Chapter 7
Pronouns

1. Kinds of Pronouns

In traditional grammar and lexicography, the term 'pronoun' applies to a wide variety of English words, including the following.

personal pronouns	I, you, he, she, it, we, they me, him, her, us, them my, your, his, her, its, our, their mine, yours, his, hers, ours, theirs myself, yourself, himself, herself, itself, ourselves, themselves
demonstrative pronouns	this, that, these, those
interrogative pronouns	who, whom, whose, which, why, when, where, how
relative pronouns	who, whom, whose, which, why, how, that whoever, whatever, whenever, wherever, however
expletive pronouns	it, there

In this chapter, we concentrate on personal pronouns.

2. Pro-Forms

Personal pronouns are a special case of the more general syntactic class called *pro-forms*, which include the following.

pro-NP	Jay respects **his** mother.
pro-VP	Jay respects Kay, and **so does** Elle.
pro-adjective	no **such** person lives here.
pro-common-noun	this dog is large, but that **one** is small.
pro-sentence	Jay may visit tomorrow, in **which** case Kay will meet him at the train station.

In principle, but not in practice, for each category K, there is an associated category of pro-Ks. Notice also that personal pronouns are pro-NPs, where NP is a multi-typed category that includes proper-nouns, determiner phrases, and relative pronouns.

3. Anaphora

Pro-forms are intimately connected to *anaphora*,[1] which are phrases that are semantically *dependent upon* other (usually earlier) phrases in the surrounding discourse unit. In addition to pro-forms, anaphoric items include the following examples.

> if it is sunny, I will play tennis; **otherwise**, I will play racket ball
> Jay and Kay played tennis yesterday, but no one **else** did
> Kay hosted a party last Friday; Jay got drunk [2]

The last one has no phonetically-overt anaphoric material; rather, the implicit place-time-reference of the second clause is dependent upon the place-time-reference of the antecedent clause.

Not all pronouns are anaphoric, however, as we see in the next section.

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[1] The term 'anaphora' is also used in Rhetoric to refer to a rhetorical device by which a phrase is repeated several times. Many famous lines, in fiction and real-life, employ this device, including examples from Dickens ["they were the best of times,…"], Churchill ["we will fight them on the beaches,…"], and Martin Luther King ["I have a dream…"].

[2] Adapted from Partee (1984).

4. Basic Classification

Henceforth, in this chapter, by 'pronoun' we usually mean *personal pronoun*. Pronouns may be thought of as pointers. A pronoun can point *externally*, in which case one might call it ***exophoric***. A pronoun can also point *internally*, in which case it one might call it ***endophoric***. Other terms commonly used are *deictic*[3] and *anaphoric*.[4] In the latter case, the phrase to which the pronoun points is called its *antecedent*, and the pronoun is said to be *anaphoric to* its antecedent.

Exophoric pronouns and endophoric pronouns can be further classified as follows.

1. Exophoric Pronouns [point externally]

1. Indexical Pronouns

Indexical expressions point at inherent features of the utterance-context, which include place, time, speaker, and addressee. and include words such as: [5]

I, you, here, now

The following is an example diagram.

I ☝	respect	you ☝
speaker		addressee

2. Demonstrative Pronouns [6]

Sometimes the utterance-context includes acts of *demonstration* (pointing, showing), which can be overt or tacit. Demonstrative pronouns can be used in this manner, as illustrated in the following diagrams.

he ☝	respects	her ☝
1st demonstratee		2nd demonstratee

I ☝	select	you ☝	you ☝	and	you ☝
speaker		1st demonstratee	2nd demonstratee		3rd demonstratee

2. Endophoric Pronouns [point internally]

1. Duplicative Pronouns

Such a pronoun *simply repeats* the **content** of its antecedent.[7]

Jay	respects	Kay	but	she ☜	does not	respect	him ☜
				= Kay			= Jay

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[3] The term 'deixis' derives from Greek **δεῖξις (display, exhibit, show, demonstrate).**

[4] The word 'anaphora' comes from Greek (ἀναφορά), which means "carrying back". Related words include 'metaphor' [carrying beyond], 'semaphore' [carrying sign], 'phosphor' [carrying light], and even 'Bosporus' ('Bosphorus') [carrying cows]. To this list we add the technical terms 'exophoric' [carrying outside] and 'endophoric' [carrying inside].

[5] Interestingly, in English, only 'I' is used *exclusively* as an indexical expression. The others are *also* used demonstratively. The pronoun 'we' is partly indexical, since it semantically includes 'I', but it is partly demonstrative, since it semantically includes other (demonstrated) individuals as well. Locative expressions like 'here' and 'now' are often indexical, but need not be.

[6] The demonstrative use of personal pronouns is distinguished from what are often called demonstrative pronouns – 'this', 'that', 'these', 'those'.

[7] Sometimes, such pronouns are called *lazy pronouns*. Here, the idea is that a lazy-pronoun is used to say something that could be said equally well without that pronoun. Note, however, that this sort of "laziness" is often a mark of good speech-pragmatics. Note also that the term 'lazy pronoun' may mean a pronoun that duplicates the *wording* of its antecedent rather than the *content* of its antecedent. We insist that such a pronoun duplicates *content*.

2. Non-Duplicative Pronouns

Such a pronoun ***does not*** *simply repeat* the content its antecedent.[8]

every man	respects	his ☜	mother
		≠ every man's	

5. Example 1

We begin by examining demonstrative and duplicative pronouns, by considering the following example.

1. Jay respects his mother

The semantic analysis depends upon answering two questions.

(1) is ‘he’ exophoric (demonstrative) or endophoric (anaphoric)?
(2) supposing ‘he’ is anaphoric, what is it anaphoric to?

1. Demonstrative Reading of ‘he’

In this case, ‘he’ denotes an entity in the domain that is demonstrated or otherwise salient, which is formally supplied by the utterance-context (situation). We propose to use ‘δ’ to refer to demonstrated entities; if there is just one such entity, we use ‘δ’ by itself; if there are more than one, then we use ‘δ^1’, ‘δ^2’, etc. The semantic-tree then looks thus.

<table>
<tr><td>Jay</td><td>+1</td><td>respects</td><td>he</td><td>'s</td><td>mother [9]</td><td>+2</td></tr>
<tr><td>J</td><td>$\lambda x.x_1$</td><td></td><td>δ</td><td>$\lambda x.x_6$</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td colspan="2">δ_6</td><td>$\lambda x_6{:}M(x)$</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td colspan="3">$M(\delta)$</td><td>$\lambda x.x_2$</td></tr>
<tr><td colspan="2"></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="4">$M(\delta)_2$</td></tr>
<tr><td colspan="2">J_1</td><td colspan="5">$\lambda x_1\mathbf{R}[x, M(\delta)]$</td></tr>
<tr><td colspan="7">$\mathbf{R}[J, M(\delta)]$</td></tr>
</table>

2. Duplicative Reading of ‘he’

In this case, ‘he’ simply duplicates the content of ‘Jay’, as seen in the following tree.

<table>
<tr><td>①
Jay</td><td>+1</td><td>respects</td><td>①
he</td><td>'s</td><td>mother</td><td>+2</td></tr>
<tr><td>J</td><td>$\lambda x.x_1$</td><td></td><td>J</td><td>$\lambda x.x_6$</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td colspan="2">J_6</td><td>$\lambda x_6{:}M(x)$</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td colspan="3">$M(J)$</td><td>$\lambda x.x_2$</td></tr>
<tr><td colspan="2"></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="4">$M(J)_2$</td></tr>
<tr><td colspan="2">J_1</td><td colspan="5">$\lambda x_1\mathbf{R}[x, M(J)]$</td></tr>
<tr><td colspan="7">$\mathbf{R}[J, M(J)]$</td></tr>
</table>

[8] Bound pronouns further subdivide into reflexive-pronouns and open-pronouns, which we discuss in later sections.
[9] In this chapter, we treat ‘mother’ and ‘father’ as definite, taking for granted the morpheme DEF.

In order to indicate duplicative relations, we insert additional markers – circled-numerals – over the relevant phrases. For example, in the above derivation, ‘Jay’ and ‘he’ are anaphorically-linked, both being marked by ①. Note that the semantic entry for ‘he’ is identical to the entry for ‘Jay’. This is the characteristic feature of a duplicative pro-form – it simply *repeats* the semantic content of its antecedent, which is officially stated in the following global semantic rule.[10]

The semantic-value of a duplicative pro-form is identical to the semantic-value of its antecedent.

6. Example 2

Although we concentrate on pronouns, we find it useful to consider at least one other kind of pro-form, namely pro-VP, which is exemplified in the following example.

2. Jay respects Kay, and **so does** Elle

We propose to treat all pro-VPs as duplicative. For example, in the above example, ‘so does’ duplicates the VP ‘respects Kay’, in which case this sentence is analyzed via the following tree. Once again, circled-numerals match pro-forms with their respective antecedents.

	①			①	
Jay +1	respects	Kay +2	and	so-does	Elle +1
	$\lambda y_2 \lambda x_1 \mathbf{R}xy$	K$_2$		$\lambda x_1 \mathbf{R}x$K	L$_1$
J$_1$	$\lambda x_1 \mathbf{R}x$K				
RJK			&	**R**LK	
RJK & **R**LK					

Note that the semantic entry for ‘so does’ is identical to the entry for ‘respects Kay’, in accordance with the global semantic rule governing duplicative pro-forms.

7. Example 3

The following example involves both a pro-NP and a pro-VP.

3. Jay respects his mother, and so does Ray

Once again, we treat ‘so does’ as duplicative; in this case, it duplicates ‘respects his mother’. This means that the interpretation of ‘his’ influences the interpretation of ‘so does’; in particular, whatever interpretation we assign to ‘his’ gets repeated inside ‘so does’.

1. Demonstrative Reading of ‘he’

		①						①		
Jay	+1	respects	he	's	mother	+2	and	so-does	Ray	+1
J	$\lambda x.x_1$		δ	$\lambda x.x_6$					R	$\lambda x.x_1$
			δ_6		λx_6:M(x)			$\lambda x_1 \mathbf{R}[x$, M(δ)]	R$_1$	
			M(δ)			$\lambda x.x_2$				
		$\lambda y_2 \lambda x_1 \mathbf{R}xy$	M(δ)$_2$							
J$_1$		$\lambda x_1 \mathbf{R}[x$, M(δ)]								
R[J, M(δ)]							&	**R**[R, M(δ)]		
R[J, M(δ)] & **R**[R, M(δ)]										

Notice that, since ‘he’ denotes δ, which is contextually-assigned, ‘respects his mother’, and hence ‘so does’, both mean “respects δ's mother”, where δ is the contextually-assigned individual.

[10] Global rules involve a failure of **locality**. The denotation of a lazy anaphor is not calculated from phrases in its vicinity within the tree.

2. Duplicative Reading of ‘he’

<table>
<tr><td></td><td></td><td colspan="5">①</td><td></td><td>①</td><td></td><td></td></tr>
<tr><td>②
Jay</td><td>+1</td><td>respects</td><td>②
he</td><td>'s</td><td>mother</td><td>+2</td><td>and</td><td>so-does</td><td>Ray</td><td>+1</td></tr>
<tr><td>J</td><td>$\lambda x.x_1$</td><td></td><td>J</td><td>$\lambda x.x_6$</td><td></td><td></td><td></td><td></td><td>R</td><td>$\lambda x.x_1$</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">J_6</td><td>$\lambda x_6\mathbf{M}(x)$</td><td></td><td></td><td>$\lambda x_1\mathbf{R}[x, \mathbf{M}(\text{J})]$</td><td colspan="2">$\text{R}_1$</td></tr>
<tr><td></td><td></td><td></td><td colspan="3">$\mathbf{M}(\text{J})$</td><td>$\lambda x.x_2$</td><td></td><td colspan="3"></td></tr>
<tr><td></td><td></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="4">$\mathbf{M}(\text{J})_2$</td><td></td><td colspan="3"></td></tr>
<tr><td colspan="2">J_1</td><td colspan="5">$\lambda x_1\mathbf{R}[x, \mathbf{M}(\text{J})]$</td><td></td><td colspan="3"></td></tr>
<tr><td colspan="7">$\mathbf{R}[\text{J}, \mathbf{M}(\text{J})]$</td><td>&</td><td colspan="3">$\mathbf{R}[\text{R}, \mathbf{M}(\text{J})]$</td></tr>
<tr><td colspan="11">$\mathbf{R}[\text{J}, \mathbf{M}(\text{J})]$ & $\mathbf{R}[\text{R}, \mathbf{M}(\text{J})]$</td></tr>
</table>

In this reading, ‘he’ duplicates ‘Jay’, so ‘he’ denotes what ‘Jay’ denotes, which is Jay. Also ‘so does’ duplicates ‘respects his mother’, which in this case means “respects Jay's mother”, so ‘so does Ray’ also means “respects Jay's mother”.

8. Another Reading

According to the demonstrative reading of ‘he’, the sentence

Jay respects his mother, and so does Ray

reads

Jay	respects	δ	's	mother	and
Ray	respects	δ	's	mother	

where δ is the individual demonstrated, or otherwise salient, in the discourse-context.

On the other hand, according to the duplicative reading of ‘he’, the sentence reads:

Jay	respects	Jay	's	mother	and
Ray	respects	Jay	's	mother	

On yet another hand, the sentence can also be read as follows, which is indeed the most natural reading.

Jay	respects	Jay	's	mother	and
Ray	respects	Ray	's	mother	

How does one semantically construct this reading? The following is a partial computation.

<table>
<tr><td></td><td>①</td><td></td><td>①</td><td></td></tr>
<tr><td>Jay +1</td><td>respects his mother</td><td>and</td><td>so-does</td><td>Ray +1</td></tr>
<tr><td>J_1</td><td>?</td><td></td><td>?</td><td>R_1</td></tr>
<tr><td colspan="2">$\mathbf{R}[\text{J}, \mathbf{M}(\text{J})]$</td><td>&</td><td colspan="2">$\mathbf{R}[\text{R}, \mathbf{M}(\text{R})]$</td></tr>
<tr><td colspan="5">$\mathbf{R}[\text{J}, \mathbf{M}(\text{J})]$ & $\mathbf{R}[\text{R}, \mathbf{M}(\text{R})]$</td></tr>
</table>

The first semantic task is to solve for **?**. Notice that the following works.

<table>
<tr><td></td><td>①</td><td></td><td>①</td><td></td></tr>
<tr><td>Jay +1</td><td>respects his mother</td><td>and</td><td>so-does</td><td>Ray +1</td></tr>
<tr><td>J_1</td><td>$\lambda x_1\ \mathbf{R}[x, \mathbf{M}(x)]$</td><td></td><td>$\lambda x_1\ \mathbf{R}[x, \mathbf{M}(x)]$</td><td>$\text{R}_1$</td></tr>
<tr><td colspan="2">$\mathbf{R}[\text{J}, \mathbf{M}(\text{J})]$</td><td>&</td><td colspan="2">$\mathbf{R}[\text{R}, \mathbf{M}(\text{R})]$</td></tr>
<tr><td colspan="5">$\mathbf{R}[\text{J}, \mathbf{M}(\text{J})]$ & $\mathbf{R}[\text{R}, \mathbf{M}(\text{R})]$</td></tr>
</table>

So, what remains is to figure out how ‘respects his mother’ is computed from its parts.

9. Reflexive Pronouns

As it turns out, *reflexive* pronouns present a similar problem, as in the following example.

4. Kay respects **herself** and so does Elle

In English, the paradigm reflexive pronouns are formed by appending ‘self’ to a pronoun stem, as in the following examples.[11]

I respect my**self**
you respect your**self**
he respects him**self**
she respects her**self**

Other constructions count as reflexive, including:

Jay respects his **[own]** mother
Kay wants **[herself]** to be president

Still other reflexive constructions seem to be semantically vacuous, as in:

Jay perjured himself
je me souviens [I remember][12]

10. Reflexive Pronouns are neither Demonstrative nor Duplicative

Consider our earlier example.

5. Kay respects herself and so does Elle

First, note that ‘herself’ cannot be demonstrative. While speaking such a sentence, one cannot point at a female person [other than Kay] at the moment one says ‘herself’ without sounding exceedingly strange.[13] So ‘herself’ is endophoric, so we next ask whether it is duplicative. Does it simply duplicate its antecedent ‘Kay’? If so, we have the following semantic analysis.

<table>
<tr><td></td><td></td><td colspan="3">①</td><td></td><td>①</td><td></td><td></td></tr>
<tr><td>②
Kay</td><td>+1</td><td>respects</td><td>②
herself</td><td>+2</td><td>and</td><td>so-does</td><td>Elle</td><td>+1</td></tr>
<tr><td>K</td><td>$\lambda x.x_1$</td><td></td><td>K</td><td>$\lambda x.x_2$</td><td></td><td></td><td>L</td><td>$\lambda x.x_1$</td></tr>
<tr><td colspan="2"></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="2">$K_2$</td><td></td><td>$\lambda x_1\mathbf{R}xK$</td><td colspan="2">$L_1$</td></tr>
<tr><td colspan="2">K_1</td><td colspan="3">$\lambda x_1\mathbf{R}xK$</td><td></td><td colspan="3"></td></tr>
<tr><td colspan="5">$\mathbf{R}KK$</td><td>&</td><td colspan="3">$\mathbf{R}LK$</td></tr>
<tr><td colspan="9">$\mathbf{R}KK$ & $\mathbf{R}LK$</td></tr>
<tr><td colspan="9">※ Kay respects Kay, and Elle respects Kay ※</td></tr>
</table>

Notice that this derivation produces an inadmissible reading.[14] A more plausible semantic analysis is sketched as follows.

[11] The stems are highly irregular; ‘my’, ‘our’, ‘your’, and ‘her’ are genitive, but ‘him’ and ‘them’ [and ‘her’] are accusative. Some dialects of English substitute genitive ‘his’ and ‘their’, which overcomes the irregularity, but these are "marked" in the standard dialect. The implicit morphology treats ‘myself’ as parallel to ‘my mother’ and ‘my dog’. The problem is that the grammar does not support this morphology. Compare the following.

☺ Jay respects his mother , and so do I
☹ Jay respects his self, and so do I

We propose that all reflexive-pronoun-stems are *accusative*, irrespective of their spelling.

[12] The motto on license plates for Quebec. Henceforth, we ignore these sorts of reflexive constructions, sometimes called *obligatorily reflexive*.

[13] In other words, ‘herself’ cannot be used as an *open demonstrative*.

[14] This also implies that ‘Kay respects herself’ is not synonymous with ‘Kay respects Kay’, even though they have exactly the same truth-conditions. This in turn implies that meaning is not identical to truth-conditions.

	①		①	
Kay +1	respects herself	and	so-does	Elle +1
K_1	$\lambda x\mathbf{R}xx$		$\lambda x\mathbf{R}xx$	L_1
RKK		&	**R**LL	
RKK & **R**LL				
Kay respects Kay, and Elle respects Elle				

So the remaining question is:

How is 'respects herself' computed from its parts?

11. Syntactic Restrictions

Before continuing, we review some syntactic facts about reflexives. In particular, we note that the following are infelicitous, presuming the usual gender assignments to the nouns.

(1) Jay's mother respects ∗himself∗
(2) Kay's father respects ∗herself∗
(3) Jay believes ∗herself∗ to be cursed
(4) Jay's mother believes ∗himself∗ to be cursed

The simplest *syntactic* method of blocking these examples is to adopt a rule that says that the antecedent of a reflexive pronoun *must* be a *predicate-mate* of that pronoun, which in turn must agree in person, number, and gender with that antecedent.[15]

12. Our Proposal – Role-Anaphora

No purely syntactic approach to reflexives is entirely satisfactory. We prefer to describe the situation as follows.

A reflexive pronoun is **directly-anaphoric**, not to an NP, but to a **functional-role**, and is **indirectly-anaphoric** to whatever NP fills that role, the latter of which controls agreement features [person, number, gender].

We note that the functional-role is usually *subject* [+1]. For example, in the following

6. Kay's mother respects herself

the reflexive pronoun 'herself' is directly-anaphoric to the subject-role, and indirectly-anaphoric to 'Kay's mother', which plays that role, and which accordingly forces the pronoun to be third person, singular, feminine.

13. Categorial Implementation of Reflexive Pronouns [16]

1. Empty Pronouns [First Approximation[17]]

In order to account for reflexive pronouns, we begin by introducing the notion of *empty pronoun*. Although such pronouns are syntactically critical, and in particular serve as *inflectional-vehicles*, they are *semantically vacuous*. We propose the symbol 'e' to encode the empty-pronoun root, which is categorically rendered as follows

e [18]	∅	∅

where the symbol '∅' conveys that the phrase is semantically-empty.[19]

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[15] This follows from Principle **A** in Chomsky (1981). Recent citation – Cunnings and Sturt (2014).
[16] This is a provisional account. The final account is presented in Section 31.7.
[17] We do a better approximation in Section 19.
[18] In concrete examples, 'e' is spelled 'he', 'she', 'they', etc. See examples below.
[19] The symbol '∅' comes from set theory according to which it denotes the empty-set. We use it widely to indicate various forms of emptiness.

2. Reflexive Morpheme

We also propose a reflexive morpheme REF, which is variously pronounced

self, own, ∅ [20]

and which is categorially rendered as follows.

REF(θ)	$D_\theta \rightarrow (D_\theta \times D)$	$\lambda x_\theta (x_\theta \times x)$

Here, θ is any non-negative integer, although most examples have θ = 1. Recall that the cross-operator × acts both as a type-operator, and as a syntactic-operator.[21]

14. Examples

7. Kay respects herself

Kay +1	respects	her [22]	+2	self	
		∅	$\lambda x.x_2$		
		$\lambda x.x_2$		$\lambda x_1(x_1 \times x)$	
	$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$\lambda x_1(x_1 \times x_2)$			①
K1	$\lambda x_1 \mathbf{R}xx$				②
$\mathbf{R}$KK					

① is obtained according to the following derivation.[23]

1.	$\lambda x.x_2$	$D \rightarrow D_2$	Pr
2.	$\lambda x_1(x_1 \times x)$	$D_1 \rightarrow (D_1 \times D)$	Pr
3.	x_1	D_1	As
4.	$x_1 \times x$	$D_1 \times D$	2,3,λO
5.	x_1	D_1	4,×O
6.	x	D	4,×O
7.	x_2	D_2	1,6,λO
8.	$x_1 \times x_2$	$D_1 \times D_2$	5,7,×I
9.	$\lambda x_1(x_1 \times x_2)$	$D_1 \rightarrow (D_1 \times D_2)$	3,8,λI

② is obtained according to the following derivation.[24]

1.	$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$D_2 \rightarrow (D_1 \rightarrow S)$	Pr
2.	$\lambda x_1(x_1 \times x_2)$	$D_1 \rightarrow (D_1 \times D_2)$	Pr
3.	x_1	D_1	As
4.	$x_1 \times x_2$	$D_1 \times D_2$	2,3,λO
5.	x_1	D_1	4,×O
6.	x_2	D_2	4,×O
7.	$\lambda x_1 \mathbf{R}xx$	$D_1 \rightarrow S$	1,6,λO
8.	$\mathbf{R}xx$	S	5,7,λO
9.	$\lambda x_1 \mathbf{R}xx$	$D_1 \rightarrow S$	3,8,λI

[20] Here, the symbol '∅' means the morpheme is unpronounced.
[21] See Appendix 2 for an account of the compositional rules for ×.
[22] We take 'her' simply to be the spelling of 'e' in this situation. The word 'her' contains numerous syntactic features – singular, feminine, third person – which we treat here as semantically vacuous. Later [+++] we treat natural gender as contentful.
[23] This uses the simplified system; see Appendix for proper derivation.
[24] This uses the simplified system; see Appendix for proper derivation.

8. Kay respects herself, and so does Elle

	①					①	
Kay+1	respects	her	+2	self	and	so-does	Elle+1
	$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$\varnothing$	$\lambda x.x_2$	$\lambda x_1 (x_1 \times x)$		$\lambda x_1 \mathbf{R}xx$	L_1
K_1	$\lambda x_1 \mathbf{R}xx$						
$\mathbf{R}\text{KK}$					&	$\mathbf{R}\text{LL}$	
$\mathbf{R}\text{KK}$ & $\mathbf{R}\text{LL}$							

9. Jay respects his **own** mother

Jay +1	respects	he	's	own	mother	+2
		$\varnothing$	$\lambda x.x_6$	$\lambda x_1 (x_1 \times x)$		
		$\lambda x_1 (x_1 \times x_6)$			$\lambda x_6{:}\mathbf{M}(x)$	
		$\lambda x_1 \{ x_1 \times \mathbf{M}(x) \}$				$\lambda x.x_2$
	$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$\lambda x_1 \{ x_1 \times \mathbf{M}(x)_2 \}$				
J_1	$\lambda x_1\, \mathbf{R}[x, \mathbf{M}(x)]$					
$\mathbf{R}[\text{J}, \mathbf{M}(\text{J})]$						

Note that the reflexive morpheme 'own' need not be pronounced, as in the following example.

10. Jay respects his [own] mother, and so does Ray

	①							①	
Jay +1	respects	he	's	[own]	mother	+2	and	so-does	Ray +1
	$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$\varnothing$	$\lambda x.x_6$	$\lambda x_1 (x_1 \times x)$	$\lambda x_6{:}\mathbf{M}(x)$	$\lambda x.x_2$		$\lambda x_1 \mathbf{R}[x, \mathbf{M}(x)]$	R_1
J_1	$\lambda x_1 \mathbf{R}[x, \mathbf{M}(x)]$								
$\mathbf{R}[\text{J}, \mathbf{M}(\text{J})]$							&	$\mathbf{R}[\text{R}, \mathbf{M}(\text{R})]$	
$\mathbf{R}[\text{J}, \mathbf{M}(\text{J})]$ & $\mathbf{R}[\text{R}, \mathbf{M}(\text{R})]$									

15. Alpha-Pronouns (Open-Pronouns)

Recall that a non-duplicative pronoun does not (simply) duplicate its antecedent. For example, in the following sentence.

11. every man respects his mother

the pronoun 'he' does not mean 'every man'. This sentence can be analyzed using reflexion, as follows.

every man +1	REF(1)	respects	he	's	mother	+2
			$\varnothing$	$\lambda z.zx_6$		
			$\lambda z.z_6$		$\lambda z_6.\mathbf{M}(z)$	
			$\lambda z\, \mathbf{M}(z)$			$\lambda z.z_2$
		$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$\lambda z\, \mathbf{M}(z)_2$			
	$\lambda x_1 (x_1 \times x)$	$\lambda z\, \lambda x_1\, \mathbf{R}[x, \mathbf{M}(z)]$				
$\wedge\{ x_1 \mid \mathbf{M}x \}$	$\lambda x_1\, \mathbf{R}[x, \mathbf{M}(x)]$					
$\wedge\{ \mathbf{R}[x, \mathbf{M}(x)] \mid \mathbf{M}x \}$ $\forall x\{ \mathbf{M}x \rightarrow \mathbf{R}[x, \mathbf{M}(x)] \}$						

This suggests that, perhaps, all non-duplicative pronouns are reflexive. Unfortunately, this hypothesis founders on the following example.

12. every man's mother respects him

The most natural reading of ‘he’ treats it as anaphoric to ‘every man’. However, it cannot be duplicative, since ‘he’ does not mean ‘every man’, and it cannot be reflexive, since ‘every man’ does not fill the subject-role.

Rather, it is yet another kind of anaphoric pronoun, which we propose to call an *alpha-pronoun*.[25] We start with the following principle.

An alpha-pronoun creates an alpha-role, which [ultimately] is *filled* by its antecedent.

For example, consider the following sentence.

Jay respects his mother

Suppose we understand ‘he’ to be an alpha-pronoun. Then ‘he’ creates an alpha-role, which is filled by ‘Jay’. Thus, ‘Jay’ fills two roles – the subject-role created by ‘respects’, and the alpha-role created by ‘he’. Alternatively stated, the verb-phrase

respects his mother

acts semantically as a two-place predicate that subcategorizes for a nominative-argument and an anaphoric-argument, and may be formally depicted as follows.

+1	respects	–1	's mother

Whereas we encode the usual functional-roles (subject, object, etc.) using positive integers, we propose to encode alpha-roles using negative integers.[26] Role-marking is accomplished as before, by case-marking functions, as follows, where i is any integer.[27]

i	$\mathsf{D} \rightarrow \mathsf{D}_i$	$\lambda x : x_i$

What is new is that roles now include alpha-roles, encoded by negative integers, in addition to functional-roles, encoded by non-negative integers.

What we need then is a corresponding technique for *role-creation*, which is given as follows, where α is any alpha-role (negative-integer), and e is the pronoun stem, which is variously pronounced.

(α) e	$\mathsf{D}_\alpha \rightarrow \mathsf{D}$	$\lambda x_\alpha : x$

Note that the parentheses are part of the morpheme. Note also that we place the role-maker (–1) *ahead* of the pronoun, which reinforces the idea that the pronoun looks *back* (usually) in the sentence for its antecedent.[28]

The following illustrates the new morpheme, where e is pronounced ‘he’.

13. respects his mother

<table>
<tr><td>respects</td><td>(–1) he</td><td>'s</td><td>mother</td><td>+2</td></tr>
<tr><td></td><td>$\lambda z_{-1}\!:\!z$</td><td>$\lambda x.x_6$</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">$\lambda z_{-1}\!:\!z_6$</td><td>$\lambda x_6\mathbf{M}(x)$</td><td></td></tr>
<tr><td></td><td colspan="3">$\lambda z_{-1} : \mathbf{M}(z)$</td><td>$\lambda x.x_2$</td></tr>
<tr><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="4">$\lambda z_{-1} : \mathbf{M}(z)_2$</td></tr>
<tr><td colspan="5">$\lambda z_{-1} : \lambda x_1\, \mathbf{R}[x,\mathbf{M}(z)]$</td></tr>
</table>

[25] An alternative term is *open pronoun*.

[26] Note that there is no grammatical upper-limit on how many open-pronouns can occur in a sentence, so we need infinitely-many negative integers "on call" . We also have infinitely-many positive integers on call, although no known natural language has infinitely-many case-markers.

[27] We continue to use the plus-symbol for functional-roles, in analogy with syntactic-feature notation.

[28] Also, notice that the role-creating function and the role-marking function are inverses of each other.

Notice that this analysis treats ‘respects his mother’ as a special two-place predicate that subcategorizes for a nominative argument and a negative-argument.[29]

16. Pronoun-Binding

How does an NP *bind* an alpha-pronoun? By filling the alpha-role created by that pronoun. How does an NP fill an alpha-role? The same way an NP fills a functional-role – by function-application. By way of illustrating, we consider a very simple example involving NP-raising.[30]

14. Jay, he is virtuous

The most natural reading of this sentence treats ‘he’ as anaphoric to ‘Jay’,[31] in which case ‘Jay’ is alpha-marked in such a way that it binds ‘he’, as seen in the following derivation.

<table>
<tr><td>Jay</td><td>–1</td><td>(–1) he</td><td>+1</td><td>is virtuous</td></tr>
<tr><td>J</td><td>$\lambda x.x_{-1}$</td><td>$\lambda x_{-1}{:}x$</td><td>$\lambda x.x_1$</td><td rowspan="2">$\lambda x_1 \mathbf{V}x$</td></tr>
<tr><td colspan="2" rowspan="2">J_{-1}</td><td colspan="2">$\lambda x_{-1}{:}x_1$</td></tr>
<tr><td colspan="3">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="5">$\mathbf{V}J$</td></tr>
</table>

In this example, ‘he’ is an alpha-pronoun (*open* pronoun), so ‘he is virtuous’ is an *open* expression, in particular a one-place predicate sub-categorizing for a negative-1 argument. ‘Jay’ is marked –1, so ‘Jay’ fills this role when combined with ‘he is virtuous’.

Usually, however, an NP plays a functional-role as well, as in the following example.

15. Jay respects his mother

Here, ‘Jay’ serves as the subject of the verb, but as we are inclined to read the sentence, it also serves as the antecedent of ‘he’, which means it is marked for both roles, as in the following derivation.

<table>
<tr><td>Jay</td><td>+1</td><td>–1</td><td>respects (–1) his mother</td></tr>
<tr><td rowspan="2">J</td><td>$\lambda x.x_1$</td><td>$\lambda x.x_{-1}$</td><td rowspan="2"></td></tr>
<tr><td colspan="2">$\lambda x(x_1 \times x_{-1})$</td></tr>
<tr><td colspan="3">$J_1 \times J_{-1}$</td><td>$\lambda z_{-1}\, \lambda x_1\, \mathbf{R}[x,\mathrm{M}(z)]$</td></tr>
<tr><td colspan="4">$\mathbf{R}[J,\mathrm{M}(J)]$</td></tr>
</table>

Notice that both role-markers are applied to ‘Jay’, which results in the expression

$$J_1 \times J_{-1}$$

which, in effect, provides two copies of ‘Jay’, one for each role it plays.[32]

---

[29] Generally, an *open* expression has more "places" than the corresponding *closed* expression, which means that syntactic categories don't always match up with semantic types. For example, supposing ‘he’ is open, ‘he is tall’ is *syntactically* a sentence but *semantically* a one-place predicate.

[30] Briefly, NP-raising is a syntactic transformation that moves an NP to the front of a clause, and deposits a trace-pronoun in the original location, either overt or covert. We discuss more examples in a later section.

[31] Another reading treats ‘Jay’ as *vocative*, in which case Jay is the addressee, and ‘he’ is presumably demonstrative. The vocative-marking is more critical in the following – let's eat Grandma!

[32] Recall that Compositional-Logic is resource sensitive. The logical details are discussed in Appendix 2.

17. More Examples

An NP can bind two pronouns, as in the following.

16. Jay respects his mother if he is virtuous

<table>
<tr><td>Jay</td><td>+1 –1 –2</td><td>respects</td><td>(–1) he</td><td>'s</td><td>mother</td><td>+2</td><td>if</td><td>(–2) he is virtuous</td></tr>
<tr><td>J</td><td>$\lambda x(x_1 \times x_{-1} \times x_{-2})$</td><td></td><td>$\lambda x_{-1}{:}x$</td><td>$\lambda x.x_6$</td><td></td><td></td><td>$\lambda X \lambda Y(X \rightarrow Y)$</td><td>$\lambda x_{-2}\mathbf{V}x$</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">$\lambda x_{-1}{:}x_6$</td><td>$\lambda x_6.\mathrm{M}(x)$</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="3">$\lambda x_{-1}{:}\mathrm{M}(x)$</td><td>$\lambda x.x_2$</td><td></td><td></td></tr>
<tr><td></td><td></td><td>$\lambda y_2 \lambda x_1 \mathbf{R}xy$</td><td colspan="4">$\lambda x_{-1}{:}\mathrm{M}(x)_2$</td><td></td><td></td></tr>
<tr><td colspan="2">$\mathrm{J}_1 \times \mathrm{J}_{-1} \times \mathrm{J}_{-2}$</td><td colspan="5">$\lambda y_{-1}\ \lambda x_1\ \mathbf{R}[x,\mathrm{M}(y)]$</td><td></td><td></td></tr>
<tr><td colspan="7">$\mathbf{R}[\mathrm{J},\mathrm{M}(\mathrm{J})] \times \mathrm{J}_{-2}$</td><td colspan="2">$\lambda x_{-2}\ \lambda Y(\mathbf{V}x \rightarrow Y)$</td></tr>
<tr><td colspan="9">$\mathbf{R}[\mathrm{J},\mathrm{M}(\mathrm{J})] \times \lambda Y(\mathbf{V}\mathrm{J} \rightarrow Y)$
$\mathbf{V}\mathrm{J} \rightarrow \mathbf{R}[\mathrm{J},\mathrm{M}(\mathrm{J})]$</td></tr>
</table>

Notice that each instance of ‘he’ creates its own role, but both are filled by ‘Jay’, which additionally fills the nominative-role. Whereas an NP can fill any number of alpha-roles, it can only fill one functional-role. The latter restriction is designed to block the following sort of derivation.

<table>
<tr><td>Jay</td><td>+1</td><td>+2</td><td>respects</td></tr>
<tr><td></td><td>$\lambda x.x_1$</td><td>$\lambda x.x_2$</td><td></td></tr>
<tr><td>J</td><td colspan="2">$\lambda x(x_1 \times x_2)$</td><td></td></tr>
<tr><td colspan="3">$\mathrm{J}_1 \times \mathrm{J}_2$</td><td>$\lambda y_2 \lambda x_1 \mathbf{R}xy$</td></tr>
<tr><td colspan="4">$\mathbf{R}\mathrm{JJ}$</td></tr>
</table>

The following example illustrates how pronoun-binding can be recursive. Notice that ‘she’ is anaphoric to ‘his mother’, which is anaphorically dependent on ‘Jay’.

17. Jay respects his mother if she is virtuous

<table>
<tr><td>Jay +1 –1</td><td>respects</td><td>(–1) he</td><td>'s</td><td>mother</td><td>+2 –2</td><td>if</td><td>(–2) she +1</td><td>is virtuous</td></tr>
<tr><td></td><td></td><td>$\lambda y_{-1}{:}y$</td><td>$\lambda y.y_6$</td><td></td><td></td><td></td><td>$\lambda x_{-2}{:}x_1$</td><td>$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td></td><td></td><td colspan="2">$\lambda y_{-1}{:}y_6$</td><td>$\lambda y_6.\mathrm{M}(y)$</td><td></td><td>$\lambda X \lambda Y(X \rightarrow Y)$</td><td colspan="2">$\lambda x_{-2}\ \mathbf{V}x$</td></tr>
<tr><td></td><td></td><td colspan="3">$\lambda y_{-1}{:}\mathrm{M}(y)$</td><td>$\lambda x(x_2 \times x_{-2})$</td><td></td><td></td><td></td></tr>
<tr><td></td><td>$\lambda y_2 \lambda x_1 \mathbf{R}xy$</td><td colspan="4">$\lambda y_{-1}\{\ \mathrm{M}(y)_2 \times \mathrm{M}(y)_{-2}\ \}$</td><td></td><td></td><td></td></tr>
<tr><td>$\mathrm{J}_1 \times \mathrm{J}_{-1}$</td><td colspan="5">$\lambda y_{-1}\ \{\ \lambda x_1 \mathbf{R}[x,\ \mathrm{M}(y)] \times \mathrm{M}(y)_{-2}\ \}$</td><td></td><td></td><td></td></tr>
<tr><td colspan="6">$\mathbf{R}[\mathrm{J},\ \mathrm{M}(\mathrm{J})] \times \mathrm{M}(\mathrm{J})_{-2}$</td><td colspan="3">$\lambda x_{-2}\ \lambda Y\ (\mathbf{V}x \rightarrow Y)$</td></tr>
<tr><td colspan="9">$\mathbf{R}[\mathrm{J},\ \mathrm{M}(\mathrm{J})] \times \lambda Y\ (\mathbf{V}[\mathrm{M}(\mathrm{J})] \rightarrow Y)$
$\mathbf{V}[\mathrm{M}(\mathrm{J})] \rightarrow \mathbf{R}[\mathrm{J},\ \mathrm{M}(\mathrm{J})]$</td></tr>
</table>

18. Pronouns Bound by Quantifier Phrases

In the previous examples, pronouns are bound by items of type D. They can also be bound by quantifier phrases, as in the following examples.

18. every man respects his mother

every	man	+1 –1	respects	(–1) he	's	mother	+2
$\lambda P_0 \bigwedge x Px$	$\mathbf{M}_0$			$\lambda z_{-1}{:}z$	$\lambda x.x_6$		
$\bigwedge x\mathbf{M}x$		$\lambda x(x_1 \times x_{-1})$		$\lambda z_{-1} : z_6$		$\lambda z_6{:}\mathrm{M}(z)$	
				$\lambda z_{-1} : \mathrm{M}(z)$			$\lambda x.x_2$
			$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$\lambda z_{-1} : \mathrm{M}(z)_2$			
$\bigwedge\{ x_1 \times x_{-1} \mid \mathbf{M}x \}$			$\lambda z_{-1}\, \lambda x_1\, \mathbf{R}[x,\mathrm{M}(z)]$				
$\bigwedge\{ \mathbf{R}[x,\mathrm{M}(x)] \mid \mathbf{M}x \}$ $\forall x \{ \mathbf{M}x \rightarrow \mathbf{R}[x,\mathrm{M}(x)] \}$							

19. every man respects his mother if she is virtuous

every man +1 –1	respects (–1) his mother –2	if (–2) she is virtuous
$\bigwedge\{ x_1 \times x_{-1} \mid \mathbf{M}x \}$	$\lambda y_{-1} \{ \lambda x_1\, \mathbf{R}[x, \mathrm{M}(y)] \times \mathrm{M}(y)_{-2} \}$	
$\bigwedge\{ \mathbf{R}[x, \mathrm{M}(x)] \times \mathrm{M}(x)_{-2} \} \mid \mathbf{M}x \}$		$\lambda z_{-2} : \lambda Y(\mathbf{V}z \rightarrow Y)$
$\bigwedge\{ \mathbf{R}[x, \mathrm{M}(x)] \times \lambda Y(\mathbf{V}[\mathrm{M}(x)] \rightarrow Y) \} \mid \mathbf{M}x \}$ $\bigwedge\{ \mathbf{V}[\mathrm{M}(x)] \rightarrow \mathbf{R}[x, \mathrm{M}(x)] \mid \mathbf{M}x \}$ $\forall x\{ \mathbf{M}x \rightarrow\!. \ \mathbf{V}[\mathrm{M}(x)] \rightarrow \mathbf{R}[x, \mathrm{M}(x)] \}$		

So far, all our examples could also be analyzed using duplicative or reflexive pronouns.[33] The following is the first example whose analysis *requires* an alpha-pronoun.

20. every woman's father respects her

First, we presume 'her' is anaphoric to 'every woman'. However, we cannot read 'her' as duplicative, since 'her' does not mean 'every woman', and we cannot read 'her' as reflexive, since 'every woman' is not the subject of the verb. Rather, the proper analysis treats 'her' as bound by 'every woman', as in the following derivation.

every woman	's	–1	father	+1	respects	(–1) her +2
	$\lambda x.x_6$	$\lambda x.x_{-1}$				
$\bigwedge\{ x \mid \mathbf{W}x \}$	$\lambda x(x_6 \times x_{-1})$				$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$\lambda z_{-1}{:}z_2$
$\bigwedge\{ x_6 \times x_{-1} \mid \mathbf{W}x \}$			$\lambda x_6{:}\mathrm{F}(x)$			
$\bigwedge\{ \mathrm{F}(x) \times x_{-1} \mid \mathbf{W}x \}$				$\lambda x.x_1$		
$\bigwedge\{ \mathrm{F}(x)_1 \times x_{-1} \mid \mathbf{W}x \}$					$\lambda z_{-1} : \lambda x_1\, \mathbf{R}xz$	
$\bigwedge\{ \mathbf{R}[\mathrm{F}(x),x] \mid \mathbf{W}x \}$ $\forall x \{ \mathbf{W}x \rightarrow \mathbf{R}[\mathrm{F}(x),x] \}$						

The following similarly requires an alpha-pronoun.

21. every man's mother respects his father

which we analyze as follows, inserting earlier computations.

every man's –1 mother	respects (–1) his father
$\bigwedge\{ \mathrm{F}(x)_1 \times x_{-1} \mid \mathbf{M}x \}$	$\lambda z_{-1} : \lambda x_1\, \mathbf{R}[x,\mathrm{M}(z)]$
$\bigwedge\{ \mathbf{R}[\mathrm{F}(x),\mathrm{M}(x)] \mid \mathbf{M}x \}$ $\forall x\{ \mathbf{M}x \rightarrow \mathbf{R}[\mathrm{F}(x),\mathrm{M}(x)] \}$	

The following is a more complicated example.

[33] Exercise for the reader!

22. every man whose mother respects his father respects his father

Here, the first 'his' cannot be reflexive or duplicative, but the second one can be reflexive, as seen in the following derivation.

every	man whose mother respects his father	+1	respects his [own] father
$\lambda P_0 \wedge x P x$	$\lambda x_0\{\mathbf{M}x \;\&\; \mathbf{R}[\mathrm{M}(x), \mathrm{F}(x)]\}$		
$\wedge\{\, x \mid \mathbf{M}x \;\&\; \mathbf{R}[\mathrm{M}(x), \mathrm{F}(x)] \,\}$		$\lambda x.x_1$	
$\wedge\{\, x_1 \mid \mathbf{M}x \;\&\; \mathbf{R}[\mathrm{M}(x), \mathrm{F}(x)] \,\}$			$\lambda x_1\, \mathbf{R}[x, \mathrm{F}(x)]$
$\wedge\{\, \mathbf{R}[x, \mathrm{F}(x)] \mid \mathbf{M}x \;\&\; \mathbf{R}[\mathrm{M}(x), \mathrm{F}(x)] \,\}$ $\forall x\, \{\, \{\mathbf{M}x \;\&\; \mathbf{R}[\mathrm{M}(x), \mathrm{F}(x)]\,\} \rightarrow \mathbf{R}[x, \mathrm{F}(x)] \,\}$			

The CNP above is computed as follows.

man	who	se	–1	mother	+1	respects	(–1) he	's	father	+2
		$\lambda x.x_6$	$\lambda x.x_{-1}$				$\lambda z_{-1}{:}z$	$\lambda x.x_6$		
	$\lambda x_0{:}x$	$\lambda x(x_6 \times x_{-1})$					$\lambda z_{-1} : z_6$		$\lambda z_6{:}\mathrm{F}(z)$	
	$\lambda x_0(x_6 \times x_{-1})$			$\lambda x_6{:}\mathrm{M}(x)$			$\lambda z_{-1} : \mathrm{F}(z)$			$\lambda x.x_2$
	$\lambda x_0(\, \mathrm{M}(x) \times x_{-1} \,)$				$\lambda x.x_1$	$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$\lambda z_{-1} : \mathrm{F}(z)_2$			
	$\lambda x_0(\, \mathrm{M}(x)_1 \times x_{-1} \,)$					$\lambda z_{-1} : \lambda x_1\, \mathbf{R}[x, \mathrm{F}(z)]$				
$\lambda x_0 \mathbf{M}x$	$\lambda x_0\, \mathbf{R}[\mathrm{M}(x), \mathrm{F}(x)]$									
$\lambda x_0\, \{\, \mathbf{M}x \;\&\; \mathbf{R}[\mathrm{M}(x), \mathrm{F}(x)] \,\}$										

Notice that 'he' is bound by 'who'.

19. Revised Account of Reflexive Pronouns

Now that we have alpha-pronouns, we go back and revise our treatment of reflexives, employing alpha-pronouns rather than empty pronouns. In particular, we replace our earlier account of reflexive-pronouns with the following.

$\mathrm{REF}(\theta,\alpha)$	$D_\theta \rightarrow (D_\theta \times D_\alpha)$	$\lambda x_\theta\, (x_\theta \times x_\alpha)$
θ is a non-negative integer[34] ; α is a negative integer		

The following illustrates the new scheme. Note that 'he' [inside 'his'] is treated now as an alpha-pronoun, not an empty-pronoun.

23. Jay respects his mother

Jay +1	REF(+1,–1)	respects	(–1) he	's +6	mother	+2
			$\lambda z_{-1}{:}z$	$\lambda z.z_6$		
			$\lambda z_{-1} : z_6$		$\lambda z_6{:}\mathrm{M}(z)$	
			$\lambda z_{-1} : \mathrm{M}(z)$			$\lambda x.x_2$
		$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$\lambda z_{-1} : \mathrm{M}(z)_2$			
	$\lambda x_1(x_1 \times x_{-1})$	$\lambda z_{-1} : \lambda x_1\, \mathbf{R}[x, \mathrm{M}(z)]$				
J_1	$\lambda x_1 \mathbf{R}[x, \mathrm{M}(x)]$					
$\mathbf{R}[\mathrm{J}, \mathrm{M}(\mathrm{J})]$						

The following two examples show how reflexives operate inside adjectival phrases. Here, it is critical that the reflexive morpheme $\mathrm{REF}(\theta,\alpha)$ admits the nullative-role [θ=0].

[34] Although we often employ theta (θ) to range over functional-roles, they are not exactly the same as theta-roles (thematic-roles). Thematic roles include roles like *agent* and *patient*, which are *metaphysical* notions, whereas functional-roles (subject, object, …) are *grammatical* notions.

24. man next to his mother

man	REF(0,–1)	next-to	(–1) he	's	mother
			$\lambda z_{-1} : z$	$\lambda z{:}z_6$	
			$\lambda z_{-1} : z_6$		$\lambda z_6{:}\mathrm{M}(z)$
		$\lambda y \lambda x_0 \mathbf{N}xy$	$\lambda z_{-1} : \mathrm{M}(z)$		
	$\lambda x_0(x_0 \times x_{-1})$	$\lambda z_{-1}\, \lambda x_0\ \mathbf{N}[x, \mathrm{M}(z)]$			
$\lambda x_0 \mathbf{M}x$	$\lambda x_0\ \mathbf{N}[x, \mathrm{M}(x)]$				
$\lambda x_0\{\ \mathbf{M}x\ \&\ \mathbf{N}[x, \mathrm{M}(x)]\ \}$					

25. man respected by his mother

man	REF(0,–1)	respected	by	(–1) he	's	mother
				$\lambda z_{-1}{:}z$	$\lambda z{:}z_6$	
				$\lambda z_{-1} : z_6$		$\lambda z_6{:}\mathrm{M}(z)$
			$\lambda x.x_5$	$\lambda z_{-1} : \mathrm{M}(z)$		
		$\lambda y_5 \lambda x_0 \mathbf{R}yx$	$\lambda z_{-1} : \mathrm{M}(z)_5$			
	$\lambda x_0(x_0 \times x_{-1})$	$\lambda z_{-1} : \lambda x_0\ \mathbf{R}[\mathrm{M}(z),x]$				
$\lambda x_0 \mathbf{M}x$	$\lambda x_0 \mathbf{R}[\mathrm{M}(x),x]$					
$\lambda x_0\{\ \mathbf{M}x\ \&\ \mathbf{R}[\mathrm{M}(x),x]\ \}$						

The following show how these last two sentences can be rephrased using ‘who’, and reiterate the observation that ‘who’ and ‘is’ are functional-inverses of each other.

26. man who is next to his mother

man	who	+1	REF(+1,–1)	is	next-to	(–1) he	's	mother
	$\lambda x_0{:}x$	$\lambda x.x_1$			$\lambda y \lambda x_0 \mathbf{N}xy$	$\lambda z_{-1}{:}z$	$\lambda z{:}z_6$	$\lambda z_6{:}\mathrm{M}(z)$
				$\lambda P_0{:}P_1$	$\lambda z_{-1} : \lambda x_0\ \mathbf{N}[x, \mathrm{M}(z)]$			
			$\lambda x_1(x_1 \times x_{-1})$	$\lambda z_{-1} : \lambda x_1\ \mathbf{N}[x, \mathrm{M}(z)]$				
	$\lambda x_0{:}x_1$		$\lambda x_1\ \mathbf{N}[x, \mathrm{M}(x)]$					
$\lambda x_0 \mathbf{M}x$	$\lambda x_0\ \mathbf{N}[x, \mathrm{M}(x)]$							
$\lambda x_0\{\ \mathbf{M}x\ \&\ \mathbf{N}[x, \mathrm{M}(x)]\ \}$								

27. man who is respected by his mother

man	who	+1	REF(+1,–1)	is	respected	by	(–1) he	's	mother
	$\lambda x_0{:}x$	$\lambda x.x_1$			$\lambda y_5 \lambda x_0 \mathbf{R}yx$	$\lambda x.x_5$	$\lambda z_{-1} : z$	$\lambda z{:}z_6$	$\lambda z_6{:}\mathrm{M}(z)$
				$\lambda P_0{:}P_1$	$\lambda z_{-1} : \lambda x_0\ \mathbf{R}[\mathrm{M}(z),x]$				
			$\lambda x_1(x_1 \times x_{-1})$	$\lambda z_{-1} : \lambda x_1\ \mathbf{R}[\mathrm{M}(z),x]$					
	$\lambda x_0{:}x_1$		$\lambda x_1 \mathbf{R}[\mathrm{M}(x),x]$						
$\lambda x_0 \mathbf{M}x$	$\lambda x_0 \mathbf{R}[\mathrm{M}(x),x]$								
$\lambda x_0\{\ \mathbf{M}x\ \&\ \mathbf{R}[\mathrm{M}(x),x]\ \}$									

20. A Fairly Big Example

Before continuing our account of pronouns, let's do a fairly big example.

28. Jay respects every man who respects his mother [... and so does Ray].

There are four readings of the pronoun stem ‘he’, according to whether ‘he’ is:

(1) demonstrative
(2) duplicative to ‘Jay’
(3) reflexive to ‘Jay’
(4) reflexive to ‘who’

Reading 1 [demonstrative]

Jay	+1	respects	every	man	who +1	respects	he	's	mother	+2	+2
J	$\lambda x.x_1$						δ	$\lambda x.x_6$			
							δ_6		$\lambda x_6{:}\mathrm{M}(x)$		
							$\mathrm{M}(\delta)$			$\lambda x.x_2$	
						$\lambda y_2\lambda x_1\mathbf{R}xy$	$\mathrm{M}(\delta)_2$				
					$\lambda x_0{:}x_1$	$\lambda x_1\mathbf{R}[x,\mathrm{M}(\delta)]$					
				$\lambda x_0\mathbf{M}x$	$\lambda x_0\mathbf{R}[x,\mathrm{M}(\delta)]$						
			$\lambda \mathrm{P}_0\wedge x\mathrm{P}x$	$\lambda x_0\{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(\delta)]\ \}$							
			$\wedge\{\ x \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(\delta)]\ \}$								$\lambda x.x_2$
		$\lambda x_2\lambda y_1\mathbf{R}yx$	$\wedge\{\ x_2 \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(\delta)]\ \}$								
J_1		$\wedge\{\ \lambda y_1\mathbf{R}yx \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(\delta)]\ \}$									
$\wedge\{\ \mathbf{R}\mathrm{J}x \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(\delta)]\ \}$ $\forall x\{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(\delta)]\ .\!\rightarrow\ \mathbf{R}\mathrm{J}x\}$											

Reading 2 [duplicative]

①							①				
Jay	+1	respects	every	man	who +1	respects	he	's	mother	+2	+2
J	$\lambda x.x_1$	$\lambda x_2\lambda y_1\mathbf{R}yx$	$\lambda \mathrm{P}_0\wedge x\mathrm{P}x$	$\lambda x_0\mathbf{M}x$	$\lambda x_0{:}x_1$	$\lambda y_2\lambda x_1\mathbf{R}xy$	J	$\lambda x.x_6$	$\lambda x_6{:}\mathrm{M}(x)$	$\lambda x.x_2$	$\lambda x.x_2$

The rest of the derivation proceeds just like Reading 1 with 'δ' being replaced by 'J'.

Reading 3 [reflexive to 'Jay']

Jay	+1	REF(+1,–1)	respects	every	man	who+1	respects	(-1) he	's	mother	+2	+2
J	$\lambda x.x_1$							$\lambda z_{-1}{:}z$	$\lambda z.z_6$			
								$\lambda z_{-1} : z_6$		$\lambda z_6.\mathrm{M}(z)$		
								$\lambda z_{-1} : \mathrm{M}(z)$			$\lambda x.x_2$	
							$\lambda y_2\lambda x_1\mathbf{R}xy$	$\lambda z_{-1} : \mathrm{M}(z)_2$				
						$\lambda x_0{:}x_1$	$\lambda z_{-1} : \lambda x_1\mathbf{R}[x,\mathrm{M}(z)]$					
					$\lambda x_0\mathbf{M}x$	$\lambda z_{-1} : \lambda x_0\mathbf{R}[x,\mathrm{M}(z)]$						
				$\lambda \mathrm{P}_0\wedge x\mathrm{P}x$	$\lambda z_{-1} : \lambda x_0\{\mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(z)]\}$							
				$\lambda z_{-1} : \wedge x\{\mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(z)]\}$								$\lambda x.x_2$
			$\lambda x_2\lambda y_1\mathbf{R}yx$	$\lambda z_{-1} : \wedge\{\ x_2 \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(z)]\ \}$								
		$\lambda y_1(y_1{\times}y_{-1})$	$\lambda z_{-1} : \wedge\{\ \lambda y_1\mathbf{R}yx \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(z)]\ \}$ $\lambda z_{-1} : \lambda y_1\ \wedge\{\ \mathbf{R}yx \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(z)]\ \}$ $\lambda z_{-1} : \lambda y_1\ \forall x\{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(z)]\ .\!\rightarrow \mathbf{R}yx\ \}$									
J_1		$\lambda y_1\ \forall x\{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(y)]\ .\!\rightarrow \mathbf{R}yx\ \}$										
$\forall x\{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathrm{M}(y)]\ .\!\rightarrow \mathbf{R}\mathrm{J}x\ \}$												

Note that when REF is unpronounced, we have a certain amount of freedom about where to place it in the sentence. We choose to place it ahead of the VP, thinking of it as a VP-operator.[35] In the above example, it is placed ahead of the first VP. In the following example, it is placed ahead of the second VP.

[35] When understood as a VP-operator, it might be called *reflexion*, as in Combinatorial Logic; e.g., see Quine (1960).

Reading 4 [reflexive to ‘who’]

Jay	+1	respects	every	man	who+1	REF(+1,–1)	respects	(-1) he	's	mother	+2	+2
J	$\lambda x.x_1$							$\lambda z_{-1}{:}z$	$\lambda z.z_6$			
								$\lambda z_{-1} : z_6$		$\lambda x_6.\mathbf{M}(x)$		
								$\lambda z_{-1} : \mathbf{M}(z)$			$\lambda x.x_2$	
							$\lambda y_2\lambda x_1\mathbf{R}xy$	$\lambda z_{-1} : \mathbf{M}(z)_2$				
						$\lambda x_1(x_1{\times}x_{-1})$	$\lambda z_{-1} : \lambda x_1\mathbf{R}[x,\mathbf{M}(z)]$					
					$\lambda x_0{:}x_1$	$\lambda x_1\mathbf{R}[x,\mathbf{M}(x)]$						
				$\lambda x_0\mathbf{M}x$	$\lambda x_0\mathbf{R}[x,\mathbf{M}(x)]$							
			$\lambda P_0\wedge xPx$	$\lambda x_0\{\mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(x)]\}$								
			$\wedge\{\ x \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(x)]\ \}$									$\lambda x.x_2$
		$\lambda x_2\lambda y_1\mathbf{R}yx$	$\wedge\{\ x_2 \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(x)]\ \}$									
J_1		$\lambda y_1 \wedge\{\ \mathbf{R}yx \mid \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(x)]\ \}$ $\lambda y_1\ \forall x\{\mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(x)]\ .{\rightarrow}\ \mathbf{R}yx\}$										
$\forall x\{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(x)]\ .{\rightarrow}\ \mathbf{R}\text{J}x\ \}$												

Thus, the VP ‘respects every man who respects his mother’ admits four readings.

1. $\lambda y_1\ \forall x\ \{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(\boxed{\delta})]\ .{\rightarrow}\ \ \mathbf{R}yx\ \}$
2. $\lambda y_1\ \forall x\ \{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(\boxed{\text{J}})]\ .{\rightarrow}\ \ \mathbf{R}yx\ \}$
3. $\lambda y_1\ \forall x\ \{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(\boxed{y})]\ .{\rightarrow}\ \ \mathbf{R}yx\ \}$
4. $\lambda y_1\ \forall x\ \{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(\boxed{x})]\ .{\rightarrow}\ \ \mathbf{R}yx\ \}$

When applied to ‘Jay’, readings 2 and 3 are truth-conditionally identical.

2. $\forall x\ \{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(\boxed{\text{J}})]\ .{\rightarrow}\ \ \mathbf{R}\boxed{\text{J}}x\ \}$
3. $\forall x\ \{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(\boxed{\text{J}})]\ .{\rightarrow}\ \ \mathbf{R}\boxed{\text{J}}x\ \}$

But when applied to ‘Ray’, they are not.

2. $\forall x\ \{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(\boxed{\text{J}})]\ .{\rightarrow}\ \ \mathbf{R}\boxed{\text{R}}x\ \}$
3. $\forall x\ \{\ \mathbf{M}x\ \&\ \mathbf{R}[x,\mathbf{M}(\boxed{\text{R}})]\ .{\rightarrow}\ \ \mathbf{R}\boxed{\text{R}}x\ \}$

21. Conditionals

It is worthwhile to examine how quantifiers interact with conditionals and alpha-pronouns. For this purpose, we introduce a new form of conditional, promoted by David Lewis (1975), based on the work by Nuel Belnap (1972) on conditional-assertion.[36]

In particular, we propose that ‘if’ occasionally has a reading similar to the word ‘given’ as in conditional probability.

PROB(A/B) =: the probability of A **GIVEN** B

With this as our model, we introduce a two-place connective ‘/’ ["given" ,"slash"] as follows.

if [CA]	S→(S→S)	λP λQ [Q/P]

The logic of slash follows Belnap.[37] To wit:

P/Q = P if Q is true;
P/Q = ⃠ if Q is false.

In other words, if Q is true, then P/Q says P, but if Q is false, then it says *nothing whatsoever* .

[36] Note that we introduce the conditional-operator in an earlier chapter [Quantification Re-Imagined] as an alternative, more sophisticated, account of junction-simplification.

[37] Note that Belnap reads slash backwards from us. We follow the order used in conditional-probability.

The usefulness of slash arises in connection with the following.[38]

<table>
<tr><th>Conditionalization Rule</th></tr>
<tr><td>Ж{ Ω / Ψ | Φ } $\quad\vdash\quad$ Ж{ Ω | Φ & Ψ }</td></tr>
<tr><td>Ж is any junction; Φ, Ψ, Ω are formulas.</td></tr>
</table>

With this in mind, we do a few examples.[39]

29. every man is happy if he is virtuous

<table>
<tr><td>every man</td><td>+1 –1</td><td>is happy</td><td>if</td><td>(–1) he is virtuous</td></tr>
<tr><td>$\wedge x\mathbf{M}x$</td><td>$\lambda x\{x_1 \times x_{-1}\}$</td><td rowspan="2">$\lambda x_1\mathbf{H}x$</td><td rowspan="2">$\lambda X\lambda Y[Y/X]$</td><td rowspan="2">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="2">$\wedge\{\, x_1 \times x_{-1} \mid \mathbf{M}x \,\}$</td></tr>
<tr><td colspan="3">$\wedge\{\, \mathbf{H}x \times x_{-1} \mid \mathbf{M}x \,\}$</td><td colspan="2">$\lambda x_{-1}\, \lambda Y\, [Y/\mathbf{V}x]$</td></tr>
<tr><td colspan="5">$\wedge\{\, \mathbf{H}x/\mathbf{V}x \mid \mathbf{M}x \,\}$
$\wedge\{\, \mathbf{V}x \mid \mathbf{M}x \,\&\, \mathbf{H}x \,\}$
$\forall x\{\, \mathbf{M}x \,\&\, \mathbf{V}x \,.\!\rightarrow \mathbf{H}x \,\}$</td></tr>
</table>

30. no man is happy if he is virtuous

<table>
<tr><td>no man</td><td>+1 –1</td><td>is happy</td><td>if</td><td>(–1) he is virtuous</td></tr>
<tr><td>$\bigcirc x\mathbf{M}x$</td><td>$\lambda x\{x_1 \times x_{-1}\}$</td><td rowspan="2">$\lambda x_1\mathbf{H}x$</td><td rowspan="2">$\lambda X\lambda Y[Y/X]$</td><td rowspan="2">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="2">$\bigcirc\{\, x_1 \times x_{-1} \mid \mathbf{M}x \,\}$</td></tr>
<tr><td colspan="3">$\bigcirc\{\, \mathbf{H}x \times x_{-1} \mid \mathbf{M}x \,\}$</td><td colspan="2">$\lambda x_{-1}\, \lambda Y\, [Y/\mathbf{V}x]$</td></tr>
<tr><td colspan="5">$\bigcirc\{\, \mathbf{H}x/\mathbf{V}x \mid \mathbf{M}x \,\}$
$\bigcirc\{\, \mathbf{V}x \mid \mathbf{M}x \,\&\, \mathbf{H}x \,\}$
$\sim\exists x\{\, \mathbf{M}x \,\&\, \mathbf{V}x \,\&\, \mathbf{H}x \,\}$</td></tr>
</table>

31. some man is happy if he is virtuous

<table>
<tr><td>some man</td><td>+1 –1</td><td>is happy</td><td>if</td><td>(–1) he is virtuous</td></tr>
<tr><td>$\vee x\mathbf{M}x$</td><td>$\lambda x\{x_1 \times x_{-1}\}$</td><td rowspan="2">$\lambda x_1\mathbf{H}x$</td><td rowspan="2">$\lambda X\lambda Y[Y/X]$</td><td rowspan="2">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="2">$\vee\{\, x_1 \times x_{-1} \mid \mathbf{M}x \,\}$</td></tr>
<tr><td colspan="3">$\vee\{\, \mathbf{H}x \times x_{-1} \mid \mathbf{M}x \,\}$</td><td colspan="2">$\lambda x_{-1}\, \lambda Y\, [Y/\mathbf{V}x]$</td></tr>
<tr><td colspan="5">$\vee\{\, \mathbf{H}x/\mathbf{V}x \mid \mathbf{M}x \,\}$
$\vee\{\, \mathbf{V}x \mid \mathbf{M}x \,\&\, \mathbf{H}x \,\}$
$\exists x\{\, \mathbf{M}x \,\&\, \mathbf{V}x \,\&\, \mathbf{H}x \,\}$</td></tr>
</table>

The following re-works a previous example involving two pronouns.

32. every man respects his mother if she is virtuous

<table>
<tr><td>every man +1 –1</td><td>respects (–1) his mother –2</td><td>if</td><td>(–2) she is virtuous</td></tr>
<tr><td>$\wedge\{\, x_1 \times x_{-1} \mid \mathbf{M}x \,\}$</td><td>$\lambda y_{-1}\, \{\, \lambda x_1\, \mathbf{R}[x, \textsc{m}(y)] \times \textsc{m}(y)_{-2} \,\}$</td><td>$\lambda X\lambda Y[Y/X]$</td><td>$\lambda z_{-2}\, \mathbf{V}z$</td></tr>
<tr><td colspan="2">$\wedge\{\, \mathbf{R}[x, \textsc{m}(x)] \times \textsc{m}(x)_{-2} \,\} \mid \mathbf{M}x \,\}$</td><td colspan="2">$\lambda z_{-2}\, \lambda Y[Y/\mathbf{V}z]$</td></tr>
<tr><td colspan="4">$\wedge\{\, \mathbf{R}[x, \textsc{m}(x)] \times \lambda Q\{\, Q \,/\, \mathbf{V}[\textsc{m}(x)] \,\} \mid \mathbf{M}x \,\}$
$\wedge\{\, \mathbf{R}[x, \textsc{m}(x)] \,/\, \mathbf{V}[\textsc{m}(x)] \mid \mathbf{M}x \,\}$
$\wedge\{\, \mathbf{V}[\textsc{m}(x)] \mid \mathbf{M}x \,\&\, \mathbf{R}[x, \textsc{m}(x)] \,\}$
$\forall x\{\, \mathbf{M}x \,\&\, \mathbf{V}[\textsc{m}(x)] \,.\!\rightarrow \mathbf{R}[x, \textsc{m}(x)] \,\}$</td></tr>
</table>

[38] This rule is derivable, based on the logic of conditional-assertion.

[39] These involve the standard ("logician") quantifiers. In Chapter 13, we consider how non-standard quantifiers, including ‘most’ and ‘few’ interact with ‘if’.

Before we go on, it is important to note that, if we employ the usual truth-functional *if-then* connective to interpret ‘if’, we produce an equivalent reading for the ‘every’ examples, but produce incorrect readings for the other two examples.

33. every man is happy if he is virtuous

every man	+1 –1	is happy	if	(–1) he is virtuous
$\bigwedge\{ x \mid \mathbf{M}x \}$	$\lambda x\{x_1 \times x_{-1}\}$			
$\bigwedge\{ x_1 \times x_{-1} \mid \mathbf{M}x \}$		$\lambda x_1\mathbf{H}x$	$\lambda X\lambda Y(X\to Y)$	$\lambda x_{-1}\mathbf{V}x$
$\bigwedge\{ \mathbf{H}x \times x_{-1} \mid \mathbf{M}x \}$			$\lambda x_{-1}\,\lambda Y\,(\mathbf{V}x\to Y)$	
$\bigwedge\{ \mathbf{V}x\to\mathbf{H}x \mid \mathbf{M}x \}$ $\forall x\{ \mathbf{M}x \to (\mathbf{V}x \to \mathbf{H}x) \}$ $\forall x\{ \mathbf{M}x\ \&\ \mathbf{V}x\ .\!\!\to \mathbf{H}x) \}$				
✓ every man who is virtuous is happy ✓				

34. no man is happy if he is virtuous

no man	+1 –1	is happy	if	(–1) he is virtuous
$\bigcirc\{ x \mid \mathbf{M}x \}$	$\lambda x\{x_1 \times x_{-1}\}$			
$\bigcirc\{ x_1 \times x_{-1} \mid \mathbf{M}x \}$		$\lambda x_1\mathbf{H}x$	$\lambda X\lambda Y(X\to Y)$	$\lambda x_{-1}\mathbf{V}x$
$\bigcirc\{ \mathbf{H}x \times x_{-1} \mid \mathbf{M}x \}$			$\lambda x_{-1}\,\lambda Y\,(\mathbf{V}x\to Y)$	
$\bigcirc\{ \mathbf{V}x\to\mathbf{H}x \mid \mathbf{M}x \}$ $\sim\exists x\{ \mathbf{M}x\ \&\ (\mathbf{V}x \to \mathbf{H}x) \}$ $\forall x\{ \mathbf{M}x \to (\mathbf{V}x\ \&\ \sim\mathbf{H}x) \}$				
※ every man is virtuous but not happy ※				

35. some man is happy if he is virtuous

some man	+1 –1	is happy	if	(–1) he is virtuous
$\bigvee\{ x \mid \mathbf{M}x \}$	$\lambda x\{x_1 \times x_{-1}\}$			
$\bigvee\{ x_1 \times x_{-1} \mid \mathbf{M}x \}$		$\lambda x_1\mathbf{H}x$	$\lambda X\lambda Y(X\to Y)$	$\lambda x_{-1}\mathbf{V}x$
$\bigvee\{ \mathbf{H}x \times x_{-1} \mid \mathbf{M}x \}$			$\lambda x_{-1}\,\lambda Y\,(\mathbf{V}x\to Y)$	
$\bigvee\{ \mathbf{V}x\to\mathbf{H}x \mid \mathbf{M}x \}$ $\exists x\{ \mathbf{M}x\ \&\ (\mathbf{V}x\to\mathbf{H}x) \}$ $\exists x(\mathbf{M}x\ \&\ \sim\mathbf{V}x) \vee \exists x(\mathbf{M}x\ \&\ \mathbf{H}x)$				
※ at least one man is not virtuous, or at least one man is happy ※				

In light of these difficulties,[40] we propose the following semantic principle.

> When a conditional is affiliated with a quantifier,[41]
> it serves as a domain-restrictor;
> i.e., it is interpreted as conditional-assertion.[42]

[40] Which are moreover multiplied for non-standard quantifiers like ‘most’ and ‘few’.

[41] The notion of affiliation [*affiliatus*, adopted as son] here includes subordination. For example, in a sentence such as

if every man is virtuous, then …

‘if’ is not subordinate to ‘every man’, so we do not *presume* that ‘if’ is conditional-assertion.

[42] There may be other cases besides in which ‘if’ is interpreted as conditional-assertion.

22. Multiple Quantifiers; Binding Issues

In this section, we illustrate pronoun-binding in examples involving multiple quantifiers.

36. every man respects some woman who respects him

<table>
<tr><td>every man +1 –1</td><td>respects</td><td>some</td><td>woman</td><td>who +1</td><td>respects</td><td colspan="2">(–1) him +2</td><td>+2</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>$\lambda z_{-1}\!:\!z$</td><td>$\lambda x.x_2$</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="2">$\lambda z_{-1}\!:\!z_2$</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>$\lambda x_0\!:\!x_1$</td><td colspan="3">$\lambda z_{-1} : \lambda x_1\mathbf{R}xz$</td><td></td></tr>
<tr><td></td><td></td><td></td><td>$\lambda x_0\mathbf{W}x$</td><td colspan="4">$\lambda z_{-1} : \lambda x_0\, \mathbf{R}xz$</td><td></td></tr>
<tr><td></td><td></td><td>$\lambda P_0\vee yPy$</td><td colspan="5">$\lambda z_{-1}\, \lambda x_0\, \{\mathbf{W}x \;\&\; \mathbf{R}xz\}$</td><td></td></tr>
<tr><td></td><td></td><td colspan="6">$\lambda z_{-1} \vee\{\, y \mid \mathbf{W}y \;\&\; \mathbf{R}yz \,\}$</td><td>$\lambda x.x_2$</td></tr>
<tr><td></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="7">$\lambda z_{-1} \vee\{\, y_2 \mid \mathbf{W}y \;\&\; \mathbf{R}yz \,\}$</td></tr>
<tr><td>$\wedge\{\, x_1{\times}x_{-1} \mid \mathbf{M}x \,\}$</td><td colspan="8">$\lambda z_{-1} \vee\{\, \lambda x_1\mathbf{R}xy \mid \mathbf{W}y \;\&\; \mathbf{R}yz \,\}$</td></tr>
<tr><td colspan="9">$\wedge\{\, x_1 \times \vee\{\, \lambda x_1\mathbf{R}xy \mid \mathbf{W}y \;\&\; \mathbf{R}yx \,\} \mid \mathbf{M}x \,\}$
$\wedge\{\, \vee\{\, \mathbf{R}xy \mid \mathbf{W}y \;\&\; \mathbf{R}yx \,\} \mid \mathbf{M}x \,\}$
$\forall x \,\{\, \mathbf{M}x \rightarrow \exists y(\mathbf{W}y \;\&\; \mathbf{R}yx \;\&\; \mathbf{R}xy) \,\}$</td></tr>
</table>

This computation grants wide-scope to ‘every man’. The following computation grants wide-scope to ‘some woman who…’.

<table>
<tr><td>every man +1 –1</td><td>respects</td><td>some</td><td>woman</td><td>who +1</td><td>respects</td><td colspan="2">(–1) him +2</td><td>+2</td></tr>
<tr><td></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td>$\lambda P_0\vee yPy$</td><td>$\lambda x_0\mathbf{W}x$</td><td>$\lambda x_0\!:\!x_1$</td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td>$\lambda z_{-1}\!:\!z$</td><td>$\lambda x.x_2$</td><td>$\lambda x.x_2$</td></tr>
<tr><td>$\wedge\{\, x_1{\times}x_{-1} \mid \mathbf{M}x \,\}$</td><td colspan="8">$\lambda z_{-1} \vee\{\, \lambda x_1\mathbf{R}xy \mid \mathbf{W}y \;\&\; \mathbf{R}yz \,\}$</td></tr>
<tr><td colspan="9">$\lambda z_{-1} \vee\{\, \wedge\{\, \mathbf{R}xy \times x_{-1} \mid \mathbf{M}x \,\} \mid \mathbf{W}y \;\&\; \mathbf{R}yz \,\}$</td></tr>
<tr><td colspan="9">※※※</td></tr>
</table>

Observe that the interior-most junction *cannot* compute to a truth-value, so the computation fails. This indicates that in order for ‘every man’ to bind ‘him’, it must have wide scope.

On the other hand, if we drop the supposition that ‘every man’ binds ‘him’, then we obtain the following, which computes, although not to a sentence, since ‘him’ remains open.

<table>
<tr><td>every man +1</td><td>respects</td><td>some</td><td>woman</td><td>who +1</td><td>respects</td><td colspan="2">(–1) him +2</td><td>+2</td></tr>
<tr><td></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td>$\lambda P_0\vee yPy$</td><td>$\lambda x_0\mathbf{W}x$</td><td>$\lambda x_0\!:\!x_1$</td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td>$\lambda z_{-1}\!:\!z$</td><td>$\lambda x.x_2$</td><td>$\lambda x.x_2$</td></tr>
<tr><td>$\wedge\{\, x_1 \mid \mathbf{M}x \,\}$</td><td colspan="8">$\lambda z_{-1} \vee\{\, \lambda x_1\mathbf{R}xy \mid \mathbf{W}y \;\&\; \mathbf{R}yz \,\}$</td></tr>
<tr><td colspan="9">$\lambda z_{-1} \vee\{\, \wedge\{\, \mathbf{R}xy \mid \mathbf{M}x \,\} \mid \mathbf{W}y \;\&\; \mathbf{R}yz \,\}$</td></tr>
<tr><td colspan="9">$\lambda z_{-1}\, \exists y\{\, \mathbf{W}y \;\&\; \mathbf{R}yz \;\&\; \forall x\{\mathbf{M}x \rightarrow \mathbf{R}xy\} \,\}$</td></tr>
</table>

This suggests that pronoun-binding is not a free-for-all – we cannot simply declare that an NP binds a pronoun by marking them by the same anaphoric-marker; they may not find each other unless the computation unfolds in a particular way. This happens in the previous example; ‘every man’ *must* be accorded wide-scope. The following is another example.

37. every man who knows her respects some woman

Presumably ‘her’ is *meant to be* bound by ‘some woman’. The derivation proceeds as follows, splitting the sentence into an NP and a VP.

every	man	who+1	knows	(–1) her +2	+1	respects	some	woman	+2	–1
			$\lambda y_2\lambda x_1\mathbf{K}xy$	$\lambda z_{-1} : z_2$			$\lambda P_0\vee yPy$	$\lambda x_0\mathbf{W}x$	$\lambda x.x_2$	$\lambda x.x_{-1}$
		$\lambda x_0{:}x_1$	$\lambda z_{-1} : \lambda x_1\mathbf{K}xz$				$\vee y\mathbf{W}y$		$\lambda x\{x_2 \times x_{-1}\}$	
	$\lambda x_0\mathbf{M}x$	$\lambda z_{-1} : \lambda x_0\mathbf{K}xz$				$\lambda y_2\lambda x_1\mathbf{R}xy$	$\vee\{ y_2 \times y_{-1} \mid \mathbf{W}y \}$			
$\lambda P_0\wedge xPx$	$\lambda z_{-1} : \lambda x_0\{\mathbf{M}x \ \& \ \mathbf{K}xz\}$									
$\lambda z_{-1} : \wedge x\{\mathbf{M}x \ \& \ \mathbf{K}xz\}$					$\lambda x.x_1$					
$\lambda z_{-1} : \wedge\{ x_1 \mid \mathbf{M}x \ \& \ \mathbf{K}xz \}$						$\vee\{ \lambda x_1\mathbf{R}xy \times y_{-1} \mid \mathbf{W}y \}$				
???										

We next must combine the NP and the VP. The question we might ask is whether 'every man…' or '…some woman' has wide scope.

The following derivation attempts to read 'every man who…' as having wide-scope.

every man who+1 knows (–1) her +2 +1	respects some woman +2 –1
$\lambda z_{-1} : \wedge\{ x_1 \mid \mathbf{M}x \ \& \ \mathbf{K}xz \}$	$\vee\{ \lambda x_1\mathbf{R}xy \times y_{-1} \mid \mathbf{W}y \}$
$\lambda z_{-1} : \wedge\{ \vee\{ \mathbf{R}xy \times y_{-1} \mid \mathbf{W}y \} \mid \mathbf{M}x \ \& \ \mathbf{K}xz \}$	
※※※	

This computation fails. On the other hand, if we instead read 'some woman' as having wide-scope, then the computation succeeds, as seen in the following.

every man who+1 knows (–1) her +2 +1	respects some woman +2 –1
$\lambda z_{-1} : \wedge\{ x_1 \mid \mathbf{M}x \ \& \ \mathbf{K}xz \}$	$\vee\{ \lambda x_1\mathbf{R}xy \times y_{-1} \mid \mathbf{W}y \}$
$\vee\{ \lambda x_1\mathbf{R}xy \times \wedge\{ x_1 \mid \mathbf{M}x \ \& \ \mathbf{K}xy \} \mid \mathbf{W}y \}$	
$\vee\{ \ \wedge\{ \mathbf{R}xy \mid \mathbf{M}x \ \& \ \mathbf{K}xy \} \mid \mathbf{W}y \}$	
$\exists y\{ \mathbf{W}y \ \& \ \forall x\{(\mathbf{M}x \ \& \ \mathbf{K}xy) \rightarrow \mathbf{R}xy\} \}$	
there is a woman who is respected by every man who knows her	

Some sentences involving 'who' can be rephrased using 'if'. For example:

every man is happy **who** is virtuous
every man is happy **if he** is virtuous

Let us examine similar sentences involving multiple-quantification.

38. **every** man respects **every** woman if she respects him

every man +1 –1	respects	every woman +2 –2	if	(–2) she +1	respects (–1) him
	$\lambda y_2\lambda x_1\mathbf{R}xy$	$\wedge\{ y_2{\times}y_{-2} \mid \mathbf{W}y \}$		$\lambda u_{-2} : u_1$	$\lambda v_{-1} : \lambda x_1 : \mathbf{R}xv$
$\wedge\{ x_1{\times}x_{-1} \mid \mathbf{M}x \}$	$\wedge\{ \lambda x_1\mathbf{R}xy \times y_{-2} \mid \mathbf{W}y \}$		$\lambda X\lambda Y[Y/X]$	$\lambda v_{-1} : \lambda u_{-2} : \mathbf{R}uv$	
$\wedge\{ \mathbf{R}xy \times x_{-1} \times y_{-2} \mid \mathbf{M}x \ \& \ \mathbf{W}y \}$			$\lambda v_{-1} : \lambda u_{-2} : \lambda Y[Y/\mathbf{R}uv]$		
$\wedge\{ \mathbf{R}xy \times \lambda Y[Y/\mathbf{R}yx] \mid \mathbf{M}x \ \& \ \mathbf{W}y \}$ $\wedge\{ \mathbf{R}xy/\mathbf{R}yx \mid \mathbf{M}x \ \& \ \mathbf{W}y \}$ $\wedge\{ \mathbf{R}xy \mid \mathbf{M}x \ \& \ \mathbf{W}y \ \& \ \mathbf{R}yx \}$ $\forall x\forall y\{ \mathbf{M}x \ \& \ \mathbf{W}y \ \& \ \mathbf{R}yx \ .{\rightarrow} \ \mathbf{R}xy \}$					
for any x,y : if x is a man, and y is a woman, and y respects x, then x respects y					

23. NP-Raising and Pronoun-Fronting

The syntactic phenomenon known as *fronting* involves taking an interior phrase and moving it to the beginning of a sentence in order to emphasize or topicalize it. This is common in Yiddish-English, and it is common in the speech of the *Star Wars* character Yoda.[43]

A *similar* phenomenon occurs when an NP is raised (moved forward), leaving a pronoun trace in the original location, as in the following example, repeated from earlier.

39. Jay, he is virtuous

This can be understood as an instance of pronoun-binding, as seen in the following derivation.

<table>
<tr><td>Jay</td><td>–1</td><td>(–1) he</td><td>+1</td><td>is virtuous</td></tr>
<tr><td>J</td><td>$\lambda x.x_{-1}$</td><td>$\lambda x_{-1}{:}x$</td><td>$\lambda x{:}x_1$</td><td rowspan="2">$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="2" rowspan="2">J_{-1}</td><td colspan="2">$\lambda x_{-1}{:}x_1$</td></tr>
<tr><td colspan="3">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="5">$\mathbf{V}\mathrm{J}$</td></tr>
</table>

In this sentence, 'Jay' does not fill the subject-role directly, but rather indirectly, by being the antecedent of 'he', which fills the subject-role directly.

The raising-maneuver can also be utilized as a way of further elucidating quantifier-binding. For example, the sentence

40. every man is virtuous

can be analyzed as containing a tacit (unpronounced) pronoun, as follows.

every man [, he] is virtuous

<table>
<tr><td>every man</td><td>–1</td><td>(–1) [he] +1</td><td>is virtuous</td></tr>
<tr><td>$\bigwedge x\mathbf{M}x$</td><td>$\lambda x.x_{-1}$</td><td>$\lambda x_{-1}{:}x_1$</td><td>$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="2">$\bigwedge\{\, x_{-1} \mid \mathbf{M}x \,\}$</td><td colspan="2">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="4">$\bigwedge\{\, \mathbf{V}x \mid \mathbf{M}x \,\}$
$\forall x\{\mathbf{M}x \rightarrow \mathbf{V}x\}$</td></tr>
</table>

More radically perhaps, the sentence

41. Jay respects every woman

can be rewritten as follows.

every woman, Jay respects her

<table>
<tr><td>every woman</td><td>–1</td><td>Jay+1</td><td>respects</td><td>(–1) her +2</td></tr>
<tr><td>$\bigwedge x\mathbf{W}x$</td><td>$\lambda x.x_{-1}$</td><td rowspan="2">J_1</td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td>$\lambda z_{-1}{:}z_2$</td></tr>
<tr><td colspan="2" rowspan="2">$\bigwedge\{\, x_{-1} \mid \mathbf{W}x \,\}$</td><td colspan="2">$\lambda z_{-1}{:}\lambda x_1\mathbf{R}xz$</td></tr>
<tr><td colspan="3">$\lambda z_{-1}{:}\mathbf{R}\mathrm{J}z$</td></tr>
<tr><td colspan="5">$\bigwedge\{\, \mathbf{R}\mathrm{J}x \mid \mathbf{W}x \,\}$
$\forall x\{\mathbf{W}x \rightarrow \mathbf{R}\mathrm{J}x\}$</td></tr>
</table>

[43] It is accordingly often called ***Y-fronting*** [presumably for Yiddish, not Yoda!]

24. Varieties of Alpha-Binding

We have already analyzed the following *in situ*,

42. every man is happy if he is virtuous

but it can also be understood as a transformational variant of the following.

every man, **he** is happy if he is virtuous

<table>
<tr><td>every man</td><td>–1</td><td>(–1) he +1</td><td>is happy</td><td>if</td><td>(–1) he +1</td><td>is virtuous</td></tr>
<tr><td>$\wedge x\mathbf{W}x$</td><td>$\lambda x.x_{-1}$</td><td>$\lambda x_{-1}{:}x_1$</td><td>$\lambda x_1\mathbf{H}x$</td><td rowspan="2">$\lambda X\lambda Y[Y/X]$</td><td>$\lambda x_{-1}{:}x_1$</td><td>$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="2" rowspan="3">$\wedge\{ x_{-1} \mid \mathbf{M}x \}$</td><td colspan="2" rowspan="2">$\lambda x_{-1}\mathbf{H}x$</td><td colspan="2">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="3">$\lambda x_{-1}\ \lambda Y[H/\mathbf{V}x]$</td></tr>
<tr><td colspan="5">$\lambda x_{-1}\ [\mathbf{H}x/\mathbf{V}x]$</td></tr>
<tr><td colspan="7">$\wedge\{ \mathbf{H}x/\mathbf{V}x \mid \mathbf{M}x \}$
$\wedge\{ \mathbf{H}x \mid \mathbf{M}x \ \&\ \mathbf{V}x \}$
$\forall x\{ \mathbf{M}x \ \&\ \mathbf{V}x \ .\!\to \mathbf{H}x \}$</td></tr>
<tr><td colspan="7">every man who is virtuous is happy</td></tr>
</table>

Note that this introduces a new **Alpha-Duplication Principle**.

<table>
<tr><td>$\alpha \quad \vdash \quad \alpha \times \alpha$</td></tr>
<tr><td>α is any alpha-marker</td></tr>
</table>

This allows one to alpha-mark an NP just once, and still have it bind many pronouns. Contrast this derivation with the following in which 'every man' plays two alpha-roles.

<table>
<tr><td>every man</td><td>–1 –2</td><td>(–1) he +1</td><td>is happy</td><td>if</td><td>(–2) he +1</td><td>is virtuous</td></tr>
<tr><td>$\wedge x\mathbf{M}x$</td><td>$\lambda x(x_{-1} \times x_{-2})$</td><td>$\lambda x_{-1}{:}x_1$</td><td>$\lambda x_1\mathbf{H}x$</td><td rowspan="2">$\lambda X\lambda Y[Y/X]$</td><td>$\lambda y_{-2}{:}y_1$</td><td>$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="2" rowspan="3">$\wedge\{ x_{-1} \times x_{-2} \mid \mathbf{M}x \}$</td><td colspan="2" rowspan="2">$\lambda x_{-1}\mathbf{H}x$</td><td colspan="2">$\lambda y_{-2}\mathbf{V}y$</td></tr>
<tr><td colspan="3">$\lambda y_{-2} : \lambda Y[Y/\mathbf{V}y]$</td></tr>
<tr><td colspan="5">$\lambda x_{-1}\ \lambda y_{-2}\ [\mathbf{H}x/\mathbf{V}y]$</td></tr>
<tr><td colspan="7">$\wedge\{ \mathbf{H}x/\mathbf{V}x \mid \mathbf{M}x \}$
$\wedge\{ \mathbf{H}x \mid \mathbf{M}x \ \&\ \mathbf{V}x \}$
$\forall x\{ \mathbf{M}x \ \&\ \mathbf{V}x \ .\!\to \mathbf{H}x \}$</td></tr>
</table>

It is also worthwhile to compare these derivations to the following in which the first occurrence of 'he' binds the second occurrence of 'he'.

<table>
<tr><td>every man</td><td>–1</td><td>(–1) he +1 –2</td><td>is happy</td><td>if</td><td>(–2) he +1</td><td>is virtuous</td></tr>
<tr><td>$\wedge x\mathbf{W}x$</td><td>$\lambda x{:}x_{-1}$</td><td>$\lambda x_{-1}(x_1 \times x_{-2})$</td><td>$\lambda x_1\mathbf{H}x$</td><td rowspan="2">$\lambda X\lambda Y[Y/X]$</td><td>$\lambda y_{-2}{:}y_1$</td><td>$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="2" rowspan="3">$\wedge\{ x_{-1} \mid \mathbf{M}x \}$</td><td colspan="2" rowspan="2">$\lambda x_{-1}\{ \mathbf{H}x \times x_{-2} \}$</td><td colspan="2">$\lambda y_{-2}\mathbf{V}y$</td></tr>
<tr><td colspan="3">$\lambda y_{-2} : \lambda Y[Y/\mathbf{V}y]$</td></tr>
<tr><td colspan="5">$\lambda x_{-1}\{ \mathbf{H}x \times \lambda Y[Y/\mathbf{V}x] \}$
$\lambda x_{-1}\ [\mathbf{H}x/\mathbf{V}x]$</td></tr>
<tr><td colspan="7">$\wedge\{ \mathbf{H}x/\mathbf{V}x \mid \mathbf{M}x \}$
$\wedge\{ \mathbf{H}x \mid \mathbf{M}x \ \&\ \mathbf{V}x \}$
$\forall x\{ \mathbf{M}x \ \&\ \mathbf{V}x \ .\!\to \mathbf{H}x \}$</td></tr>
</table>

So 'every man' binds the second 'he' in virtue of binding the first 'he'.

25. Such That

Philosophers are fond of the expression 'such that', and use it in phrases like the following.

every woman is **such that** Jay respects her
every man is **such that** if he is virtuous then he is happy

Whereas the former explicates example **Error! Reference source not found.** above, the latter explicates example **Error! Reference source not found.** above

So, how do we analyze 'such that'? Consider the following incomplete derivation.

43. every man is such that he is virtuous

<table>
<tr><td>every man +1</td><td>is</td><td>such-that</td><td>(–1) he is virtuous</td></tr>
<tr><td rowspan="3">$\wedge\{ x_1 \mid \mathbf{M}x \}$</td><td rowspan="2">$\lambda P_0{:}P_1$</td><td>**?**</td><td>$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="2">$\lambda x_0\mathbf{V}x$</td></tr>
<tr><td colspan="3">$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="4">$\wedge\{ \mathbf{V}x \mid \mathbf{M}x \}$
$\forall x\{ \mathbf{M}x \rightarrow \mathbf{V}x \}$</td></tr>
</table>

We have worked backwards, leaving blank only the entry for 'such that'. By way of solving for the unknown, we propose the following lexical entry.[44]

<table>
<tr><td>such-that</td><td>$D_0 \rightarrow D$</td><td>$\lambda x_0{:}x$</td></tr>
<tr><td colspan="3">admits only alpha-markers
(no functional-markers)</td></tr>
</table>

Note that the categorial rendering makes 'such that' behave semantically just like 'that'. However, there is an important syntactic-restriction that prevents it from playing a functional-role. With this in hand, we complete the above derivation as follows.

<table>
<tr><td>every man +1</td><td>is</td><td>such-that</td><td>–1</td><td>(–1) he +1</td><td>is virtuous</td></tr>
<tr><td rowspan="4">$\wedge\{ x_1 \mid \mathbf{M}x \}$</td><td rowspan="3">$\lambda P_0{:}P_1$</td><td>$\lambda x_0{:}x$</td><td>$\lambda x{:}x_{-1}$</td><td>$\lambda x_{-1}{:}x_1$</td><td>$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="2">$\lambda x_0{:}x_{-1}$</td><td colspan="2">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="4">$\lambda x_0\mathbf{V}x$</td></tr>
<tr><td colspan="5">$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="6">$\wedge\{ \mathbf{V}x \mid \mathbf{M}x \}$
$\forall x\{ \mathbf{M}x \rightarrow \mathbf{V}x \}$</td></tr>
</table>

The following example further illustrates our account.

44. man such that he is virtuous

<table>
<tr><td>man</td><td>such-that</td><td>–1</td><td>(–1) he +1</td><td>is virtuous</td></tr>
<tr><td rowspan="3">$\lambda x_0\mathbf{M}x$</td><td>$\lambda x_0{:}x$</td><td>$\lambda x.x_{-1}$</td><td>$\lambda x_{-1}{:}x_1$</td><td>$\lambda x_1\mathbf{V}x$</td></tr>
<tr><td colspan="2">$\lambda x_0{:}x_{-1}$</td><td colspan="2">$\lambda x_{-1}\mathbf{V}x$</td></tr>
<tr><td colspan="4">$\lambda x_0\mathbf{V}x$</td></tr>
<tr><td colspan="5">$\lambda x_0\{\mathbf{M}x \;\&\; \mathbf{V}x\}$</td></tr>
</table>

[44] This is **monadic** *such-that*. There is also **polyadic** *such-that*, which occurs in even more abstruse constructions such as: man and woman such that he respects her. +++$[\lambda(x{+}y)_0{:}(\mathbf{M}x \;\&\; \mathbf{W}y \;\&\; \mathbf{R}xy)]$+++

26. Comparison of Bound and Reflexive Pronouns

It may be interesting to see what happens if we re-parse the following

45. Jay respects his mother

<table>
<tr><td>Jay</td><td>+1</td><td>REF(+1,–1)</td><td>respects (–1) his mother</td></tr>
<tr><td>J</td><td>$\lambda x.x_1$</td><td>$\lambda x_1(x_1 \times x_{-1})$</td><td>$\lambda y_{-1}\ \lambda x_1\ \mathbf{R}[x, \mathrm{M}(y)]$</td></tr>
<tr><td colspan="2">J_1</td><td colspan="2">$\lambda x_1 \mathbf{R}[x, \mathrm{M}(x)]$</td></tr>
<tr><td colspan="4">$\mathbf{R}[\mathrm{J}, \mathrm{M}(\mathrm{J})]$</td></tr>
</table>

so that REF(+1,–1) attaches to 'Jay+1'.

<table>
<tr><td>Jay</td><td>+1</td><td>REF(+1,–1)</td><td>respects (–1) his mother</td></tr>
<tr><td>J</td><td>$\lambda x.x_1$</td><td></td><td></td></tr>
<tr><td colspan="2">J_1</td><td>$\lambda x_1(x_1 \times x_{-1})$</td><td></td></tr>
<tr><td colspan="3">$J_1 \times J_{-1}$</td><td>$\lambda y_{-1}\ \lambda x_1\ \mathbf{R}[x, \mathrm{M}(y)]$</td></tr>
<tr><td colspan="4">$\mathbf{R}[\mathrm{J}, \mathrm{M}(\mathrm{J})]$</td></tr>
</table>

Compare this with the following derivation, which treats 'he' as bound by 'Jay'.

<table>
<tr><td>Jay</td><td>+1</td><td>–1</td><td>respects (–1) his mother</td></tr>
<tr><td rowspan="2">J</td><td>$\lambda x.x_1$</td><td>$\lambda x.x_{-1}$</td><td></td></tr>
<tr><td colspan="2">$\lambda x(x_1 \times x_{-1})$</td><td></td></tr>
<tr><td colspan="3">$J_1 \times J_{-1}$</td><td>$\lambda y_{-1} \lambda x_1 \mathbf{R}[x, \mathrm{M}(y)]$</td></tr>
<tr><td colspan="4">$\mathbf{R}[\mathrm{J}, \mathrm{M}(\mathrm{J})]$</td></tr>
</table>

This shows how reflexive-pronouns are formal-semantically very similar to bound-pronouns. Note carefully, however, that this is a semantic point, not a syntactic point. We do not propose that the new parsing is syntactically-admissible.[45]

27. Possessive Pronouns

So far, we have an account of nearly every word that counts as a personal pronoun. The only items missing are the following.

mine, yours, his, hers, ours, theirs

We concentrate on 'mine', leaving the remaining forms as an exercise.[46]

Now, 'mine' behaves like an adjective, perhaps the first one some children learn.[47] The semantics for 'mine' is in fact the same as the semantics for 'my' in its possessive form; it means "belongs to me". The difference is syntactic: whereas 'mine' acts syntactically as a bare-adjective, 'my' acts syntactically as a determiner, and accordingly can't stand alone.

As usual, there is more to say! For, we can also think of 'mine' as short for 'my one', in which case it can be genitive or possessive, and also anaphoric, as in:

Elle is your mother, but she is also mine [i.e., my mother].
Elle is your dog, but she is also mine [i.e., my dog].

[45] The idea is that the unpronounced reflexive morpheme attaches to a VP. This suggests that, deep down, reflexion is a VP-operator.

[46] Note that 'mine' also serves as a phonetic-variant of 'my' [like 'a' changing to 'an'], as in the following verse.

mine eyes have seen the glory of the coming of the Lord…

[47] Our child's first word was 'down'. Our neighbors had a child, born the same night, whose first word was 'more'. Different children have different needs!

28. Unpronounced Pronouns

We have concentrated on overt personal pronouns. Occasionally, however, personal pronouns are unpronounced.[48] For example, compare the following sentences.

Kay wants to be president
Jay wants Kay to be president

Contemporary Syntax posits a covert morpheme PRO, which makes the first sentence have the same form as the second sentence.

Kay wants **PRO** to be president

Semantics must render PRO so that these sentences entail that Jay and Kay both want Kay to be president. We propose the following rendering.

PRO	$D_1 \rightarrow (D_1 \times D_2)$	$\lambda x_1\{x_1 \times x_2\}$

In other words, PRO is a reflexive pronoun, which is not surprising considering the following paraphrase.

Kay wants **herself** to be president

The following is the analysis, which contains numerous details that we leave until later.[49]

Kay +1	wants	PRO	to	be president	+2
			$\lambda x_1 Fx \rightarrow \lambda x_2\langle Fx\rangle$	$\lambda x_1 \mathbf{P}x$	
		$\lambda x_1\{x_1 \times x_2\}$	$\lambda x_2\langle \mathbf{P}x\rangle$		
		$\lambda x_1\{ x_1 \times \langle \mathbf{P}x\rangle \}$			$\lambda x.x_2$
	$\lambda y_2\lambda x_1\mathbb{W}[x,y]$	$\lambda x_1\{ x_1 \times \langle \mathbf{P}x\rangle_2 \}$			
K_1	$\lambda x_1\mathbb{W}[x, \langle \mathbf{P}x\rangle]$				
$\mathbb{W}[\text{K}, \langle \mathbf{P}\text{K}\rangle]$					

29. Expletive Pronouns

Also, by way of anticipating a later chapter, we mention expletive-pronouns 'there' and 'it'. The following sentence, although stilted and academic, illustrates both.

Kay wants **it** to be the case that **there** is peace everywhere

In Chapter 12, we offer a detailed account of expletive-pronouns. Our central claim is that an expletive-pronoun ['it' and 'there', as used above] is:

(1) an anaphoric pronoun, which
(2) anticipates its antecedent, and
(3) marks its antecedent as the **topic** of the immediate containing clause.

30. Irreducibly Duplicative Pronouns

We have postulated two basic types of endophoric pronouns – duplicative-pronouns and alpha-pronouns. We have seen that alpha-pronouns are often not reducible to duplicative-pronouns. What about the converse – are all duplicative-pronouns reducible to alpha-pronouns? The following is a simple example.

46. Jay respects his mother

As noted earlier, this has readings according to which:

---

[48] There is also pronoun-dropping in imperative sentences, and pronoun-dropping in declarative sentences in languages with rich subject-verb morphology, such as Spanish and Italian. We ignore these.
[49] Chapter 12 [There and It].

		main components		final formula
1.	'he' is demonstrative	J_1	$\lambda x_1\ \mathbf{R}[x,\mathbf{M}(\delta)]$	$\mathbf{R}[J,\mathbf{M}(\delta)]$
2.	'he' is duplicative	J_1	$\lambda x_1\ \mathbf{R}[x,\mathbf{M}(J)]$	$\mathbf{R}[J,\mathbf{M}(J)]$
3.	'he' is reflexive	J_1	$\lambda x_1\ \mathbf{R}[x,\mathbf{M}(x)]$	$\mathbf{R}[J,\mathbf{M}(x)]$
4.	'he' is bound	$J_1 \times J_{-1}$	$\lambda y_{-1}\ \lambda x_1\ \mathbf{R}[x,\mathbf{M}(y)]$	$\mathbf{R}[J,\mathbf{M}(J)]$

The trees for 2 and 4 are:

<table>
<tr><td>①
Jay</td><td>+1</td><td>respects</td><td>①
he</td><td>'s</td><td>mother</td><td>+2</td></tr>
<tr><td>J</td><td>$\lambda x.x_1$</td><td></td><td>J</td><td>$\lambda x.x_6$</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td colspan="2">J_6</td><td>λx_6:$\mathbf{M}(x)$</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td colspan="3">$\mathbf{M}(J)$</td><td>$\lambda x.x_2$</td></tr>
<tr><td colspan="2"></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="4">$\mathbf{M}(J)_2$</td></tr>
<tr><td colspan="2">J_1</td><td colspan="5">$\lambda x_1\mathbf{R}[x,\mathbf{M}(J)]$</td></tr>
<tr><td colspan="7">$\mathbf{R}[J,\mathbf{M}(J)]$</td></tr>
</table>

<table>
<tr><td>Jay +1 –1</td><td>respects</td><td>(–1) he</td><td>'s</td><td>mother</td><td>+2</td></tr>
<tr><td></td><td></td><td>λy_{-1}:y</td><td>$\lambda y.y_6$</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">λy_{-1}:y_6</td><td>λy_6:$\mathbf{M}(y)$</td><td></td></tr>
<tr><td></td><td></td><td colspan="3">λy_{-1}:$\mathbf{M}(y)$</td><td>$\lambda y.y_2$</td></tr>
<tr><td></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="4">$\lambda y_{-1}$:$\mathbf{M}(y)_2$</td></tr>
<tr><td>$J_1 \times J_{-1}$</td><td colspan="5">$\lambda y_{-1}\ \lambda x_1\ \mathbf{R}[x,\mathbf{M}(y)]$</td></tr>
<tr><td colspan="6">$\mathbf{R}[J,\mathbf{M}(J)]$</td></tr>
</table>

Examples such as these suggest that duplicative-pronouns are theoretically superfluous; any sentence that can be analyzed using duplicative pronouns can just as easily be analyzed using alpha-pronouns. Unfortunately, this hypothesis founders when it faces a number of examples, three types of which we examine. The first type is as follows; the remaining two types are examined in the following two sections.

47. Jay respects his mother, and Ray respects her [too] [50]

In this sentence, 'her' is plausibly read as anaphoric to 'his mother', and 'his' is plausibly read as anaphoric to 'Jay'.[51] The following analysis reads 'his' as bound by 'Jay', and 'her' as bound by 'his mother'.

<table>
<tr><td>Jay +1 –1</td><td>respects</td><td>(–1) his</td><td>mother</td><td>+2 –2</td><td>and</td><td>Ray +1</td><td>respects</td><td>(–2) her +2</td></tr>
<tr><td></td><td></td><td>λy_{-1}:y_6</td><td>λy_6:$\mathbf{M}(y)$</td><td></td><td></td><td></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td>$\lambda z_{-2}$:$z_2$</td></tr>
<tr><td></td><td></td><td colspan="2">λy_{-1} : $\mathbf{M}(y)$</td><td>$\lambda x(x_2 \times x_{-2})$</td><td></td><td>$R_1$</td><td colspan="2">$\lambda z_{-2}\ \lambda x_1\ \mathbf{R}xz$</td></tr>
<tr><td></td><td>$\lambda y_2\lambda x_1\mathbf{R}xy$</td><td colspan="3">$\lambda y_{-1}$ { $\mathbf{M}(y)_2 \times \mathbf{M}(y)_{-2}$ }</td><td></td><td colspan="3"></td></tr>
<tr><td>$J_1 \times J_{-1}$</td><td colspan="4">$\lambda y_{-1}\ \lambda x_1$ { $\mathbf{R}[x, \mathbf{M}(y)] \times \mathbf{M}(y)_{-2}$ }</td><td></td><td colspan="3"></td></tr>
<tr><td colspan="5">$\mathbf{R}[J, \mathbf{M}(J)] \times \mathbf{M}(J)_{-2}$</td><td>&</td><td colspan="3">$\lambda z_{-2}\ \mathbf{R}RZ$</td></tr>
<tr><td colspan="9">$\mathbf{R}[J, \mathbf{M}(J)] \times \mathbf{R}[R, \mathbf{M}(J)]$</td></tr>
<tr><td colspan="9">Jay respects Jay's mom, and Ray respects Jay's mom</td></tr>
</table>

This is an admissible reading, but there is another reading according to which 'her' somehow refers to Ray's mom, not Jay's mom. This is accomplished by treating 'her' as duplicative on 'his mother', as in the following analysis.

[50] [+++where does this originate?+++]
[51] A demonstrative reading of 'her' is possible, but the presence of the word 'too' makes this reading strange.

		①						①	
Jay +1 –1	respects	(–1) his	mother	+2	and	Ray +1 –1	respects	her	+2
		$\lambda y_{-1}{:}y_6$	$\lambda y_6{:}\mathbf{M}(y)$					$\lambda y_{-1} : \mathbf{M}(y)$	$\lambda x.x_2$
		$\lambda y_{-1} : \mathbf{M}(y)$		$\lambda x.x_2$			$\lambda y_2\lambda x_1\mathbf{R}xy$	$\lambda y_{-1} : \mathbf{M}(y)_2$	
	$\lambda y_2\lambda x_1\mathbf{R}xy$	$\lambda y_{-1}\ \mathbf{M}(y)_2$				$R_1 \times R_{-1}$	$\lambda y_{-2}\ \lambda x_1\ \mathbf{R}[x, \mathbf{M}(y)]$		
$J_1 \times J_{-1}$	$\lambda y_{-1}\ \lambda x_1\ \mathbf{R}[x, \mathbf{M}(y)]$								
$\mathbf{R}[J, \mathbf{M}(J)]$					&	$\mathbf{R}[R, \mathbf{M}(R)]$			
$\mathbf{R}[J, \mathbf{M}(J)] \times \mathbf{R}[R, \mathbf{M}(R)]$									
Jay respects Jay's mom, and Ray respects Ray's mom									

31. Bach-Peters Sentences

The following are examples, known as Bach-Peters sentences.[52]

48. every pilot who shot at it hit the MIG that chased him

49. every boy who deserved it received the prize he wanted

The latter is complicated by three questions.

(1) is 'it' a pro-NP or a pro-sentence?
(2) is 'he' reflexive or anaphoric?
(3) is 'wants' an attitude-verb?
(4) is 'deserves' an attitude-verb?

We propose a simplified account of this sentence, which treats 'deserves' and 'wants' as ordinary extensional predicates, and accordingly treats 'it' as a pro-NP. On this reading, the two sentences have the same form; in the following, we analyze the second one.

every	boy	who+1	deserved	(–2) it +2	+1 –1	received	the P (–1) he wanted	+2 –2
			$\lambda y_2\lambda x_1\mathbf{D}xy$	$\lambda z_{-2}{:}z_2$			$\lambda z_{-1}[\iota y\mathbf{P}zy]$	$\lambda x\{x_2 \times x_{-2}\}$
		$\lambda x_0{:}x_1$	$\lambda z_{-2}\ \lambda x_1\mathbf{D}xz$			$\lambda y_2\lambda x_1\mathbf{R}xy$	$\lambda z_{-1}\ \{\ [\iota y\mathbf{P}zy]_2 \times [\iota y\mathbf{P}zy]_{-2}\ \}$	
	$\Sigma x\mathbf{B}x$	$\lambda z_{-2}\ \lambda x_0\mathbf{D}xz$						
$\Sigma{\rightarrow}\bigwedge$	$\lambda z_{-2}\ \Sigma x(\mathbf{B}x\ \&\ \mathbf{D}xz)$							
$\lambda z_{-2} \bigwedge x(\mathbf{B}x\ \&\ \mathbf{D}xz)$					$\lambda x(x_1 \times x_{-1})$			
$\lambda z_{-2} \bigwedge\{\ x_1 \times x_{-1} \mid \mathbf{B}x\ \&\ \mathbf{D}xz\ \}$						$\lambda z_{-1}\ \{\ \lambda x_1\mathbf{R}[x, \iota y\mathbf{P}zy] \times [\iota y\mathbf{P}zy]_{-2}\ \}$		
$\lambda z_{-2} \bigwedge\{\ x_1 \times \lambda x_1\mathbf{R}[x, \iota y\mathbf{P}xy] \times [\iota y\mathbf{P}xy]_{-2} \mid \mathbf{B}x\ \&\ \mathbf{D}xz\ \}$ $\lambda z_{-2} \bigwedge\{\ \mathbf{R}[x, \iota y\mathbf{P}xy] \times [\iota y\mathbf{P}xy]_{-2} \mid \mathbf{B}x\ \&\ \mathbf{D}xz\ \}$ **???** $\bigwedge\{\ \mathbf{R}[x, \iota y\mathbf{P}xy] \mid \mathbf{B}x\ \&\ \mathbf{D}[x,\iota y\mathbf{P}xy]\ \}$ **???** $\forall x\{\ \mathbf{B}x\ \&\ \mathbf{D}[x,\iota y\mathbf{P}xy]\ .{\rightarrow}\ \mathbf{R}[x, \iota y\mathbf{P}xy]\ \}$								
every boy who deserved the prize he wanted received the prize he wanted								

This produces the proper reading. Unfortunately, the maneuver marked '**???**' is mathematically dubious at best, ridiculous at worst. The function requires an item of type D_{-1}. There is an item of this type – $[\iota y\mathbf{P}xy]_{-2}$ – but it is part of the function's *output*. The maneuver involves a "snake eating its own tail" – it *somehow* extracts $[\iota y\mathbf{P}xy]_{-2}$ from the output expression and submits it to the function, which involves substituting $\iota y\mathbf{P}xy$ for z, which results in the proposed expression.

The sentence can more legitimately be computed by treating 'it' as a duplicative pronoun, while treating both verbs as reflexive.

[52] Bach (1970). A detailed account may be found in Karttunen (1971). Also see Jacobson (2000).

every	boy	who+1	REF(+1,–1)	deserved	① it	+2	+1	REF(+1,–1) received the P (–1) he wanted
					$\lambda z_{-1}[\iota y\mathbf{P}zy]$	$\lambda x{:}x_2$		
				$\lambda y_2\lambda x_1\mathbf{D}xy$	$\lambda z_{-1}[\iota y\mathbf{P}zy]_2$			
			$\lambda x_1(x_1 \times x_{-1})$	$\lambda z_{-1}\lambda x_1\,\mathbf{D}[x, \iota y\mathbf{P}zy]$				
		$\lambda x_0{:}x_1$	$\lambda x_1\,\mathbf{D}[x, \iota y\mathbf{P}xy]$					
	$\Sigma x\mathbf{B}x$	$\lambda x_0\,\mathbf{D}[x, \iota y\mathbf{P}xy]$						
$\Sigma\to\wedge$	$\Sigma x(\mathbf{B}x\ \&\ \mathbf{D}[x, \iota y\mathbf{P}xy])$							
$\wedge x(\mathbf{B}x\ \&\ \mathbf{D}[x, \iota y\mathbf{P}xy])$							$\lambda x.x_1$	[from below] $\lambda x_1\,\mathbf{R}[x, \iota y\mathbf{P}xy]$
$\wedge\{\, x_1 \mid \mathbf{B}x\ \&\ \mathbf{D}[x, \iota y\mathbf{P}xy]\,\}$								
$\wedge\{\, \mathbf{R}[x, \iota y\mathbf{P}xy] \mid \mathbf{B}x\ \&\ \mathbf{D}[x, \iota y\mathbf{P}xy]\,\}$ $\forall x\{\, \mathbf{B}x\ \&\ \mathbf{D}[x, \iota y\mathbf{P}xy]\ .\!\to \mathbf{R}[x, \iota y\mathbf{P}xy]\,\}$								
every boy who deserved the prize he wanted received the prize he wanted								

REF(+1,–1)	receives	① the P (–1) he wants	+2
		$\lambda z_{-1}[\iota y\mathbf{P}zy]$	$\lambda x.x_2$
	$\lambda y_2\lambda x_1\mathbf{R}xy$	$\lambda z_{-1}[\iota y\mathbf{P}zy]_2$	
$\lambda x_1(x_1 \times x_{-1})$	$\lambda z_{-1}\lambda x_1\,\mathbf{R}[x, \iota y\mathbf{P}zy]$		
$\lambda x_1\,\mathbf{R}[x, \iota y\mathbf{P}xy]$			

32. Paycheck Pronouns

These are pronouns such as in the following example.[53]

50. a wise man gives his paycheck to his wife; a fool gives it to his mistress

The following is an attempt at alpha-binding 'it' to 'his paycheck'. Note that we treat 'a' as general (universal).[54]

a wise man +1	REF(+1,–1)	gives	his paycheck +2 –2	to his wife
		$\lambda z_3\lambda y_2\lambda x_1\mathbf{G}xyz$	$\lambda z_{-1}\,\{\mathbf{P}(z)_2 \times \mathbf{P}(z)_{-2}\}$	$\lambda z_{-1}\,\mathbf{W}(z)_3$
	$\lambda x_1(x_1 \times x_{-1})$	$\lambda z_{-1}\lambda x_1\,\{\mathbf{G}[x, \mathbf{P}(z), \mathbf{W}(z)] \times \mathbf{P}(z)_{-2}\}$		
$\wedge\{\, x_1 \mid \mathbf{W}x\,\}$	$\lambda x_1\,\{\mathbf{G}[x, \mathbf{P}(x), \mathbf{W}(x)] \times \mathbf{P}(x)_{-2}\}$			
$\wedge\{\, \mathbf{G}[x, \mathbf{P}(x), \mathbf{W}(x)] \times \mathbf{P}(x)_{-2}\} \mid \mathbf{W}x\,\}$				

a fool +1	REF(+1,–1)	gives	(–2) it	to his mistress
		$\lambda z_3\lambda y_2\lambda x_1\mathbf{G}xyz$	$\lambda y_{-2}{:}y_2$	$\lambda z_{-1}\,\mathbf{M}(z)_3$
	$\lambda x_1(x_1 \times x_{-1})$	$\lambda z_{-1}\lambda y_{-2}\lambda x_1\,\mathbf{G}[x, y, \mathbf{M}(z)]$		
$\wedge\{\, x_1 \mid \mathbf{F}x\,\}$	$\lambda y_{-2}\lambda x_1\,\mathbf{G}[x, y, \mathbf{M}(x)]$			
$\lambda y_{-2}\wedge\{\, \mathbf{G}[x, y, \mathbf{M}(x)] \mid \mathbf{F}x\,\}$ $\lambda y_{-2}\forall x\{\, \mathbf{F}x \to \mathbf{G}[x, y, \mathbf{M}(x)]\,\}$				

a wise man gives his paycheck to his wife	a fool gives it to his mistress
$\wedge\{\, \mathbf{G}[x, \mathbf{P}(x), \mathbf{W}(x)] \times \mathbf{P}(x)_{-2}\} \mid \mathbf{W}x\,\}$	$\lambda y_{-2}\forall x\{\mathbf{F}x \to \mathbf{G}[x, y, \mathbf{M}(x)]\}$
$\wedge\{\, \mathbf{G}[x, \mathbf{P}(x), \mathbf{W}(x)] \times \forall y\{\, \mathbf{F}y \to \mathbf{G}[y, \mathbf{P}(x), \mathbf{M}(y)]\,\} \mid \mathbf{W}x\,\}$ $\forall x\{\, \mathbf{W}x \to{:}\ \mathbf{G}[x, \mathbf{P}(x), \mathbf{W}(x)]\ \&\ \forall y\{\mathbf{F}y \to \mathbf{G}[y, \mathbf{P}(x), \mathbf{M}(y)]\}\,\}$	
for any x, if x is wise, then x gives x's paycheck to x's wife, and every fool y gives x's paycheck to y's mistress	

This is a truly bizarre claim; perhaps the fool is not so foolish after all! The likely intended meaning, however, is quite different. How is it constructed from these components? The answer is that we can

[53] For example Jacobson (2000).

[54] See Chapter 8 [Indefinite Noun Phrases].

treat ‘it’ as duplicative on ‘his paycheck’, as follows. Note that, although it is not necessary, it is logically cleaner to treat the VPs as reflexive.

a wise man +1	REF(+1,–1)	gives	① his paycheck +2	to his wife
		$\lambda z_3\lambda y_2\lambda x_1\mathbf{G}xyz$	$\lambda z_{-1}\ \mathbf{P}(z)_2$	$\lambda z_{-1}\ \mathbf{W}(z)_3$
	$\lambda x_1(x_1 \times x_{-1})$	$\lambda z_{-1}\ \lambda x_1\ \mathbf{G}[x, \mathbf{P}(z), \mathbf{W}(z)]$		
$\wedge\{\ x_1 \mid \mathbf{W}x\ \}$	$\lambda x_1\ \mathbf{G}[x, \mathbf{P}(x), \mathbf{W}(x)]$			
$\wedge\{\ \mathbf{G}[x, \mathbf{P}(x), \mathbf{W}(x)] \mid \mathbf{W}x\ \}$ $\forall x\{\ \mathbf{W}x \rightarrow \mathbf{G}[x, \mathbf{P}(x), \mathbf{W}(x)]\ \}$				
for any x, if x is wise, then x gives x's paycheck to x's wife				

a fool +1	REF(+1,–1)	gives	① it	to his mistress
		$\lambda z_3\lambda y_2\lambda x_1\mathbf{G}xyz$	$\lambda z_{-1}\ \mathbf{P}(z)_2$	$\lambda z_{-1}\ \mathbf{M}(z)_3$
	$\lambda x_1(x_1 \times x_{-1})$	$\lambda z_{-1}\ \lambda x_1\ \mathbf{G}[x, \mathbf{P}(z), \mathbf{M}(z)]$		
$\wedge\{\ x_1 \mid \mathbf{F}x\ \}$	$\lambda x_1\ \mathbf{G}[x, \mathbf{P}(x), \mathbf{M}(x)]$			
$\wedge\{\ \mathbf{G}[x, \mathbf{P}(x), \mathbf{M}(x)] \mid \mathbf{F}x\ \}$ $\forall x\{\ \mathbf{F}x \rightarrow \mathbf{G}[x, \mathbf{P}(x), \mathbf{M}(x)]\ \}$				
for any x, if x is a fool, then x gives x's paycheck to x's mistress				

The following is a similar example.

51. a wise man gives his mother a savings bond; a fool gives her a lottery ticket

In a manner similar to the previous example, this has a bizarre reading according to which every fool gives every wise man's mother a lottery ticket. The plausible reading treats ‘her’ as duplicative. Note that this reading treats the outer ‘a’ as universal, and treats the inner ‘a’ as existential.[55]

a wise man +1	REF(+1,–1)	gives	① (–1) his mother +3	a savings bond +2
		$\lambda z_3\lambda y_2\lambda x_1\mathbf{G}xyz$	$\lambda z_{-1}\ \mathbf{M}(z)_3$	$\vee\{\ y_2 \mid \mathbf{B}y\ \}$
	$\lambda x_1(x_1 \times x_{-1})$	$\vee\{\ \lambda z_{-1}\lambda x_1\mathbf{G}[x,y,\mathbf{M}(z)] \mid \mathbf{B}y\ \}$		
$\wedge\{\ x_1 \mid \mathbf{W}x\ \}$	$\vee\{\ \lambda x_1\mathbf{G}[x,y,\mathbf{M}(x)] \mid \mathbf{B}y\ \}$			
$\wedge\{\ \vee\{\ \mathbf{G}[x,y,\mathbf{M}(x)] \mid \mathbf{B}y\ \} \mid \mathbf{W}x\ \}$ $\forall x\{\ \mathbf{W}x \rightarrow \exists y(\mathbf{B}y\ \&\ \mathbf{G}[x,y,\mathbf{M}(x)]\ \}$				

a fool +1	REF(+1,–1)	gives	① (–1) her +3	a lottery ticket +2
		$\lambda z_3\lambda y_2\lambda x_1\mathbf{G}xyz$	$\lambda z_{-1}\ \mathbf{M}(z)_3$	$\vee\{\ y_2 \mid \mathbf{T}y\ \}$
	$\lambda x_1(x_1 \times x_{-1})$	$\vee\{\ \lambda z_{-1}\lambda x_1\mathbf{G}[x,y,\mathbf{M}(z)] \mid \mathbf{T}y\ \}$		
$\wedge\{\ x_1 \mid \mathbf{F}x\ \}$	$\vee\{\ \lambda x_1\mathbf{G}[x,y,\mathbf{M}(x)] \mid \mathbf{T}y\ \}$			
$\wedge\{\ \vee\{\ \mathbf{G}[x,y,\mathbf{M}(x)] \mid \mathbf{T}y\ \} \mid \mathbf{F}x\ \}$ $\forall x\{\ \mathbf{F}x \rightarrow \exists y(\mathbf{T}y\ \&\ \mathbf{G}[x,y,\mathbf{M}(x)]\ \}$				

33. Reference and Sloppy Identity

The notion of *referential pronouns* arises in some accounts of pronouns,[56] but does not play a fundamental role in our account. Basically, a referential pronoun is one that denotes an item of type D [a domain element; an entity]. For us:

(1) exophoric pronouns are *always* referential;
(2) duplicative pronouns are *sometimes* referential, but *not always*;
(3) non-duplicative pronouns are *never* referential.

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[55] See Chapter 8 [Indefinite Noun Phrases].
[56] For example, Heim and Kratzer (1998), Chapter 9.

Nevertheless, pragmatically speaking, a pronoun can "find" an entity even without technically denoting it. For example, in the following sentence,

52. Kay respects herself, and so does Elle

the reflexive pronoun ‘herself’ "finds" Kay eventually, and ‘so does’ "finds" Elle eventually.

This apparent mismatch between the first ‘herself’ and the second ‘herself’ prompts the notion of "sloppy identity".[57] A duplicative-pronoun duplicates the *content* of its antecedent, but often there is no issue of *co-reference*, in the usual sense, since neither phrase is *fundamentally* referential. Although such expressions are identical in *denotation*, they are not identical in "reference".

B. Appendix – Summary

1. Overall Classification

1. Exophoric Pronouns
    1. Indexical
    2. Demonstrative
2. Endophoric Pronouns
    1. Duplicative
    2. Alpha (Open)
    3. Reflexive

2. Indexical Pronouns

These pronouns denote *inherent* features of the discourse-context, including speaker (‘I’) and addressee (‘you’).

3. Demonstrative Pronouns

These pronouns denote demonstrated, or otherwise salient, entities in the discourse-context. For encoding we propose to use ‘δ’, if there is just one such entity, and to use ‘δ_1’, ‘δ_2’, etc., if there is more than one such entity.

4. Duplicative Pro-Forms

A duplicative pro-form simply *repeats* the content of its antecedent, which is officially stated in the following global semantic rule.

The semantic-value of a duplicative pro-form is identical to the semantic-value of its antecedent.

In order to indicate duplicative relations, we insert additional markers – circled-numerals – over the relevant phrases.

5. Alpha-Pronouns

Alpha-pronouns are ***essentially-anaphoric*** pronouns.[58] According to our account, alpha-pronouns create alpha-roles. They include third-person pronouns [‘he’, ‘she’, ‘it’, ‘they’], which are rendered as follows.

(α) e	$D_\alpha \rightarrow D$	$\lambda x_\alpha\mathbf{:}x$
α is a negative-integer; e is a third person pronoun; he, she, it, they [+ case]		

[57] For example, Heim and Kratzer (1998), Chapter 9.

[58] In other words, an anaphoric/endophoric pronoun that is not duplicative.

6. Binding

Alpha-pronouns are bound by their antecedents, which accomplish this by being marked by the corresponding role-marking morpheme,

α	$D \rightarrow D_\alpha$	$\lambda x{:}x_\alpha$

which behaves exactly like a case-marking morpheme. Alpha-marked antecedents bind alpha-pronouns by filling the alpha-roles they create, which is done the same way case-marked NPs fill functional-roles – by function-application.

7. Reflexive Pronouns

Reflexive pronouns are a species of alpha-pronouns, but with a twist.

A reflexive pronoun is **directly-anaphoric**, not to an NP, but to a **functional-role**, and is **indirectly-anaphoric** to whatever phrase fills that role; the latter controls agreement features [person, number, gender].

By way of implementation, a reflexive pronoun is combines an alpha-pronoun with a reflexion-operator, the latter being categorially rendered as follows.

REF(θ,α)	$D_\theta \rightarrow (D_\theta \times D_\alpha)$	$\lambda x_\theta(x_\theta \times x_\alpha)$
pronunciation: self, own, null		

The reflexion operator binds an alpha-pronoun (marked α) to a functional-role (encoded by θ).

8. Such That

This phrase is treated as a lexical entry, which categorially acts as special relative pronoun that can only be alpha-marked.

such-that	$D_0 \rightarrow D$	$\lambda x_0{:}x$
admits only alpha-markers (no functional-markers)		

9. Conditionals

Conditionals often arise in conjunction with quantifiers, where they are understood to be domain restrictors. For this purpose we employ conditional-assertion, which is categorially rendered as follows.

if [CA]	$S \rightarrow (S \rightarrow S)$	$\lambda X \lambda Y[Y/X]$

The logic follows Belnap (1972).[59]

$A/B = A$	if	B is true
$A/B = \oslash$	if	B is false

In other words, A/B says A if A is true, but says *nothing whatsoever* if A is false. This is key to the following.

Conditionalization Rule		
Ж{ Ω/Ψ | Φ }	$\vdash$	Ж{ Ω | Φ & Ψ }
Ж is any junction; Φ,Ψ,Ω are formulas.		

[59] Note that Belnap reads slash backwards from us. We follow the order used in conditional-probability.

We also insist that, when associated with a quantifier, ‘if’ is interpreted as conditional-assertion.

> When a conditional is affiliated with a quantifier,[60]
> it serves as a domain-restrictor, which amounts to saying that
> it is interpreted as conditional-assertion.

10. Type-Logical Rules for ×

Many examples in this chapter revolve around the cross-operator ×. In this appendix, we summarize the type-logical principles that govern ×, and we provide a few examples of logical derivations.

First, recall that we have introduced × earlier in connection with polyadic functions such as logical-conjunction. For example, logical conjunction ‘&’ can be analyzed as having type:

$(\mathsf{S}\times\mathsf{S})\rightarrow\mathsf{S}$

It is customary to treat × basically as punctuation, in which case this just means that ‘&’ takes two sentences as arguments and delivers a sentence as output. But we also want types that look thus.

$A\rightarrow(B\times C)$

The easiest way to achieve this is to treat × as a type-forming operator, on a par with →, characterized as follows.[61]

if A and B are types, then $(A\times B)$ is a type.

We also treat × as a syntactic-operator in Loglish, characterized by the following formation rule.

if α has type A, and β has type B, then
$(\alpha\times\beta)$ has type $(A\times B)$

What sort of item is $\alpha\times\beta$? We think of it as an *unordered*-pair consisting of α and β, treated basically as a computational device. If a function requires a pair of arguments, then $\alpha\times\beta$ can perform this duty.

With a wider class of types/items in the syntax of Loglish, expanded lambda-abstraction is even more expanded. For example, the following makes perfectly good sense.

$\lambda(x\times y)\mathbf{R}xy$ $(\mathsf{D}\times\mathsf{D})\rightarrow\mathsf{S}$

This function takes a pair of entities as input and delivers proposition as output.[62] Now, although this is definitely not *identical* to the following

$\lambda x\lambda y\mathbf{R}xy$ $\mathsf{D}\rightarrow(\mathsf{D}\rightarrow\mathsf{S})$

they are nevertheless type-logically equivalent, which is demonstrated as follows, except using case-marked types.

1. Example 1a

$\lambda(x_1\times y_2)\mathbf{R}xy \vdash \lambda x_1\lambda y_2\mathbf{R}xy$

1.	$\lambda(x_1\times y_2)\mathbf{R}xy$	$(\mathsf{D}_1\times\mathsf{D}_2)\rightarrow\mathsf{S}$	1	Pr	
2.	x_1	D_1	2	As	
3.	y_2	D_2	3	As	
4.	$x_1\times y_2$	$\mathsf{D}_1\times\mathsf{D}_2$	23	2,3,×I	
5.	$\mathbf{R}xy$	S	123	1,2,λO	→O
6.	$\lambda y_2\mathbf{R}xy$	$\mathsf{D}_2\rightarrow\mathsf{S}$	12	3,5,λI	→I
7.	$\lambda x_1\lambda y_2\mathbf{R}xy$	$\mathsf{D}_1\rightarrow(\mathsf{D}_2\rightarrow\mathsf{S})$	1	2,6,λI	→I

[60] Affiliation includes subordination, following the original root-meaning of *affiliatus*.
[61] More generally, we treat × as an anadic operator, which takes any number of arguments.
[62] Notice that this similar to, but not identical to, $\lambda xy\mathbf{R}xy$. The latter is more properly thought of as a variant of $\lambda(x\otimes y)\mathbf{R}xy$, where $x\otimes y$ is the ordered-pair of x and y in that order. We see ordered-pairs again in a later chapter [14] in which we discuss cases and states-of-affairs.

2. Example 1b

$\lambda x_1 \lambda y_2 \mathbf{R}xy \vdash \lambda(x_1 \times y_2)\mathbf{R}xy$

1.	$\lambda x_1 \lambda y_2 \mathbf{R}xy$	$D_1 \to (D_2 \to S)$	1	Pr	
2.	$x_1 \times y_2$	$D_1 \times D_2$	2	As	
3.	x_1	D_1	3	As	
4.	y_2	D_2	4	As	
5.	$\lambda y_2 \mathbf{R}xy$	$D_2 \to S$	13	1,3,λO	→O
6.	$\mathbf{R}xy$	S	123	4,5,λO	→O
7.	$\mathbf{R}xy$	S	12	2,3-6,×O	×O
8.	$\lambda(x_1 \times y_2)\mathbf{R}xy$	$(D_1 \times D_2) \to S$	1	2,7,λI	→I

Note that ×-In corresponds to And-In, and ×-Out corresponds to And-Out. However, as usual, resource-tracking complicates the derivation, so the rules are officially given as follows.

×I	α	$\mathcal{A}$	i
	β	$\mathcal{B}$	j
	$\alpha \times \beta$	$\mathcal{A} \times \mathcal{B}$	$i{+}j$

×O	$\alpha \times \beta$	$\mathcal{A} \times \mathcal{B}$	i
	$\alpha\ ;\ \beta \hookrightarrow \gamma$	…	j
	γ	$\mathcal{C}$	$i{+}j$

Here, '$\alpha\ ;\ \beta \hookrightarrow \gamma$' is any sub-derivation of γ from α, β, dependent upon j, which is a sequence of the following form.

α	$\mathcal{A}$	a	As
β	$\mathcal{B}$	b	As
…	…	…	…
γ	$\mathcal{C}$	abj	…

3. Example 2

$\lambda x.x_2\ ;\ \lambda x_1(x_1 \times x) \vdash \lambda x_1(x_1 \times x_2)$

1.	$\lambda x.x_2$	$D \to D_2$	1	Pr
2.	$\lambda x_1(x_1 \times x)$	$D_1 \to (D_1 \times D)$	2	Pr
3.	x_1	D_1	3	As
4.	$x_1 \times x$	$D_1 \times D$	23	2,3,λO
5.	x_1	D_1	4	As
6.	x	D	5	As
7.	x_2	D_2	15	1,6,λO
8.	$x_1 \times x_2$	$D_1 \times D_2$	145	5,6,×I
9.	$x_1 \times x_2$	$D_1 \times D_2$	123	4,5-9,×O
10.	$\lambda x_1(x_1 \times x_2)$	$D_1 \to (D_1 \times D_2)$	12	3,9,λI

4. Example 3

$\lambda y_2 \lambda x_1 \mathbf{R}xy$; $\lambda x_1(x_1 \times x_2) \vdash \lambda x_1 \mathbf{R}xx$

1.	$\lambda y_2 \lambda x_1 \mathbf{R}xy$	$D_2 \to (D_1 \to S)$	1	Pr
2.	$\lambda x_1(x_1 \times x_2)$	$D_1 \to (D_1 \times D_2)$	2	Pr
3.	x_1	D_1	3	As
4.	$x_1 \times x_2$	$D_1 \times D_2$	23	2,3,λO
5.	x_1	D_1	4	As
6.	x_2	D_2	5	As
7.	$\lambda x_1 \mathbf{R}xx$	$D_1 \to S$	15	1,6,λO
8.	$\mathbf{R}xx$	S	145	5,7,λO
9.	$\mathbf{R}xx$	S	123	4,5-8,×O
10.	$\lambda x_1 \mathbf{R}xx$	$D_1 \to S$	12	3,9,λI

5. Example 4

$\mathrm{J}_1 \times \mathrm{J}_{-1}$; $\lambda y_{-1} \lambda x_1 \mathbf{R}[x, \mathrm{M}(y)] \vdash \mathbf{R}[\mathrm{J}, \mathrm{M}(\mathrm{J})]$

(1)	$\mathrm{J}_1 \times \mathrm{J}_{-1}$	$D_1 \times D_{-1}$	1	Pr
(2)	$\lambda y_{-1} \lambda x_1 \mathbf{R}[x, \mathrm{M}(y)]$	$D_{-1} \to (D_1 \to S)$	2	Pr
(3)	J_1	D_1	3	As
(4)	J_{-1}	D_{-1}	4	As
(5)	$\lambda x_1 \mathbf{R}[x, \mathbf{m}(\mathrm{J})]$	$D_1 \to S$	24	2,4,λO
(6)	$\mathbf{R}[\mathrm{J}, \mathbf{m}(\mathrm{J})]$	S	234	3,5,λO
(7)	$\mathbf{R}[\mathrm{J}, \mathbf{m}(\mathrm{J})]$	S	12	1,3-6,×O

Another vital rule is **Function-Multiplication**, which goes as follows.

$\lambda\alpha{:}\beta$	$\mathcal{A} \to \mathcal{B}$	i
$\lambda\alpha{:}\gamma$	$\mathcal{A} \to \mathcal{C}$	j
$\lambda\alpha\ (\beta \times \gamma)$	$\mathcal{A} \to (\mathcal{B} \times \mathcal{C})$	$i{+}j$

This is used repeatedly when applying two different case-markers to an expression, as in the following example.

6. Example 5

$\lambda x.x_1$	$\lambda x.x_{-1}$
$\lambda x(x_1 \times x_{-1})$	

(1)	$\lambda x.x_1$	$D \to D_1$	1	Pr
(2)	$\lambda x.x_{-1}$	$D \to D_{-1}$	2	Pr
(3)	$\lambda x(x_1 \times x_{-1})$	$D \to (D_1 \times D_{-1})$	12	1,2,FM