitchen "one rice please", he uses *rice* as a count noun, meaning "bowl of rice". When the cannibal says he prefers man to pork, he treats *man* as a mass noun, meaning "human flesh". Some permanent change of category has taken place in historical time; thus, once there was a mass noun *pease*, which was later re-interpreted as a plural, spelled *peas*, of the new word *pea*. As I have told my students for years, there may come a time when *rice* is conceived as the plural of a new word *rouse*.

One way we can distinguish the different types of nouns is by the determiners, including articles, they may help to form complete noun phrases. Names of type $n$ are already complete, but we may consider complete noun phrases $\overline{n}_k$ $(k = 0, 1, 2)$ as in:

$$\begin{array}{ccc} \mathit{much\ rice}, & \mathit{a\ pea}, & \mathit{many\ beans}; \\ (\overline{n}_0 \underbrace{n_0^\ell)\ n_0} \to \overline{n}_0 & (\overline{n}_1 \underbrace{n_1^\ell) n_1} \to \overline{n}_1 & (\overline{n}_2 \underbrace{n_2^\ell) n_2} \to \overline{n}_2 \end{array}$$

but we should not say:

$$^*\mathit{many\ water}, \quad ^*\mathit{much\ pea}, \quad ^*\mathit{much\ police}.$$

The definite article *the* may apply to each of these kinds of nouns, hence has type $\overline{n}_k n_k^\ell$ $(k = 0, 1, 2)$. Mass nouns and plurals do not require determiners, hence we postulate:

$$n_0 \to \overline{n}_0, \qquad n_2 \to \overline{n}_2,$$

but $n_1 \not\to \overline{n}_1$.

Of course, we have only scratched the surface here and we have not explained why one can say, for example,

$$\mathit{many\ a\ bean}, \quad \mathit{the\ very\ many\ beans},$$

but why the combinations *many the* and *very the* are not admitted.

**4. Adjectives**.

Adjectives, used *attributively*, may modify nouns. Thus we have

$$old\ rice, \quad old\ man, \quad old\ men$$

of the same type as *rice, man, men* respectively. (Marginally, one may also refer to *old Napoleon*, but then *Napoleon* is probably treated as a count noun.) We account for this by saying that the adjective *old* has types $n_k n_k^\ell$ $(k = 0, 1, 2)$. For example,

$$\begin{array}{cc} old & men \\ (n_2\underline{n_2^\ell})\ \underline{n_2} & \to n_2. \end{array}$$

The type assignment of adjectives allows iteration, thus one can say

$$\begin{array}{ccc} good & old & men \\ (n_2\underline{n_2^\ell})\ \underline{(n_2\underline{n_2^\ell})}\ \underline{n_2} & \to & n_2 \end{array}$$

and observe that

$$(n_2 n_2^\ell)\ (n_2 n_2^\ell)\ \to n_2 n_2^\ell\ ,$$

and so *good old* has the same type as *old*.[4)]

However, the type $n_k n_k^\ell$ for adjectives won't work in all contexts, certainly not when the adjective is used predicatively, as witnessed by

$$the\ men\ are\ good, \quad the\ men\ are\ old, \quad {}^*the\ men\ are\ good\ old.$$

I would like to assign to each adjective primarily the basic type $a$, to be used in such predicative constructions.

Although this article is mainly concerned with the noun phrase, it will be helpful to point out that, in the above context, the finite verb form

$$are \text{ has type } \pi_2^r s_1 a^\ell.$$

Here the basic type

$s_1$ stands for declarative sentences in the present tense

and the basic type

$\pi_2$ stands for plural nominative pronouns *you, we, they.*

We postulate

$$\overline{n}_2 \to \pi_2$$

to indicate that any complete plural noun phrase has the same type also. Thus we have

$$\begin{array}{ccc} men & are & good \\ \underline{n_2} & \underline{(\pi_2^r s_1 a^\ell)} & \underline{a} \to s_1 \end{array}$$

since

$$n_2 \to \overline{n}_2 \to \pi_2,$$

hence

$$n_2\pi_2^r \to 1,$$

where 1 denotes the empty string of simple types.

For completeness, let me also mention the types of singular pronouns:

$\pi_1$ for the first person *I*,

$\pi_3$ for the third person *he, she, it*,

and add the postulates

$\overline{n}_0 \to \pi_3, \quad \overline{n}_1 \to \pi_3.$

What is the relation between the types $a$ and $n_k n_k^\ell$ of adjectives? It would be tedious to list both types for each adjective in the dictionary. Yet, we cannot identify them; for if we put $a = n_k n_k^\ell$ we would wrongly accept $^*$*the men are good old*. We would also have a problem with the modifier *very* of adjectives. We would like to say

$$very \text{ has type } aa^\ell,$$

as in

$$\begin{array}{l} they \quad are \quad very \quad good. \\ \pi_2 \ (\pi_2{}^r s_1 a^\ell)(aa^\ell) \ a \to s_1 \end{array}$$

Yet *very* cannot have type [3)]

$$(n_k n_k^\ell)\ (n_k n_k^\ell)^\ell = n_k n_k^\ell n_k^{\ell\ell} n_k^\ell \to n_k n_k^\ell,$$

since we cannot usually say $^*$ *very rice*.

We have shown that $a \neq n_k n_k^\ell$, but perhaps we could postulate $a \to n_k n_k^\ell$ or, equivalently, $an_k \to n_k$? We could then justify

$$\begin{array}{llll} the & very & old & men \\ (\overline{n}_2 n_2^\ell) & (aa^\ell) & a & n_2 \end{array} \begin{array}{l} \to \ \overline{n}_2 n_2^\ell a n_2 \\ \to \overline{n}_2 n_2^\ell n_2 n_2^\ell n_2 \to \overline{n}_2. \end{array}$$

However, such postulates are not permitted in a free pregroup. (If one allowed postulates of the form $\alpha \to \beta$ even in a finitely generated monoid, one would already have a device capable of recognizing all recursively enumerable sets of strings of symbols.)

**5. Invisible endings of adjectives**.

Even if we listed both types $a$ and $n_k n_k^\ell$ for each adjective in the dictionary and the type $aa^\ell$ for *very*, we still could not justify *the very good men*.

Here is one possible solution. For each adjective in the dictionary list four types:

$$a, \ aa^r n_k n_k^\ell \ (k = 0, 1, 2).$$

We could then justify the plural noun phrase

$$\begin{array}{lll} very & old & men \\ (aa^\ell) & (aa^r n_2 n_2^\ell) n_2 & \end{array} \to n_2 \to \overline{n}_2.$$

Since $aa^r \to 1$, this will still work if *very* is omitted. Equivalently, to avoid tedious repetition, we adopt

METARULE I. An adjective of type $a$ also has type $aa^r n_k n_k^\ell$ $(k = 0, 1, 2)$.

Such metarules affect only the dictionary. Note that we are not allowed to postulate $a \to aa^r n_k n_k^\ell$, since the right-hand side of the arrow is not a basic type.

At first sight, it seems that the type $aa^r n_k n_k^\ell$ is unnaturally complicated. However, it has a historical justification, as is seen by paraphrasing the metarule as follows:

Every attributive adjective has an invisible ending of type $a^r n_k n_k^\ell$.

As we saw in Section 1, such endings are visible in German.

**6. Restrictive relative clauses**.

Nouns may be modified by adjectives on the left and by *restrictive* relative clauses on the right. (We shall ignore here *non-restrictive* relative clauses, which modify complete noun phrases.) For example, we may say

*the man who saw me yesterday*,
*the man whom I saw yesterday*.

I may be accused of being pedantic, but I follow Inspector Morse in distinguishing the accusative *whom* from the nominative *who*. It is the former we are interested in here; it may be replaced by *which* or *that* (or even omitted altogether, as we shall consider in Section 6). To be precise, *whom* is restricted to persons, while *which* and *that* may refer to persons or things.

Although it is not my intention to investigate sentence structure in this article, to understand the above noun phrases we must first understand the simple sentence

*I saw him yesterday*.

First, let us forget about the adverb *yesterday* and analyze

$$\begin{array}{l} I \quad saw \quad him \\ \pi_1 \ (\pi_1^r s_2 o^\ell) \ o \ \to s_2. \end{array}$$

Here we make use of the basic types

$$\begin{array}{rcl} s_2 & = & \text{statement in the past tense,} \\ o & = & \text{direct object.} \end{array}$$

We can then also analyze

$$\begin{array}{c} I \quad saw \quad the \quad man, \\ \underbrace{\pi_1 \ (\pi_1^r s_2 o^\ell)} \ \underbrace{(\overline{n}_1 n_1^\ell)} \underbrace{n_1} \end{array}$$

provided we postulate

$$\overline{n}_k \to o$$

in the partially ordered set of basic types.

Now let us look at the noun phrase

$$\begin{array}{l} the \quad man \quad whom \quad I \quad saw - \\ \underbrace{(\overline{n}_1 n_1^\ell)} \ \underbrace{n_1} \ \underbrace{(n_1^r n_1 o^{\ell\ell} s^\ell)} \underbrace{\pi_1 (\pi_1^r s_2 o^\ell)} \ \to \overline{n}_1. \end{array}$$

Here "–" denotes a Chomskyan trace. As it turns out, a double adjoint, such as $o^{\ell\ell}$, occurs in a pregroup grammar whenever the orthodox analysis inserts a trace. We postulate

$$s_i \to s \ (i = 1, 2),$$

since the tense is irrelevant as far as the relative pronoun is concerned.

**7. A small modification**.

The story becomes a bit more complicated if we take account of adverbs such as *yesterday* or prepositional phrases such as *on Tuesday*. For a complete treatment of adverbs and adverbial phrases, including prepositional ones, one ought to distinguish different adverbial types denoting time, place, manner and whatever else. For the present purpose, I shall pretend that there is only one adverbial type $\alpha$. Thus, the finite verb form *saw* has not only type $\pi_1^r s_2 o^\ell$, but also type $\pi_1^r s_2 \alpha^\ell o^\ell$ to justify

$$\begin{array}{c} I\ saw\ him\ yesterday \\ \pi_1\ (\pi_1^r s_2 \alpha^\ell o^\ell)\ o\ \alpha \to s_2. \end{array}$$

The new type of *saw* should be derived by a metarule involving the infinitive of the verb, which lies outside the scope of this article. For our present purpose we may state it as follows.

METARULE II. If the finite form of the verb has type $\pi_j^r s_i x^\ell$, then it also has type $\pi_j^r s_i \alpha^\ell x^\ell$. Here $x$ is a verb complement such as $x = o$, but possibly also $x = 1$ (the absence of a complement). The subscript $j = 1, 2$ or 3, the subscript $i = 1$ or 2.

As it turns out, to treat accusative relative clauses we require yet another type for *saw* (to be taken care of by another metarule), namely $\pi_1^r s_2 \hat{o}^\ell \alpha^\ell$, where

$$\hat{o} \to o, \quad o \not\to \hat{o}$$

in the partially ordered set of basic types. The purpose of the hat is to prevent such non-sentences as

$$\begin{array}{c} {}^*I\ saw\ yesterday\ him\ . \\ \pi_1 \quad (\pi_1^r s_2 \hat{o}^\ell \alpha^\ell)\ \alpha \quad o \end{array}$$

We even want $\overline{n}_k \not\to \hat{o}$ to prevent

$${}^*I\ saw\ yesterday\ a\ man,$$

where the object has type $\overline{n}_1$.[5)]

With the new type for *whom* we can now handle

$$\begin{array}{c} the\ man\ whom\ I\ saw\ yesterday\ - \\ (\overline{n}_1 n_1^\ell)\ n_1\ (n_1^r n_1 \hat{o}^{\ell\ell} s^\ell) \pi_1\ (\pi_1^r s_2 \hat{o}^\ell \alpha^\ell) \alpha \end{array}$$

This does not imply that the old type $n_1^r n_1 o^{\ell\ell} s^\ell$ was wrong, since we can prove that

$$n_k^r n_k \hat{o}^{\ell\ell} s^\ell \to n_k^r n_k o^{\ell\ell} s^\ell.$$

This follows from $\hat{o}^{\ell\ell} \to o^{\ell\ell}$, which follows from $\hat{o} \to o$ via $o^\ell \to \hat{o}^\ell$.

The other metarule may be stated in a somewhat more general form than needed here:

METARULE III. If a word has type $\cdots y^\ell o^\ell$, then it also has type $\cdots \hat{o}^\ell y^\ell$.
In particular, if a finite verb has type $\pi_j^r s_i \alpha^\ell o^\ell$, then it also has type $\pi_j^r s_i \hat{o}^\ell \alpha^\ell$.

**8. Invisible relative pronouns**.

Now let us see what happens if we omit the relative pronoun *whom*:

$$\begin{array}{l} \textit{the man I saw yesterday} \\ (\overline{n}_1 n_1^\ell)\ n_1\ \underbrace{\pi_1}\ (\pi_1^r s_2 \hat{o}^\ell \underbrace{\alpha^\ell})\ \underbrace{\alpha} \quad \to (\overline{n}_1 n_1^\ell) n_1 s \hat{o}^\ell\ . \end{array}$$

In earlier papers, I had agonized over what to do about this. Should one adopt the grammatical rule

$$n_k s \hat{o}^\ell \to n_k,$$

thus abandoning the requirement that our pregroup be free, or should one insert an invisible word with the type of *whom*, namely $n_k^r n_k \hat{o}^{\ell\ell} s^\ell$? Both these solutions to the problem have disadvantages and I now wish to explore another solution, namely to propose the following metarule.

METARULE IVa. Every noun of type $n_k$ also has type $n_k \hat{o}^{\ell\ell} s^\ell$.

This metarule may be paraphrased by saying that nouns of type $n_k$ have invisible endings of type $\hat{o}^{\ell\ell} s^\ell$. However, there is no historical justification for such endings.

Unfortunately, Metarule IVa does not cover all occurrences of an invisible relative pronoun. It won't account for the following examples:

$$\textit{the approach to this problem I favour now},$$

$$\textit{the girls at the party he admired.}$$

The problem is that here the new type $n_k \hat{o}^{\ell\ell} s^\ell$ should be attached not to the nouns *problem* and *girls*, but to the noun phrases *approach to the problem* and *girls at the party*. But these noun phrases are not in the dictionary![6)]

**9. Noun complements**.

The approach to this problem I favour now is to allow nouns to have complements, here prepositional phrases, let us say of type $\beta$. Thus we require yet another metarule:

METARULE V. A noun of type $n_k$ also has type $n_k \beta^\ell$, where $\beta$ is the type of a prepositional phrase.

I realize that not all prepositional phrases go well with every noun. While we could easily accept

$$\textit{the approach at the party},$$

it may be more difficult to make sense of

$$^?\textit{the girls to the problem.}$$

I don't see how to resolve this difficulty without distinguishing between different types of prepositional phrases, something I am not prepared to do at the moment.

I propose that Metarule IVa be accompanied by

METARULE IVb. Any noun of type $n_k\beta^\ell$ also has type $n_k\hat{o}^{\ell\ell}s^\ell\beta^\ell$.

We could combine metarules IVa and IVb into one by allowing $\beta = 1$. Unfortunately, Metarule IVb cannot easily be paraphrased by attaching an invisible ending to nouns of type $n_k\beta^\ell$.

We can now analyze the examples at the end of section 7. For instance, the noun *approach* of type $n_1$ receives type $n_1\beta^\ell$ by Metarule V and then type $n_1\hat{o}^{\ell\ell}s^\ell\beta^\ell$ by Metarule IVb. We may now calculate as follows:

$$\begin{array}{c} \textit{the approach to this problem I favour now} - \\ (\overline{n}_1 n_1^\ell)\ (n_1\hat{o}^{\ell\ell}s^\ell\beta^\ell)\ (\beta o^\ell)\ (\overline{n}_1 n_1^\ell)\ n_1\ \pi_1\ (\pi_1^r s_1\hat{o}^\ell\alpha^\ell)\ \alpha \end{array}$$

We have used the rules $\overline{n}_1 \to o$ and $s_1 \to s$ and the type of *favour* assigned to it by Metarule III.

**10. Conclusion**.

It is my opinion that, given enough information about each word of a language, one may determine how words are strung together to form sentences or other phrases. This opinion is shared by other people who work with *categorial* or *type logical* grammars. The rules for stringing words together are expected to be universal, independent of the language under consideration. There ought to be no need for transformations acting on string or labelled bracketed strings of words as in the linguistic paradigm until recently in fashion.[7)]

The basic information about each word should be encoded in one or more types, namely elements of an algebraic or logical system. While there is some disagreement among categorial grammarians about which system to employ, my own preference is for free pregroups (or, equivalently, compact bilinear logic).

In order not to overload the dictionary, it is convenient to list only a few types in the dictionary and to allow other types to be derived by certain metarules. These metarules apply only to single lexical items, not to strings of words or to labelled bracketed strings of words.[8)]

We have concentrated here on two metarules applying to English adjectives and nouns. One (Metarule I) may conveniently be paraphrased by saying that adjectives, when used attributively, have invisible endings which carry syntactic information. The other (Metarule IVa) says essentially that each common noun may be assigned a type which incorporates the type of an invisible accusative relative pronoun. The former has some historical justification, since corresponding endings in German are visible. The latter seems to be an innovation in modern English, without any historical precedent.[9)]

## Endnotes

[1)] The author acknowledges support from the Social Sciences and Humanities Research Council of Canada.

[2)] Actually, in German the story is even more complicated, there being different possible endings

$$+e,\ +em,\ +en,\ +er,\ +es,$$

which encode information about gender, number and case, and also about what kind of determiner (if any) may head the noun phrase in which the adjective occurs. Here are some illustrations:

$$\textit{der gute Mann},\ \textit{mit gutem Wasser},$$
$$\textit{dem guten Mann},\ \textit{ein kleiner Mann},\ \textit{ohne gutes Wasser}.$$

[3)] A free pregroup is a special kind of pregroup. While I do not wish to burden the reader of this article with a complete explanation of pregroups, I will mention that the definition requires not only contractions $a^\ell a \to 1$ and $aa^r \to 1$, but also *expansions* $1 \to aa^\ell$ and $1 \to a^r a$. The expansions are not required in a *free* pregroup for computing the simple type of a sentence or phrase, as was shown in [L1999], but they are useful for proving other properties, e.g.,

$$a^{\ell r} = a = a^{r\ell},$$
$$(ab)^\ell = b^\ell a^\ell,\ (ab)^r = b^r a^r.$$

[4)] I am ignoring here the observation that people don't like to say $^?$*old good men*, which would be justified by the same calculation on types. In order to avoid complications, I will accept this phrase provisionally as syntactically well-formed, even if not stylistically acceptable. The situation is different in French, where I am told the ordering of adjectives is obligatory and has to be incorporated into the grammar.

[5)] Note, however, that German admits sentences such as

$$\textit{ich sah gestern einen Mann},$$

where the object is an indefinite noun phrase, as was pointed out to me by Anne Preller, but rules out

$$^*\textit{ich sah gestern den Mann}.$$

[6)] A similar problem might arise in connection with Metarule I, if we allow attributive adjectives to have complements:

$$\textit{men are easy to please},\quad ^?\textit{easy to please men};$$
$$\textit{the cup is hot to the touch},\quad ^?\textit{the hot to the touch cup}.$$

If necessary, Metarule I could be expanded to account for such examples.

[7)] I am not sure to what extent this paradigm has been completely replaced by the latest minimalistic approach.

[8] The metarules of Gazdar et al. [1985] apply to rewrite rules, thus resemble what logicians call "rules of inference".

[9] As I have pointed out elsewhere, invisible relative pronouns may challenge the intelligibility of English sentences. For example, the string

(∗) *police police police police police*

may be analyzed as a sentence in two distinct ways, if we realize that *police* is not only a plural noun, but also a verb meaning "control". Thus (∗) could be analyzed to mean

*police control police* [*whom*] *police control* −,

or

*police* [*whom*] *police control* − *control police*,

where the dash denotes a Chomskyan trace.

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