Standard Anaphoric Pronouns

Gary Hardegree
Department of Philosophy
University of Massachusetts
Amherst, MA 01003

1. Introduction

A *standard anaphoric pronoun* is a pronoun that is **bound by its antecedent,** in the same sense that a variable is bound by a quantifier in logic. We can use standard-anaphoric pronouns to re-analyze certain lazy pronouns; but more importantly, we can use them to analyze pronouns bound by QPs and by relative pronouns.

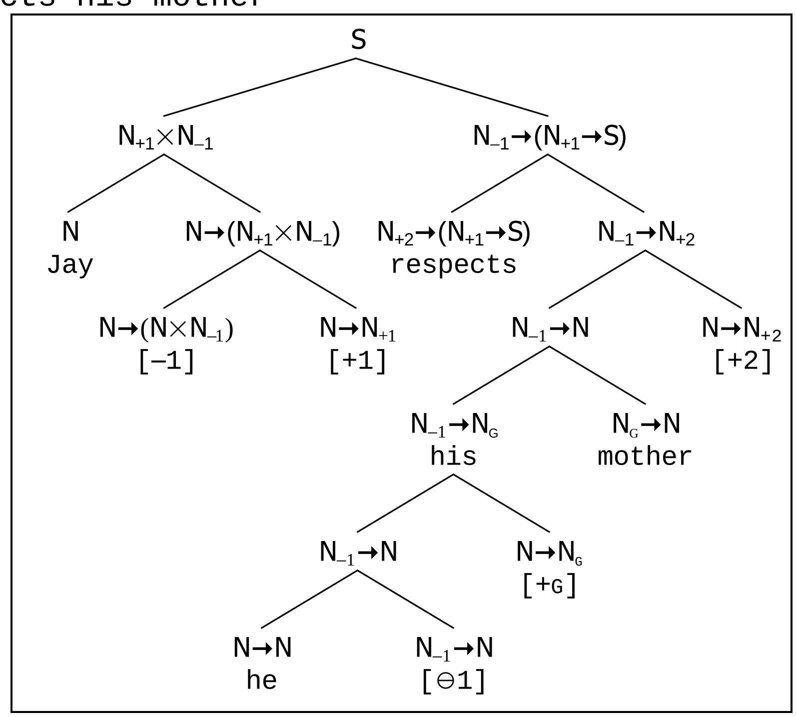
2. Anaphoric-Inflections

Anaphoric-inflections correspond to the usual numerical subscripts that appear in most linguistic analyses of anaphora, although we employ negative integers [–1, –2, …], since we already employ non-negative integers for case-inflections. They are formally analogous to case-inflections, except that they come in two forms. In particular, whereas a case-inflection [θ] has just one inflectional functor [$N \rightarrow N_\theta$], an anaphoric-inflection [α] has two such functors – an opening-inflection [$N_\alpha \rightarrow N$], and a closing-inflection [$N \rightarrow (N \times N_\alpha)$].[1] As in the case of reflexive pronouns, we categorially render essentially-anaphoric pronoun-roots as vacuous functors of type $N \rightarrow N$. The following table summarizes the categorial information.

name	type	symbol	denotation
opening-inflection	$N_{-k} \rightarrow N$	[⊖*k*]	$\lambda x_{-k}\{ x \}$
closing-inflection	$N \rightarrow (N \times N_{-k})$	[–*k*]	$\lambda x\{ x \times x_{-k} \}$
pronoun-root	$N \rightarrow N$	e	$\lambda x\{ x \}$

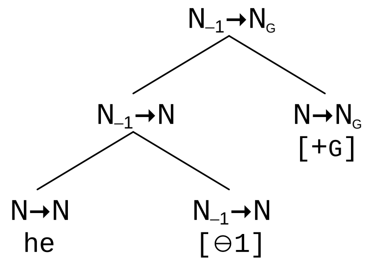
3. Examples

1. `Jay respects his mother`



[1] The closing-inflection operator inflects the N and also duplicates it. For a few special applications, however, the closing-inflection does not duplicate N, but merely inflects it, and accordingly has type $N \rightarrow N_\alpha$.

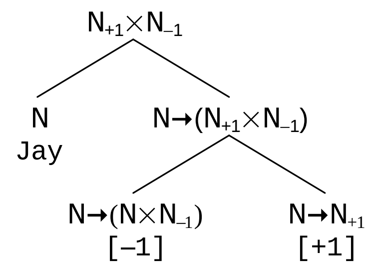
Previously, we have offered an analysis of this sentence in which we treat `'he'` as lazy-anaphoric to `'Jay'`. In the above analysis, we treat `'he'` as logically-bound by `'Jay'`. The details go as follows.



`'he'` is a semantically-empty pronoun-stem,
which serves principally as an inflectional-vehicle;

in this case, it carries the open –1-inflection `[⊖1]`,

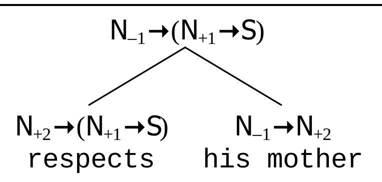
and it carries the genitive-inflection `[+G]`



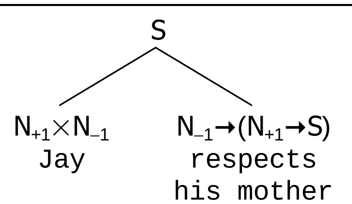
`'Jay'` is double-inflected, in virtue of which it plays two roles in the sentence.

(1) it serves as verb-subject [+1];

(2) it serves to bind any [–1] pronoun inside its scope;



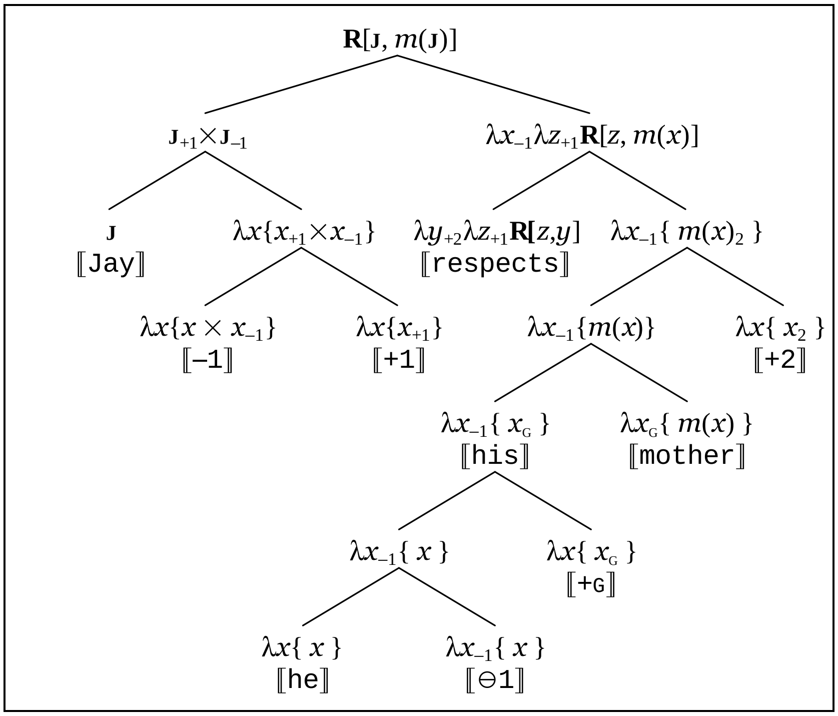
`'respects his mother'` is a VP by traditional syntactic accounts, but it is a two-place predicate by the proposed categorial account. However, unlike ordinary two-place predicates [e.g., transitive verbs], it does not subcategorize for an accusative `[+2]` argument; rather, it subcategorizes for an anaphoric argument – in this case `[-1]`.



Note that $N_{-1}\to(N_{+1}\to S)$ is logically-equivalent to $(N_{+1}\times N_{-1})\to S$.[2]

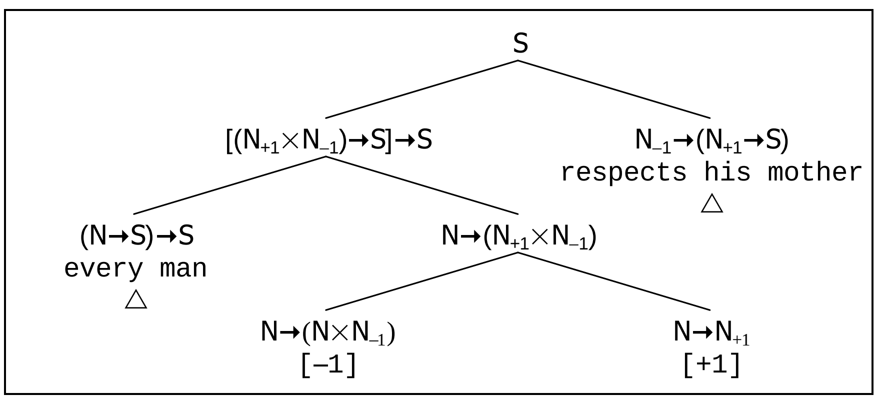
We now look at the corresponding semantic-tree.

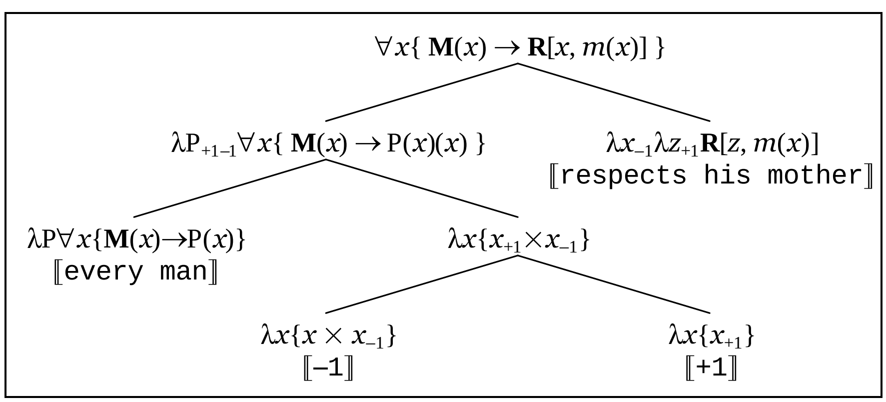
[2] Recall the Schönfinkel technique.



We next consider a parallel example involving a QP.

2. `every man respects his mother`





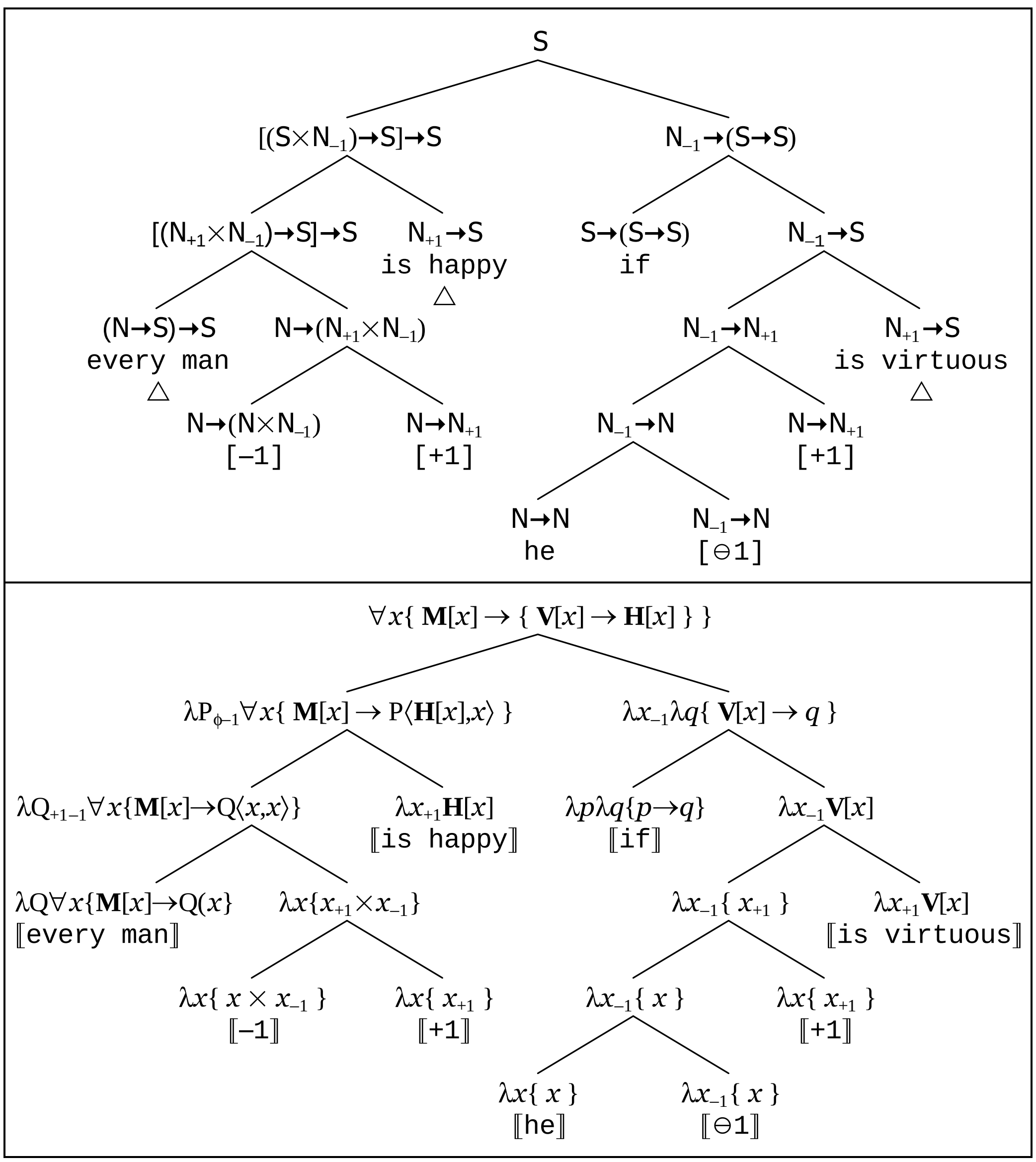
Key Computation:

(1)	$(N\rightarrow S)\rightarrow S$	1	Pr	$\lambda P\forall x\{\ \mathbf{M}(x\,)\rightarrow P(x)\ \}$	
(2)	$N\rightarrow(N_{+1}\times N_{-1})$	2	Pr	$\lambda x\{x_{+1}\times x_{-1}\}$	
(3)	$(N_{+1}\times N_{-1})\rightarrow S$	3	As	P_{+1-1}	$\lambda x_{+1}y_{-1}P\langle x,y\rangle$
(4)	N	4	As	x	
(5)	$N_{+1}\times N_{-1}$	24	2,4,→O	$x_{+1}\times x_{-1}$	$\langle x_{+1}, x_{-1}\rangle$
(6)	S	234	3,5,→O	$P_{+1-1}\langle x_{+1}, x_{-1}\rangle$	$P\langle x,x\rangle$
(7)	$N\rightarrow S$	23	4-6,→I	$\lambda xP\langle x,x\rangle$	
(8)	S	123	1,7,→O	$\forall x\{\ \mathbf{M}(x)\rightarrow P\langle x,x\rangle\ \}$	
(9)	$[(N_{+1}\times N_{-1})\rightarrow S]\rightarrow S$	12	3-8,→I	$\lambda P_{+1-1}\ \forall x\ \{\ \mathbf{M}(x)\rightarrow P\langle x,x\rangle\ \}$	

Notice that we use both the traditional corner-bracket notation and the cross notation for ordered pairs.

$$a\times b \quad = \quad \langle a,b\rangle$$

3. `every man is happy if he is virtuous`



Key Computation:

(1)	$[(N_{+1}\times N_{-1})\rightarrow S]\rightarrow S$	1	Pr	$\lambda Q_{+1-1}\forall x\{\ \mathbf{M}[x]\rightarrow Q\langle x,x\rangle\ \}$	
(2)	$N_{+1}\rightarrow S$	2	Pr	$\lambda x_{+1}\mathbf{H}[x]$	
(3)	$(S\times N_{-1})\rightarrow S$	3	As	$P_{\phi\text{-}1}$	$\lambda\langle p,y_{-1}\rangle P\langle p,y\rangle$
(4)	$N_{+1}\times N_{-1}$	45	As	$x_{+1}\times y_{-1}$	$\langle x_{+1},y_{-1}\rangle$
(5)	N_{+1}	4	$4,\times O_1$	x_{+1}	
(6)	N_{-1}	5	$4,\times O_2$	y_{-1}	
(7)	S	24	$2,5,\rightarrow O$	$\mathbf{H}[x]$	
(8)	$S\times N_{-1}$	245	$6,7,\times I$	$\mathbf{H}[x]\times y_{-1}$	
(9)	S	2345	$3,8,\rightarrow O$	$P_{\phi\text{-}1}\langle\mathbf{H}[x],y_{-1}\rangle$	$P\langle\mathbf{H}[x],y\rangle$
(10)	$(N_{+1}\times N_{-1})\rightarrow S$	23	$4\text{-}9,\rightarrow I$	$\lambda\langle x_{+1},y_{-1}\rangle P\langle\mathbf{H}[x],y\rangle$	
(11)	S	123	$1,10,\rightarrow O$	$\forall x\{\ \mathbf{M}[x]\rightarrow P\langle\mathbf{H}[x],y\rangle\ \}$	
(12)	$[(S\times N_{-1})\rightarrow S]\rightarrow S$	12	$3\text{-}11,\rightarrow I$	$\lambda P_{\phi\text{-}1}\ \forall x\{\ \mathbf{M}[x]\rightarrow P\langle\mathbf{H}[x],x\rangle\ \}$	

4. A More Problematic Example

Our previous example works out great; for example, it tells us that the sentence

```
every man is happy if he is virtuous
```

is in effect synonymous with

$$\forall x\{\ \mathbf{M}[x]\rightarrow\{\ \mathbf{V}[x]\rightarrow\mathbf{H}[x]\ \}\ \}$$

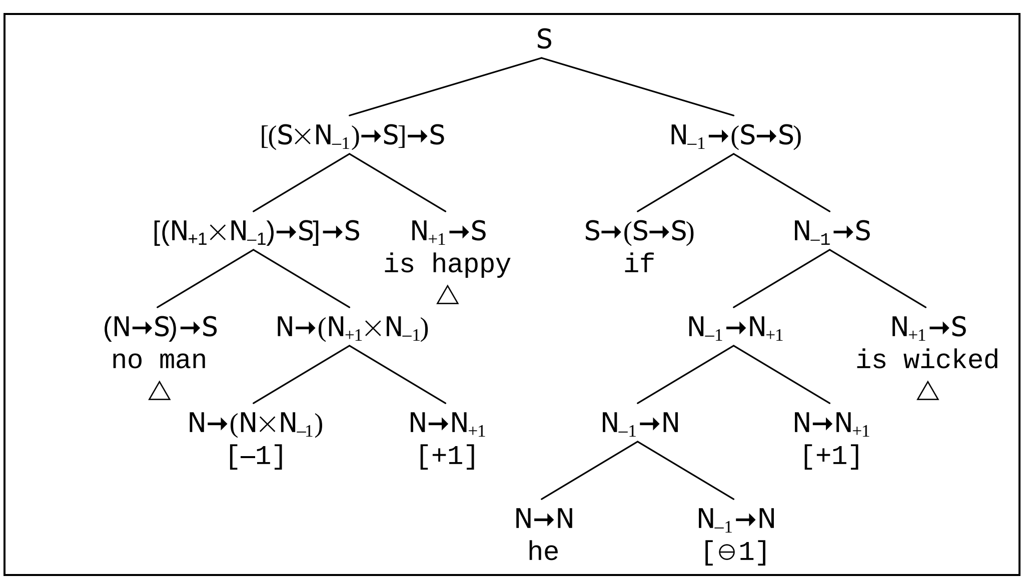
which in elementary logic is translated thus.

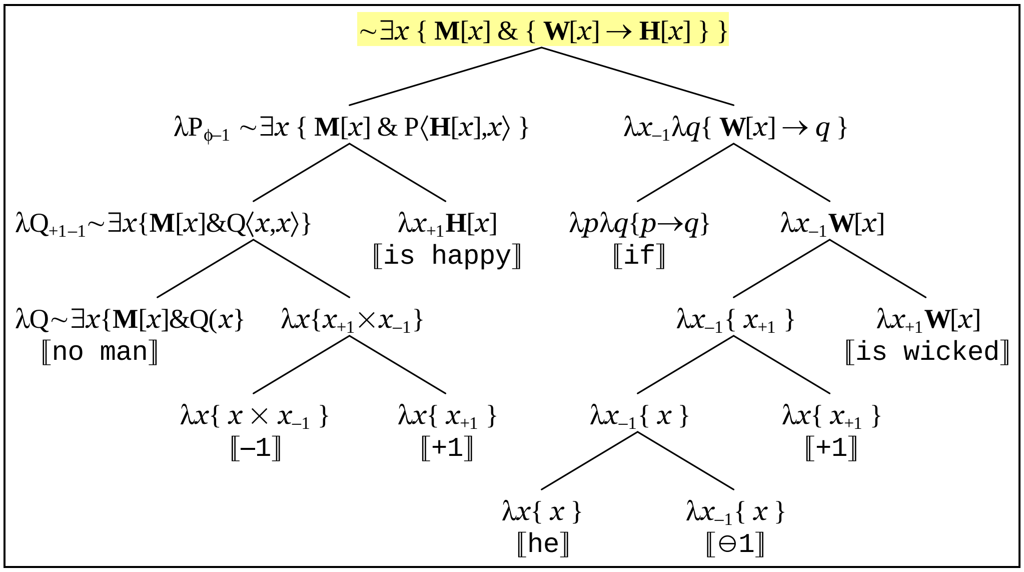
for any x, if x is a man, then if x is virtuous, then x is happy.

Unfortunately, we cannot accomplish the same magic with the following example.

```
no man is happy if he is wicked
```

In particular, the expected semantic analysis produces the following tree.





The problem, quite simply, is that the above computation produces the wrong truth-value. To see this, we note that the expression at the top node is logically equivalent to the following

$$\forall x\{\ \mathbf{M}[x] \rightarrow \{\ \mathbf{W}[x]\ \&\ {\sim}\mathbf{H}[x]\ \}\ \}$$

which says that every man is unhappy *and* wicked, but what we want it to say is that every many is unhappy *if* (he is) wicked.

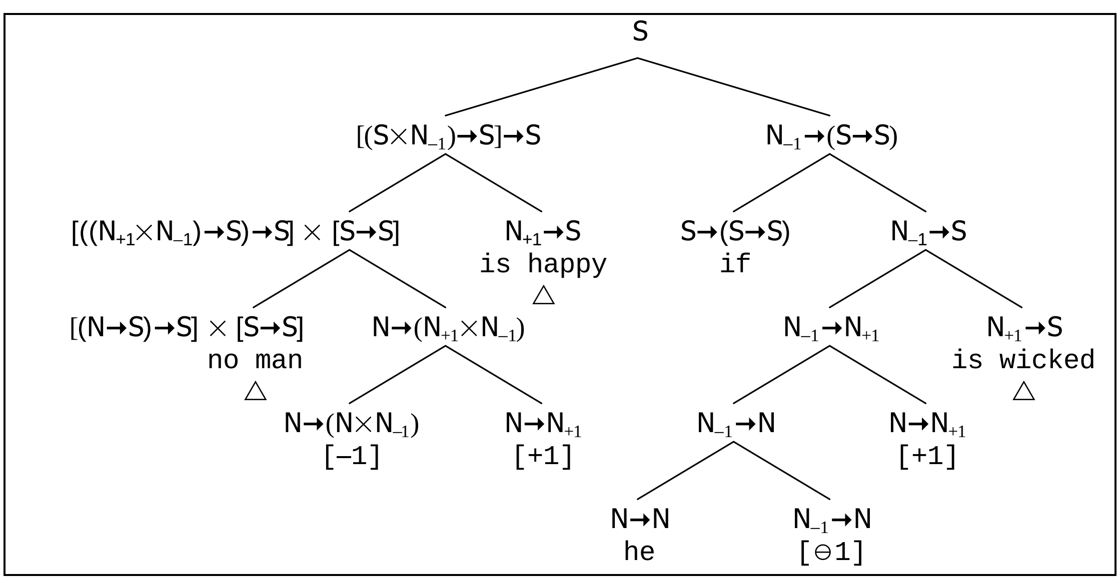
5. Semantic-Decomposition Revisited

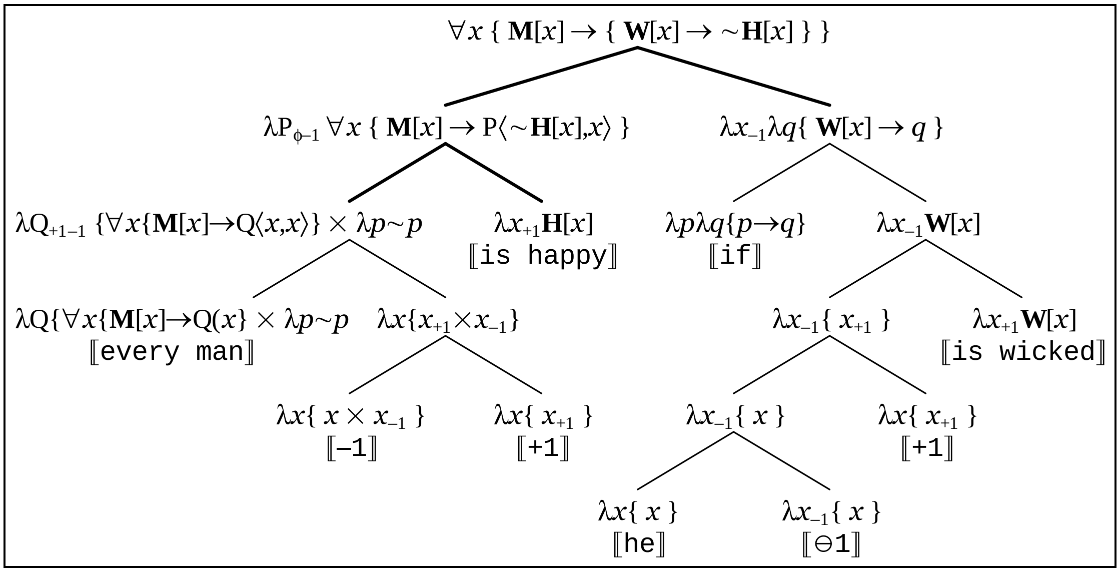
Recall that our analysis of `'no-any'` involves decomposing `'no P'` into a universal-module and a negative-module, as follows.

$$[\![\text{no P}]\!] \quad = \quad \lambda Q\forall x\{P(x)\rightarrow Q(x)\} \times \lambda p{\sim}p$$

$$[\![\text{no}]\!] \quad = \quad \lambda P\ [\ \lambda Q\forall x\{P(x)\rightarrow Q(x)\} \times \lambda p{\sim}p\ ]$$

As it turns out, this maneuver can be employed to solve the difficulty presented in the previous section. as seen in the following analysis.





The highlighted compositions are underwritten by the following derivations respectively.

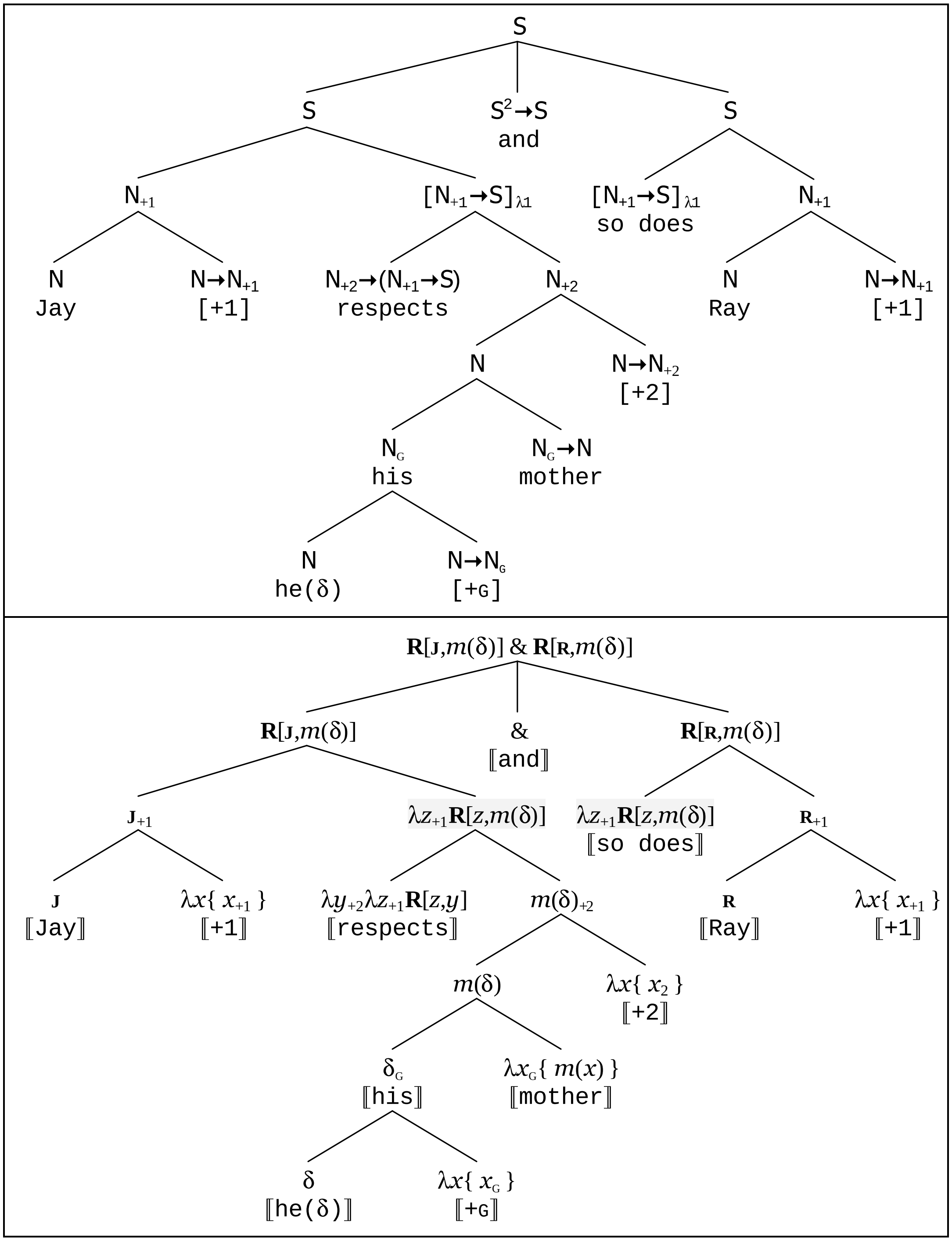
(1)	$[((N_{+1}\times N_{-1})\to S)\to S]\times S\to S$	12	Pr	$\lambda Q_{+1-1}\{\forall x\{\mathbf{M}[x]\to Q\langle x,x\rangle\}\times\lambda p{\sim}p$	
(2)	$N_{+1}\to S$	3	Pr	$\lambda x_{+1}\mathbf{H}[x]$	
(3)	$(S\times N_{-1})\to S$	4	As	$P_{\phi-1}$	$\lambda\langle p,x_{-1}\rangle P\langle p,x\rangle$
(4)	$((N_{+1}\times N_{-1})\to S)\to S$	1	$1,\times O_1$	$\lambda Q_{+1-1}\{\forall x\{\mathbf{M}[x]\to Q\langle x,x\rangle\}$	
(5)	$S\to S$	2	$1,\times O_2$	$\lambda p{\sim}p$	
(6)	$N_{+1}\times N_{-1}$	56	As	$x_{+1}\times y_{-1}$	
(7)	N_{+1}	5	$6,\times O_1$	x_{+1}	
(8)	N_{-1}	6	$6,\times O_2$	y_{-1}	
(9)	S	35	$2,7,\to O$	$\mathbf{H}[x]$	
(10)	S	235	$5,9,\to O$	${\sim}\mathbf{H}[x]$	
(11)	$S\times N_{-1}$	2356	$8,10,\times I$	${\sim}\mathbf{H}[x]\times y_{-1}$	
(12)	S	23456	$3,11,\to O$	$P\langle{\sim}\mathbf{H}[x],y_{-1}\rangle$	
(13)	$(N_{+1}\times N_{-1})\to S$	234	$6\text{-}12,\to I$	$\lambda\langle x_{+1},y_{-1}\rangle P\langle{\sim}\mathbf{H}[x],y_{-1}\rangle$	
(14)	S	1234	$4,13,\to O$	$\forall x\{\mathbf{M}[x]\to P\langle{\sim}\mathbf{H}[x],x\rangle\}$	
(15)	$[(S\times N_{-1})\to S]\to S$	123	$3\text{-}14,\to I$	$\lambda P_{\phi-1}\forall x\{\mathbf{M}[x]\to P\langle{\sim}\mathbf{H}[x],x\rangle\}$	

(1)	$[(S\times N_{-1})\to S]\to S$	1	Pr	$\lambda P_{\phi-1}\forall x\{\mathbf{M}[x]\to P\langle{\sim}\mathbf{H}[x],x\rangle$	
(2)	$N_{-1}\to(S\to S)$	2	Pr	$\lambda x_{-1}\lambda q\{\mathbf{W}[x]\to q\}$	
(3)	$S\times N_{-1}$	34	As	$p\times x_{-1}$	
(4)	S	3	$3,\times O_1$	p	
(5)	N_{-1}	4	$3,\times O_2$	x_{-1}	
(6)	$S\to S$	24	$2,5,\to O$	$\lambda q\{\mathbf{W}[x]\to q\}$	
(7)	S	234	$4,6,\to O$	$\mathbf{W}[x]\to p$	
(8)	$(S\times N_{-1})\to S$	2	$3\text{-}7,\to I$	$\lambda\langle p,x_{-1}\rangle\{\mathbf{W}[x]\to p\}$	
(9)	S	12	$1,8,\to O$	$\forall x\{\mathbf{M}[x]\to(\mathbf{W}[x]\to{\sim}\mathbf{H}[x])\}$	

6. An Example involving a Pro-VP

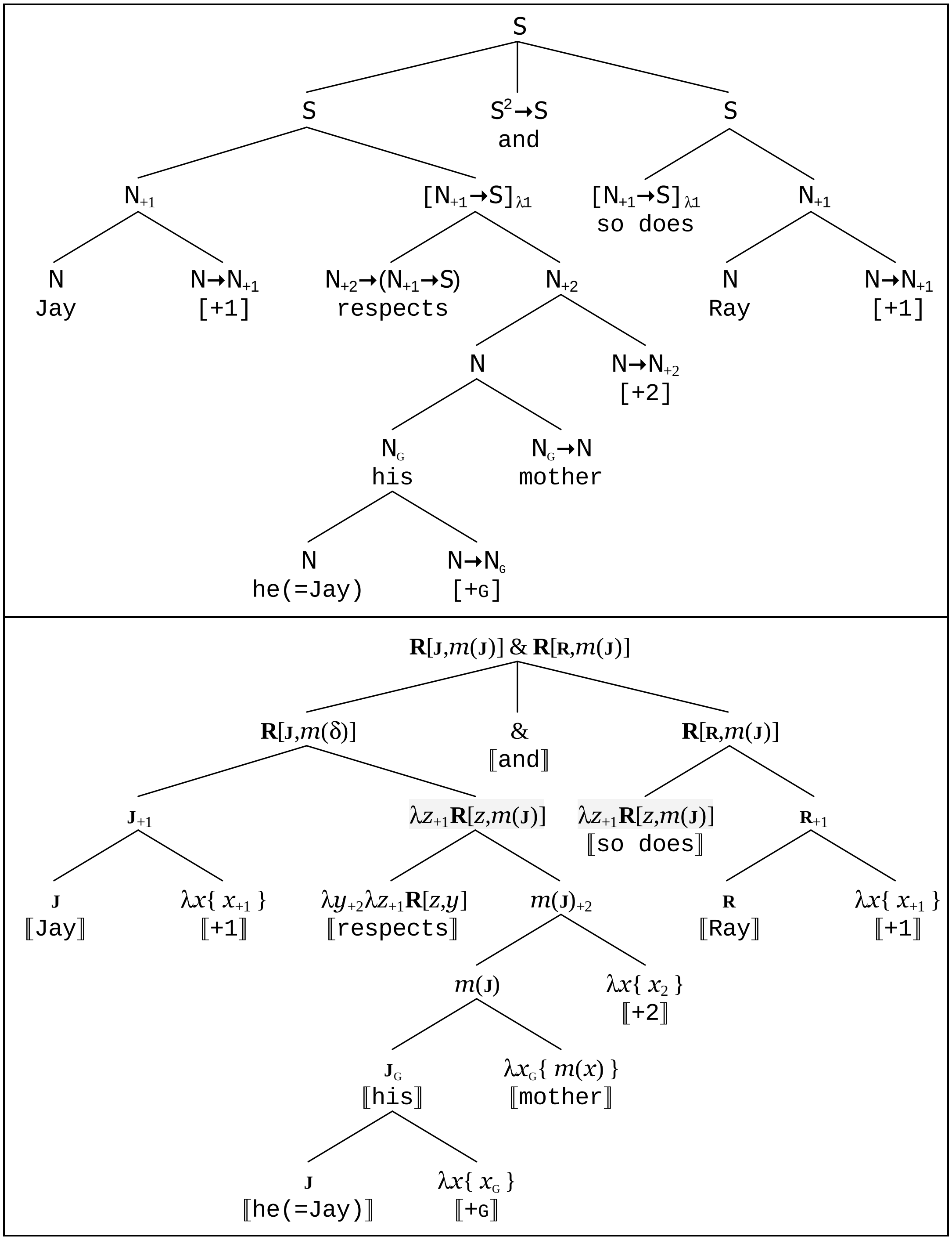
`Jay respects his mother, and so does Ray`

1. Demonstrative-Reading of 'his'



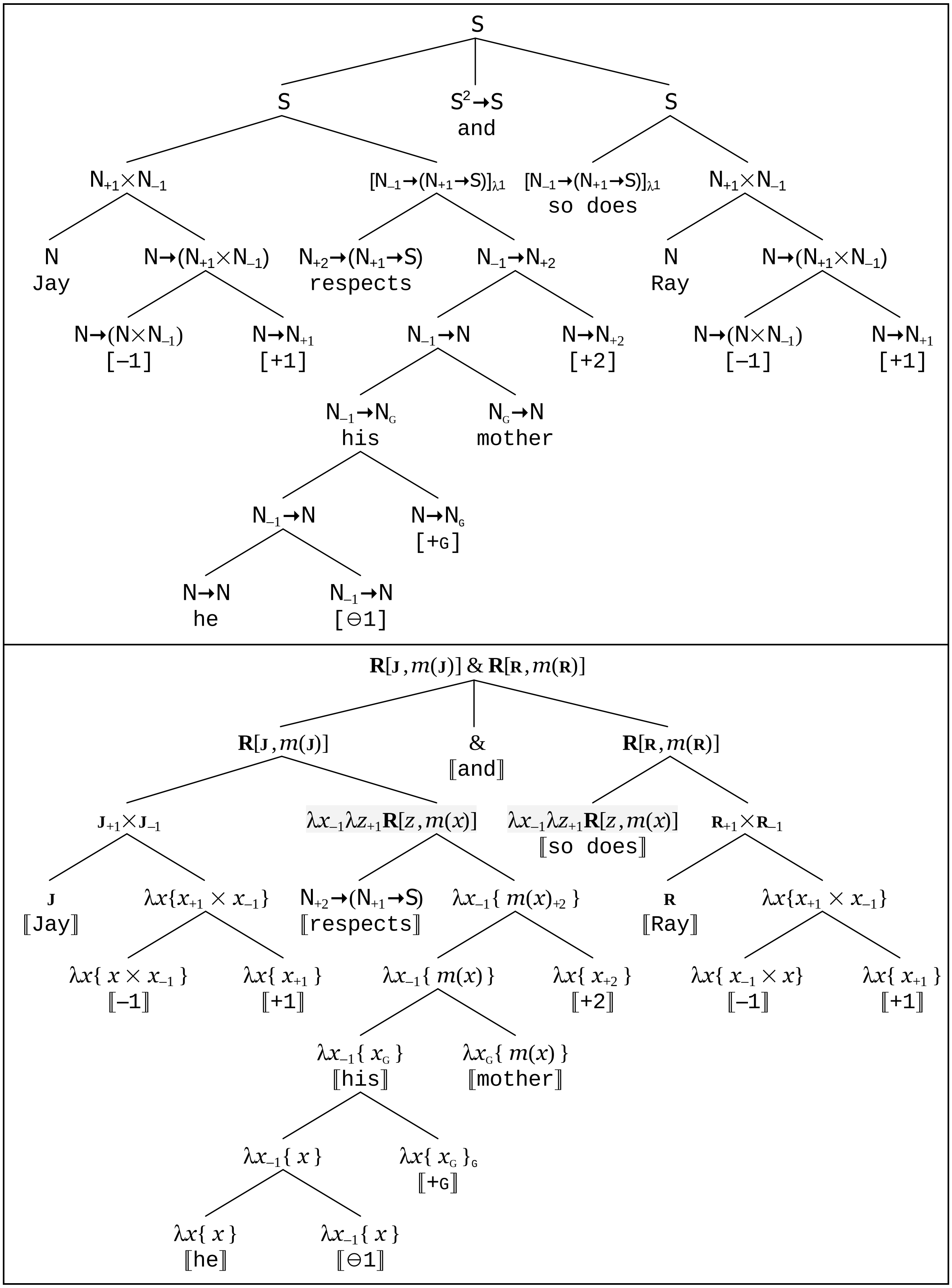
Here, δ is the individual (male) to whom one is pointing during the utterance of the phrase. Notice that, on this analysis, the pro-VP 'so does' is a lazy pro-form that simply repeats its antecedent, in virtue of which it has exactly the same denotation as its antecedent, as noted by the shading in the above diagram.

2. IE-Pronoun Reading of 'his'



On this analysis, the pronoun stem `'he'` is a pronoun of laziness, which simply repeats its antecedent `'Jay'`. It accordingly has exactly the same denotation as its antecedent – they both denote Jay [=J]. As before, the pro-VP `'so does'` is a lazy pro-form that simply repeats its antecedent, in virtue of which it has exactly the same denotation as its antecedent, as noted by the shading in the above diagram.

3. Essentially-Anaphoric Reading of ‘his’



On this analysis, the pronoun stem `‘he’` is essentially-anaphoric. As before, the pro-VP `‘so does’` is a lazy pro-form that simply repeats its antecedent. Note once again that the pro-VP `‘so does’` has exactly the same denotation as its antecedent, being shaded in the above diagram.

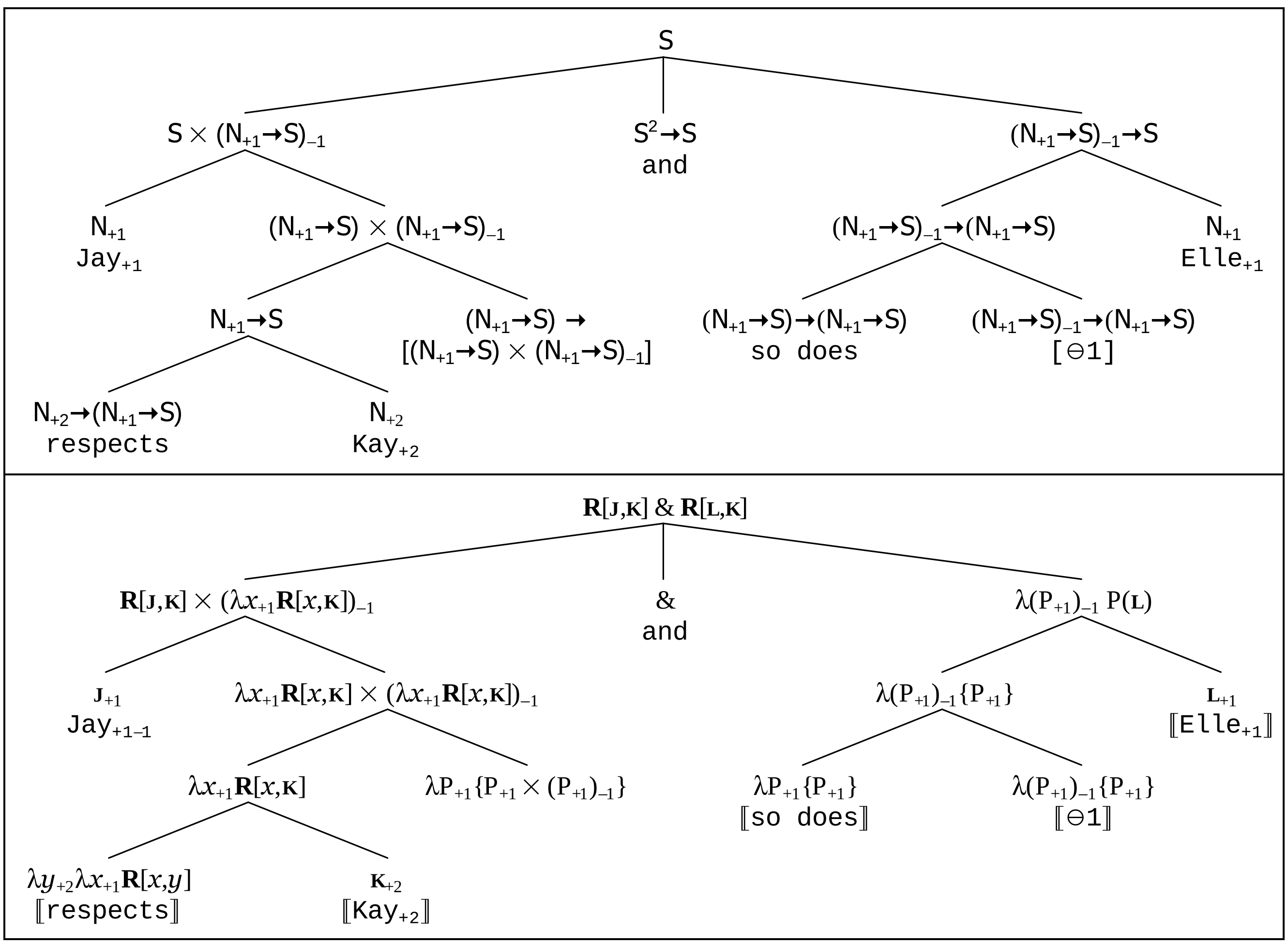
7. Anaphoric Treatment of Pro-VPs

In the previous section, we treat the pro-VP `'so does'` as a lazy pro-form. In this section, we examine how it can be treated as bound by its antecedent, in precisely the same way that pronouns are bound by their antecedents. For this purpose, we introduce the following general pro-form notation, where K is any type.

name	type	symbol	denotation
opening pro-K inflection	$K_{-k} \rightarrow K$	$[\ominus k]$	$\lambda\nu_{-k}\{\ \nu\ \}$
closing pro-K inflection	$K \rightarrow (K \times K_{-k})$	$[-k]$	$\lambda\nu\{\ \nu \times \nu_{-k}\}$
pronoun-root	$K \rightarrow K$	e	$\lambda\nu\{\ \nu\ \}$

The following illustrates how this works in a fairly simple example.

`Jay respects Kay and so does Elle`



8. Essentially-Lazy Pro-Nouns [Pro-Forms]

As we have seen, some pronouns can be treated either as lazy-pronouns or as bound-pronouns. Others are essentially-anaphoric, and can only be treated as bound-pronouns. This naturally raises the question whether there are pronouns that cannot be treated as bound-pronouns, but can only be treated as lazy-pronouns. Such pronouns are naturally referred to as essentially-lazy pronouns. Everything we have just said applies *mutatis mutandis* to pro-forms. The obvious question is whether there are any essentially lazy pro-forms. We offer three kinds of examples.

1. Example 1 –
Pro-VP anaphoric to a VP containing a Quasi-Reflexive Pronoun

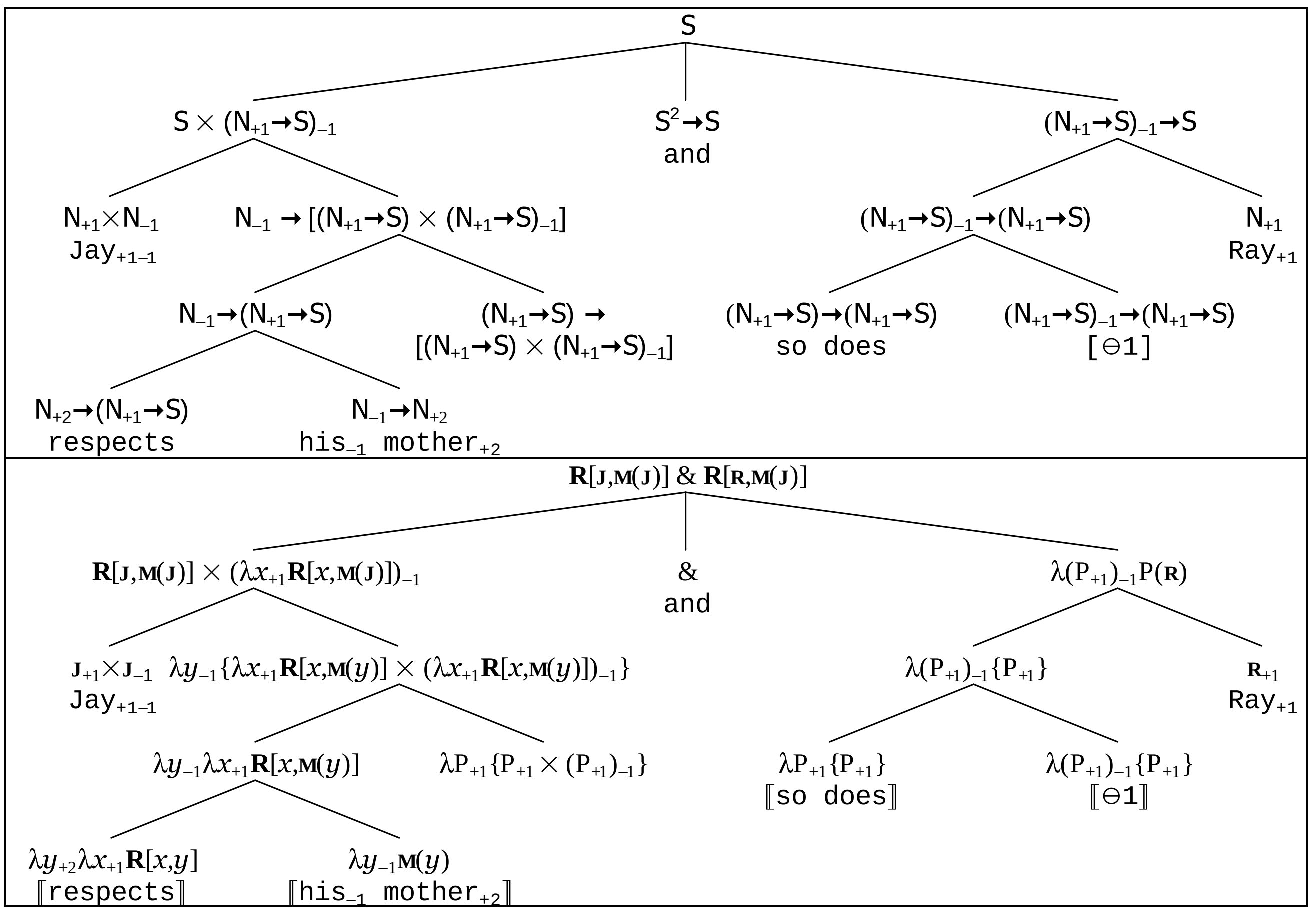
Although we did not identify it as such, we have recently seen an example in which a pro-form is essentially-lazy. Specifically, recall the sentence

`Jay respects his mother, and so does Ray`

where we understand the pronoun `'his'` to be quasi-reflexive, so that the sentence means:

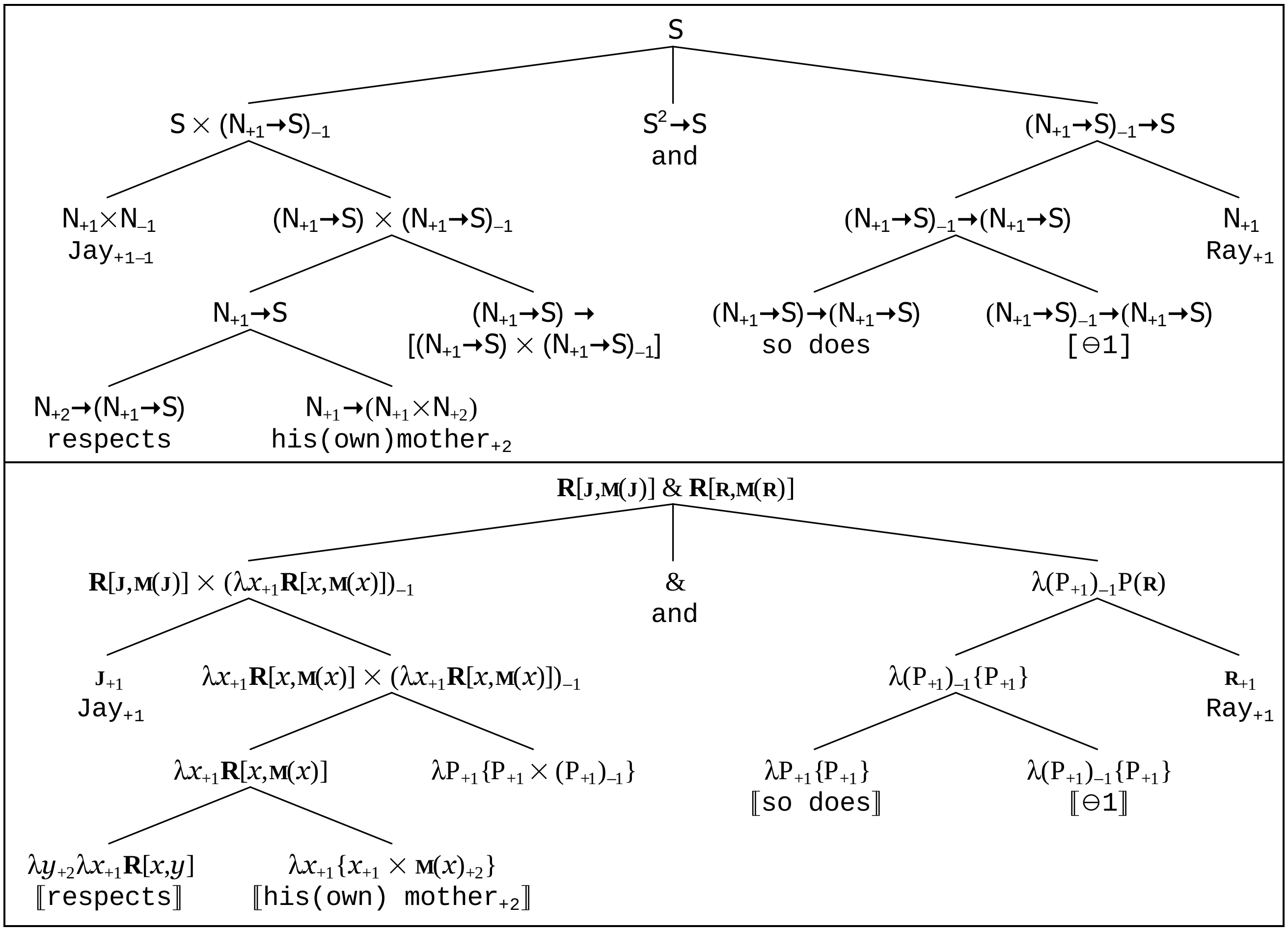
`Jay respects` **`Jay's`** `mother, and Ray respects` **`Ray's`** `mother`

Next, consider the following analysis, where we treat `'so does'` as a pro-VP bound by `'respects his mother'`, which in turn is bound by `'Jay'`. This turns out to be problematic.[3]



[3] The bound-pro-form analysis can be salvaged if we allow `'so does'` to be a pro-form of exactly the same type as its antecedent. This ultimately means that a pro-VP has arbitrarily-many distinct non-equivalent types, which seems theoretically extravagant. We *might* adopt this strategy *if* this were the only example of an essentially-lazy pro-form. But since there are other examples, it is more economical simply to include this among the essentially-lazy pro-forms.

One solution to this problem is to treat `'his'` as an abbreviation for `'his own'`, as seen in the following analysis.



This is a fairly attractive solution, but it does not work on more complicated examples in which the quasi-reflexive pronoun cannot be converted into a true-reflexive pronoun. Consider the following example.

`Jay respects everyone who respects him, and so does Ray`

It is fairly evident that `'him'` cannot be replaced by `'himself'` in this example. It is accordingly best to continue treating the earlier example as a quasi-reflexive pronoun, since this analysis does not require the additional, and perhaps *ad hoc*, reflexive-deletion hypothesis.

2. Example 2 – Pro-NP anaphoric to a Quasi-Reflexive Pronoun

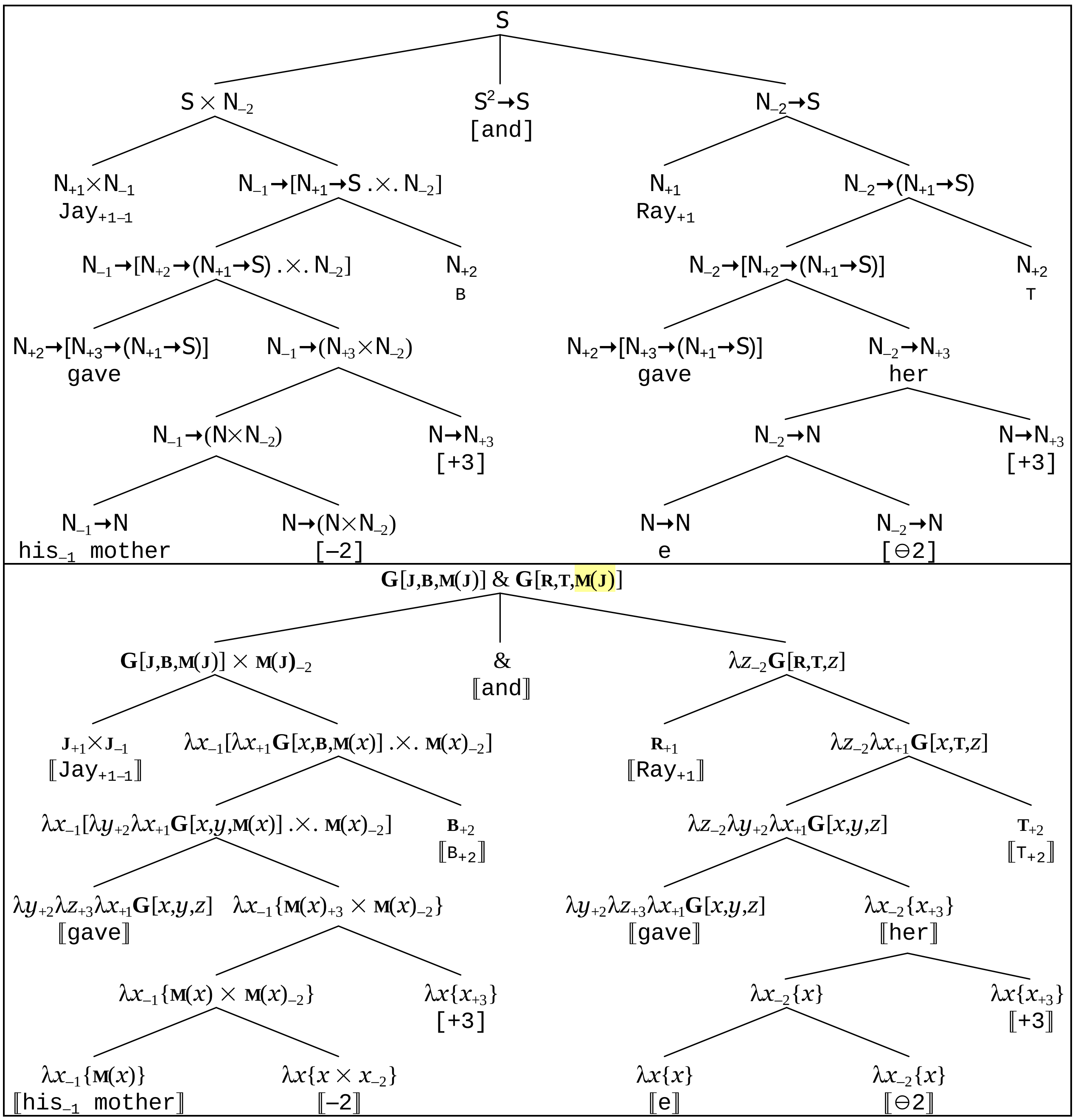
Next, consider the following example.

```
every wise man gives his mother a savings bond;
every fool gives her a lottery ticket
```

Let us, however, do a simpler example, which makes the same point.

```
Jay gave his mother B [a savings bond];
Ray gave her T [a lottery ticket]
```

Note that we employ 'B' and 'T' as *ad hoc* proper-names, which simplifies the semantic calculations. Notice that we obtain the wrong semantic calculation, since the analysis tells us that the sentence says that Ray gave Jay's mother a lottery ticket, and want it to say that Ray gave Ray's mother a lottery ticket.

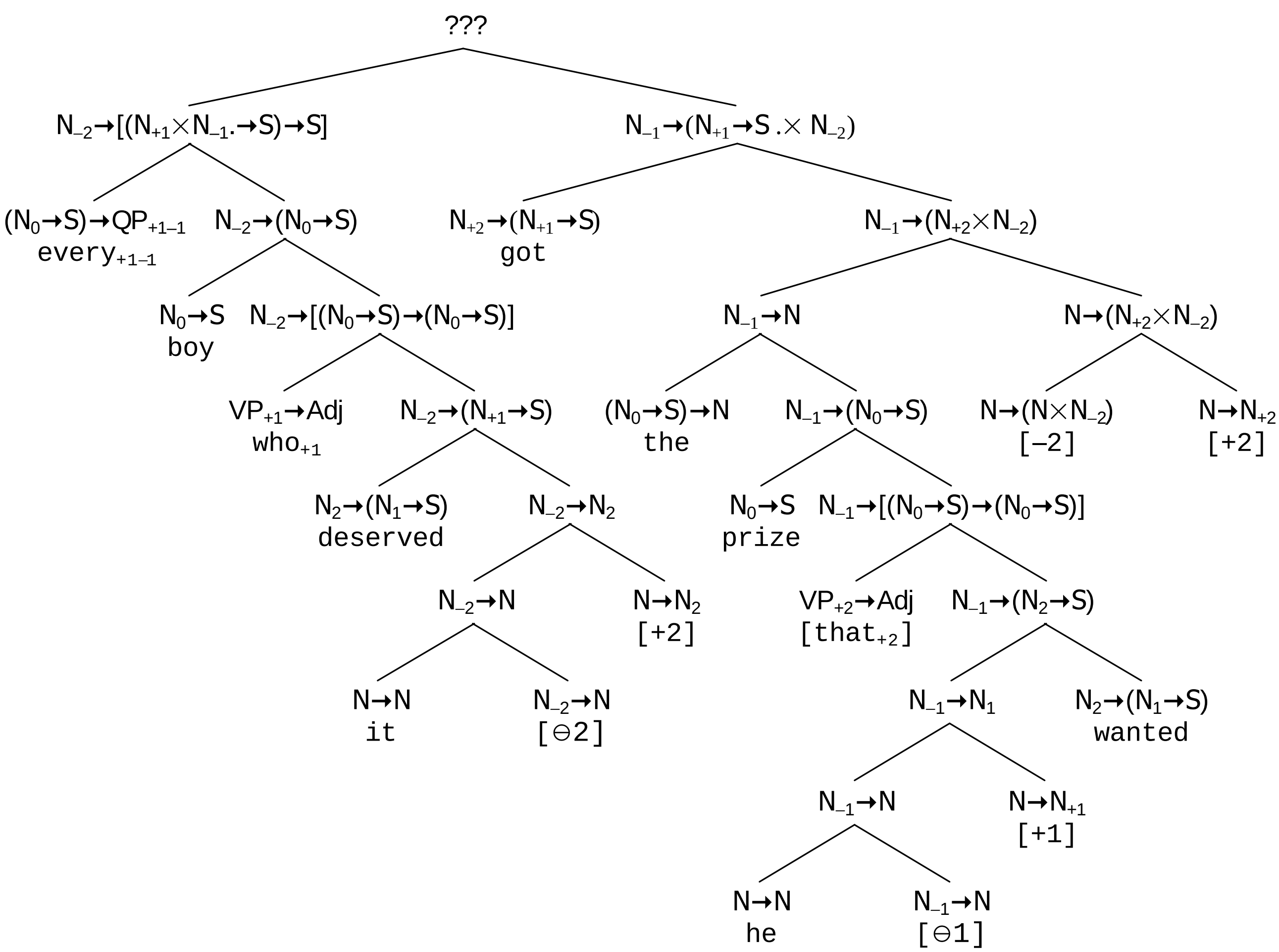


3. Example 3 – Bach-Peters Sentences

A Bach-Peters sentence is one that contains two NPs, each of which contains a pronoun that is anaphoric to the other NP, which sets up a referential situation reminiscent of a snake eating its own tail. The following is an example.

$[\texttt{every boy who deserved } [\texttt{it}]_{-2}]_{+1}$
$\texttt{got } [\texttt{the prize } [\texttt{he}]_{-1} \texttt{ wanted}]_{+2}$

It is fairly evident that the two pronouns cannot both be lazy-anaphoric to the other, on pain of an infinite regress. It is less evident that they cannot both be bound-anaphoric either; at least one pronoun must be lazy-anaphoric to the other. This latter point may be seen when we do the syntactic-type analysis, which goes as follows.



Notice, in particular, that the penultimate nodes do not compose to form a sentence, which can be seen by noting that S does not follow from the inputs – even by classical logic standards.[4]

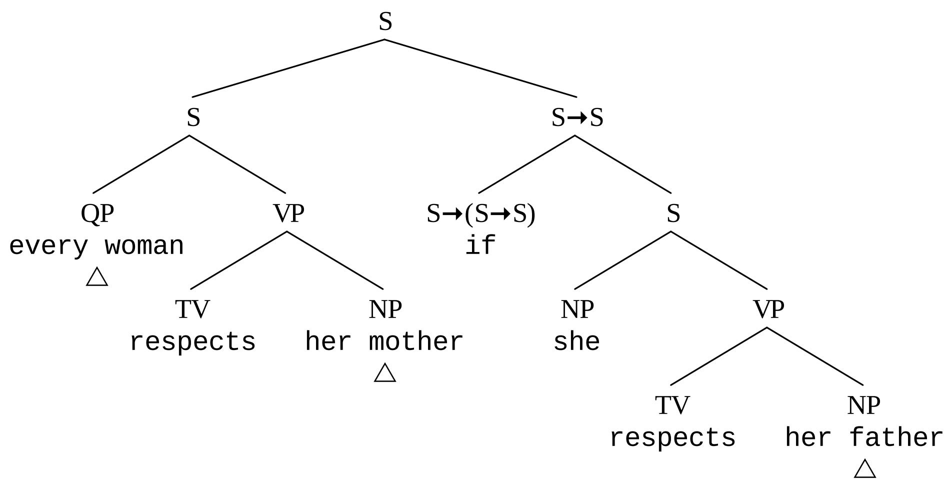
[4] This can be demonstrated using the familiar truth-table analysis, treating × as &. In particular, one can set every atomic formula to F (false). This assignment makes the two premises true, but does not make S true.

9. Anaphoric-Duplication

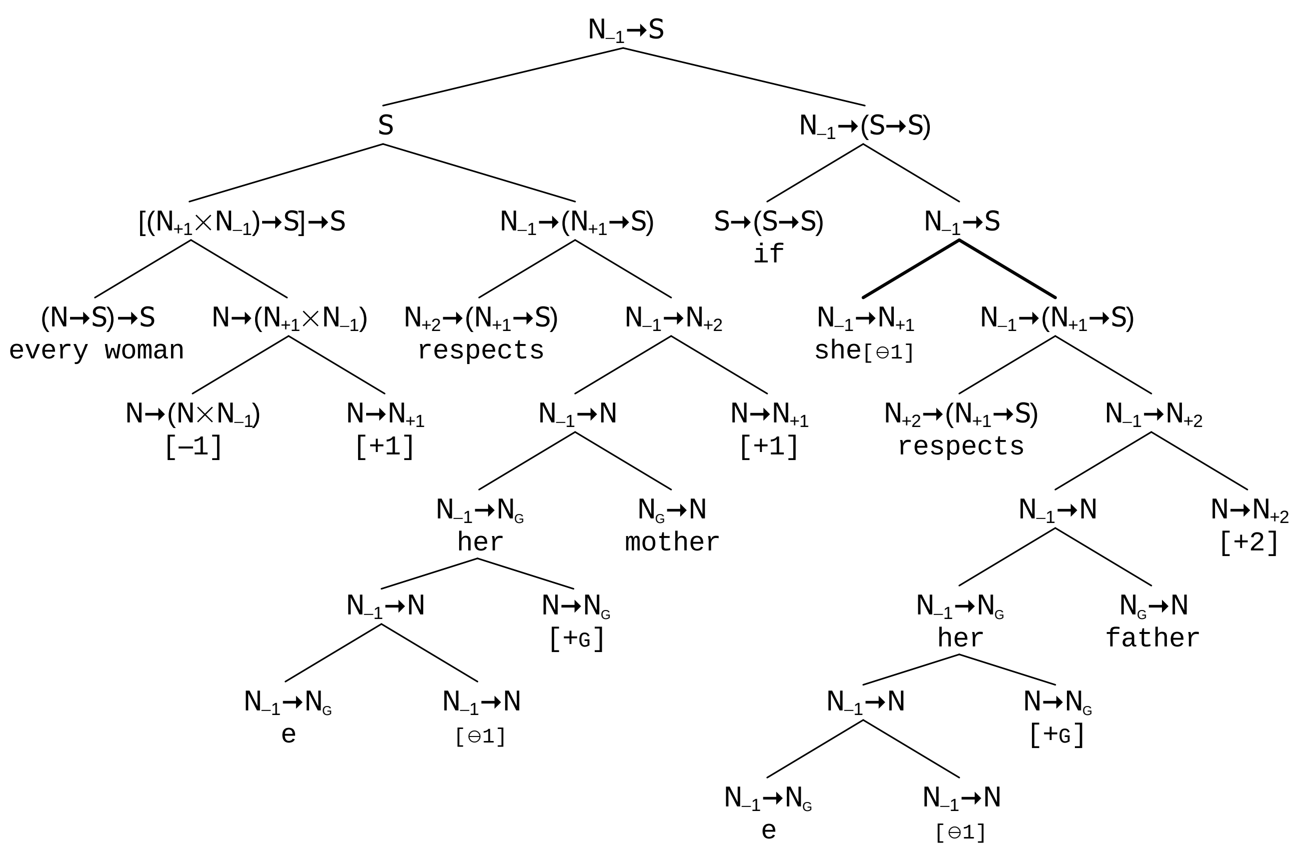
In the following example, we encounter a puzzle involving quantifier scope. First, we examine the traditional solution, and then present a more phonetically-congenial solution.

`every woman respects her father if she respects her mother`

First, it seems syntactically very natural to analyze this sentence as follows.



The problem is that the QP `‘every woman’` does not govern (S-command) the second occurrence of `‘she’` or the second occurrence of `‘her’`, which are presumably anaphoric to it. This problem is further illustrated in the most natural categorial-tree.



First, notice that the highlighted composition employs anaphoric-duplication, as seen in the associated derivation.

(1)	$N_{-1}\to N_{+1}$	1	Pr	$\lambda x_{-1}\ \{\ x_{+1}\ \}$
(2)	$N_{-1}\to(N_{+1}\to S)$	2	Pr	$\lambda y_{-1}\lambda x_{+1}\mathbf{R}[x,\mathbf{M}(y)]$
(3)	N_{-1}	3	As	x_{-1}
(4)	$N_{-1}\times N_{-1}$	3	3,Dup	$x_{-1}\times x_{-1}$
(5)	N_{-1}	3a	4,$\times O_1$	x_{-1}
(6)	N_{-1}	3b	4,$\times O_2$	x_{-1}
(7)	N_{+1}	13a	1,5,$\to$O	x_{+1}
(8)	$N_{+1}\to S$	23b	2,6,$\to$O	$\lambda x_{+1}\mathbf{R}[x,\mathbf{M}(x)]$
(9)	S	123	7,8,$\to$O	$\mathbf{R}[x,\mathbf{M}(x)]$
(10)	$N_{-1}\to S$	12	3-9,$\to$I	$\lambda x_{-1}\mathbf{R}[x,\mathbf{M}(x)]$

Recall that the (Anaphoric) **Duplication Rule** is given as follows.

Anaphoric-Duplication Rule

$$\frac{\mathcal{A}_\alpha}{\mathcal{A}_\alpha\times\mathcal{A}_\alpha}$$

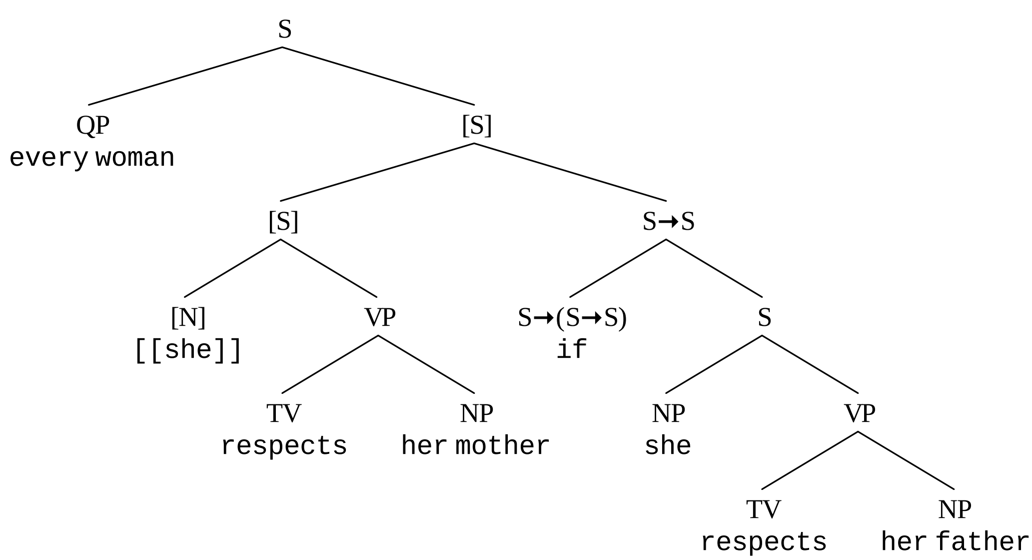
where $\mathcal{A}$ is any type and α is any anaphoric-inflection [negative integer]

It serves two purposes.

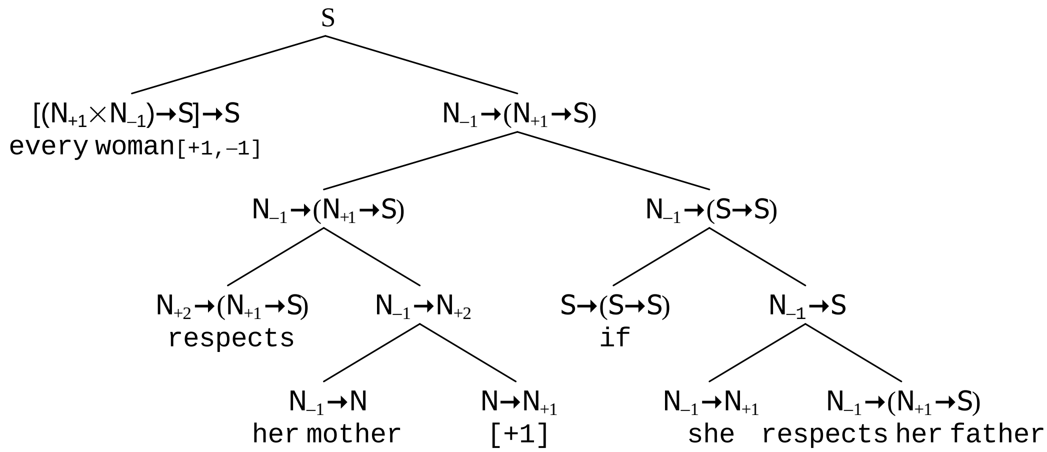
(1) it enables the contraction of multiple anaphora [as above]
(2) it enables any phrase of type K to bind all pro-Ks that are anaphoric to it [as we will see below]

Next, notice that the top node is not a (**closed**) sentence, but is rather an **open-sentence**, since the anaphoric `'she'` remains open.

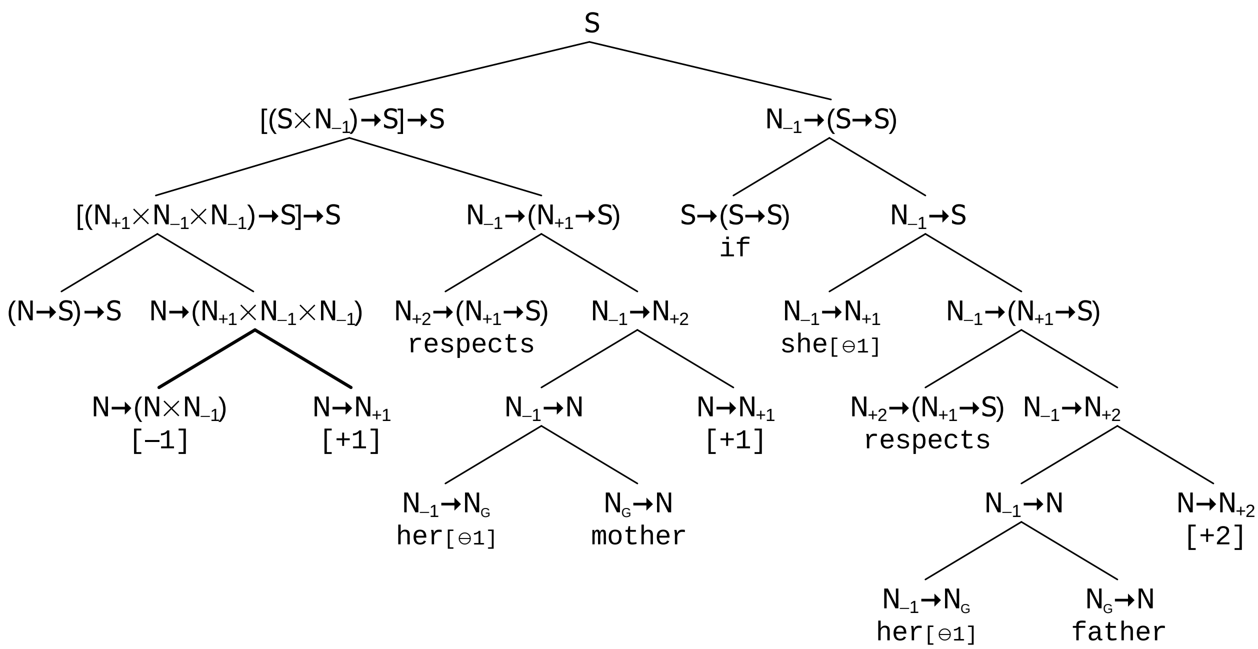
The traditional way of dealing with this problem is to transform the sentence so that the underlying location of `'every woman'` is higher in the sentence – something like the following, where the first occurrence of `'she'`, which is silent, serves as the "trace" of the moved QP.



This problem can also be solved using categorial grammar, in a very similar manner, by rewriting the syntactic form as follows.



Both of the above techniques require rewriting the syntactic form of the original sentence. As it turns out, we can preserve the original syntactic form, if we wish, by employing a different grammatical derivation, given as follows.



This is another application of compositional-ambiguity. The following derivation underwrites the highlighted composition. Notice, in particular, the application of Anaphoric-Duplication at line (8).

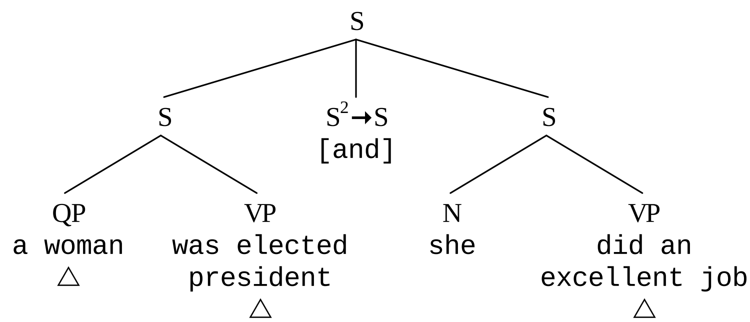
(1)	$N\to(N\times N_{-1})$	1	Pr	$\lambda x\ \{\ x \times x_{-1}\}$
(2)	$N\to N_{+1}$	2	Pr	$\lambda x\ \{\ x_{+1}\}$
(3)	N	3	As	x
(4)	$N \times N_{-1}$	13	As	$x \times x_{-1}$
(5)	N	(13)a	$4,\times O_1$	x
(6)	N_{+1}	2(13)a	$2,5,\to O$	x_{+1}
(7)	N_{-1}	(13)b	$4,\times O_2$	x_{-1}
(8)	$N_{-1} \times N_{-1}$	(13)b	7,Dup	$x_{-1} \times x_{-1}$
(9)	$N_{+1} \times N_{-1} \times N_{-1}$	123	$6,8,\times I$	$\lambda x\ \{\ x_{+1} \times x_{-1} \times x_{-1}\ \}$

10. Another Example of Binding without Government

The following example further illustrates how our treatment of anaphora is semantically useful.

```
a woman was elected president;
she did an excellent job
```

The natural syntactic analysis of this sentence is as follows.



Once again, the standard analysis of government and binding tells us that 'a woman' does not govern 'she', so an alternative syntactic analysis must be offered. Once again, an alternative analysis of semantic-binding can be provided, as seen in the following analysis.