Pronouns

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1 Pronoun Types and Basic Interpretation

The class of pronouns in English includes expressions like *he, she, it, us, they, her, herself, ourselves, each other, here, there, now, someone, somewhere, this, that* and *these*. It is a closed class of mostly one-word expressions in the category DP or PP (perhaps among others), whose semantic content is limited to basic features such as number, gender and person. Most, if not all, languages have expressions of this type, but no definition of the term will be attempted here, and examples will mostly be drawn from English. We can cross-classify pronouns according to their ontological status — e.g. personal (*you, she, this, someone*), temporal (*now, then, sometimes*), or locative (*here, there, somewhere*) — and their (in)definiteness — *you, she, this, now, then, here, there* etc. versus *someone, somewhere* etc. Definites can be demonstrative (*this, that*) or non-demonstrative, the latter deictic (or indexical: *you, now, here*) or non-deictic (*she, then, there*). Among the definite non-demonstratives, English furthermore distinguishes *reflexive* pronouns (*herself, ourselves*), *non-reflexive* pronouns (*she, her, our*), sometimes called *pronominals*, and *reciprocals* (*each other, one another*).

In what follows we will concentrate on personal pronouns, which have received by far the most attention in the literature; many aspects of the semantics of temporal and locative pronouns will be analogous, but their details will hinge to a large extent on the chosen ontology for temporal and locative expressions in general, which this article will be agnostic about. In this section we will in turn discuss the three major classes indefinite, definite, and demonstrative pronouns. Discussion of reciprocals will be found

in section 4.2 on plural pronouns, reflexives will be treated in section 6 on Binding Theory.

1.1   Indefinite Pronouns

Indefinite pronouns come in several *series* like the English *some-, no-* and *any*-series, with each series having exponents for the major ontological categories, such as English *-one/body, -thing, -where, -how* etc. (Haspelmath, 1997, esp. ch.3). We won't discuss the peculiarities of the *any*-series here (→**73: Negative polarity items and positive polarity items**); the *some-* and *no-* series seem to have the same denotation as the parallel quantified DPs like *some person, no thing* etc. In a generalized quantifier framework, for example (→**46: Quantifiers**), their interpretation would be along the lines of (1a), and their translation into second-order logic like in (1b):

(1)   a.   ⟦someone⟧ = that function from sets of individuals to truth values that maps any set of individuals p to True iff p contains one or more people
       b.   someone $\rightsquigarrow \lambda P_{et}.\exists x_e[person'(x)\&P(x)]$

Since indefinite pronouns can be modified by relative clauses as well as adjectives, it seems plausible to analyze them as a determiner *some/no/any* plus NP *body, one, where*, the latter of which can be modified. The Pron+AP order may then be derived by movement of the N to D:

(2)   a.   nobody I know = [$_{PDP}$ no [$_{NP}$ body [$_{RelCl}$ I know]]]
       b.   someone important = [$_{PDP}$ some [$_{NP}$ [$_{AP}$ important] one]]

Numerous arguments in favor of alternative semantic analyses for indefinite DPs have been put forth in the literature, and these apply to indefinite pronouns to varying degrees. Indefinite pronouns occur as antecedents in donkey sentences (cf. section 2.2.2 below), where they appear to display quantificational variabilty, suggesting they should perhaps be analyzed as containing unbound variables:

(3)   Mostly, if I call someone, they hang up on me.
       'most people who I call hand up on me'

On the other hand, they part ways with lexical indefinite DPs in generic and adverbial sentences: (4a/b) can be paraphrased roughly as 'few/most

people/men have enough time', but no similar interpretation is available for (4c):[1]

(4)   a.   People rarely/usually have enough time.
        b.   A man rarely/usually has enough time.
        c.   Someone rarely/usually has enough time.

Finally, indefinite pronouns seem less prone to wide scope or specific interpretations; (5a) has a reading which is true even if only one specific relative will bequeath a fortune on her, but the same reading seems less available for (5b) with an indefinite, arguing against an analysis of indefinite pronouns in terms of choice functions (Reinhart, 1997; Winter, 1997):

(5)   a.   If some relative of hers dies, she'll inherit a fortune.
        b.   If someone in her family dies, she'll inherit a fortune.

Since the arguments and analyses here entirely parallel those in the discussion of indefinite DPs in general, I refer to reader to →**44: Definiteness and Indefiniteness** for more analytical options regarding the semantics of (the determiner part in) indefinite pronouns.

1.2 Demonstrative pronouns

We briefly discuss here the English singular demonstratives *this* and *that* on their individual-denoting use, ignoring plural demonstratives, and putative locative, temporal or propositional demonstratives; also, many languages show an ostensibly demonstrative use of bare definite articles, e.g. German *der, die, das*. Demonstratives display at least two properties that distinguish them from non-demonstrative pronouns: a proximal/distal specification, and a heightened sensitivity to speakers' exralinguistic demonstrations. To a first, crude approximation, *this/that* are most naturally used when accompanied by a pointing gesture; *this* additionally expresses closeness (in some sense) to the speaker, *that* lack thereof:

(6)   (pointing at a picture on the wall) This is a Picasso.

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[1]Replacing *someone* in (4c) with *one* yields the reading in question; we will not discuss generic pronouns in this article, see Moltmann (2006) and Kratzer (1997).

As Kaplan (1977) famously points out, demomstratives appear to be *directly referential*: (7) is not true even if there is a Pollock painting hanging opposite the Picasso (note that the definite paraphrase in (7) seems true under these circumstances):

(7)   (pointing at a Picasso on the wall) If I were pointing to the opposite wall, this would be a Pollock.
       (can't mean '...the picture I would be pointing to would be a Pollock')

This is reflected in (8), where the referent of the demonstrative is fixed with no regard to the world w of evaluation, but only to the context of utterance (→**Context Dependency**):

(8) $[\![\text{this/that}]\!]^{w,g}$ = the unique proximal/distant object the speaker is actually pointing at at the time of utterance[2]

Several things are worth noting, though: First, the sensitivity to demonstrations is found equally with second, third, and first person plural non-demomstrative pronouns:

(9)   She/they/you/we (pointing at appropriate group) are better at the game than she/they/you/we (pointing at different appropriate group).

Likewise, these appear directly referential in the same way:

(10)   (pointing at a picture of Pollock, which is next to a picture of Picasso) If I were pointing at the next picture, he would be a Spaniard.

One might conclude from this that we generally use demonstrative gestures as a clue to discern speakers' (actual) referential intensions, and that the semantics shouldn't distinguish demonstratives in that regard.

    Second, demonstratives seem to allow for 'special' uses much like ordinary pronouns (examples from Elbourne (2006)):

(11)   a.   (A new faculty member picks up her first paycheck from her mailbox. Waving it in the air, she says to a colleague:) Do most faculty members deposit this in the Credit Union? (*this* = their paycheck)
       b.   Every man who owns a donkey beats that and nothing else.

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[2]Or perhaps intending to demonstrate, cf. Bach (1992); Kaplan (1989).

This in turn suggests that the meaning of demonstratives should include some variable that can be locally, linguistically bound, be it in the form of an index pointing to an individual in the assignment, or a situation variable. The semantic literature on simple demonstratives is rather scarce, but the reader is referred to the rich literature on complex demonstratives, among others Elbourne (2006); King (2001); Roberts (2002)

1.3   Non-Demonstrative Definite Pronouns

Traditional grammars distinguish between the anaphoric, deictic and bound uses of third person definite pronouns:

(12)   a.   Every soprano brought her union card.   (bound)
       b.   Josh met a soprano. He liked her.   (anaphoric)
       c.   (*scenario: A woman walks in.*)
            She must be a soprano.   (deictic)

A bound pronoun acts like a bound individual variable in quantificational logic; crucially, no contextual information is necessary in order to interpret (12a) or the pronouns therein. This is different in the case of anaphoric and deictic pronouns (12b,c), where we need to know the (linguistic or extra-linguistic) context in order to interpret the pronouns.

   Anaphoric uses, however, do not always involve more than one sentence: *her* in (13a) is anaphoric to *Joan* within the same sentence. One might think that (13a) involves a bound pronoun, but note that binding of *her* by a true quantificational DP like *every soprano* is impossible in the structurally identical (13b); thus the relation between *Joan* and *herself* in (13a) must be anaphoric coreference, not binding:

(13)   a.   What the doctor told Joan impressed her.
       b.   What the doctor told every soprano impressed her.
       c.   Claudia forgot her password.

The case in (13c), on the other hand, is less clear, since *her* can be bound by *every soprano* in the structurally parallel (12a); but it could also just corefer with, and hence be anaphoric to, the subject *Claudia* (obviously not an option with *every soprano*, which doesn't refer to begin with). We will return to this issue in section 3.3.

2 The Meaning of Definite Pronouns

2.1 Pronouns as Variable-Like Expressions

2.1.1 Pronouns as Variables

The basic semantics of of personal pronouns is often likened to that of variables in predicate logic. A straightforward implementation of this idea will assume pronouns to be *indexed* with a natural number, and have their interpretation depend on an *assignment function*, i.e. a sequence of, or a function from numbers to, DP meanings. The interpretation rule (14) (where i is a variable over natural numbers, and g a variable over assignment functions) provides a simple illustration:

(14)   for any assignment function g, $[\![[_{\text{pron}} \text{ X }]_{\text{i}}]\!] = g(i)$ ($\approx$ the i-th member of g)

Rule (14) certainly oversimplifies, most clearly in ignoring any lexical content of the pronoun (i.e. gender, person, number), which we will discuss in 4.1, as well as types of pronouns that appear to have meanings more complex than just individuals (see section 2.2). It can serve, however, to explicate the deictic, anaphoric and bound uses of definite pronouns mentioned in 1.3 more formally.

We will discuss bound pronouns in much detail in section 3. In a nutshell, the binder of a pronoun, for example a quantificational DP like *every soprano* in (12a) (*every soprano brought her union card*), can manipulate the assignment function in much the same way the quantifiers $\exists$ and $\forall$ do in quantified logic. The interpretation of a sentence that contains bound pronouns only will thus not, as a whole, depend on the assignment, which plays an ancillary role only: $[\![(12\text{a})]\!]^g$ is the same for any g.

This is different for sentences with non-bound, i.e. anaphoric and deictic pronouns. For example, the second sentence in (12b), *Josh liked her$_i$*, for any assignment g, is true iff Josh liked $g(i)$; which proposition it expresses crucially hinges on g, that is, the assignment here models an essential part of the context. Specifying how this comes about is not part of the semantics of pronouns proper, but we will give some indications in the next subsection ($\rightarrow$**39: Discourse Representation Theory**, $\rightarrow$**40: Dynamic semantics**,

). [3]

2.1.2 Assignments, Discourse, and Saliency

Given what was said so far, a pronoun like *her* can refer to any element in the range of the assignment function, depending on its index. If we want the semantics to model the range of available referents for pronouns, we need to include a theory of how assignments are incrementally 'build' in a discourse.

As a first step, assume that assignment functions are partial, and that their domain reflects the anaphoric options in a given context, i.e. which *discourse referents* (DRs), modelled by indices, are available at a given point in the conversation. A pronoun like her_7, if unbound, will thus only be interpretable in a context that has previously introduced the discourse referent 7 (and only if $g(7)$ is female, see again 4.1 below). Discourse referents can be introduced (i.e. indices can be added to the domain an assignment) in at least two different ways: Linguistically, by the use of full DPs, in particular indefinites, and extralinguistically, by pointing to an object, or simply by virtue of that object becoming salient.

One may wish to go further and model the intuition that, say, *she* can't usually refer to *any* female individual previously introduced, but will refer to the most *salient* one. To do this, the context needs to provide an ordering among the available DRs; since assignments are sequences, a straightforward way of achieving this is to assume that the last element in the assignment is more salient than the one before it, which in turn is more salient than the one before it, etc. Using an indefinite, for example, will serve not only to introduce a new DR, but also to make that DR maximally salient, i.e. put it at the end of the list. Other linguistic devices, say marking a DP as a topic, or referring to an existing DR using a definite description, may yield the same effect, as will pointing to an object etc.

Using assignments in this way allows for a radically different semantics of unbound pronouns, using lexical entries like (15):

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[3] All of this of couse presupposes that all three usus of pronouns — bound, anaphoric and deictic — involve the same semantics for the pronoun (here: that of a variable, (14)). A common alternative view is that pronouns are ambiguous between two or more interpretations for pronouns. Most commonly, a distinction is made between bound pronouns, which are usually treated as variables (or their equivalents in variable-free theories), and deictic pronouns, which are treated differently; anaphoric pronouns are then usually grouped with one or the other of those. We will return to some of these issues in section 2.2.

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(15) $[\![\text{she}]\!]^g$ = the final (=most salient) female individual in the sequence g

A semantics along these lines allows us to eliminate indices on free pronouns. It will, however, need refinements to model cases of genuinely ambiguous pronouns like *she* in (16):

(16)   Norma hates Sally. She criticized her novel.

To allow for either interpretation, one must assume that the first sentence can leave either Norma or Sally as the maximally salient female (to then be referred to by *she*). Furthermore, *her* most naturally picks out that woman *she* doesn't, which would mean that the saliency ordering 'flips' somewhere between *she* and *her*.

   Saliency orderings along these lines have been used to model definite DPs. Thus $[\![\text{the dog}]\!]^g$ denotes the most salient dog under g, $[\![\text{the neighbor's dog}]\!]^g$ the most salient among the neighbor's dogs etc. (e.g. Heusinger, 1997). The view just sketched can thus be straightforwardly adopted to a theory like the one we'll develop in section 2.2 according to which, say, *she* is just a surface rendering of something like *the female person*, picking out, again, the most salient female person under the given assignment.

2.1.3   Pronouns in Variable-Free Semantics

As is well-known, variables and assignment functions are eliminable. Accordingly, it is possible to maintain the general idea that pronouns behave like variables in quantified logic without actually eschewing the formal apparatus of indices and assignments, as is done most prominently in the work of Anna Szabolcsi and Pauline Jacobson. It is important to stress that this question of implementation is independent of the question whether all pronouns should be interpreted uniformly, and in a term-like fashion.

   The key ingredient of a variable-free semantics for pronouns is to treat an expression E containing a free DP pronoun semantically parallel to one that is a function from ordinary DP meanings to the type of meaning E would have without any free pronouns in it. This is achieved in two steps. First, the pronoun itself is interpreted as an identity function, for example the identity function on individuals:

(17) $[\![\text{her}]\!] = \lambda x_e.x$ (defined only if x is female)

Note that this follows the characterization just given: The pronoun denotes

a function from ordinary DP meanings, type e, to ordinary DP meanings, type e. The second step is a propagation mechanism that allows an expression E containing pronouns to combine with any element it could 'normally' combine with (i.e. if E didn't contain free pronouns), while 'bequeathing' its open argument slots onto the resulting expression. For example, *her* in (17) combines with a transitive verb, resulting in a VP meaning like (18):

(18) $[\![\text{likes her}]\!] = \lambda x_e \lambda y_e . y$ likes x (defined only if x is female)

This is a function from DP meanings to 'ordinary' VP meanings, type $\langle e, et \rangle$, the same as that of a transitive verb (indeed this function is almost the same as $[\![\text{likes}]\!]$). The different distributional properties of, say, a transitive verb and a VP with a free pronoun in it, in particular the fact that the expression in (18) cannot combine with two DPs to form a sentence, is logged in the syntactic category of the expression. In Jacobson system, *likes Mary* and *likes* are of the (standard) categories S\NP and (S\NP)/NP, respectively; *likes her*, on the other hand, is of the category (S\NP)$^{\text{NP}}$, i.e. a verb phrase with a free NP pronoun in it (accordingly, the pronoun itself is of category NP$^{\text{NP}}$). Roughly, syntactic combinatorics are 'blind' to superscripts, that is X^Y combines with whatever plain X combines with, while the superscript and the semantic argument position corresponding to it are propagated upwards by function composition.

If an expression contains free, i.e. anaphoric or deictic, pronouns, it will end up being of category X^{NP} or $X^{\text{NP}^{\text{NP}}}$ etc. In particular, a sentence containing a free pronoun will be of category S$^{\text{NP}}$, and denote a function of type $\langle e, t \rangle$. This may seem odd at first but is, as Jacobson points out, entirely parallel to the idea that a sentence denotes a function from assignments to truth values.

Bound pronoun uses are modelled by a rule that 'swallows' a superscript category and identifies its semantic argument with an open 'proper' argument position. (19) gives a very simplified version of such a rule, whose application is illustrated in (20) (| ranges over \ and /):

(19) $[\![\text{z}]\!] = \lambda p_{e, \langle e, \alpha \rangle} \lambda x_e . p(x)(x)$; (X|NP)|(X|NP)$^{\text{NP}}$

(20) a. $[\![\text{likes her cat}]\!] = \lambda z_e \lambda y_e . y$ likes z's cat; (S\NP)$^{\text{NP}}$
      b. $[\![\text{z(likes her cat)}]\!] = [\lambda p_{e, \langle e, \alpha \rangle} \lambda x_e . p(x)(x)](\lambda z_e \lambda y_e . y$ likes z's cat$)$
          (i) $= \lambda x_e . [\lambda z_e \lambda y_e . y$ likes z's cat$](x)(x)$
          (ii) $= \lambda x_e . x$ likes x's cat; S\NP

This must suffice to illustrate the general treatment of pronouns in variable-free semantics. For arguments in favor of a variable treatment and a thorough formal treatment see Jacobson (1999).

2.1.4   Resumptive Pronouns

Gaps corresponding to displaced constituents ('traces') usually receive an interpretation identical to bound pronouns, e.g. as bound variables. The difference between gaps and pronouns, then, is a purely syntactic one (roughly whether there has to be an antecedent, and whether that antecedent can bear its own thematic relation to an element in the clause or not). Given that, the existence of *resumptive* pronouns, i.e. pronouns that occur in the thematic position of a dislocated element (in the position where a trace might be expected) is unproblematic from a semantic point of view.

2.2   Pronouns as Non-Logical Functions

In this subsection we will contrast the 'pronouns as variables' view outlined in the previous subsection with one that essentially assumes pronouns to have the logical form of definite noun phrases, call that the 'pronouns as descriptions' view. To motivate this view, consider the examples in (21):

(21)   a.   I know this woman. She ('this/the woman') is a famous soprano.
       b.   Bill owns some sheep. Harry vaccinates them ('the sheep (Bill owns)').
       c.   This year the president is a Republican, but one fine day, he ('the president') will be a member of the Green party.
       d.   Mary, who deposited her paycheck at the ATM, was smarter than any woman who kept it ('her paycheck') in her purse.
       e.   Every farmer who owned donkeys had Lucy vaccinate them ('the donkeys (he owns)').

(21a/b) involve referential pronouns; while the paraphrase in terms of a definite may be suggestive, there is no obstacle to assuming instead that the pronuns are simply individual variables. This is different in (21c–e). Here, the pronouns aren't referential. Rather, they denote functions: from world/times to the president in/at that world/time; from women to their paychecks; from farmers to the sheep they own. These functions, it seems, are provided by the linguistic context.

And even (21b) is not straightforward on the pronouns-as-variables view, as pointed out in Evans (1980): Plural pronouns anaphoric to quantificational DPs have a 'maximum interpretation'. For example, (21b) is judged false unless Harry vaccinates *all* of Bill's sheep. This follows if we interpret *them* synonymous with *Bill's/the sheep*. A theory that has *them* denote a (plural) individual variable has to employ additional means to ensure that an utterance of *Bill owns some sheep* triggers the introduction of a discourse referent including all the sheep Bill owns, rather than some sub-group thereof (see e.g. Kamp and Reyle, 1993).

2.2.1 Pronouns of Lazyness and Paycheck Pronouns

Historically, pronouns that stand for a literal repetition of a full definite DP, e.g. (21a) and (21c)/(22a), are called *pronouns of lazyness* (Geach, 1962). In case these DPs contain bound pronouns, (21d)/(22b) one often finds the term *paycheck pronouns*; finally pronouns in configurations like (21e), whose content seems 'distilled' from a previous sentence, but that don't have a literal DP antecedent go by the name of 'donkey pronouns' or — especially for those researcers who eschew the pronouns-as-descriptions view — *e-type* pronouns (Evans, 1977, 1980). We will now develop an implementation of the idea that in all of these cases the pronouns are indeed essentially definite descriptions.

For concreteness, let us model these pronouns as *bona fide* definite DPs of the general form *the NP*. Interpreted at world/time w, t, they denote the unique (singular) or maximal (plural) element in the extension of NP at w, t. NP consists of a lexical head, e.g. the nouns *woman, sheep, president, paycheck* plus an appropriate number of unpronounced individual variables (one for *paycheck*, zero for the others). This whole complex DP is spelled out as an appropriate pronoun if the content of N is contextually recoverable:

(22)   a. $[\![$he ~~the president~~$]\!]^{g,w,t}$ = the president at w, t
       b. $[\![$it ~~the paycheck of v_n~~$]\!]^{g,w,t}$ = $g(n)$'s paycheck at w, t
                    (where v_n will be bound by *any woman* in (21d))

Pronouns of lazyness, including paycheck pronouns, then simply involve N(P)-ellipsis under identity; the definite determiner is spelled out as a pronoun if and only if everything in the NP following it is unpronounced. (Alternatively, we could assume with Postal (1970) and Elbourne (2001) that

pronouns *are* definite determiners (with additional feature specifications) followed by ellided NPs.)

2.2.2 Donkey Sentences

Extending the pronouns-as-descriptions approach to donkey pronouns runs into several problems, as pointed out famously in Heim (1982), most vexing among them the *uniqueness problem*: If *he* in (23a) is interpreted as 'the unique man who is in Athens', we wrongly predict (23a) to imply that there is only one man in Athens; likewise, (23b) is predicted to be infelicitous, since its assertion contradicts that there is 'the unique sage plant that (s)he bought':

(23) a. If a man is in Athens, he is not in Rhodes.
      b. Everyone who bought a sage plant here bought eight others along with it.
      c. No father with a teenage son would lend him the car on the weekend.

Similarly, Rooth (1987) points out that (24c) is understood to quantify over all fathers, not just those that have a unique teenage son.

Heim (1982) instead develops an account in keeping with the pronouns-as-variables view, on which these pronouns are bound invidual variables in logical forms like (24) (variables corresponding to pronouns underlined for clarity) ; crucially, adverbial as well as adnominal quantifiers are taken to *unelectively bind* tuples of variables (see →**39: Discourse Representation Theory** and →**40: Dynamic semantics** on how such lfs are built):

(24) a. for all x, if x is a man in Athens, $\underline{x}$ is not in Rhodes.
      b. for all x, y, if x bought y here and y is a sage plant, x bought eight other sage plants along with $\underline{y}$
      c. there are no x, y such that, if x is a man and y is a teenage son of x, x lends $\underline{y}$ the car on the weekend.

Various researchers have argued that the pronouns-as-descriptions view, too, can be modified to handle such cases. For starters, note that (25), where the pronouns have been replaced by definite DPs, provide intuitively accurate paraphrase for the exemples in (23):

(25) a. If a man is in Athens, that man is not in Rhodes.

b. Everyone who bought a sage plant here bought eight others along with that sage plant.

c. No father with a teenage son would lend his son the car on the weekend.

This suggests that the problem lies with the assumption that definite DPs strictly require uniqueness of their referent among the elements in $[\![NP]\!]$. Heim (1990), building on work in Berman (1987), suggests instead that definites in general, and e-type pronouns in particular, refer to the unique element in $[\![NP]\!]$ in a given *situation* ($\rightarrow$**38: Situation semantics**, $\rightarrow$**44: Definiteness and indefiniteness**). Situations are parts of worlds, but crucially contain fewer things than the world they are part of. Take (23a)/(25a): The conditional is interpreted as a universal quantifier over minimal situations described by the antecedent clause, i.e. situations that contain a man in Athens. Crucially, each such minimal situation contains only one man (else it wouldn't be minimal), and now *the man who is in Athens* can refer to the unique man in Athens *in that situation*, cf. (26a); (26b/c) sketch a parallel treatment for (23b)/(25b) and (23c)/(25c):

(26)   a.   for every situation s, if s is a minimal situation containing a man in Athens, then s can be extended to a minmal situation s' containing the unqiue man in Athens in s not being in Rhodes

b.   for every person y and minimal situation s of y buying a sage plant here, there is an extension s' of s in which y buys eight other sage plants along with the unique sage plant he buys in s

c.   for no man x and minimal situation s of x having a teenage son in s is there an extension s' of s in which x lets x's unique son in s borrow the car on the weekend

A necessary assumption of this approach, seen in (26b/c), is that DP quantifiers such as *everyone...* or *no man...* quantify over pairs of individuals and situations. Generally, where the unselective binding approach has quantifiers quantify over n-tuples of individuals, the situation approach uses pair of individuals and situations. On virtually all ontologies for situation semantics, we can find, for every n-tuple of individuals, an appropriate situation that contains only those individuals; on the other hand, for every situation, we can presumably find an appropiate tuple of entities that are unique to it ((23a)/(25a), for example, should more realistically be interpreted as quantfying over occasions of men being in Athens, which can be thought of

as temporally limited situations, or pairs of individuals and time intervals). Thus, the two approaches are more similar (conceptually and empirically) than might appear at first, differing essentially only in how they spell out the notion of what Lewis (1975) calls a *case*.

2.2.3 The Formal Link Problem

Expanding on such situation-based approaches, Elbourne (2001, 2005) argues that the descriptive content of e-type pronouns is indeed poorer than hitherto assumed. For example, the pronoun in (21e) would, in a standard e-type approach be 'the unique donkey he owns in s', where s is a minnimal situation of a farmer owning a donkey. But given such a minimal situation, the simpler description 'the unique donkey in s' would identify the same donkey. Assuming poorer descriptions like that allows Elbourne to argue that *all* descriptive pronouns involve simple NP ellipsis, thereby solving a second problem for e-type approaches to donkey pronouns, called the *problem of the formal link* since Kadmon (1987). The problem can be put as follows: What makes, for example, the meaning 'wife of x' available for the e-type pronoun in (27a), but not (27b), given that neither contains an NP-antecedent meaning 'wife of x'?

(27)   a.   Every man who has a wife should bring her along.
         b. #Every married man should bring her along.

According to Elbourne, the pronoun in (27b) is simply *the wife*, yieding the meaning 'the unique wife in s', where for each man x, s is a minimal situation containing, roughly, x and his wife. But ellipsis of that NP is impossible in (27b) for lack of an NP antecedent (the formal link). Note that this argument would not go through if (27a) would need to be 'the wife of his', which doesn't have an NP antecedent in (27a) either.

2.2.4 Alternative Implementations of the 'Pronouns as Descriptions' View

It seems controversial at present whether all instances of 'non-standard' pronouns, including donkey-pronouns, should be analyzed as definites, or whether other analytical options such as unselective binding should be used as well. But it appears that some kind of descriptive pronouns will be required to model pronouns of lazyness as in (21c) and especially (21d). This

doesn't mean that the very implementation used above has to be used. One may assume, for example, that rather than containing deleted lexical nouns, descriptive pronouns contain a variable over n-ary relations (e.g. Heim and Kratzer, 1998). For example, instead of *the* ~~*paycheck*~~ v_n we'd have *the* $R_m v_n$, where R_m is the m-th variable over relations, which gets assigned the value 'paycheck' ($\lambda x.\lambda y.y$ is a paycheck of x) by the context in question. Assignment functions as part of the context, then, keep track of an inventory of 'nominal relations' that can serve as antecedents to (the N-part inside) descriptive pronouns (see e.g. Rooy, 1997), just as we assumed for individual referents above (including the possibility of ordering them by salience etc.). Going that route, one can also assume that the variable in question is indeed simply a function from e.g. people to (the intension of) their unique paycheck (Cooper, 1979); as a limiting case, instead of *he* ~~*the president*~~ in (21c)/(22a) one then simply has a variable expression he_n that is assigned the function from world/times or situations to the president at that world/time/situation as its value; sample logical forms are given in (28):

(28)   a. $[_{DP}$ the [paycheck v_n]]   NP ellipsis
          b. $[_{DP}$the $[R_m v_n]]$ relational variable
          c. $[_{DP}$ $P_m v_n]$ functional variable

These approaches may be empirically indistinguishable, especially if one spells out the theory of NP ellipsis along the lines of e.g. Merchant (2004), where ellipsis of a constituent α is itself licensed by an operator that requires a silent anaphoric argument; that argument in turn must denote the same as α. So deletion of, say, *paycheck* is licensed by virtue of an operator whose argument is a silent anaphoric pronoun that denotes the meaning of *paycheck* — effectively R from (28b).

2.2.5   Bound Pronouns as Descriptions

Given that descriptive pronouns of some sort seem necessary, is it possible, on the other hand, to give up the idea that definite pronouns are variables ever, and use *only* descriptive pronouns? Referential anaphoric pronouns would simply be pronouns of lazyness, cf. (21a), but what about ordinary bound pronouns, as in (29)?

(29)   Every girl played her trumpet.

There are two ways to achieve a bound pronoun interpretation here: The first uses the idea, introduced above, that *every girl* quantifies over pairs consisting of a girl and a situation, namely for each girl x the minimal situation containing x. *Her* in (29) is then interpreted as 'the unique girl in s', cf. (30a). The second takes the pronoun to be something like 'the ID_n' or 'the girl ID_n', where for any n, $[\![\text{ID}_n]\!]^{w,g} =_{\text{def}} \lambda x.x = g(n)$ (cf. Elbourne, 2005); thus, if n is bound by *every girl*, we get (30b) as the meaning for (29):

(30)   a.   for every girl x and minimal situation s containg girl x, s can be extended to a situation in which x plays the unique trumpet of the unique girl in s

   b.   for every girl x, x played the unique trumpet of the unique y that is (a girl and) identical to x

See Elbourne (2005, 2006) for discussion of these options.

3   Pronoun Binding

In this section we discuss a particular implementation of the semantics and syntax of pronoun binding. For concreteness, we adopt the 'pronouns as variables' view, but *mutatis mutandis*, our discussion carries over to variable free treatments, as well as either of the adoptions of the 'pronouns as description' view to bound pronouns sketched in 2.2.5 above.

3.1   Bound v. Free Pronouns

The clearest examples of bound pronouns are pronouns whose antecedents are non-referring expressions such as *no one, every stork, fewer than two sopranos* etc.:

(31)   No soprano forgot her hat.

To achieve binding of *her* (by assumption an individual variable) by *no soprano*, we introduce a binding operator β, defined in (32), closely modelled on the z-operator from section 2.1.3, which binds any free occurrence of pronouns with a given index to the next open argument of a function. A logical form and derivation for (31) is then as in (33):

(32) $[\![\beta_i\ \alpha]\!] =_{\text{def}} \lambda x_e.[\![\alpha]\!]^{g[i \to x]}(x)$

(33) a.   [[no soprano] [β_2 [forgot [her$_2$ hat]]]]
      b.   (i) $\llbracket \text{forgot her}_2 \text{ hat} \rrbracket^g = \lambda y_e.y \text{ forgot } g(2)\text{'s hat}$
            (ii) $\llbracket \beta_2 \text{ [forgot her}_2 \text{ hat]} \rrbracket^g = \lambda x_e.\llbracket \text{forgot her}_2 \text{ hat} \rrbracket^{g[2\rightarrow x]}(x)$
                  $= \quad \lambda x_e.[\lambda y_e.y \text{ forgot } g[2 \rightarrow x](2)\text{'s hat}](x)$
                  $= \quad \lambda x_e.x \text{ forgot } g[2 \rightarrow x](2)\text{'s hat}$
                  $= \quad \lambda x_e.x \text{ forgot } x\text{'s hat}$

3.2 Structural Conditions on Pronoun Binding

Rule (32) above imposes a structural condition on the binder–bindee rela-
tion: the bindee must be contained in the sister constituent to the binder;
if this isn't the case, β applies vacuously. This corresponds to the syntactic
condition that a binder must *c-command* its bindee.[4]

   There are two empirical generalizations we may try to tie to this c-
command requirement. First, the *scope generalization*: the putative binder
has to be able to take scope over the pronoun position. Take (34): *every man*
in (34a) can't scope over *a schnapps* (which would yield as many schnappses
for us as there were men who left); unsurprisingly *him* in (34b) can't be
bound by *every man* either:

(34) a.   Once every man left we talked drank a schnapps.
      b.   Once *every man* left we talked about *him*.

But secondly, there are examples in which the putative binder clearly *can*
take scope over the position in question, yet is unable to bind a pronoun
therein; (35a) can describe a scenario in which there are as many pictures as
there are desks, but (35b) can't mean that each picture showed the owner of
the desk it was standing on:

(35) a.   A picture was standing on every desk.
            for every desk x, there is a picture y standing on x
      b.   A picture of *its* owner was standing on *every desk*.
            not: for every desk x, there is a picture of x's owner on x

It seems, then, that scoping over a pronoun's position is a necessary, but
not a sufficient condition for binding that pronoun. In addition, the binder
apparently has to sit in the position where it receives it's thematic role.

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[4]α c-commands β if every node that dominates α dominates β, α doesn't dominate β
and α isn't the root of the phrase marker.

Call this the *a(rgument)-command generalization*; for example, the adjunct DP *every desk* in (35) can scope over the matrix subject (say via a covert movement step to a scope position), but it is unable to bind into the subject from that (non-thematic) position.

Wh-movement patterns analogously: Even within its overt c-command domain a *wh*-expression can only bind pronouns in positions lower than its original thematic position (the so-called *weak cross-over effect*:

(36)   a.   *Who* did you tell that *he* won?
                for which x is it true that you told x that x won?
    b.   *Who* did *his father* tell that Mary won?
                not: for which x is it true that x's father told x that Mary won?

Assuming the generalization to be correct, the c-command requirement on binding imposed by the semantics of β in (32) is too lenient. We need to stipulate in addition that β cannot be adjoined to positions that are created by *wh*-movement or covert scoping movement; it can only apply to lexical predicates (cf. again the *z*-rule in 2.1.3, as well as Büring (2004) and (Büring, 2005a, ch.4)).

There are, however, notorious counter-examples to the a-command requirement, such as *binding out of DP* and binding by an object into an adjunct (often collectively called *indirect binding*):

(37)   a.   *Whose* mother loves *him*?
    b.   *Every senator*'s portrait was on *his* desk.
    c.   Somebody from *every city* despises *it/its*
    d.   We will drink *no wine* before *its* time.

In keeping with the scope generalization, the binders in (37) can take semantic scope over the pronoun positions: in (38) for example, an indefinite in the place of the pronoun in (37b) takes scope below the universal (there are as many glasses of schnapps as there are senators):

(38)   Every senator's portrait sat next to a glass of schnapps.

But clearly, *every senator* in (37b) receives its thematic role within the subject DP, from where — according to the a-command generalization — it shouldn't be able to bind the pronoun.

    Analyzing these examples then involves two steps: First, let the binders

scope over the pronoun position, presumably by whatever scoping mechanisms one employs in (35a). Second, explain why such scoping results in a configuration that allows binding, unlike in (35b). This has been done in at least three different ways in the literature: First, by refining the definition of a position from which binding is possible (the a-command condition) to include derived scope positions of the kind found in (37), but not (35b) (Barker and chieh Shan, 2005; Higginbotham, 1983; May, 1988). Second, by replacing the c-command condition by one that allows the QDPs in (37) to bind from their surface, thematic position (Hornstein, 1995). And third, by assuming that there is no binding relation between the QDP and the pronoun, but rather that the pronoun is an e-type pronoun whose argument is bound by the DP that c-commands the pronoun; (37c) for example, would get be analyzed roughly as (39) (see Büring, 2004, for details):

(39)   for every city x, some person y from x despises [it ~~the city (y is from)~~]

3.3 Binding v. Coreference

In section 1.3 we asked whether the relation between *Claudia* and *her* in (13c), repeated here, is binding, or mere coreference; we can now spell these options out as in (40a/b):

(40)   *Claudia* knows *her* password.
     a. Claudia β_2 [knows her$_2$ password]   (binding)
     b. Claudia knows her$_2$ password   (coref.: $g(2)$ = Claudia)

(40a) and (40b) yield the same truth conditions. But in other cases, the two readings can be teased apart, for example by making the antecedent an associated focus (here and henceforth I will write e.g. *her$_{2=Claudia}$* to abbreviate that 2 is a free index which is assigned the value Claudia by the assignment function):

(41)   I only want CLAUdia$_F$ to know her password.
     a. I only want Claudia$_F$ β_2 [to know her$_2$ password]   (binding)
           'C. should know her own password, no one else should know theirs.'
     b. I only want Claudia$_F$ to know her$_{2=Claudia}$ password (coreference)
           'Claudia's password should be known to Claudia only.'

If *her* is bound to *Claudia* as in (41a), it will co-vary with the focus alternatives to Claudia, yielding the meaning paraphrased. If pronoun and name merely corefer, as in (41b), the pronoun's referent is constant for all focus alternatives, as indicated in the second paraphrase. Clearly, these two readings are truth-conditionally different. Since both readings are available for sentence (41), we can conclude that both binding and coreference are possible between names (indeed all referring DPs) and pronouns anaphorically related to them.

It has been argued, however, that *ceteris paribus*, binding is preferred over coreference, or more precisely, that configuration (42a) is preferred over (42b) if the resulting interpretation is the same:[5]

(42)   Binding is Preferred:
       (42b) is ungrammatical ('blocked') if (42a) yields the same interpretation.[6]

    a.   ... DP'$_i$ β_j ... DP$_j$
    b.   ... DP'$_i$ ... DP$_i$

But how can we know which of two semantically equivalent representations an unambiguous sentence has? At least two phenomena have been argued to be probes into this question: Reinhart (1983), and following her Heim (1993), argue that Binding Condition violations (see section 6 below) occur only with binding, not coreference. For example, (43) is acceptable despite what appears to be a Condition B violation, but only on a reading where *him* corefers with *John* (LF (43a)), rather than being bound by it:

(43)   (Not many people voted for John. In fact,) only JOHN voted for him.

    a.   only John$_F$ voted for him$_{1=John}$
        'no one but John voted for John'
    b. *only John$_F$ β_1 voted for him$_1$
        'no one but John voted for themselves'

This suggests, the argument goes on, that Binding Condition B ignores the coreferent construal in (43a), but renders ungrammatical the local binding

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[5]Note that DP' may itself be bound by a higher DP", in which case the relation between DP' and DP in (42b) wouldn't be one of coreference, but of 'co-binding'. The claim is that coreference as well as co-binding are 'blocked' wherever binding as in (42a) is possible.

[6]This formulation is vague in various ways, see Büring (2005b) for a more precise statement and discussion.

in (43b). But if coreference can 'circumvent' Binding Conditions, how come sentences with two referring DPs ever violate them? Why, that is, is (44) ungrammatical (with ⟦him⟧ =John), if LF (44b) is not in violation of Binding Condition B?

(44) *John voted for *him*.

    a. *John β_1 voted for him$_1$

    b. *John voted for him$_{1=\text{John}}$

The answer Reinhart and Heim suggests is that (44a), an instance of (42a), binding, blocks, and thereby renders ungrammatical, (44b), an instance of (42b), coreference (since both have identical interpretations). And (44a) in turn is ruled out as a Condition B violation (see Büring, 2005b, for detailed discussion of this argument).

    The second argument for something like (42) comes from the discussion of 'Dahl's puzzle' in (Fox, 2000, ch.4). It is based on the the premise that sloppy identity in VP-ellipsis requires 'parallelism' in binding. Thus *his* in the elided VP in (45) can be bound by *Bob* (yielding the sloppy reading) because the corresponding *his* in the antecedent is bound by the corresponding subject *John*:

(45) John said his name, and Bob did ~~say his name~~, too.

Dahl's puzzle goes like this: Why can't (46) report the following two statements: John: 'I'll pay for my drinks'; Bill: 'John will pay for my drinks, too'?

(46) John says he will pay for his drinks. Bill does, too.

To get to this reading, we would need the following LF:

(47) John β_1 says he$_1$ will pay for his$_1$ drinks.

              Bill β_3 does ~~say that he$_{2=\text{John}}$ will pay for his$_3$ drinks~~, too

His$_3$ is bound, sloppily as it were, to *Bill*, which, by assumption, requires *his$_1$* to be bound in structurally parallel fashion by *John*. But that means that *he$_1$* and *his$_1$* in the first conjunct are co-bound (by *John*), an instance of (42b), illegitimately so, since the same interpretation could have been achieved by *he$_1$* binding *his$_1$* as in (48), an instance of (42a).

	SINGULAR	PLURAL	DUAL	PAUCAL
1st exclusive	yau	´eimami	´eirau	´eitou
1st inclusive	—	´eta	´eetaru	´etatou
2nd	i´o	´emunuu	´emudrau	´emudou
3rd	´ea	(i)ra	(i)rau	(i)ratou

Table 1: Boumaa Fijian cardinal pronouns (Dixon, 1988, pp.54f)

(48)   John β_1 says he$_1$ β_2 will pay for his$_2$ drinks

Since (48) is the only proper LF for the first conjunction (47), parallelism makes it impossible for *his* in the second conjunct of (47)/(48) to be directly bound to *Bill*, explaining Dahl's puzzle (cf. Fox, 2000; Büring, 2005b).

4   Pronominal Content

4.1   Semantic Features on Pronouns

The most common semantic information encoded in pronouns are person, number, and gender or class. Generally, this information does not contribute to the assertive or at-issue content of an utterance: If I point to a boy saying *If she is in your class, she's skipping school right now*, what I am saying is not true — or false, for that matter — but infelicitous. This can be modelled by making features like human, male, singular etc. presuppositions of pronouns:

(49) $[\![\text{she}_i]\!]^g = g(i)$ if $g(i)$ is a singular female, undefined otherwise

An utterance of a sentence containing a free occurrence of *she$_7$*, then, will only be defined if the context provides an assignment function that maps 7 onto a single female individual.

Which values the features person, number and gender/class can take is differs from language to language. For example, besides the familiar singular and plural, Boumaa Fijian has *dual* pronouns (denoting groups of two) as well as *paucals* (groups of more than two, but not many), cf. table 1.

Since the number of properties expressed by pronouns cross-linguistically is limited, we can think of them as privative syntactic features as in (50), given with their obvious interpretations:

(50)   a. $[\![[\text{SINGULAR}]]\!] = \lambda x_e.x$ is an atomic individual

b. $[\![\text{FEMININE}]\!] = \lambda x_e.x$ is female
c. $[\![\text{1ST}]\!] = \lambda x_e.x$ is (a group containing) the speaker
d. $[\![\text{2ND}]\!] = \lambda x_e.x$ is (a group containing) the addressee

On the 'pronouns as variables' view, the interpretation of a pronoun is now as in (51a); (51b) does the same for a variable-free system; on the 'pronouns as descriptions view', we can simply assume that these features are adjoin to the elided NP as in (52):

(51) Let α be a definite pronoun with index i and features F_1 through F_n, then for all assignments g

a. $[\![\alpha]\!]^g = g(i)$ if $g(i) \in [\![F_1]\!] \ldots [\![F_n]\!]$, undefined otherwise
b. $[\![\alpha]\!] = \lambda x.x$, if $x \in [\![F_1]\!] \ldots [\![F_n]\!]$, undefined otherwise

(52) $[_{\text{DP}} \text{ pron }] = [\text{ the } [F_1 [\ldots [F_n \text{ NP }]]]]$

Pronoun types such as the inclusive first person plural (referring to a group containing (at least) speaker and addressee) can be modelled by combining more basic features, e.g. [1st] and [2nd]. Other pronoun types, such as *logophoric pronouns* may require additional refinements of this machinery ($\rightarrow$**70: Logophoricity**).

The inventory of features necessary also depends on theoretical choices. It has, for example, been argued that certain unmarked properties, for example masculine, 3rd, and plural should not be represented by features in their own right, but rather just as the absence of other features, i.e. the pronoun *they* would simply be completely unspecified. The grammar then imposes a requirement that any referent be referred to by an expression that is as semantically specific as possible, leaving third person plural as the default for which there are no features. This might also explain why, for example, such less specified forms can be used to avoid, say, gender specification, as in *no one brought their homework*.

It has been observed, though, that sometimes grammar appears to 'ignore' features even on more specific pronoun forms. For example, (53) has a natural reading on which it entails that other people did their own homeworks (not the speaker's) (I. Heim, unpubl. notes; discussed e.g. in Rullman, 2004):

(53) Even I did my homework.

In other words, (53) asserts that the property denoted by β_i *did my$_i$ homework* applies to individuals that are not the speaker. But if the pronoun

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my_i is defined only if $g(i)$ is or includes the speaker, this reading should be impossible. This dilemma could be avoided if we assume that features on bound pronoun aren't interpreted, but simply grammatically inherited from the antecedent (i.e. the pronoun is a *bona fide* unrestricted variable). Of course, since features evidently *are* interpreted on free pronouns (anaphoric as well as deictic), we'd have to say that features are interpreted as indicated above on free pronouns, but can be semantically inert on bound pronouns.

4.2 Plural Pronouns

So far we assumed the denotation of a plural pronoun to be the same as that of a plural name like *the Kennedies* or plural definite DP *the boxes*. Concretely, all of these denote plural individuals, or pluralities, for short, which are themselves in the domain of individuals (type e; →**50: Mass nouns and plurals**). The assignment function then has to assign a plurality to the index i on a plural pronoun, lest the presupposition encoded by the feature [PLURAL] be violated.

Looking at bound plural pronouns, however, we find cases in which a plural pronoun can have *split antecedents* (P. Schlenker p.c.; Rullman, 2004; Büring, 2005a, sec.9.3.3):

(54)   *Every boy* has asked *some girls* if *they* could go out on a date.

The reading we are interested in here is one were each boy asked some girl: 'Can the two of us go out on a date?' To represent this reading we have to allow for the pronoun *they* to be bound simultaneously by *every boy* and *some girl*. An LF that expresses this reading is given in (55), assuming a rule like (56) to replace (14):

(55)   every boy [β_1 has asked some girl β_2 [if they$_{1,2}$ could go on out on a date]]

(56) $[\![\text{they}_{i,j,\ldots n}]\!]^g$ = the smallest group $X \in D_e$ s.t. $g(i), g(j), \ldots g(n)$ are all (possibly improper) parts of X

At an extreme, (56) allows for a pronoun to bear a distinct index for every atomic individual that is part of the pronoun's denotation, but nothing requires this; a plural pronoun can also bear a single index, as before, which is then mapped onto a group of arbitrary cardinality, or any combination of 'singular' and 'plural' indices.

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5 Reciprocal Pronouns

A particular exotic subcase of plural pronouns are *reciprocals*. The truth condition for a simple reciprocal sentence are easily stated:

(57) $[\![A \text{ and } B \text{ R-ed each other}]\!] = 1$ iff $[\![R]\!]\, ([\![A]\!])([\![B]\!])$ and $[\![R]\!]\, ([\![B]\!])([\![A]\!])$

But what meaning to assign to *each other* to derive (57)? And how does this recipe generalize to cases of more than two? Starting with the second question, *strong reciprocity* seems an appropriate generalization in cases such as (58) ($\sqsubseteq_A$ stands for 'be an atomic part of'; recall that we treat pluralities as individuals, not sets of individuals):

(58)   The suspects knew each other.
        'each suspect knows all the other suspects, and is known by them'
        $\forall x, y \sqsubseteq_A X[x \neq y \rightarrow R(y)(x)]$ \hfill (strong reciprocity)

But weaker notions such as *weak reciprocity* and *chaining* seem to be required in other instances:

(59)   The contestants killed each other.
        'each killed one of the others, and was killed by one of them'
        $\forall x \sqsubseteq_A X, \exists y, z \sqsubseteq_A X[y, z \neq x \wedge R(y)(x) \wedge R(x)(z)]$(weak reciprocity)

(60)   The children followed each other into the room.
        'each child follows, or is followed by, one of the other children'
        $\forall x \sqsubseteq_A X, \exists y \sqsubseteq_A X[y \neq x \wedge [R(y)(x) \vee R(x)(y)]]$ \hfill (chaining)

While these notions of reciprocity become successively weaker, it seems problematic to just find the weakest meaning and assume that to be the meaning of reciprocal sentences. For example (59) seems intuitively false if among suspects A–D, A knows B, B knows C, C knows D, but no one else knows anyone (a possible chaining scenario); similarly if A and B know each other, as do C and D, and no one else (a weak reciprocity scenario). This leads Dalrymple et al. (1998) to the *Strongest Meaning Hypothesis*: Each reciprocal sentence has to be interpreted using the strongest reciprocal relation applicable in its case. What constitutes the set of applicable relations, though, is unclear. Why, for example, do we judge *These two women gave birth to each other* to be false if said of a mother-daughter pair, although they meet chaining, and biologically, no stronger reciprocal relation could possibly hold

between them?

Turning to the first question above, the easiest way to think of the meaning of the reciprocal itself is as a function that maps a relation onto a property of (plural) individuals. This is illustrated (for the case of strong reciprocity) in (61):

(61) $[\![\text{R each other}]\!] = \lambda X_e.\forall x, y \sqsubseteq_A X[x \neq y \rightarrow R(y)(x)]$

However, *each other* does not always apply locally to a relation, as for example if it occurs within a complex DP, (62a), or with a long-distance antecedent as in (62b):[7]

(62) a. They read each other's biographies.
      b. Fred and Sarah are convinced that they can beat each other.

The predicates corresponding to R in (61) in these cases are (63a/b), respectively:

(63) a. $\lambda x \lambda y.y$ read x's bibliography
      b. $\lambda x \lambda y.y$ is convinced that y can beat x

But neither of these correspond to a constituent that would likely be the sister of *each other*.

If we instead try to interpret *each other* as a term, we have to give it two indices, which are bound to the plural antecedent (the *range*) and the distributed part of it (the *contrast*), respectively:

(64) $[\![\text{each other}_{r,c}]\!]^g$ = the biggest plurality X such that X is a part of $g(r)$ and $g(c)$ is not a part of X; defined only if $g(c)$ is a part of $g(r)$

For any assignment g, any two pluralities $X = g(r)$ and $Y = g(c)$, *each other*$_{r,c}$, if defined, will denote X-Y, i.e. those X that are not part of Y. (65) gives representative LFs for some reciprocal sentences, using a silent *each*, which we call DIST, defined in (66):

(65) a. the suspects β_1 [DIST [β_2 [knew each other$_{1,2}$]]]

---

[7]One may think that the antecedent for *each other* in (62b) should be *they* rather than *Fred and Sarah*, but inspection of the truth conditions shows that *they* denotes an atomic individual here, hence cannot antecede *each other* (Heim et al., 1991).

b. Fred and Sarah β_1 [DIST[β_2 [are convinced that they$_2$ can beat each other$_{1,2}$]]]

(66) $[\![\text{DIST}]\!] = \lambda P_{e,t}.\lambda X_e.\forall x \sqsubseteq_A X.P(x)$

If we want to capture weaker reciprocities along these lines, further refinements are required, see e.g. Schwarzschild (1996).

6   Binding Theory

As mentioned at the beginning of this article, pronouns come in different varieties such as reflexive and non-reflexive. Usually these morphological classes are subject to *binding conditions*; that is, for each morphological class, the grammar may specify whether its elements have to be be bound, or must not be bound, and if so, within which structural domain.

The literature both on the finer points of the English system as well as on binding systems crosslinguistically is huge (see Dalrymple, 1993; Koster and Reuland, 1992; Huang, 2000; Büring, 2005a, for overviews and references). Most of these proposals use syntactic conditions that filter out certain configuration of indices on pronouns, e.g. the classical 'ABC' of binding in Chomsky (1981), roughly paraphrased in (67) (where 'bound' means 'be coindexed with a c-commanding DP'):

(67)   Binding Conditions A–C
   A   A reflexive or reciprocal pronoun ('anaphor') must be bound within the smallest clause containing it
   B   A non-reflexive pronouns ('pronominal') must not be bound within the smallest clause containing it
   C   A non-pronominal DP must not be bound at all.

Some languages don't have separate reflexive and non-reflexive pronouns, while many others have more pronoun classes than just these two, and the binding conditions associated with these can be considerably more complex. In particular, one and the same class can have more than one condition (for example that it be free within one domain, but bound within the other), and members of two or more classes can have overlapping distribution.

Apart from purely syntactic approaches to binding theory, which won't be discussed any further here, there are attempts to derive binding conditions

semantically. A common idea is that reflexive pronouns are simply functions from transitive relations to intransitives, as in (68):

(68) $[\![\text{herself}]\!] = \lambda R_{e,et}.\lambda x.R(x)(x)$, defined only if x is female

Without further ado (and in particular without the use of indices), this lexical entry derives that reflexives must be locally 'bound' by the next higher co-argument. By the same token, however, it requires modification in all cases where the antecedent to the reflexive can be any one of its higher coarguments, or not a coargument at all:

(69)   a.   Gilbert$_1$ told Spencer$_2$ about himself$_{1/2}$.
        b.   Fritz lässt mich für sich   arbeiten.   (German)
              F.   lets   me   for SELF work
              'Fritz has me work for him.' (lit. 'for himself')

The ban on locally bound non-reflexive pronouns can be explained by a preference principle that forces the use of the reflexive wherever possible. Alternatively, Jacobson (2007) proposes that predicates are irreflexivized whenever they combine with a pronoun. The irreflexivizing operation is given in (70):

(70)   for any two-place predicate R, $\textsc{Irr}(R) =_{def} \lambda x.\lambda y.R(x)(y)$, defined only if $x \neq y$

By assumption, the syntactic category of pronouns is different from that of regular NPs, e.g. NP[p] instead of NP. For a predicate to syntactically combine with a pronoun, it has to undergo a rule that shifts it from, say, category (S\NP)/NP to (S\NP)/NP[p]; the semantics of that rule in turn applies $\textsc{Irr}$ to the meaning of the predicate. Hence coreference between the two arguments results in presupposition failure. Note that this result holds regardless of whether the subject actually binds the object or just corefers with it, preempting any need to force binding over coreference in order to enforce binding conditions (as per section 3.3 above).

   A different semantic implementation of binding theory is presented in Schlenker (2005). Schlenker assumes that assignment functions, conceived of as sequences of individuals, are subject to 'Non-Redundancy': An individual can occur at most once in a given sequence. In interpreting a sentence top down, sequences grow longer; in particular, each referring DP adds its referent r to the end of the sequence s (symbolized as $s + r$):

(71)   If α is a non-pronominal referential DP, $[\![\alpha\ \beta]\!]^s =_{\text{def}} [\![\beta]\!]^{s+[\![\alpha]\!]^s}$

e.g. $[\![\text{John}\ \beta]\!]^s = [\![\beta]\!]^{s+[\![John]\!]^s} = [\![\beta]\!]^{s+John}$

(71), combined with Non-Redundancy yields binding condition C: If α is c-commanded by a coreferential DP, the referent r of DP has been added to the sequence s under which α is interpreted; by (71), α appends r to s, yielding a new sequence s' in which r occurs twice, in violation of non-redundancy.

Pronouns, on the other hand, serve exactly the purpose of retrieving a pre-existing referent from a sequence s. Bound pronouns are given negative indices $-n$, which instruct the interpretation procedure to remove the n-th element counting from the end of the current sequence and appending it to the end of the sequence. This is illustrated for one particular sequence s in (72) (# marks the original position of that element, for reasons that need not concern us yet):

(72) $[\![\text{she}_{-2}\ \beta]\!]^{Bob+Sally+Sue+Tom} = [\![\beta]\!]^{Bob+Sally+\#+Tom+Sue}$

It follows that negatively indexed pronouns are the only way to get coreference with a c-commanding expressions. It follows, too, that there can be no such thing as a pronoun that is coreferent with, rather than bound by, a c-commanding DP; in other words, the preference for binding over coreference, expressed in (42) above, is derived.

Note that neither (71) nor (72) seem to use the interpretation of the DP (α/*John*/*she*) other than appending its referent to the sequence under which its sister is interpreted. This is so because any n-place predicate R is automatically interpreted relative to the n last elements of the sequence (which, by (71) are the referents of the last n DPs that minimally c-command R), as illustrated in (73) (where for any n-place predicate p, p' stands for the extension of α, i.e. a set of n-tuples):

(73)   a. $[\![\text{run}]\!]^{Bob+Sally+Sue+Tom} = 1$ iff run$'$(Tom)$=1$
        b. $[\![\text{see}]\!]^{Bob+Sally+Sue+Tom} = 1$ iff see$'$(Sue,Tom)$=1$

(74)   a. $[\![\text{Steve ran}]\!]^{Bob+Sally} = [\![\text{ran}]\!]^{Bob+Sally+[\![Steve]\!]^{Bob+Sally}}$
              $= [\![\text{ran}]\!]^{Bob+Sally+Steve}$
              $= \text{ran}'(\text{Steve})$
        b.   (Steve told Mary that) $[\![\text{he}_{-2}\ \text{ran}]\!]^{Steve+Mary}$
              $= [\![\text{ran}]\!]^{\#+Mary+Steve} = \text{ran}'(\text{Steve})$

Since, say, two-place predicates take the last two elements of the evaluation

sequence as their arguments, and sequences are subject to non-redundancy, it is impossible to express reflexive statements given what we've said so far (note that e.g. *John praised him$_{-1}$* would yield the interpretation praised$'$(#,John), which by assumption is undefined); we thus have an overly strongly 'generalized' version of binding condition B: no predicate can have two identical arguments. Essentially like in the approaches to reflexives discussed above, then, reflexive pronouns serve to reflexivize a predicate by reducing its arity, sketched in (75):

(75) $[\![$John recommended himself$]\!]$ = $[\![$recommended himself$]\!]^{John}$
       = SELF(recommended$'$)(John) = recommended$'$(John)(John)

With these sketchy and exemplary illustrations we end our overview of semantic approaches to binding theory. Note that these approaches to conditions A and B all crucially equate the domain in question with some variant of the coargument domain of a given predicate (as do several more syntactic approaches such as Pollard and Sag (1992) and Reinhart and Reuland (1993)). It seems fair to say, then, that the more intricate facts about the reflexive/non-reflexive distribution in less canonical argument positions such as inside DPs, in clause-sharing constructions such as ECM, and as complements to prepositions, in English and cross-linguistically, pose the strongest challenge to a comprehensive development of such semantic approaches.

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